Comment ID	From Page	From Line	To Page	To Line	Comment	Response
42520	0	0	0	0	There is some redunancy between sections about glaciers. I would recommend that one author take the lead on these sections to ensure redundancy (e.g. sensitive indicators of climate) is removed and introducted in a single place. As I specified for Chapter 8 I think that both chapters needs a bit of better integration about the glacier system and which processes (e.g. changes in albedo) are not well understood for future projections. Also, I would propose that authors consider a simple figure (or Box similar to the one described about sea level) to describe aspects about glaciers that readers need to know (terminolog and/or key processes). For example, both chapters describe 'peak water' but the term is never described in detail. Consider a illustration to show elements of an alpine glacier (land or water-terminating), elevation, rise of snowline, changes and firna area/albedo and also components of glacier runoff (seasonal ice melt vs. ice wastage). [Brian Menounos, Canada]	There is some redunancy between sections about glaciers. I would recommend that one author take the lead on these sections to ensure redundancy (e.g. sensitive indicators of climate) is removed and introducted in a single place. As I specified for Chapter 8 I think that both chapters needs a bit of better integration about the glacier system and which processes (e.g. changes in albedo) are not well understood for future projections. Also, I would propose that authors consider a simple figure (or Box similar to the one described about sea level) to describe aspects about glaciers that readers need to know (terminolog and/or key processes). For example, both chapters describe 'peak water' but the term is never described in detail. Consider a illustration to show elements of an alpine glacier (land or water-terminating), elevation, rise of snowline, changes and firna area/albedo and also components of glacier runoff (seasonal ice melt vs. ice wastage).
7528	0	0	0	0	The chapter could perhaps benefit from being clearer about which aspects/parameters we should not trust the model projections since most models fail to adequately represent the necessary processes, e.g. lower limb of AMOC due to overflows, Antarctic bottom water formation and associated stratification, shelf-seas, etc [Patrick Hyder, United Kingdom (of Great Britain and Northern Ireland)]	The chapter could perhaps benefit from being clearer about which aspects/parameters we should not trust the model projections since most models fail to adequately represent the necessary processes, e.g. lower limb of AMOC due to overflows, Antarctic bottom water formation and associated stratification, shelf-seas, etc
7570	0	0	0	0	Comment: Perhaps by necessity, the chapter sections appear to vary quite a bit in terms of the level of technical detail that is that is included? [Patrick Hyder, United Kingdom (of Great Britain and Northern Ireland)]	Comment: Perhaps by necessity, the chapter sections appear to vary quite a bit in terms of the level of technical detail that is that is included?
48030	0	0	0	0	Scoping Outline Check: All bullets from approved outline are covered in the first order draft (with CMIP6 results pending). [WGI TSU, France]	Scoping Outline Check: All bullets from approved outline are covered in the first order draft (with CMIP6 results pending).
28840	0	0	0	0	Very clear and original chapter, I liked the ES format a lot and clear structure. The cross chapter box on the energy budget nicely integrates with Chapter 7 [Piers Piers Forster, United Kingdom (of Great Britain and Northern Ireland)]	Very clear and original chapter, I liked the ES format a lot and clear structure. The cross chapter box on the energy budget nicely integrates with Chapter 7
48046	0	0	0	0	Please check the correct use of IPCC Confidence/Uncertainty language. In some cases some assessment arguments are provided with uncertainty language without a discussion of the results of cited papers. Please refer to the IPCC guidance note on uncertainty: https://wg1.ipcc.ch/SR/documents/ar5_uncertainty-guidance-note.pdf [WGI TSU, France]	Please check the correct use of IPCC Confidence/Uncertainty language. In some cases some assessment arguments are provided with uncertainty language without a discussion of the results of cited papers. Please refer to the IPCC guidance note on uncertainty: https://wg1.ipcc.ch/SR/documents/ar5_uncertainty-guidance-note.pdf

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
28874	0	0	0	0	Great FAQ ideas - FAQ 9.3 and 9.4 should probably be "Will the ice sheets collapse and what will happen if they do?" and same framing for gulf stream - as this is what we get asked [Piers Piers Forster, United Kingdom (of Great Britain and Northern Ireland)]	Great FAQ ideas - FAQ 9.3 and 9.4 should probably be "Will the ice sheets collapse and what will happen if they do?" and same framing for gulf stream - as this is what we get asked
7958	0				Need to check what is included in Ch 4 and what is included here to make sure no gaps/overlaps. It would make sense to discuss projections in more detail in Ch 4 and use this section to discuss processes/details. [Laura Jackson, United Kingdom (of Great Britain and Northern Ireland)]	Need to check what is included in Ch 4 and what is included here to make sure no gaps/overlaps. It would make sense to discuss projections in more detail in Ch 4 and use this section to discuss processes/details.
7960	0				Need to improve links to SROCC - ie where there is more detail in the SROCC please point the reader towards it (this is done in some sections but not others). Also check messages are the same (ie likelihood/confidence statements), unless there is a good reason to change the message [Laura Jackson, United Kingdom (of Great Britain and Northern Ireland)]	Need to improve links to SROCC - ie where there is more detail in the SROCC please point the reader towards it (this is done in some sections but not others). Also check messages are the same (ie likelihood/confidence statements), unless there is a good reason to change the message
53810	0				At LAM1 and LAM2 we agreed to aim for using a common core set of scenarios across chapters - to the extent possible given the literature. Please keep this ambition in mind for SOD, and check consistency with ch1 and ch4. [Jan Fuglestvedt, Norway]	At LAM1 and LAM2 we agreed to aim for using a common core set of scenarios across chapters - to the extent possible given the literature. Please keep this ambition in mind for SOD, and check consistency with ch1 and ch4.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
27464	0				Expert review by Nils-Axel Mörner (Paleogeophysics & Geodynamics, Stockholm, Sweden, mornerpog.nu) of Chapter 9 Preamble I have been expert reviewer 1999, 2003 and 2013 (when I withdraw due to the exceptionally low quality of the sea level chapter). I am a sea level specialist – yes, indeed. But just because I am a sea level specialist, it implies that I will guide my review with respect to Science of sea level changes and its frames set by physical laws, accumulated knowledge, observational facts and ethics (Figure 1). Figure 1. Frames of realistic sea level changes and the nonsense outside those frames. Chapter 9 – What is this? First, I ask myself; what kind of document is this chapter? • A scientific document that should be evaluated for its scientific standard • A document set to glorify previous concepts by the IPCC implying that it can only be assessed as a lobbying document with respect to preconceived pro or con views In the instructions for the IPCC Sixth Assessment Report (AR6) it was decided (point 2): • That this repost assesses relevant literature We can immediately answer this point:	Expert review by Nils-Axel Mörner (Paleogeophysics & Geodynamics, Stockholm, Sweden, mornerpog.nu) of Chapter 9 Preamble I have been expert reviewer 1999, 2003 and 2013 (when I withdraw due to the exceptionally low quality of the sea level chapter). I am a sea level specialist – yes, indeed. But just because I am a sea level specialist, it implies that I will guide my review with respect to Science of sea level changes and its frames set by physical laws, accumulated knowledge, observational facts and ethics (Figure 1). Figure 1. Frames of realistic sea level changes and the nonsense outside those frames. Chapter 9 – What is this? First, I ask myself; what kind of document is this chapter? • A scientific document that should be evaluated for its scientific standard • A document set to glorify previous concepts by the IPCC implying that it can only be assessed as a lobbying document with respect to
48480	0				General comment on whole chapter: I commend the authors for putting together such a comprehensive and generally polished document. I learned quite a bit reading it. One general concern I had was that the flow throughout could be improved: many sections touch on observed historical changes, historical climate model simulations, model projections of future changes, and paleoclimate observations. Yet the order in which these were discussed changed section by section, and I found the ones where paleo was discussed first to be particularly jarring. I recommend trying to keep the ordering in which these are introduced more consistent throughout (I prefer the above ordering, but see what works). [Kyle Armour, United States of America]	General comment on whole chapter: I commend the authors for putting together such a comprehensive and generally polished document. I learned quite a bit reading it. One general concern I had was that the flow throughout could be improved: many sections touch on observed historical changes, historical climate model simulations, model projections of future changes, and paleoclimate observations. Yet the order in which these were discussed changed section by section, and I found the ones where paleo was discussed first to be particularly jarring. I recommend trying to keep the ordering in which these are introduced more consistent throughout (I prefer the above ordering, but see what works).

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
25452	0				Recent Canadian reports might be useful for various sections of the report for regional syntheses: Canada's Changing Climate Report https://www.nrcan.gc.ca/environment/impacts-adaptation/21177; Canada's Marine Coasts in a Changing Climate https://www.nrcan.gc.ca/environment/resources/publications/impacts-adaptation/reports/assessments/2016/18388 [Sharon Smith, Canada]	Recent Canadian reports might be useful for various sections of the report for regional syntheses: Canada's Changing Climate Report https://www.nrcan.gc.ca/environment/impacts-adaptation/21177; Canada's Marine Coasts in a Changing Climate https://www.nrcan.gc.ca/environment/resources/publications/impacts-adaptation/reports/assessments/2016/18388
39794	0				Thank you for your hard work. The reports needs extensive work to become robust and accessible. The major overall issues are: (1) There must be an effort to focus the report on the issues important for the IPCC process and not for each and every research question in environmental science. (2) there are many parts which do not link with the chapter's title and, although relevant perhaps to regional or local changes appear together with global change. (3) the model evaluation is inconsistent in that the different parts of the report argue for one or the other potential option using different criteria. (4) The report must become more conclusive and cut out with brief statements areas where knowledge has not yet advanced to the point of providing useful outcomes. (5) It appears the people who wrote the last part of the chapter have not read the first part of the chapter and this creates a feeling of inconsistency 6) the mutliple levels of projections are not justifiable. A decision is needed to state which, in the experts' view, are to be reliaed upon. (6) The last parts of the report, i.e ESL, coastal effects and the concluding part are the weakest and need significant reconsideration. (7) The citation policy seems arbitrary in some parts new, even unpublished works are cited for well known issues, in others only newer, after the AR5, citations are used, in others a mixture of selected older and selected newer publications are used. Coupled with arbitrary comments on specific regional effects in some parts it gives an impression of a random collection of thoughts which would have been very different with different authors (8) the mapping of this assessment against AR5 is only partly done. [Michael Tsimplis, China]	Thank you for your hard work. The reports needs extensive work to become robust and accessible. The major overall issues are: (1) There must be an effort to focus the report on the issues important for the IPCC process and not for each and every research question in environmental science. (2) there are many parts which do not link with the chapter's title and, although relevant perhaps to regional or local changes appear together with global change. (3) the model evaluation is inconsistent in that the different parts of the report argue for one or the other potential option using different criteria. (4) The report must become more conclusive and cut out with brief statements areas where knowledge has not yet advanced to the point of providing useful outcomes. (5) It appears the people who wrote the last part of the chapter have not read the first part of the chapter and this creates a feeling of inconsistency 6) the mutliple levels of projections are not justifiable. A decision is needed to state which, in the experts' view, are to be reliaed upon. (6) The last parts of the report, i.e ESL, coastal effects and the concluding part are the weakest and need significant reconsideration. (7) The citation policy seems arbitrary in some parts new, even unpublished works are cited for well known issues, in others only newer, after the AR5, citations are used, in others a mixture of selected older and selected newer publications are
44946	0				I very much enjoyed reading CH9 FOD! It contains a balanced treatment of oceans and cryosphere, observations and models. It's truly an excellent contribution to the WG1 report. My comments focus on my expertise in paleoclimatology. [Darrell Kaufman, United States of America]	I very much enjoyed reading CH9 FOD! It contains a balanced treatment of oceans and cryosphere, observations and models. It's truly an excellent contribution to the WG1 report. My comments focus on my expertise in paleoclimatology.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
25266	0				Overall the chapter is very comprehensive and appears to do a good job covering the advances since AR5. However, some sections are probably much longer than they need to be and the amount of background material and repetition could be reduced to enhance focus on the key advancements and conclusions. In some sections (e.g. 9.2) many pre-AR5 articles are cited and it is sometimes unclear what the advances have been since AR5 (detailed background information?). Although some sections where this is the case have been highlighted in comments below, there are other places throughout the chapter where this occurs. More cross-referencing to other chapters might also help in some sections. [Sharon Smith, Canada]	Overall the chapter is very comprehensive and appears to do a good job covering the advances since AR5. However, some sections are probably much longer than they need to be and the amount of background material and repetition could be reduced to enhance focus on the key advancements and conclusions. In some sections (e.g. 9.2) many pre-AR5 articles are cited and it is sometimes unclear what the advances have been since AR5 (detailed background information?). Although some sections where this is the case have been highlighted in comments below, there are other places throughout the chapter where this occurs. More cross-referencing to other chapters might also help in some sections.
52154	0				The current approach of opening with / embedding the findings runs counter to the structure adopted by most (but not all) preceding chapters. For a reader who wants to scan across chapters it would be useful to adopt a common structure across chapters. Most open with the AR5/SR findings of relevance, perform a new synthesis and assessment then close with a new assessment finding. [Peter Thorne, Ireland]	The current approach of opening with / embedding the findings runs counter to the structure adopted by most (but not all) preceding chapters. For a reader who wants to scan across chapters it would be useful to adopt a common structure across chapters. Most open with the AR5/SR findings of relevance, perform a new synthesis and assessment then close with a new assessment finding.
52158	0				1. Its very well written overall. 2. At last I have found a chapter that integrates observations, models and theory holistically (although with occassional lapses). Thankyou. The power of chapters 5 through 9 should be this integration and considering changes in an integrated fashion is so much clearer to the reader (ocean section is particularly strong in this regard and it would be great to see this truly integrated approach employed throughout). [Peter Thorne, Ireland]	1. Its very well written overall. 2. At last I have found a chapter that integrates observations, models and theory holistically (although with occassional lapses). Thankyou. The power of chapters 5 through 9 should be this integration and considering changes in an integrated fashion is so much clearer to the reader (ocean section is particularly strong in this regard and it would be great to see this truly integrated approach employed throughout).

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
56528	0				The ocean has seemed like something of a 'poor relation' or 'afterthought' in previous ARs. Whatever the strengths and weakenesses of the new structure for WGI AR6, I think it works well to have a dedicated end-to-end chapter on oceans and ice. It was a pleasure to review the FOD and I think the authors have done a great job in bringing this together, given the information available at this stage (particularly the very limited information available from the CMIP6 models). It's clear that there has been some really substantial progress in several areas of the chapter since AR5. The end-to-end nature of the chapter does bring some challenges and I think the chapter as a whole would benefit from consideration in the SOD of a uniform approach to the flow of information in the text, along the traditional lines of observation-attribution-future change. This is currently a little patchy and occasionally hard to follow or even duplicated. I've indicated in later comments a few specific places where I particularly noticed this, but I suggest the LAs consdier adopting as consistent approach to this as possible, and perhaps indicate their approach in the Introduction. [Richard Wood, United Kingdom (of Great Britain and Northern Ireland)]	The ocean has seemed like something of a 'poor relation' or 'afterthought' in previous ARs. Whatever the strengths and weakenesses of the new structure for WGI AR6, I think it works well to have a dedicated end-to-end chapter on oceans and ice. It was a pleasure to review the FOD and I think the authors have done a great job in bringing this together, given the information available at this stage (particularly the very limited information available from the CMIP6 models). It's clear that there has been some really substantial progress in several areas of the chapter since AR5. The end-to-end nature of the chapter does bring some challenges and I think the chapter as a whole would benefit from consideration in the SOD of a uniform approach to the flow of information in the text, along the traditional lines of observation-attribution-future change. This is currently a little patchy and occasionally hard to follow or even duplicated. I've indicated in later comments a few specific places where I particularly noticed this, but I suggest the LAs consdier adopting as consistent approach to this as possible, and perhaps indicate their approach in the Introduction.
56530	0				The question of model evaulation is an important one, especially as it has no specific chapter. In several places I saw some statements on model evaluation that were relevant to the models' reliability for specific topic being discussed. I think this worked well. Necessarily at this stage much of the literature discussed is based on CMIP5 models. That will still be the case in the final version of the chapter. Much literature on evaluation of the CMIP5 models has appeared since AR5. Indeed I would expect the majority of the literature assessed in this chapter to be based on CMIP5 models. I therefore think it is important that subsequent versions of the chapter maintain a thorough evaluation discussion of the CMIP5 models on which many of the results are based, as well as bringing in the (early) CMIP6 resuts as they become available. [Richard Wood, United Kingdom (of Great Britain and Northern Ireland)]	The question of model evaulation is an important one, especially as it has no specific chapter. In several places I saw some statements on model evaluation that were relevant to the models' reliability for specific topic being discussed. I think this worked well. Necessarily at this stage much of the literature discussed is based on CMIP5 models. That will still be the case in the final version of the chapter. Much literature on evaluation of the CMIP5 models has appeared since AR5. Indeed I would expect the majority of the literature assessed in this chapter to be based on CMIP5 models. I therefore think it is important that subsequent versions of the chapter maintain a thorough evaluation discussion of the CMIP5 models on which many of the results are based, as well as bringing in the (early) CMIP6 resuts as they become available.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
49900	0				Terminology for changes in sea level. This is introduced in part in Box 9.2 but it does not define RSL vs. regional and local sea level vs GMSL adequately. It is important to do this somewhere and to ensure consistency across the chapter and between chapters. Gregory et al Surv Geophysics paper 2019 is a good starting point or possibly the basis for terminology conventions to use. Box 9.2 needs some more work. E.g. it defines thermosteric and then steric, which doesn't really make sense. Either define halo and thermo separately or together. GRD is described as causing regional sea level variations but then is described as inducing RSL changes. Both are correct but confusing to a non expert reader. In the deep open ocean goecentric sea level and RSL are identical (ignoring OBD) but this is not clear in the descriptions. Need to also include something on ocean bottom deformation (Frederikse, 2017). While not that large (may similar to deep steric) globally, regionally important part of the SLB. Lastly the acronym GIS is used for the greenland ice sheet in the box but GrIS in the main text. The latter is preferred. [Jonathan Bamber, United Kingdom (of Great Britain and Northern Ireland)]	Terminology for changes in sea level. This is introduced in part in Box 9.2 but it does not define RSL vs. regional and local sea level vs GMSL adequately. It is important to do this somewhere and to ensure consistency across the chapter and between chapters. Gregory et al Surv Geophysics paper 2019 is a good starting point or possibly the basis for terminology conventions to use. Box 9.2 needs some more work. E.g. it defines thermosteric and then steric, which doesn't really make sense. Either define halo and thermo separately or together. GRD is described as causing regional sea level variations but then is described as inducing RSL changes. Both are correct but confusing to a non expert reader. In the deep open ocean goecentric sea level and RSL are identical (ignoring OBD) but this is not clear in the descriptions. Need to also include something on ocean bottom deformation (Frederikse, 2017). While not that large (may similar to deep steric) globally, regionally important part of the SLB. Lastly the acronym GIS is used for the greenland ice sheet in the box but GrIS in the main text. The latter is preferred.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
49914	0				I could not find the time to go through all the sections that I had planned to. This is a large chapter, covering a huge range of topics from paleo to projection, attribution, models, observations of multiple components of the climate system, some of which are connected and some not. Permafrost and seasonal snow don't have much relation to oceans, SLR, ice sheets or sea ice. The latter doesn't have much to do with SLR etc. etc. I am not sure what the solution is but, IMO, as it stands the chapter is unwieldy and the remit to broad to be coherent. Probably the wild card is SLR as this is influenced by factors that are not central to the chapter (hydrology and VLM) and is a substantial topic in its own right taking up a lot of space and with a limited link to some sections listed above. These issues are evident in the executive summary satatements for the chapter which include points about ocean circulation, SLR, trends in ocean and cryosphere, ocean carbon cycle. Some of these points are linked, some are not. This chapter is almost like a mini SROCC without the risk and adaptation. Given that the SROCC will appear in Sept 2019, there is presumably going to be a huge overlap between multiple chapters in that report and what is in this chapter but with no (?) common authors. I don't have a specific suggestion but note that, as it stands, the chapter as a whole will be hard to absorb by non-expert readers and would be more accessible if it were sub-divided into say, i) oceans and SLR, and ii) cryosphere at the least. The sections on snow and river/lake ice, for example, are fairly unconnected to anything else. The SROCC had six chapters and a cross-cutting chapter for an approximately similar topic. This also made the chapter difficult to review in full [Jonathan Bamber, United Kingdom (of Great Britain and Northern Ireland)]	I could not find the time to go through all the sections that I had planned to. This is a large chapter, covering a huge range of topics from paleo to projection, attribution, models, observations of multiple components of the climate system, some of which are connected and some not. Permafrost and seasonal snow don't have much relation to oceans, SLR, ice sheets or sea ice. The latter doesn't have much to do with SLR etc. etc. I am not sure what the solution is but, IMO, as it stands the chapter is unwieldy and the remit to broad to be coherent. Probably the wild card is SLR as this is influenced by factors that are not central to the chapter (hydrology and VLM) and is a substantial topic in its own right taking up a lot of space and with a limited link to some sections listed above. These issues are evident in the executive summary satatements for the chapter which include points about ocean circulation, SLR, trends in ocean and cryosphere, ocean carbon cycle. Some of these points are linked, some are not. This chapter is almost like a mini SROCC without the risk and adaptation. Given that the SROCC will appear in Sept 2019, there is presumably going to be a huge overlap between multiple chapters in that report and what is in this chapter but with no (?) common authors. I don't have a specific suggestion but note that, as it stands, the chapter as a whole will be hard to absorb by non-expert readers and would be more
42642	1	1	127	55	The document reflects an ingrained conviction that recent climate change (during the last 150 years, but particularly the last 50 years) is solely due to processes on Earth and that any recent warming is unrelated to the Sun or cosmic events. There is an ever increasing number of peer-reviewed scientific articles showing that cold periods can occur with high levels of C02 and also that changes in sun spot activity and changes in the Sun’s magnetic flux are associated with cold periods. The decade since the IPCC report in 2007 has seen a continued drop in sunspot activity and predictions of a cooling in the mid-21st century. The IPCC with a responsibility to inform mankind of potential harmful effects due to climate change should also consider the need to address problems caused by future cooling as well as future warming. [Howard Brady, Australia]	The document reflects an ingrained conviction that recent climate change (during the last 150 years, but particularly the last 50 years) is solely due to processes on Earth and that any recent warming is unrelated to the Sun or cosmic events. There is an ever increasing number of peer-reviewed scientific articles showing that cold periods can occur with high levels of C02 and also that changes in sun spot activity and changes in the Sun’s magnetic flux are associated with cold periods. The decade since the IPCC report in 2007 has seen a continued drop in sunspot activity and predictions of a cooling in the mid-21st century. The IPCC with a responsibility to inform mankind of potential harmful effects due to climate change should also consider the need to address problems caused by future cooling as well as future warming.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
15376	1	1	128	1	Fast costal erosion in Arctic becase of permafrost thowing and longer ice-free sea period is missed. It is good to mention, that retreat of sea shores of Ushakov IIsland in the Kara Sea (a glacier island) was up to 100 meter per year and even more. Aleynikov, A., Lipka, O. The degradation of the Ushakov Island ice cover according to the remote sensing data analysis. In: the Earth from Space 9(25) 2018. Co-author. http://zikj.ru/images/25/7.pdf Please add a paragraph into the chapter. [Oksana Lipka, Russian Federation]	Fast costal erosion in Arctic becase of permafrost thowing and longer ice-free sea period is missed. It is good to mention, that retreat of sea shores of Ushakov IIsland in the Kara Sea (a glacier island) was up to 100 meter per year and even more. Aleynikov, A., Lipka, O. The degradation of the Ushakov Island ice cover according to the remote sensing data analysis. In: the Earth from Space 9(25) 2018. Co-author. http://zikj.ru/images/25/7.pdf Please add a paragraph into the chapter.
45214	1	1	246	9	Chapter 9 as a whole: I would say that the chapter looks a bit unbalanced in the FOD. The "ocean" section, which includes the sea-ice element of the cryosphere is allocated about 31 pages. The sea-level section is allocated about 33 pages. However, the (land-based) cryosphere is currently allocated 44 pages - about 40% more space than the other two key topics. I suspect this indicates that the cryosphere text could be made more concise and would probably benefit from this. [Matthew Palmer, United Kingdom (of Great Britain and Northern Ireland)]	Chapter 9 as a whole: I would say that the chapter looks a bit unbalanced in the FOD. The "ocean" section, which includes the sea-ice element of the cryosphere is allocated about 31 pages. The sea-level section is allocated about 33 pages. However, the (land-based) cryosphere is currently allocated 44 pages - about 40% more space than the other two key topics. I suspect this indicates that the cryosphere text could be made more concise and would probably benefit from this.
45216	1	1	246	9	Chapter 9 OVERALL: I think the chapter team have done a great job with the FOD. It's an important chapter for the AR6 and covers a lot of ground. I look forward to working with you all on the second order draft. [Matthew Palmer, United Kingdom (of Great Britain and Northern Ireland)]	Chapter 9 OVERALL: I think the chapter team have done a great job with the FOD. It's an important chapter for the AR6 and covers a lot of ground. I look forward to working with you all on the second order draft.
46308	1	1			This chapter needs more coherence especially in the first pages. Glaciers have been discussed but less attention to the mountainous ones. This chapter may require to discuss on the global trend of snow melting and its relation with the radiation. Page 115 has discussed on future change but does not explain how it will happen and why. The effects of carbon emission have been widely discussed but it needs to have some text on the effects of methane. [sadegh zeyaeyan, Iran]	This chapter needs more coherence especially in the first pages. Glaciers have been discussed but less attention to the mountainous ones. This chapter may require to discuss on the global trend of snow melting and its relation with the radiation. Page 115 has discussed on future change but does not explain how it will happen and why. The effects of carbon emission have been widely discussed but it needs to have some text on the effects of methane.
57584	1	1			This chapter needs more coherence especially in the first pages. Glaciers have been discussed but less attention to the mountainous ones. This chapter may require to discuss on the global trend of snow melting and its relation with the radiation. Page 115 has discussed on future change but does not explain how it will happen and why. The effects of carbon emission have been widely discussed but it needs to have some text on the effects of methane. [Sahar Tajbakhsh Mosalman, Iran]	This chapter needs more coherence especially in the first pages. Glaciers have been discussed but less attention to the mountainous ones. This chapter may require to discuss on the global trend of snow melting and its relation with the radiation. Page 115 has discussed on future change but does not explain how it will happen and why. The effects of carbon emission have been widely discussed but it needs to have some text on the effects of methane.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
6730	1	20	1	20	Author is presumably "Marta" Marcos. [Joanne Williams, United Kingdom (of Great Britain and Northern Ireland)]	Author is presumably "Marta" Marcos.
32322	6	1	6	1	Ch.9. Exec Summary. Comparisons with AR5 conclusions are included at various points in the Chapter text. However, it would be good to see highlighted right at the start of the chapter - in the Exec Summary - the 4 or 5 key points where new results have been obtained relative to AR5 i.e. where the likelihood/confidence levels have changed significantly. Could such a summary bullet point list be included? [Simon Josey, United Kingdom (of Great Britain and Northern Ireland)]	Ch.9. Exec Summary. Comparisons with AR5 conclusions are included at various points in the Chapter text. However, it would be good to see highlighted right at the start of the chapter - in the Exec Summary - the 4 or 5 key points where new results have been obtained relative to AR5 i.e. where the likelihood/confidence levels have changed significantly. Could such a summary bullet point list be included?
53808	6	1	9	4	The ES is very rich in information and material included, and compared to other Executive Summaries, a bit more compact. The authors may consider to split into clearer blocks, like other chapter have done; e.g. ch8. [Jan Fuglestvedt, Norway]	The ES is very rich in information and material included, and compared to other Executive Summaries, a bit more compact. The authors may consider to split into clearer blocks, like other chapter have done; e.g. ch8.
48482	6	1	9	4	I was surprised not to see in the Executive Summary anything about closure of the sea level budget which seems a key point in the chapter (it is noted in Chap 7 too, but this seems a natural place). [Kyle Armour, United States of America]	I was surprised not to see in the Executive Summary anything about closure of the sea level budget which seems a key point in the chapter (it is noted in Chap 7 too, but this seems a natural place).
19344	6	1	9	4	In the summary you should also discuss the impact of changes in the gravitational pull of ice sheets on local and global sea level rise. E.g. Mitrovica et al., 2018 doi:10.1175/JCLI-D-17-0465.1; Gomez et al. 2010, doi:10.1038/ngeo1012 [Gwenaelle GREMION, Canada]	In the summary you should also discuss the impact of changes in the gravitational pull of ice sheets on local and global sea level rise. E.g. Mitrovica et al., 2018 doi:10.1175/JCLI-D-17-0465.1; Gomez et al. 2010, doi:10.1038/ngeo1012
28570	6	1	9	4	In the summary you should also discuss the impact of changes in the gravitational pull of ice sheets on local and global sea level rise. E.g. Mitrovica et al., 2018 doi:10.1175/JCLI-D-17-0465.1; Gomez et al. 2010, doi:10.1038/ngeo1012 [Thomas Ronge, Germany]	In the summary you should also discuss the impact of changes in the gravitational pull of ice sheets on local and global sea level rise. E.g. Mitrovica et al., 2018 doi:10.1175/JCLI-D-17-0465.1; Gomez et al. 2010, doi:10.1038/ngeo1012
6339	6	1	9	5	The Executive Summary does not reveal any impact on humans or marine organisms. Suggest to dedicate at least a single clause summarizing SR 1.5 and SROCC to present a holistic overview [Baruch Rinkevich, Israel]	The Executive Summary does not reveal any impact on humans or marine organisms. Suggest to dedicate at least a single clause summarizing SR 1.5 and SROCC to present a holistic overview
56534	6	1			From the perspective of a busy scientist, I liked the level of detail and information presented in the Exec Summ. I'm not so sure it would be attractive to someone working at the science-policy interface. For that audience I think a little more focus on how understanding has moved on or changed since AR5 would be valuable. It may not be easy to satisfy both audiences, but I suggest the authors consider whether it is possible to sharpen the messages for a policy-facing audience. [Richard Wood, United Kingdom (of Great Britain and Northern Ireland)]	From the perspective of a busy scientist, I liked the level of detail and information presented in the Exec Summ. I'm not so sure it would be attractive to someone working at the science-policy interface. For that audience I think a little more focus on how understanding has moved on or changed since AR5 would be valuable. It may not be easy to satisfy both audiences, but I suggest the authors consider whether it is possible to sharpen the messages for a policy-facing audience.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
56540	6	1			I think for the Exec Summ it is particularly important to make the flow of the discussion clear. I think the topics are probably the right ones, but at present it seems jump around between topics. Is the flow: (a) Discuss phenomena one by one, and for each phenomenon consider observed change - attribution - future projection, or (b) Consider oberved changes for all phenomena first, followed by attribution for all phenomena, followed by future change for all phenomena? Or something else? I relaise it's not as simple as I've painted it but while I found the individual paragraphs of the ES interesting I felt a bit lost reading it and I encourage the authors to consider if this flow can be improved for the SOD. [Richard Wood, United Kingdom (of Great Britain and Northern Ireland)]	I think for the Exec Summ it is particularly important to make the flow of the discussion clear. I think the topics are probably the right ones, but at present it seems jump around between topics. Is the flow: (a) Discuss phenomena one by one, and for each phenomenon consider observed change - attribution - future projection, or (b) Consider oberved changes for all phenomena first, followed by attribution for all phenomena, followed by future change for all phenomena? Or something else? I relaise it's not as simple as I've painted it but while I found the individual paragraphs of the ES interesting I felt a bit lost reading it and I encourage the authors to consider if this flow can be improved for the SOD.
52148	6	3	6	7	It feels to me like it should be in the introduction and not the ES. Suggest move there and merge. [Peter Thorne, Ireland]	It feels to me like it should be in the introduction and not the ES. Suggest move there and merge.
52404	6	3	6	7	Excellent framing few sentences to begin this chapter -- consider similar flow in SOD Executive Summary, eg Attribution and Observed Changes, Potential Irreverisbility and Implied Commitment. [Pam Pearson, Sweden]	Excellent framing few sentences to begin this chapter -- consider similar flow in SOD Executive Summary, eg Attribution and Observed Changes, Potential Irreverisbility and Implied Commitment.
46018	6	9	6	9	I like how the executive summary has summarized main points in bold. Executive summaries in other chapters (e.g. Chapter 4), should follow the same format. [Isaac Pearlman, United States of America]	I like how the executive summary has summarized main points in bold. Executive summaries in other chapters (e.g. Chapter 4), should follow the same format.
56536	6	9	6	9	The word 'rapidly' is somewhat emotive and has a special meaning to some people (cf. all the discussions in the community about defining'rpaid' or 'abrupt' clilmate change in the early 2000s). Suggest rephrase this to avoid misunderstanding [Richard Wood, United Kingdom (of Great Britain and Northern Ireland)]	The word 'rapidly' is somewhat emotive and has a special meaning to some people (cf. all the discussions in the community about defining'rpaid' or 'abrupt' clilmate change in the early 2000s). Suggest rephrase this to avoid misunderstanding
45884	6	9	6	11	Virtually certain' is repeated in the same sentence. It can be omitted the second time easily without changing the meaning of the sentence. [Shikha Singh, India]	Virtually certain' is repeated in the same sentence. It can be omitted the second time easily without changing the meaning of the sentence.
47004	6	9	6	16	The increase in upper ocean stratification (discussed in 9.2.3.3) is a robust result of climate change with large consequences for ocean biogeochemistry and ecosystems (see also SROCC Chapter 5). The findings of this chapter regarding projected upper ocean stratification increases should be highlighted somewhere in the executive summary. [Robert Hallberg, United States of America]	The increase in upper ocean stratification (discussed in 9.2.3.3) is a robust result of climate change with large consequences for ocean biogeochemistry and ecosystems (see also SROCC Chapter 5). The findings of this chapter regarding projected upper ocean stratification increases should be highlighted somewhere in the executive summary.
56538	6	9	6	21	I imagine anyone reading this paragraph with knowledge of previous ARs would want to know the latest on what's been happening to Antarctic sea ice so I think it belongs here. [Richard Wood, United Kingdom (of Great Britain and Northern Ireland)]	I imagine anyone reading this paragraph with knowledge of previous ARs would want to know the latest on what's been happening to Antarctic sea ice so I think it belongs here.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
39160	6	12	6	12	compare it with the rate for air surface temperature? [Pascale Braconnot, France]	compare it with the rate for air surface temperature?
42618	6	13	6	14	The "fresher get fresher and saltier gets saltier" statement does not seem well supported in the main text and the wording here can be taken to mean that the trend is extremely likely. [William Gutowski, United States of America]	The "fresher get fresher and saltier gets saltier" statement does not seem well supported in the main text and the wording here can be taken to mean that the trend is extremely likely.
19346	6	13	6	14	I'd suggest adding "near-surface" in the sentence. It is extremely likely that near-surface ocean salinity ranges... [Gwenaelle GREMION, Canada]	I'd suggest adding "near-surface" in the sentence. It is extremely likely that near-surface ocean salinity ranges...
7892	6	14	6	16	See comments for page 25, lines 36-37 [Laura Jackson, United Kingdom (of Great Britain and Northern Ireland)]	See comments for page 25, lines 36-37
19348	6	15	6	16	It should say "decreased" instead of "declined" [Gwenaelle GREMION, Canada]	It should say "decreased" instead of "declined"
16046	6	15	6	21	Suggest quoting some ice/mass loss figures in different periods of time for the Arctic sea ice, Greenland and Antarctic Ice Sheets. [SAI MING LEE, China]	Suggest quoting some ice/mass loss figures in different periods of time for the Arctic sea ice, Greenland and Antarctic Ice Sheets.
9174	6	16	6	19	Refer to previous comments 17 and 18 above made on the Arctic and Greenland. [Jim O'Brien, Ireland]	Refer to previous comments 17 and 18 above made on the Arctic and Greenland.
25268	6	17	6	17	Poor sentence. Do you mean glacier melt, which has accelerated since 2012, has resulted in increases in sea level since 1992? ("melt" is probably a better word than "decline" or you could say "loss of mass") [Sharon Smith, Canada]	Poor sentence. Do you mean glacier melt, which has accelerated since 2012, has resulted in increases in sea level since 1992? ("melt" is probably a better word than "decline" or you could say "loss of mass")
15656	6	17	6	18	Update with estimates 1961-2016 by Zemp et al. (2019, Nature). [Michael Zemp, Switzerland]	Update with estimates 1961-2016 by Zemp et al. (2019, Nature).
39162	6	17	6	18	are we sure it is 2012 and not somewhere around this? Uncertainty is needed here [Pascale Braconnot, France]	are we sure it is 2012 and not somewhere around this? Uncertainty is needed here
32248	6	21	6	21	The text states that it is highly likely that permafrost has been warming, which I agree with, but I also think it can be stated with the same level of confidence that there has been a net loss of permafrost as well. It is very well documented in the sporadic and discontinous permafrost zones that we have rapid and accelerating permafrost loss which is not compensated for by new permafrost aggradation. Permafrost loss includes both active layer deepening, but perhaps more importantly and with greater certainty the complete loss of permafrost along edges of lakes, peat plateaus, palsas. [David Olefeldt, Canada]	The text states that it is highly likely that permafrost has been warming, which I agree with, but I also think it can be stated with the same level of confidence that there has been a net loss of permafrost as well. It is very well documented in the sporadic and discontinous permafrost zones that we have rapid and accelerating permafrost loss which is not compensated for by new permafrost aggradation. Permafrost loss includes both active layer deepening, but perhaps more importantly and with greater certainty the complete loss of permafrost along edges of lakes, peat plateaus, palsas.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
32424	6	22	6	30	Some of these statements are absolutely wrong, as they are purely based on satellite data without confirmation on surface measurements. The main statements that need to be deleted here, are, especially: 1) The rate of global mean sea level rise over 1980-2000 was faster than during any preceding 20-year period since at least 1000 BCE {low confidence; 9.6.2}.; and: 2) and 3.1 ? 0.3 mm yr-1 over 1993-2017 {high confidence; 9.6.2}.Further confirmation is needed for these periods, before IPCC can make these bold statements! [Martin Hovland, Norway]	Some of these statements are absolutely wrong, as they are purely based on satellite data without confirmation on surface measurements. The main statements that need to be deleted here, are, especially: 1) The rate of global mean sea level rise over 1980-2000 was faster than during any preceding 20-year period since at least 1000 BCE {low confidence; 9.6.2}.; and: 2) and 3.1 ? 0.3 mm yr-1 over 1993-2017 {high confidence; 9.6.2}.Further confirmation is needed for these periods, before IPCC can make these bold statements!
13730	6	23	6	23	The text that follows does not substantiate "several millenia", which is in any case vague and unspecific wording. Please, reformulate. [Charalampos Charalampidis, Germany]	The text that follows does not substantiate "several millenia", which is in any case vague and unspecific wording. Please, reformulate.
56542	6	23	6	23	Please clarify that this means the rate of sea level change [Richard Wood, United Kingdom (of Great Britain and Northern Ireland)]	Please clarify that this means the rate of sea level change
27250	6	23	6	32	Fig. 3.14 of the AR5 report shows that sea level rise seems to follow a 60-70 years cycle which is documented in a number of papers: Schlesinger and Ramankutty, 1994; Ogurtsov et al., 2002; Klyashtorin and Lyubushin, 2003; Loehle, 2004; Zhen-Shan and Xian, 2007; Carvalo et al., 2007; Swanson and Tsonis, 2009; Scafetta, 2009; Akasofu, 2010; D'Aleo and Easterbrook, 2010; Loehle and Scafetta, 2011; Humlum et al., 2011; Chambers et al., 2012; Lüdecke et al., 2013; Courtillot et al., 2013; Akasofu, 2013; Macias et al., 2014; Ogurtsov et al., 2015, Ollila 2017. The apparent acceleration of sea level rise might be related to the last ascending phase of the natural cycle. See Fig. 2a of http://dx.doi.org/10.1016/j.earscirev.2016.02.005. Professor Nix-Axel Mörner published tens of peer-reviewed papers on sea-level rise that minimize the alarmism. He is not cited in this Chapter. This expert reviewer recommends that his findings that contradict the paragraphs of this chapter should be cited and discussed. Parker and Ollier (Phys. Sci. Int. J. 6,119 (2015)) reports an average sea level rise of only 1 mm/year by considering more than 500 tide gauges, viz. more than the 240 of NOAA. Donchyts et al (Nature Climate Change 6,810, (2016)) reported an average extension of lands on seas. Luijendijk, A. et al, 2018 (The state of the world's beaches. Nature Sci. Rep. DOI:10.1038/s41598-018-24630-6) also show an average extension of beaches. How to reconcile such an extension with sea level rise? Major revision of the paragraphs about sea level rise, therefore, is strongly recommended. [François GERVAIS, France]	Fig. 3.14 of the AR5 report shows that sea level rise seems to follow a 60-70 years cycle which is documented in a number of papers: Schlesinger and Ramankutty, 1994; Ogurtsov et al., 2002; Klyashtorin and Lyubushin, 2003; Loehle, 2004; Zhen-Shan and Xian, 2007; Carvalo et al., 2007; Swanson and Tsonis, 2009; Scafetta, 2009; Akasofu, 2010; D'Aleo and Easterbrook, 2010; Loehle and Scafetta, 2011; Humlum et al., 2011; Chambers et al., 2012; Lüdecke et al., 2013; Courtillot et al., 2013; Akasofu, 2013; Macias et al., 2014; Ogurtsov et al., 2015, Ollila 2017. The apparent acceleration of sea level rise might be related to the last ascending phase of the natural cycle. See Fig. 2a of http://dx.doi.org/10.1016/j.earscirev.2016.02.005. Professor Nix-Axel Mörner published tens of peer-reviewed papers on sea-level rise that minimize the alarmism. He is not cited in this Chapter. This expert reviewer recommends that his findings that contradict the paragraphs of this chapter should be cited and discussed. Parker and Ollier (Phys. Sci. Int. J. 6,119 (2015)) reports an average sea level rise of only 1 mm/year by considering more than 500 tide gauges, viz. more than the 240 of NOAA. Donchyts et al (Nature Climate Change 6,810, (2016)) reported an average extension of lands on seas. Luijendijk, A. et al, 2018 (The state of the world's beaches. Nature Sci. Rep. DOI:10.1038/s41598-018-24630-6) also show an

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
42648	6	23	6	32	In line 23, page 9-6 there is talk of unprecedented sea level rise over the 'last several millennia, medium confidence'. This statement ignores increasing evidence of a gradual fall (not rise) from a high sea level stand between 8000 and 2000 BP. Such evidence comes from an increasing number of peer-reviewed articles describing evidence of this high sea level stand and its decline along the coasts of Australia, South Africa, South America, South Korea, and Vietnam.There is increasing evidence that such a wide occurrence of a high sea level stand, especially in the Southern Hemisphere, cannot be interpreted as due to crustal movements (Glacial Isostatic Adjustments -GIAs) in different continents at the same time as these area did not experience any significant glacial or ice crustal loading during the last ice age advances. Basically, there is now so much data on this fall in sea level from a high-level stand that the GIAs quoted by Dutton and Lambeck 2012 should be abandoned.A few references to peer reviewed articles describing a high sea level stand in the HTM and the fall in sea-level from 8000 -2000 BP are listed below. There is no justification for any glacio-eustatic uplift since 8000 BP that stopped (for some unknown reason about 2000 BP) in regions that did not experience any ice loading during the last glaciation. There is an increasing body of evidence against the earlier views put forward by Kurt Lambeck. [Howard Brady, Australia]	In line 23, page 9-6 there is talk of unprecedented sea level rise over the 'last several millennia, medium confidence'. This statement ignores increasing evidence of a gradual fall (not rise) from a high sea level stand between 8000 and 2000 BP. Such evidence comes from an increasing number of peer-reviewed articles describing evidence of this high sea level stand and its decline along the coasts of Australia, South Africa, South America, South Korea, and Vietnam.There is increasing evidence that such a wide occurrence of a high sea level stand, especially in the Southern Hemisphere, cannot be interpreted as due to crustal movements (Glacial Isostatic Adjustments -GIAs) in different continents at the same time as these area did not experience any significant glacial or ice crustal loading during the last ice age advances. Basically, there is now so much data on this fall in sea level from a high-level stand that the GIAs quoted by Dutton and Lambeck 2012 should be abandoned.A few references to peer reviewed articles describing a high sea level stand in the HTM and the fall in sea-level from 8000 -2000 BP are listed below. There is no justification for any glacio-eustatic uplift since 8000 BP that stopped (for some unknown reason about 2000 BP) in regions that did not experience any ice loading during the last glaciation. There is an increasing body of evidence against the earlier views put forward by Kurt
19350	6	25	6	26	The range of growth is not included in the cited section (9.6.2.3) [Gwenaelle GREMION, Canada]	The range of growth is not included in the cited section (9.6.2.3)
19352	6	25	6	26	The section here should be 9.6.2.1.2 or 9.6.2.1. Therefore the text should be revised to: "Over the 20th century, tide gauge-based reconstructions show that global mean sea level has risen by 0.15 - 0.22 m between 1901 and 2015 {high confidence; 9.6.2.1}". [Gwenaelle GREMION, Canada]	The section here should be 9.6.2.1.2 or 9.6.2.1. Therefore the text should be revised to: "Over the 20th century, tide gauge-based reconstructions show that global mean sea level has risen by 0.15 - 0.22 m between 1901 and 2015 {high confidence; 9.6.2.1}".
45886	6	27	6	28	1000 BCE is not clear? What is BCE? Or is this a typo and authors meant BC? [Shikha Singh, India]	1000 BCE is not clear? What is BCE? Or is this a typo and authors meant BC?

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
9742	6	27	6	29	Since there is only low confidence in the statement that "The rate of global mean sea level rise over 1980-2000 was faster than during any preceding 20-year period since at least 1000 BCE", I'm not sure that this statement should be included in the executive summary. Given the limitations on our ability to measure changes in rates of SLR with this kind of precision as far back as 1000 BCE, the low confidence rating is understandable and appropriate, and these findings would certainly warrant discussion within the full report. However, I would be hesitant to include this particular point in the executive summary, given that there are a number of other statements with higher confidence to support this paragraph. [Andra Garner, United States of America]	Since there is only low confidence in the statement that "The rate of global mean sea level rise over 1980-2000 was faster than during any preceding 20-year period since at least 1000 BCE", I'm not sure that this statement should be included in the executive summary. Given the limitations on our ability to measure changes in rates of SLR with this kind of precision as far back as 1000 BCE, the low confidence rating is understandable and appropriate, and these findings would certainly warrant discussion within the full report. However, I would be hesitant to include this particular point in the executive summary, given that there are a number of other statements with higher confidence to support this paragraph.
19354	6	27	6	29	In the case of "… and this increase was faster than that of any century since at least 1000 BCE {medium confidence; 9.6.2} ...{low confidence; 9.6.2}", the referenced section is correct but could be further specified upward to 9.6.2.1.1 [Gwenaelle GREMION, Canada]	In the case of "… and this increase was faster than that of any century since at least 1000 BCE {medium confidence; 9.6.2} ...{low confidence; 9.6.2}", the referenced section is correct but could be further specified upward to 9.6.2.1.1
56544	6	27	6	29	This is a powerful statement but is assigned low confidence. Should such a statement be elevated to the ES? [Richard Wood, United Kingdom (of Great Britain and Northern Ireland)]	This is a powerful statement but is assigned low confidence. Should such a statement be elevated to the ES?

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
42650	6	27	6	32	Statements about the sudden acceleration of sea level after 1990 using data from the Topex-Poseidon, Jason series of satellites ignore the discordance between satellite data (1993 onwards) and tide gauge data (20th and 21st century) as first put forward by Houston and Dean. Unfortunately, all the IPCC sea level projections have been distorted by a 'false' acceleration derived from a difference between two different methods of estimating sea level rise; a false methodology.Houston, J.R., Dean, R.G., 2012. Comparisons at tide gauge locations of glacial isostatic adjustment predictions with global positioning system measurements. Journal of Coastal Research 28 (4), 739–744. Dean, R, Houston,J. 2013. Houston Recent sea level trends and accelerations: Comparison of tide gauge and satellite results .Coastal Engineering. Vol 75 pp4-9The altimetry problems of this satellite system highlighted by Professors Houston and Dean will not be resolved until a new satellite system for calculating sea level rise is introduced. The IPCC should strongly recommend funding for the better designed NASA designed system -Geodetic Reference Antennae in Space (GRASP) as that should help resolve debate about discrepancies between tide gauge data and satellite data. This new system and problems with the Jason satellites are described in this article by NASA design engineers at Caltech:Bar-Server, Y, Haines, B, Bertiger, W, Desai, S, Wu, S, 2012, 'Geodetic Reference Antennae in Space:- a mission to enhance Space Geodesy', Jet Propulsion Laboratory Papers, Caltech. [Howard Brady, Australia]	Statements about the sudden acceleration of sea level after 1990 using data from the Topex-Poseidon, Jason series of satellites ignore the discordance between satellite data (1993 onwards) and tide gauge data (20th and 21st century) as first put forward by Houston and Dean. Unfortunately, all the IPCC sea level projections have been distorted by a 'false' acceleration derived from a difference between two different methods of estimating sea level rise; a false methodology.Houston, J.R., Dean, R.G., 2012. Comparisons at tide gauge locations of glacial isostatic adjustment predictions with global positioning system measurements. Journal of Coastal Research 28 (4), 739–744. Dean, R, Houston,J. 2013. Houston Recent sea level trends and accelerations: Comparison of tide gauge and satellite results .Coastal Engineering. Vol 75 pp4-9The altimetry problems of this satellite system highlighted by Professors Houston and Dean will not be resolved until a new satellite system for calculating sea level rise is introduced. The IPCC should strongly recommend funding for the better designed NASA designed system -Geodetic Reference Antennae in Space (GRASP) as that should help resolve debate about discrepancies between tide gauge data and satellite data. This new system and problems with the Jason satellites are described in this article by NASA design engineers at Caltech:Bar-Server, Y, Haines, B,
56546	6	29	6	29	Please clarify: is [0.9, 1.7] the very likely range? [Richard Wood, United Kingdom (of Great Britain and Northern Ireland)]	Please clarify: is [0.9, 1.7] the very likely range?
19356	6	29	6	30	It's not very which data has "high confidence" and which one is "very likely" to occur. [Gwenaelle GREMION, Canada]	It's not very which data has "high confidence" and which one is "very likely" to occur.
9176	6	29	6	32	On sea level rise, refer to comment 19 above, plus Fig 2.32 which shows a vitually constant rate of rise of around 2mm/year since 1880. [Jim O'Brien, Ireland]	On sea level rise, refer to comment 19 above, plus Fig 2.32 which shows a vitually constant rate of rise of around 2mm/year since 1880.
19358	6	30	6	32	The data in the Cross-Chapter Box 9.2 talks about the 1971-2014 period, not the 1971-2018 [Gwenaelle GREMION, Canada]	The data in the Cross-Chapter Box 9.2 talks about the 1971-2014 period, not the 1971-2018
39230	6	31	6	31	"...can be consistently closed within uncertainties..." - phrase not obvious [Dmitry Kovalevsky, Germany]	"...can be consistently closed within uncertainties..." - phrase not obvious
14950	6	34	6	44	Would it be better to use "Extreme sea level events" rather than "Extreme sea level" in order to stress that this refers to spesific time-constained events rather than a general rise in sea-level? [Jo Brendryen, Norway]	Would it be better to use "Extreme sea level events" rather than "Extreme sea level" in order to stress that this refers to spesific time-constained events rather than a general rise in sea-level?
9178	6	34	6	44	This paragraph predicting "100-year events" on an annual basis in some regions perhaps needs a reality check? [Jim O'Brien, Ireland]	This paragraph predicting "100-year events" on an annual basis in some regions perhaps needs a reality check?

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
56548	6	34	6	44	Throughout this paragraph it is unclear whether the statements refer to past or future sea level, or both. [Richard Wood, United Kingdom (of Great Britain and Northern Ireland)]	Throughout this paragraph it is unclear whether the statements refer to past or future sea level, or both.
56554	6	34	6	44	Of course increases in high water extremes are the most likely to have impact, but there is interest in low water extremes too. Is it worth saying something about these? [Richard Wood, United Kingdom (of Great Britain and Northern Ireland)]	Of course increases in high water extremes are the most likely to have impact, but there is interest in low water extremes too. Is it worth saying something about these?
38454	6	35	6	35	I don't think the phrase "relative sea level" is used in an absolute sense, without "change" or "rise". [Jonathan Gregory, United Kingdom (of Great Britain and Northern Ireland)]	I don't think the phrase "relative sea level" is used in an absolute sense, without "change" or "rise".
8334	6	35	6	35	Should relative sea level be defined relative to a specified land datum (e.g. like a tide gauge), rather than 'the sea floor'? E.g. from EPA definition: "Relative sea level change is how the height of the ocean rises or falls relative to the land at a particular location." [Jeremy Fyke, Canada]	Should relative sea level be defined relative to a specified land datum (e.g. like a tide gauge), rather than 'the sea floor'? E.g. from EPA definition: "Relative sea level change is how the height of the ocean rises or falls relative to the land at a particular location."
33448	6	35	6	35	I thought relative sea level rise took into account uplift/subsidence, and so was relative to the land (e.g., as measured by tide gauges), rather than being "relative to the sea floor". [Marcus Sarofim, United States of America]	I thought relative sea level rise took into account uplift/subsidence, and so was relative to the land (e.g., as measured by tide gauges), rather than being "relative to the sea floor".
8336	6	36	6	36	In some locations, the primarily RSL contributor is vertical land motion due to tectonic/isostatic effects. This is not mentioned, but probably should be, in this summary. [Jeremy Fyke, Canada]	In some locations, the primarily RSL contributor is vertical land motion due to tectonic/isostatic effects. This is not mentioned, but probably should be, in this summary.
44436	6	36	6	37	here : "changes in tides" with "high confidence", but in table 9.1 page 9 there is no attribution for tides. [Anne Marie Treguier, France]	here : "changes in tides" with "high confidence", but in table 9.1 page 9 there is no attribution for tides.
49272	6	36	6	38	I completely understand that effect of tides could change due to climate change. Maybe, in the way is written here the reader (inexpert) could get the idea that the tidal phenomenon is related with climate. But, we know it is astromically forced. [Catalina Aguirre Galaz, Chile]	I completely understand that effect of tides could change due to climate change. Maybe, in the way is written here the reader (inexpert) could get the idea that the tidal phenomenon is related with climate. But, we know it is astromically forced.
6766	6	37	6	37	Attribution of tidal changes. Table 1 has "no attribution", but in the exec. summary it states (line 37-40) "Relative sea-level rise and direct anthropogenic factors, such as dredging, are the primary drivers of observed tidal changes {medium confidence; 9.6.5}. Most observed changes in extreme sea level can be attributed to human activity, because long-term relative sea-level change can be attributed {medium confidence; 9.6.5}. Dredging is also an anthropogenic activity. I would also query "most" changes, since it has been shown [Idier 2017 again] that tidal changes are usually only about 15% of sea-level rise, yet locally larger changes of tides have been observed. [Joanne Williams, United Kingdom (of Great Britain and Northern Ireland)]	Attribution of tidal changes. Table 1 has "no attribution", but in the exec. summary it states (line 37-40) "Relative sea-level rise and direct anthropogenic factors, such as dredging, are the primary drivers of observed tidal changes {medium confidence; 9.6.5}. Most observed changes in extreme sea level can be attributed to human activity, because long-term relative sea-level change can be attributed {medium confidence; 9.6.5}. Dredging is also an anthropogenic activity. I would also query "most" changes, since it has been shown [Idier 2017 again] that tidal changes are usually only about 15% of sea-level rise, yet locally larger changes of tides have been observed.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
46020	6	37	6	38	Consider also mentioning groundwater extraction and subsidence as another important factor in local relative sea level change. [Isaac Pearlman, United States of America]	Consider also mentioning groundwater extraction and subsidence as another important factor in local relative sea level change.
9744	6	38	6	40	"Most observed changes in extreme sea level can be attributed to human activity, because long-term relative sea-level change can be attributed" . . . Just for clarification, I think that the end of this sentence needs an additional phrase to explain to what it is that the long-term relative sea-level change can be attributed. [Andra Garner, United States of America]	"Most observed changes in extreme sea level can be attributed to human activity, because long-term relative sea-level change can be attributed" . . . Just for clarification, I think that the end of this sentence needs an additional phrase to explain to what it is that the long-term relative sea-level change can be attributed.
7530	6	38	6	40	Clarify sentence? [Patrick Hyder, United Kingdom (of Great Britain and Northern Ireland)]	Clarify sentence?
8066	6	38	6	40	attributed… something is missing from the sentence. [Rasmus Tonboe, Denmark]	attributed… something is missing from the sentence.
33450	6	38	6	40	What about regions with large long-term natural subsidence? There is also missing logic in this sentence. [Marcus Sarofim, United States of America]	What about regions with large long-term natural subsidence? There is also missing logic in this sentence.
52910	6	38	6	40	Missing the end of this sentence, or otherwise confusing wording: "because long-term relative sea-level change can be attributed" to..? [Abigail Bodner, United States of America]	Missing the end of this sentence, or otherwise confusing wording: "because long-term relative sea-level change can be attributed" to..?
13732	6	39	6	40	The end of this sentence is an unfinished clause. [Charalampos Charalampidis, Germany]	The end of this sentence is an unfinished clause.
13734	6	40	6	40	Substitute "rare" with "relatively infrequent". [Charalampos Charalampidis, Germany]	Substitute "rare" with "relatively infrequent".
8338	6	41	6	41	"historical hundred-year flooding events on an annual basis": i.e. flooding that has a 1% chance of occurring each year becomes flooding with 100% chance of occurring? Perhaps clarify if this is the true intention with this statement. [Jeremy Fyke, Canada]	"historical hundred-year flooding events on an annual basis": i.e. flooding that has a 1% chance of occurring each year becomes flooding with 100% chance of occurring? Perhaps clarify if this is the true intention with this statement.
56550	6	42	6	43	There is low cnfidence in the surge and wave contributions, yet high confidence that mean sea level is the dominant term. Is that right? I think it sort of is, and agrees with my understanding, but I thinkthis would be confusing for someone not working in this area. Needs clarification. [Richard Wood, United Kingdom (of Great Britain and Northern Ireland)]	There is low cnfidence in the surge and wave contributions, yet high confidence that mean sea level is the dominant term. Is that right? I think it sort of is, and agrees with my understanding, but I thinkthis would be confusing for someone not working in this area. Needs clarification.
8340	6	43	6	43	"Changing coastlines are a potentially dominant process in extreme sea levels". Chicken and egg: in fact, it's probably the opposite case, that extreme sea levels will be a dominant process in changing coastlines. Perhaps remove or clarify this statement. [Jeremy Fyke, Canada]	"Changing coastlines are a potentially dominant process in extreme sea levels". Chicken and egg: in fact, it's probably the opposite case, that extreme sea levels will be a dominant process in changing coastlines. Perhaps remove or clarify this statement.
13736	6	43	6	43	"…are expected to have dominant role…", since this is substantiated by high-confidence evidence. [Charalampos Charalampidis, Germany]	"…are expected to have dominant role…", since this is substantiated by high-confidence evidence.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
12970	6	43	6	43	“Changing coastlines are a potentially dominant process in extreme sea levels”. I find this to be a bit counter intuitive, as ESL is a purely oceanic phenomenon. ESLs will have an effect on coastlines (temporarily most of the time), not the other way around. [Roshanka Ranasinghe, Netherlands]	“Changing coastlines are a potentially dominant process in extreme sea levels”. I find this to be a bit counter intuitive, as ESL is a purely oceanic phenomenon. ESLs will have an effect on coastlines (temporarily most of the time), not the other way around.
56552	6	43	6	44	If changing coastlines are a potentially dominant term, how is this consistent with relative SL change being the dominant term? Presumably this refers to just a few locations? Needs clarification. [Richard Wood, United Kingdom (of Great Britain and Northern Ireland)]	If changing coastlines are a potentially dominant term, how is this consistent with relative SL change being the dominant term? Presumably this refers to just a few locations? Needs clarification.
25270	6	46	6	46	"Changes" rather than "trends" [Sharon Smith, Canada]	"Changes" rather than "trends"
13738	6	46	6	47	"…decades, depending on greenhouse-gas emmisions during the 21st century and beyond (high confidence)." Since we are talking about ocean as well as cryosphere trends in one sentence, the greenhouse-gas emissions have been and are important already, and will play a critical role in the near future, as well as later in the century and beyond. [Charalampos Charalampidis, Germany]	"…decades, depending on greenhouse-gas emmisions during the 21st century and beyond (high confidence)." Since we are talking about ocean as well as cryosphere trends in one sentence, the greenhouse-gas emissions have been and are important already, and will play a critical role in the near future, as well as later in the century and beyond.
32426	6	46	6	50	These statements are purely based on conjectures and projections of numerical simulations, which have a long history of being wrong. Therefore no bold statements of ocean future ocean warming can be made on them. [Martin Hovland, Norway]	These statements are purely based on conjectures and projections of numerical simulations, which have a long history of being wrong. Therefore no bold statements of ocean future ocean warming can be made on them.
8342	6	46	7	4	There should be a statement on Greenland/Antarctica ice sheet future response in this section (currently only includes oceans, glaciers, permafrost, snow cover, lake/river ice [Jeremy Fyke, Canada]	There should be a statement on Greenland/Antarctica ice sheet future response in this section (currently only includes oceans, glaciers, permafrost, snow cover, lake/river ice
7532	6	48	6	48	Should this read '...regardless of emission scenario'? [Patrick Hyder, United Kingdom (of Great Britain and Northern Ireland)]	Should this read '...regardless of emission scenario'?
39164	6	48	6	48	specifiy the reason, showing that we understand. Ocean inertia [Pascale Braconnot, France]	specifiy the reason, showing that we understand. Ocean inertia
28484	6	49	6	49	"Will take up" not "will uptake" [David Schoeman, Australia]	"Will take up" not "will uptake"
44358	6	49	6	50	The evidence for this statement needs to be strengthened (see later comment) [Michael Bell, United Kingdom (of Great Britain and Northern Ireland)]	The evidence for this statement needs to be strengthened (see later comment)
56556	6	49	6	50	This is a puzzling statement. It is very likley that the heat uptake will be in a specified range. Looking at the main chapter text the range is plus/minus one std according to one study. So what is the basis of 'very likely'? I think the language needs more carelful calibration here. Also tere is a risk with the statement as phrased that it will be taken to imply that RCP8.5 is a very likley scenrio (I know that's not what was intended). [Richard Wood, United Kingdom (of Great Britain and Northern Ireland)]	This is a puzzling statement. It is very likley that the heat uptake will be in a specified range. Looking at the main chapter text the range is plus/minus one std according to one study. So what is the basis of 'very likely'? I think the language needs more carelful calibration here. Also tere is a risk with the statement as phrased that it will be taken to imply that RCP8.5 is a very likley scenrio (I know that's not what was intended).

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
19360	6	49	6	52	In the mentioned section (9.2.3.1) is compared the 2000±350 ZJ from RCP8.5 with the 1000 ZJ under RCP2.6. It doesn't say 1000±200ZJ like in the Executive Summary. [Gwenaelle GREMION, Canada]	In the mentioned section (9.2.3.1) is compared the 2000±350 ZJ from RCP8.5 with the 1000 ZJ under RCP2.6. It doesn't say 1000±200ZJ like in the Executive Summary.
48484	6	52	6	52	AMOC has likely declined by 10% from what period? And 10% ecactly, or by at least that amount? [Kyle Armour, United States of America]	AMOC has likely declined by 10% from what period? And 10% ecactly, or by at least that amount?
19362	6	52	6	52	You're stating that the AMOC has declined by 10%. Please give a reference compared to what/when the AMOC declined by 10%. [Gwenaelle GREMION, Canada]	You're stating that the AMOC has declined by 10%. Please give a reference compared to what/when the AMOC declined by 10%.
56558	6	52	6	52	The statement about pas AMOC decline duplicates a statement at [6,14-15]. Suggest remove. This relates to my more generic comment about how to structure the flow of material through the ES. [Richard Wood, United Kingdom (of Great Britain and Northern Ireland)]	The statement about pas AMOC decline duplicates a statement at [6,14-15]. Suggest remove. This relates to my more generic comment about how to structure the flow of material through the ES.
39232	6	52	6	53	"...in mass transport..." could probably be moved to the first part of the sentence, proposed correction: "The Atlantic Meridional Overturning Circulation has likely declined in mass transport by 10%, and by 2100 it is likely to have declined by up to 50% under higher emissions scenarios." [Dmitry Kovalevsky, Germany]	"...in mass transport..." could probably be moved to the first part of the sentence, proposed correction: "The Atlantic Meridional Overturning Circulation has likely declined in mass transport by 10%, and by 2100 it is likely to have declined by up to 50% under higher emissions scenarios."
13740	6	52	6	53	These percentages are with respect to which year/average period? Please, clarify. [Charalampos Charalampidis, Germany]	These percentages are with respect to which year/average period? Please, clarify.
45888	6	52	6	54	instead of 'declines', 'weakens' may be more suitable to use. [Shikha Singh, India]	instead of 'declines', 'weakens' may be more suitable to use.
7894	6	52	6	54	Where does the 'likely declined by 10%' come from? I can't see anything in the main text. Declined by 10% since when, what is the evidence? Also there is nothing in the main text talking about the magnitude of the decline to 2100 (only that it is uncertain) [Laura Jackson, United Kingdom (of Great Britain and Northern Ireland)]	Where does the 'likely declined by 10%' come from? I can't see anything in the main text. Declined by 10% since when, what is the evidence? Also there is nothing in the main text talking about the magnitude of the decline to 2100 (only that it is uncertain)
28562	6	52			You're stating that the AMOC has declined by 10%. Please give a reference compared to what/when the AMOC declined by 10%. [Thomas Ronge, Germany]	You're stating that the AMOC has declined by 10%. Please give a reference compared to what/when the AMOC declined by 10%.
50410	6	53	6	53	Is volume transport more appropriate than "mass transport" in this context? [Chris Wilson, United Kingdom (of Great Britain and Northern Ireland)]	Is volume transport more appropriate than "mass transport" in this context?
57184	6	54	6	54	I do not fully understand “committed” in this context. Is this referring to a commitment based on historical emissions or certain future scenarios? Please specify or reformulate. [F. Alexander Haumann, Germany]	I do not fully understand “committed” in this context. Is this referring to a commitment based on historical emissions or certain future scenarios? Please specify or reformulate.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
32102	6		9		The projections in this chapter focus overwhelmingly on the most likely future changes, but it is essential for policy makers to also assess potential low-likelihood high impact scenarios (e.g. Sutton, ESD 2018 & BAMS 2019). In this context, I suggest this chapter should include a specific assessment of the potential for significant changes in ocean circulation - not limited to the AMOC - and crucially including quantification of some of the key impacts that could arise. It could be organised basin-by-basin, e.g. the likelihood of significant changes in Arctic Ocean circulation must be very high. [Rowan Sutton, United Kingdom (of Great Britain and Northern Ireland)]	The projections in this chapter focus overwhelmingly on the most likely future changes, but it is essential for policy makers to also assess potential low-likelihood high impact scenarios (e.g. Sutton, ESD 2018 & BAMS 2019). In this context, I suggest this chapter should include a specific assessment of the potential for significant changes in ocean circulation - not limited to the AMOC - and crucially including quantification of some of the key impacts that could arise. It could be organised basin-by-basin, e.g. the likelihood of significant changes in Arctic Ocean circulation must be very high.
48006	6		9		Executive Summary formatting. Please arrange points/paragraphs under subheadings and ensure uncertainty language is provided for each point where it is relevant. [WGI TSU, France]	Executive Summary formatting. Please arrange points/paragraphs under subheadings and ensure uncertainty language is provided for each point where it is relevant.
56560	7	1	7	1	limited' would be clearer than 'constrained'. The letter suggests that background variability may provide information on the trends. [Richard Wood, United Kingdom (of Great Britain and Northern Ireland)]	limited' would be clearer than 'constrained'. The letter suggests that background variability may provide information on the trends.
25272	7	3	7	3	Section 9.5.3.4 doesn't quite make this conclusion and presents results from different models which don't all consider "near-surface permafrost extent" (issues/shortcomings with these models are also mentioned). You could just say that permafrost extent will decrease as "extent" can refer to vertical (permafrost becoming thinner) and lateral. [Sharon Smith, Canada]	Section 9.5.3.4 doesn't quite make this conclusion and presents results from different models which don't all consider "near-surface permafrost extent" (issues/shortcomings with these models are also mentioned). You could just say that permafrost extent will decrease as "extent" can refer to vertical (permafrost becoming thinner) and lateral.
13742	7	6	7	7	I propose rephrasing as: "Changes in Arctic sea ice, glaciers…, and salinity are attributable...", since some of these aspects have been mentioned earlier. [Charalampos Charalampidis, Germany]	I propose rephrasing as: "Changes in Arctic sea ice, glaciers…, and salinity are attributable...", since some of these aspects have been mentioned earlier.
51668	7	7	7	8	can "substantial" be quantified? [Samuel Jaccard, Switzerland]	can "substantial" be quantified?
49904	7	8	7	9	This statement is not correct for the 20th C. See e.g. Marzeion et al 2017, Science. Over the 20th C, the LIA was the dominant influence until ~1990, when AGW started to dominate. [Jonathan Bamber, United Kingdom (of Great Britain and Northern Ireland)]	This statement is not correct for the 20th C. See e.g. Marzeion et al 2017, Science. Over the 20th C, the LIA was the dominant influence until ~1990, when AGW started to dominate.
48942	7	9	7	10	It is not clear if this sentence is referring to direct human interaction with snow cover and mass changes or as a indirect forcing of these changes. [Laura Reynolds, United States of America]	It is not clear if this sentence is referring to direct human interaction with snow cover and mass changes or as a indirect forcing of these changes.
13744	7	10	7	10	"…in the Northern Hemisphere during springtime." [Charalampos Charalampidis, Germany]	"…in the Northern Hemisphere during springtime."
19364	7	12	7	12	For the exec. Summary, I think it's worth to explain what basin scale refers to. [Gwenaelle GREMION, Canada]	For the exec. Summary, I think it's worth to explain what basin scale refers to.
28564	7	12			For the exec. Summary, I think it's worth to explain what basin scale refers to. [Thomas Ronge, Germany]	For the exec. Summary, I think it's worth to explain what basin scale refers to.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
52912	7	13	7	13	"changes are virtually certain to be result from anthropogenic forcing" should instead be "To result from anthropogenic forcing", remove the "be" [Abigail Bodner, United States of America]	"changes are virtually certain to be result from anthropogenic forcing" should instead be "To result from anthropogenic forcing", remove the "be"
9424	7	13	7	13	Insert "the" after "are virtually certain to be". [Klaus Radunsky Radunsky, Austria]	Insert "the" after "are virtually certain to be".
13746	7	14	7	14	"comparisons with" [Charalampos Charalampidis, Germany]	"comparisons with"
19366	7	15	7	15	0-2000 m --> 0-2000 m below sea level or mbsl [Gwenaelle GREMION, Canada]	0-2000 m --> 0-2000 m below sea level or mbsl
57186	7	15	7	17	: I don't think that a "medium confidence" can be implied here, given that only one model and one study could really do such an attribution (Swart et al., 2018). Other studies as cited throughout the chapter have shown substantial differences between models in historical simulations and multi-decadal variability might also play a role in temperature and salinity changes. [F. Alexander Haumann, Germany]	: I don't think that a "medium confidence" can be implied here, given that only one model and one study could really do such an attribution (Swart et al., 2018). Other studies as cited throughout the chapter have shown substantial differences between models in historical simulations and multi-decadal variability might also play a role in temperature and salinity changes.
49278	7	15	7	17	Cross-reference issue - In 9.2.3.4, there is no mention of measurements for 0-2000 m in the Southern Ocean. Is this supposed to be the Wang et al 2015b reference? [Zelina Zaiton Ibrahim, Malaysia]	Cross-reference issue - In 9.2.3.4, there is no mention of measurements for 0-2000 m in the Southern Ocean. Is this supposed to be the Wang et al 2015b reference?
49280	7	15	7	17	The sentence reference is about the Southern Ocean, it may be more appropriate to refer to 9.2.4.2 Southern Ocean, instead of the more generic 9.2.3.4 Water Masses. [Zelina Zaiton Ibrahim, Malaysia]	The sentence reference is about the Southern Ocean, it may be more appropriate to refer to 9.2.4.2 Southern Ocean, instead of the more generic 9.2.3.4 Water Masses.
28566	7	15			0-2000 m --> 0-2000 m below sea level or mbsl [Thomas Ronge, Germany]	0-2000 m --> 0-2000 m below sea level or mbsl
8344	7	17	7	19	Important: clarify the difference between DETECTION and ATTRIBUTION. Agreed that ATTRIBUTION for ice sheets is not possible at this point. However, DETECTION of change IS possible and HAS occurred, at least with high confidence for Greenland (as per Ch. 9 page 6, lines 18-19). ATTRIBUTION (e.g. identifying a causal forcing behind a detected change), at least in the standard sense applied to other AR6 contexts, is primarily limited by the ability to perform comprehensive attribution simulation-based studies, mostly as a result of incomplete and/or uncertain models of the coupled ice-sheet/climate system that can be driven directly by emissions/volcanoes/aerosols/etc (the standard external climate forcing boundary conditions). [Jeremy Fyke, Canada]	Important: clarify the difference between DETECTION and ATTRIBUTION. Agreed that ATTRIBUTION for ice sheets is not possible at this point. However, DETECTION of change IS possible and HAS occurred, at least with high confidence for Greenland (as per Ch. 9 page 6, lines 18-19). ATTRIBUTION (e.g. identifying a causal forcing behind a detected change), at least in the standard sense applied to other AR6 contexts, is primarily limited by the ability to perform comprehensive attribution simulation-based studies, mostly as a result of incomplete and/or uncertain models of the coupled ice-sheet/climate system that can be driven directly by emissions/volcanoes/aerosols/etc (the standard external climate forcing boundary conditions).

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
13748	7	17	7	19	There is extensive recent literature on ice-sheet changes - primarily for Greenland - that attribute negative mass-balance anomalies, as well as changing ice-sheet properties, to climate warming, and hence anthropogenic activity. Good examples include: de la Peña et al. (2015) Changes in the firn structure of the western Greenland Ice Sheet caused by recent warming, The Cryosphere, 9, 1203-1211; van As et al. (2016) Placing Greenland ice sheet ablation measurements in a multi-decadal context, Geological Survey of Denmark and Greenland Bulletin 35, 71-74; Charalampidis et al. (2015) Changing surface–atmosphere energy exchange and refreezing capacity of the lower accumulation area, West Greenland, The Cryosphere 9 (6), 2163-2181; Machguth et al. (2016) Greenland meltwater storage in firn limited by near-surface ice formation, Nature Climate Change 6 (4), 390-393. [Charalampos Charalampidis, Germany]	There is extensive recent literature on ice-sheet changes - primarily for Greenland - that attribute negative mass-balance anomalies, as well as changing ice-sheet properties, to climate warming, and hence anthropogenic activity. Good examples include: de la Peña et al. (2015) Changes in the firn structure of the western Greenland Ice Sheet caused by recent warming, The Cryosphere, 9, 1203-1211; van As et al. (2016) Placing Greenland ice sheet ablation measurements in a multi-decadal context, Geological Survey of Denmark and Greenland Bulletin 35, 71-74; Charalampidis et al. (2015) Changing surface–atmosphere energy exchange and refreezing capacity of the lower accumulation area, West Greenland, The Cryosphere 9 (6), 2163-2181; Machguth et al. (2016) Greenland meltwater storage in firn limited by near-surface ice formation, Nature Climate Change 6 (4), 390-393.
9180	7	17	7	19	It is interesting to see that it has not yet been possible to attribute changes in ice sheets to anothropogenic forcing. [Jim O'Brien, Ireland]	It is interesting to see that it has not yet been possible to attribute changes in ice sheets to anothropogenic forcing.
38456	7	21	7	21	The *change* in area is proportional to the *change* in temperature. There is a non-zero intercept! [Jonathan Gregory, United Kingdom (of Great Britain and Northern Ireland)]	The *change* in area is proportional to the *change* in temperature. There is a non-zero intercept!
56568	7	21	7	21	Arctic sea ice area': summer/winter/annual/all? [Richard Wood, United Kingdom (of Great Britain and Northern Ireland)]	Arctic sea ice area': summer/winter/annual/all?
39234	7	21	7	22	"Arctic sea ice area is proportional to global mean temperature and cumulative greenhouse gas emissions…" - Should "proportional" be understood here like the higher the temperature/emisions, the higher the Arctic sea ice area? [Dmitry Kovalevsky, Germany]	"Arctic sea ice area is proportional to global mean temperature and cumulative greenhouse gas emissions…" - Should "proportional" be understood here like the higher the temperature/emisions, the higher the Arctic sea ice area?
16048	7	21	7	22	"Arctic sea ice area" should read "Arctic sea ice loss". [SAI MING LEE, China]	"Arctic sea ice area" should read "Arctic sea ice loss".

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
32900	7	21	7	23	With present emissions at about 80 GtC/yr, this is suggesting that it will take 80 years or so if emissions remain the same and less if they increase for the Arctic to be essentially ice free in September. This seems to be well behind the indications that observations indicate--models just do not seem to be losing sea ice to the extent that observations are showing. It seems to me that there needs to be mention that this could happen much sooner than is indicated by the statement here. And the statement on lines 25-28 that it is unlikely to be lost seems far too strong compared to observations. My personal view is that the cause of the discrepancy of models and observations is due to inadequate representations of the forcings and their changes in the Arctic. I just don't understand the basis for the statement here. [Michael MacCracken, United States of America]	With present emissions at about 80 GtC/yr, this is suggesting that it will take 80 years or so if emissions remain the same and less if they increase for the Arctic to be essentially ice free in September. This seems to be well behind the indications that observations indicate--models just do not seem to be losing sea ice to the extent that observations are showing. It seems to me that there needs to be mention that this could happen much sooner than is indicated by the statement here. And the statement on lines 25-28 that it is unlikely to be lost seems far too strong compared to observations. My personal view is that the cause of the discrepancy of models and observations is due to inadequate representations of the forcings and their changes in the Arctic. I just don't understand the basis for the statement here.
26152	7	21	7	32	Better to say " Arctic Sea Ice decreases as global mean temperatures increases, and by the time a further 800GTCO2 is emitted from anthropogenic sources, the predictions are that the Arctic Ocean will be ice free in September. At current emission levels this will be in approximately 21 years time. [Stephen Taylor, United Kingdom (of Great Britain and Northern Ireland)]	Better to say " Arctic Sea Ice decreases as global mean temperatures increases, and by the time a further 800GTCO2 is emitted from anthropogenic sources, the predictions are that the Arctic Ocean will be ice free in September. At current emission levels this will be in approximately 21 years time.
52406	7	21	7	32	Begins noting link to GMT as well as carbon budgets, but then includes no GMT basis for Arctic sea ice loss, suggest adding temperature metric as well as carbon budget figures especially because of policy focus on 1.5 v. 2 degree pathways. [Pam Pearson, Sweden]	Begins noting link to GMT as well as carbon budgets, but then includes no GMT basis for Arctic sea ice loss, suggest adding temperature metric as well as carbon budget figures especially because of policy focus on 1.5 v. 2 degree pathways.
52194	7	21	7	32	This results for a specific month (September) feels out of place and lacks context. Is there something which makes September in particular the month of interest? I think it would be useful to either provide that context briefly, or discuss/determine how anthropogenic changes affect whether or not the Arctic will allow passage contigent on human choices. [Daniel Gilford, United States of America]	This results for a specific month (September) feels out of place and lacks context. Is there something which makes September in particular the month of interest? I think it would be useful to either provide that context briefly, or discuss/determine how anthropogenic changes affect whether or not the Arctic will allow passage contigent on human choices.
8346	7	21	7	54	In these future projection summary paragraphs for sea ice, sea level rise, and long-term commitment, different metrics of 'driving change' are provided: cumulative C emissions, RCP scenario, and global temperature change. To the extent possible, is it possible to standardize these in this description (since they are all closely related) or at least clarify to reader the reasons for utilizing these different metrics (presumably they are based on the specific designs of the reference studies)? [Jeremy Fyke, Canada]	In these future projection summary paragraphs for sea ice, sea level rise, and long-term commitment, different metrics of 'driving change' are provided: cumulative C emissions, RCP scenario, and global temperature change. To the extent possible, is it possible to standardize these in this description (since they are all closely related) or at least clarify to reader the reasons for utilizing these different metrics (presumably they are based on the specific designs of the reference studies)?

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
37872	7	21			Modern observations show that Arctic sea-ice area has decreased over the last 40 years and global-mean temperature has increased. It is, however, stretching the use of the word "proportional" to write without qualification that Arctic sea-ice area and global-mean temperature are proportional. If the word "proportional" is retained, it should be preceded by the word "inversely". A further point is that the correlation shown later is for summer ice area, not ice area in general. Is the statement made here intended to apply only to summer? [Adrian Simmons, United Kingdom (of Great Britain and Northern Ireland)]	Modern observations show that Arctic sea-ice area has decreased over the last 40 years and global-mean temperature has increased. It is, however, stretching the use of the word "proportional" to write without qualification that Arctic sea-ice area and global-mean temperature are proportional. If the word "proportional" is retained, it should be preceded by the word "inversely". A further point is that the correlation shown later is for summer ice area, not ice area in general. Is the statement made here intended to apply only to summer?
56570	7	23	7	25	I don't understand this sentence.Please clarify what is meant. [Richard Wood, United Kingdom (of Great Britain and Northern Ireland)]	I don't understand this sentence.Please clarify what is meant.
8308	7	23	7	32	The way the cumulative emissions post-2018 details are presented are very difficult to understand on first read. I suggest some phrasing where the post-2018 nature of both following comments is presented together, e.g., "Independent of scenario, beyond 2018, outcomes differ based on cumulative emissions. For cumulative emissions of less than 500 Pg.... (result) and for cumulative emissons of more than 800 Pg C.... (result)." [Sarah Cooley, United States of America]	The way the cumulative emissions post-2018 details are presented are very difficult to understand on first read. I suggest some phrasing where the post-2018 nature of both following comments is presented together, e.g., "Independent of scenario, beyond 2018, outcomes differ based on cumulative emissions. For cumulative emissions of less than 500 Pg.... (result) and for cumulative emissons of more than 800 Pg C.... (result)."
13750	7	24	7	24	Delete "well described as" [Charalampos Charalampidis, Germany]	Delete "well described as"
48944	7	25	7	27	specify emissions scenario [Laura Reynolds, United States of America]	specify emissions scenario
48198	7	30	7	32	I suggest to ellaborate here or in the respective subsection (9.3.1.2 is listed, but there might be other subsection(s) actual) more about the reversibility and role of atmospheric and oceanic forcings and processes that are crucial for sea ice formation, growth and melt. In line 31, I suggest to specify what temperature is meant; global mean, atmospheric, sea surface, ocean. [Sebastian Gerland, Norway]	I suggest to ellaborate here or in the respective subsection (9.3.1.2 is listed, but there might be other subsection(s) actual) more about the reversibility and role of atmospheric and oceanic forcings and processes that are crucial for sea ice formation, growth and melt. In line 31, I suggest to specify what temperature is meant; global mean, atmospheric, sea surface, ocean.
57188	7	30	7	32	What level of confidence do we have on this reversibility? [F. Alexander Haumann, Germany]	What level of confidence do we have on this reversibility?
13752	7	30	7	32	I wonder about the purpose of this sentence, since it is describing a hypothetical and highly unrealistic scenario: it is very unlikely that the atmospheric temperature will recover to preindustrial levels with more than 400 ppm CO2 currently in the atmosphere (at least 42% increase from preindustrial levels) and the subsequent warming feedbacks. Perhaps it is better to reformulate the sentence to reflect a realistic course of events, while assigning a confidence level. [Charalampos Charalampidis, Germany]	I wonder about the purpose of this sentence, since it is describing a hypothetical and highly unrealistic scenario: it is very unlikely that the atmospheric temperature will recover to preindustrial levels with more than 400 ppm CO2 currently in the atmosphere (at least 42% increase from preindustrial levels) and the subsequent warming feedbacks. Perhaps it is better to reformulate the sentence to reflect a realistic course of events, while assigning a confidence level.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
9426	7	31	7	31	Insert "is" after "ist preindustrial state if temperature". [Klaus Radunsky Radunsky, Austria]	Insert "is" after "ist preindustrial state if temperature".
52196	7	34	7	42	The final sentence relates primarily to thermal expansion, but this section is talking about sea levels over all. If the statement in the headline is meant to apply specifically to thermal expansion as the primary driver of the statement, I suggest adding "because of ongoing thermal expansion" at the end of the headline. [Daniel Gilford, United States of America]	The final sentence relates primarily to thermal expansion, but this section is talking about sea levels over all. If the statement in the headline is meant to apply specifically to thermal expansion as the primary driver of the statement, I suggest adding "because of ongoing thermal expansion" at the end of the headline.
56572	7	34	7	42	This paragraph is out of place given the previous paras on sea level. Please see my generic commentg about orderig of material in the ES. [Richard Wood, United Kingdom (of Great Britain and Northern Ireland)]	This paragraph is out of place given the previous paras on sea level. Please see my generic commentg about orderig of material in the ES.
56576	7	34	7	54	These ideas seem highly policy-relevant. However most of the results are low confidence. On the other hand the bold opening sentence is high confidence but not obviously of high interest for policy. I think this paragraph needs careful consideration about how to formulate a headline sentence whose policy relevance is clear but which is not based on low confidence results. [Richard Wood, United Kingdom (of Great Britain and Northern Ireland)]	These ideas seem highly policy-relevant. However most of the results are low confidence. On the other hand the bold opening sentence is high confidence but not obviously of high interest for policy. I think this paragraph needs careful consideration about how to formulate a headline sentence whose policy relevance is clear but which is not based on low confidence results.
45892	7	35	7	38	X & Y in line 35, and P &Q in line 38 are not defined. To be replaced by numbers. [Shikha Singh, India]	X & Y in line 35, and P &Q in line 38 are not defined. To be replaced by numbers.
31232	7	37	7	37	"marine cliff instability" should probably not be mentionned here : it is rather unclear without context. In addition, they are other instability mechanims that should be mentionned if cliff instability is mentioned. [Jeremie Mouginot, France]	"marine cliff instability" should probably not be mentionned here : it is rather unclear without context. In addition, they are other instability mechanims that should be mentionned if cliff instability is mentioned.
45268	7	37	7	37	Is it necessary to include the marine ice cliff instability here? It seems to me a bit too technical. [Alessandro Silvano, Australia]	Is it necessary to include the marine ice cliff instability here? It seems to me a bit too technical.
56574	7	37	7	38	The MICI has not been defined at this stage. Since it is a new concept since AR5 I think it needs to be properly introduced at some level, even in the ES. At present this doesn't happen until a page later. [Richard Wood, United Kingdom (of Great Britain and Northern Ireland)]	The MICI has not been defined at this stage. Since it is a new concept since AR5 I think it needs to be properly introduced at some level, even in the ES. At present this doesn't happen until a page later.
14952	7	38	7	39	The Executive Summary text for global mean sea level should also acknowledge and quantify the fat tail of probability towards even higher mean sea level rise due to the potential for a substantial contribution from processes such as marine ice cliff instability as is done in the Executive Summary text for ice sheet processes [Jo Brendryen, Norway]	The Executive Summary text for global mean sea level should also acknowledge and quantify the fat tail of probability towards even higher mean sea level rise due to the potential for a substantial contribution from processes such as marine ice cliff instability as is done in the Executive Summary text for ice sheet processes
31234	7	41	7	41	I suggest that "sea level rise beyond 2100" includes more than just thermal expansion (glacier and ice sheets will continue melt). [Jeremie Mouginot, France]	I suggest that "sea level rise beyond 2100" includes more than just thermal expansion (glacier and ice sheets will continue melt).
13754	7	41	7	42	"…that global mean sea level will continue rising beyond 2100, with sea level rise due to…" [Charalampos Charalampidis, Germany]	"…that global mean sea level will continue rising beyond 2100, with sea level rise due to…"

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
52408	7	42	7	42	Add phrase along lines of, "..and contribution from glaciers and ice sheets highly dependent on temperature and emissions pathways." [Pam Pearson, Sweden]	Add phrase along lines of, "..and contribution from glaciers and ice sheets highly dependent on temperature and emissions pathways."
48486	7	44	7	54	It seems that the key point could be made more clearly here that sea level rise would continue even if global temperature could be stabilized, both owing to ongoing thermal expansion as the deep oceans warm and as ice sheets continue to melt. [Kyle Armour, United States of America]	It seems that the key point could be made more clearly here that sea level rise would continue even if global temperature could be stabilized, both owing to ongoing thermal expansion as the deep oceans warm and as ice sheets continue to melt.
32902	7	45	7	45	Given how the documentary "Chasing Ice" showed how rapid collapse of ice streams could be, and the real lack of histroy on how ice streams will behave with warming occurring that is an order of magnitude or so faster than during the deglaciation following the Last Glacial Maximum, it is really hard to understand how "high confidence" can be attributed to this finding. With the equilibrium sea level sensitivity from paleoclimatic records being something like 20 meters per degree C, and how rapidly deglaciation has occurred over glacial-interglacial cycles, I fail to understand the basis for high confidence. [Michael MacCracken, United States of America]	Given how the documentary "Chasing Ice" showed how rapid collapse of ice streams could be, and the real lack of histroy on how ice streams will behave with warming occurring that is an order of magnitude or so faster than during the deglaciation following the Last Glacial Maximum, it is really hard to understand how "high confidence" can be attributed to this finding. With the equilibrium sea level sensitivity from paleoclimatic records being something like 20 meters per degree C, and how rapidly deglaciation has occurred over glacial-interglacial cycles, I fail to understand the basis for high confidence.
57190	7	48	7	50	I found it a bit confusing that there is a range in the rate of sea-level rise for a warming of about 2°C but not for a warming above 2°C. Is the 6 m/°C a minimum or maximum or is there a range? [F. Alexander Haumann, Germany]	I found it a bit confusing that there is a range in the rate of sea-level rise for a warming of about 2°C but not for a warming above 2°C. Is the 6 m/°C a minimum or maximum or is there a range?
32904	7	48	7	50	How is this statement consistent with the rate of deglaciation and sea level rise following the Last Glacial Maximum? The rates given here are not much different than the steric estimates reported elsewhere in this report--ice streams can collapse much more rapidly than indicted by the statements here. [Michael MacCracken, United States of America]	How is this statement consistent with the rate of deglaciation and sea level rise following the Last Glacial Maximum? The rates given here are not much different than the steric estimates reported elsewhere in this report--ice streams can collapse much more rapidly than indicted by the statements here.
19368	7	49	7	54	It should say "9.6.3.5" instead of "9.6.3.4" [Gwenaelle GREMION, Canada]	It should say "9.6.3.5" instead of "9.6.3.4"
57928	7	52	7	52	Cumulative emissions before 2018.. Cummulative emissions from which year to which year? [Bas de Boer, Netherlands]	Cumulative emissions before 2018.. Cummulative emissions from which year to which year?
57930	7	52	7	53	Statement doesn't make sense: "Over the next ... if emitted in the future", this also depends on which scenario is taken that will both determine the cummulative emmisions and will impact how much sea-level will rise. [Bas de Boer, Netherlands]	Statement doesn't make sense: "Over the next ... if emitted in the future", this also depends on which scenario is taken that will both determine the cummulative emmisions and will impact how much sea-level will rise.
48946	7	52	7	54	This sentence is unclear-- do you mean "Over the next 2000 years, the cumulative emissions of CO2 before 2018 will cause a rise in sea-level less than the amount of rise that would occur if the same amount of additional CO2 were emitted in the future" [Laura Reynolds, United States of America]	This sentence is unclear-- do you mean "Over the next 2000 years, the cumulative emissions of CO2 before 2018 will cause a rise in sea-level less than the amount of rise that would occur if the same amount of additional CO2 were emitted in the future"

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
8310	7	52	7	54	This sentence needs rephrasing because it's an important point and not currently very comprehensible. Maybe something like: "The cumulative emissions until 2018 have caused a sea level rise that is less than the sea level rise that will occur in the future from the same amount of additional CO2." [Sarah Cooley, United States of America]	This sentence needs rephrasing because it's an important point and not currently very comprehensible. Maybe something like: "The cumulative emissions until 2018 have caused a sea level rise that is less than the sea level rise that will occur in the future from the same amount of additional CO2."
32906	7	52	7	54	This is also hard to accept. As the ice sheets lose mass, their altitude is lower and so the temperature is warmer and it would seem this would more than make up for the log effect of radiative forcing.Also, being loser, there can be less protection from snow cover. Also, past changes have been mainly due to changes in the amount of warm season solar radiation--that then gets follwoed by cold season cooling that is strong when the CO2 concentration is less than 300 ppm, etc.--with the overall warming caused by the increase in CO2, this has a warming effect all year and there is no opprotunity for the ice sheets to lose IR and get really cold during the winter--so the whole thickness of the ice sheet warms instead of just an upper layer as in the past with changes in orbital elements. I just do not understand where even the medium confidence comes with this finding. [Michael MacCracken, United States of America]	This is also hard to accept. As the ice sheets lose mass, their altitude is lower and so the temperature is warmer and it would seem this would more than make up for the log effect of radiative forcing.Also, being loser, there can be less protection from snow cover. Also, past changes have been mainly due to changes in the amount of warm season solar radiation--that then gets follwoed by cold season cooling that is strong when the CO2 concentration is less than 300 ppm, etc.--with the overall warming caused by the increase in CO2, this has a warming effect all year and there is no opprotunity for the ice sheets to lose IR and get really cold during the winter--so the whole thickness of the ice sheet warms instead of just an upper layer as in the past with changes in orbital elements. I just do not understand where even the medium confidence comes with this finding.
9428	7	53	7	53	Insert "have" after "of additional CO2 will". [Klaus Radunsky Radunsky, Austria]	Insert "have" after "of additional CO2 will".
44360	8	1	8	7	The head-line has high confidence but all contributing statements are low or medium. This is unsatisfactory [Michael Bell, United Kingdom (of Great Britain and Northern Ireland)]	The head-line has high confidence but all contributing statements are low or medium. This is unsatisfactory
8312	8	1	8	7	I have no idea what lines 1 and 2 mean without reading the chapter. Rewrite in plain, jargon-free English. They don't seem to relate all that clearly to lines 3-7, either. [Sarah Cooley, United States of America]	I have no idea what lines 1 and 2 mean without reading the chapter. Rewrite in plain, jargon-free English. They don't seem to relate all that clearly to lines 3-7, either.
52198	8	2	8	2	"from unforced conditions" is confusing and not very specific in this headline. I had to read it several times to understand that it was referring to the noisy (unforced) internal variabiulity of these systems. One way to rewrite it for clarity could be "the background internal variability" [Daniel Gilford, United States of America]	"from unforced conditions" is confusing and not very specific in this headline. I had to read it several times to understand that it was referring to the noisy (unforced) internal variabiulity of these systems. One way to rewrite it for clarity could be "the background internal variability"
56578	8	4	8	5	I think this statement about the trend is inconsistent with the discussion of the trend in the main body of the chapter. [Richard Wood, United Kingdom (of Great Britain and Northern Ireland)]	I think this statement about the trend is inconsistent with the discussion of the trend in the main body of the chapter.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
8348	8	5	8	7	The 2040 year for anthropogenic signal emergence for Greenland Ice Sheet is based on a very highly conservative signal-to-noise assessment (S/N ratio>1). The paper from where this value stems (I was lead author, paper at https://agupubs.onlinelibrary.wiley.com/doi/epdf/10.1002/2014GL060735) notes that for more sensitive signal-to-noise assessment techniques, the emergence year can strongly reduce, to 2021. This paper also notes that point-specific emergence (e.g. at Summit Camp, or in ablation areas) can occur much sooner. Suggest noting these contexts and more generally noting that 'emergence year' depends strongly on the tecnhique used to separate signal from noise (more sensitive techniques will detect emergence earlier). [Jeremy Fyke, Canada]	The 2040 year for anthropogenic signal emergence for Greenland Ice Sheet is based on a very highly conservative signal-to-noise assessment (S/N ratio>1). The paper from where this value stems (I was lead author, paper at https://agupubs.onlinelibrary.wiley.com/doi/epdf/10.1002/2014GL060735) notes that for more sensitive signal-to-noise assessment techniques, the emergence year can strongly reduce, to 2021. This paper also notes that point-specific emergence (e.g. at Summit Camp, or in ablation areas) can occur much sooner. Suggest noting these contexts and more generally noting that 'emergence year' depends strongly on the tecnhique used to separate signal from noise (more sensitive techniques will detect emergence earlier).
8350	8	5	8	7	It is slightly alluded to, but worth reinforcing if possible given constraints, that emergence of anthropogenic signal in large systems (e.g. global oceans, hemispheric sea ice, ice sheets) will occur earlier in some places, and later in others, often for well-understood reasons. In Greenland model simulation-based study mentioned here, for example, ablation area emergence started in as far back as 1960s - 60-80 years before the simulated integrated surface mass balance signal emerged using similar metrics. [Jeremy Fyke, Canada]	It is slightly alluded to, but worth reinforcing if possible given constraints, that emergence of anthropogenic signal in large systems (e.g. global oceans, hemispheric sea ice, ice sheets) will occur earlier in some places, and later in others, often for well-understood reasons. In Greenland model simulation-based study mentioned here, for example, ablation area emergence started in as far back as 1960s - 60-80 years before the simulated integrated surface mass balance signal emerged using similar metrics.
13218	8	5	8	7	This sentences is confusing. What is meant by "the Greenland ice sheet surface mass balance change will emerge from background variability"? Does this mean that around 2040 we should see a negative surface mass balance in Greenland? [Nora Richter, United States of America]	This sentences is confusing. What is meant by "the Greenland ice sheet surface mass balance change will emerge from background variability"? Does this mean that around 2040 we should see a negative surface mass balance in Greenland?
13756	8	5	8	7	Perhaps mention that this is a result suggested by simulations, and is likely an overestimate given the increasing amount of evidence in the literature on changing Greenland mass balance processes and feedbacks. [Charalampos Charalampidis, Germany]	Perhaps mention that this is a result suggested by simulations, and is likely an overestimate given the increasing amount of evidence in the literature on changing Greenland mass balance processes and feedbacks.
31236	8	6	8	6	Change "ice sheet surface mass balance" to "ice sheet mass balance" [Jeremie Mouginot, France]	Change "ice sheet surface mass balance" to "ice sheet mass balance"
44086	8	9	8	10	May be higher impact to switch "the carbon cycle and ecosystems" to "ecosystems and the carbon cycle" given traction following recent IPBES report [Sara Kahanamoku, United States of America]	May be higher impact to switch "the carbon cycle and ecosystems" to "ecosystems and the carbon cycle" given traction following recent IPBES report

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
19370	8	9	8	10	The emboldened text does not really reflect the content referenced in the following sentences; the carbon cycle and impacts to ecosystems are only tangentially discussed in the cross-chapter box and sections referred to. As a suggestion, something along the lines of "Increased ocean temperatures are impacting ocean circulation and increasing the occurrence of extreme marine heatwave events". [Gwenaelle GREMION, Canada]	The emboldened text does not really reflect the content referenced in the following sentences; the carbon cycle and impacts to ecosystems are only tangentially discussed in the cross-chapter box and sections referred to. As a suggestion, something along the lines of "Increased ocean temperatures are impacting ocean circulation and increasing the occurrence of extreme marine heatwave events".
44088	8	9	8	15	Provide brief example of ecosystem impacts of ocean heating and changes in overturning (e.g., coral bleaching, reduced productivity and increased hypoxia following shoaling of the mixed layer) to strengthen ecosystem impact claim [Sara Kahanamoku, United States of America]	Provide brief example of ecosystem impacts of ocean heating and changes in overturning (e.g., coral bleaching, reduced productivity and increased hypoxia following shoaling of the mixed layer) to strengthen ecosystem impact claim
56580	8	9	8	16	The link from the paragraph text to carbon cycle and ecosystems needs to be more explicit here. [Richard Wood, United Kingdom (of Great Britain and Northern Ireland)]	The link from the paragraph text to carbon cycle and ecosystems needs to be more explicit here.
32104	8	9	8	16	Here and elsewhere it is very important to add quantitative information concerning, e.g., how much more frequent marine heatwaves are expected to become. Qualitative information is of very limited use to policy makers. [Rowan Sutton, United Kingdom (of Great Britain and Northern Ireland)]	Here and elsewhere it is very important to add quantitative information concerning, e.g., how much more frequent marine heatwaves are expected to become. Qualitative information is of very limited use to policy makers.
51670	8	9	8	16	The impacts of the ocean processes on the carbon cycle and ecosystems are not explicitely outlined. The § should focus on how changing ocean physics/circulation will affect the marine carbon cycle and mroe generally marine ecosystems and marine ressources. [Samuel Jaccard, Switzerland]	The impacts of the ocean processes on the carbon cycle and ecosystems are not explicitely outlined. The § should focus on how changing ocean physics/circulation will affect the marine carbon cycle and mroe generally marine ecosystems and marine ressources.
44362	8	12	8	13	The deepest mixed layers will shoal with high confidence. Some others may not. The qualification is important [Michael Bell, United Kingdom (of Great Britain and Northern Ireland)]	The deepest mixed layers will shoal with high confidence. Some others may not. The qualification is important
45890	8	14	8	14	Here it is written that AMOC 'has or will' weaken, but on Page 6, Line 14 it is mentioned that it has declined. In order to be consistent, 'has or will' can be changed to 'has and will' [Shikha Singh, India]	Here it is written that AMOC 'has or will' weaken, but on Page 6, Line 14 it is mentioned that it has declined. In order to be consistent, 'has or will' can be changed to 'has and will'
13758	8	18	8	18	Replace "and" with "at" [Charalampos Charalampidis, Germany]	Replace "and" with "at"
52200	8	18	8	18	"and higher resolution" reads very odd in this sentence. Maybe just need to rewrite like "and have higher resolutions". It's also not clear what "higher" (or really any of these improvements) is relative to in the headline. [Daniel Gilford, United States of America]	"and higher resolution" reads very odd in this sentence. Maybe just need to rewrite like "and have higher resolutions". It's also not clear what "higher" (or really any of these improvements) is relative to in the headline.
54886	8	18	8	20	Start of the sentence is slightly unclear/ feels clumsy grammatically, could be rearranged to "Climate models have higher resolution and improved representation of ocean and cryosphere processes,…. [Jonathan Rosser, United Kingdom (of Great Britain and Northern Ireland)]	Start of the sentence is slightly unclear/ feels clumsy grammatically, could be rearranged to "Climate models have higher resolution and improved representation of ocean and cryosphere processes,….

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
7534	8	18	8	30	This section could perhaps benefit from being clearer about which aspects/parameters we should not trust the model projections since most models fail to adequately represent the necessary processes, e.g. lower limb of AMOC due to overflows, Antarctic bottom water formation and associated stratification, shelf-seas, etc [Patrick Hyder, United Kingdom (of Great Britain and Northern Ireland)]	This section could perhaps benefit from being clearer about which aspects/parameters we should not trust the model projections since most models fail to adequately represent the necessary processes, e.g. lower limb of AMOC due to overflows, Antarctic bottom water formation and associated stratification, shelf-seas, etc
7896	8	19	8	19	reducing some model biases [Laura Jackson, United Kingdom (of Great Britain and Northern Ireland)]	reducing some model biases
8352	8	25	8	30	This paragraph describes improvements in climate models (both in increased process representation/diversity, and reduced bias). However, the ice sheet aspect of this paragraph only describes progress in standalone ice sheet modelling for Greenland. Additional content is needed to describe Antarctic progress (particularly on marine ice sheet representation in models) but also - especially in light of paragraph purpose - to describe progress towards ice sheet representation in global climate/Earth system models. [Jeremy Fyke, Canada]	This paragraph describes improvements in climate models (both in increased process representation/diversity, and reduced bias). However, the ice sheet aspect of this paragraph only describes progress in standalone ice sheet modelling for Greenland. Additional content is needed to describe Antarctic progress (particularly on marine ice sheet representation in models) but also - especially in light of paragraph purpose - to describe progress towards ice sheet representation in global climate/Earth system models.
39166	8	32	8	32	it can only be partial analogus and I think is can be misleading to let people think we can directly use the pelao results. In this particular case I think you could supress the word. [Pascale Braconnot, France]	it can only be partial analogus and I think is can be misleading to let people think we can directly use the pelao results. In this particular case I think you could supress the word.
32908	8	32	8	33	What is really important is that the CO2 increase provides positive forcing for the ice through the whole year, not just during summer as for solar forcing in the past. It is this sustained effect that lets the ice sheet really warm and become vulnerable. [Michael MacCracken, United States of America]	What is really important is that the CO2 increase provides positive forcing for the ice through the whole year, not just during summer as for solar forcing in the past. It is this sustained effect that lets the ice sheet really warm and become vulnerable.
7898	8	33	8	34	The second half of this sentence is very vague [Laura Jackson, United Kingdom (of Great Britain and Northern Ireland)]	The second half of this sentence is very vague
51672	8	33	8	41	Emerging paleo-evidence suggests that Southern Ocean Overturning (specifically AABW production) may also have been transiently stalled as a result of freshwater forcing (Hayes et al., 2014 (Science)) under warm (warmer-than-today?) climate background conditions. More generally, Southern Ocean Overturning shows a strong climate-related sensitivity, with generally higher overturning rates under warmer climate and comparatively lower overturning during colder climate states (e.g. Jaccard et al., 2013 (Science) Rae et al., 2018 (Nature)). [Samuel Jaccard, Switzerland]	Emerging paleo-evidence suggests that Southern Ocean Overturning (specifically AABW production) may also have been transiently stalled as a result of freshwater forcing (Hayes et al., 2014 (Science)) under warm (warmer-than-today?) climate background conditions. More generally, Southern Ocean Overturning shows a strong climate-related sensitivity, with generally higher overturning rates under warmer climate and comparatively lower overturning during colder climate states (e.g. Jaccard et al., 2013 (Science) Rae et al., 2018 (Nature)).

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
57932	8	34	8	41	I think the beginning statement (line 32-34) is good. But then the mid-Piacenzian Warm Period should be mentioned here as well, speficically effort has been made to find an orbital configuration during this time (namely MIS KM5c at 3.205 Myr ago) that closely matches the present, but which does show high warming, high CO2 and elevated sea levels. Confidence is naturally lower compared to the LIG. [Bas de Boer, Netherlands]	I think the beginning statement (line 32-34) is good. But then the mid-Piacenzian Warm Period should be mentioned here as well, speficically effort has been made to find an orbital configuration during this time (namely MIS KM5c at 3.205 Myr ago) that closely matches the present, but which does show high warming, high CO2 and elevated sea levels. Confidence is naturally lower compared to the LIG.
39168	8	35	8	35	They are rgeat of course, but in the particular case of the eemian, the conclusion is somehow misleading,for LIG because it results from a huge forcing in terms of changes in insolation seaonal cycle, even though there is almost no changes in insolation annual mean. The analogy between LIG and fure has been shown to be restricted to summer months when albedo, water vapor long wave have similar feedbacks are very similar between the two period, and when thresholds in temperature are reached both for sea ice, ice-sheet or snow melting. see Masson delmotte et al IPCC 2013, A new study on polar amplification in the Arctic by Yoshimori et al. should also be of interest for this discussion in the chapter. [Pascale Braconnot, France]	They are rgeat of course, but in the particular case of the eemian, the conclusion is somehow misleading,for LIG because it results from a huge forcing in terms of changes in insolation seaonal cycle, even though there is almost no changes in insolation annual mean. The analogy between LIG and fure has been shown to be restricted to summer months when albedo, water vapor long wave have similar feedbacks are very similar between the two period, and when thresholds in temperature are reached both for sea ice, ice-sheet or snow melting. see Masson delmotte et al IPCC 2013, A new study on polar amplification in the Arctic by Yoshimori et al. should also be of interest for this discussion in the chapter.
52204	8	35	8	39	It would be helpful to note how (and to what confidence level) the LIG can inform individual processes which influence sea levels [Daniel Gilford, United States of America]	It would be helpful to note how (and to what confidence level) the LIG can inform individual processes which influence sea levels
13760	8	36	8	36	"…likely was between 6 and 10 m higher thank pre-industrial levels…" [Charalampos Charalampidis, Germany]	"…likely was between 6 and 10 m higher thank pre-industrial levels…"
32910	8	37	8	39	Indeed, also not an analogue because the CO2 concentration was less than 300 ppm and so the ice sheet could emit away a lot of the warmth taken up during the summer. With the CO2 concentration to be above, even well above 400 and then 500 ppm, this wintertime cooling cannot occur and the whole ice sheet will warm up, becoming much more vulnerable and with greater flow rates. [Michael MacCracken, United States of America]	Indeed, also not an analogue because the CO2 concentration was less than 300 ppm and so the ice sheet could emit away a lot of the warmth taken up during the summer. With the CO2 concentration to be above, even well above 400 and then 500 ppm, this wintertime cooling cannot occur and the whole ice sheet will warm up, becoming much more vulnerable and with greater flow rates.
8854	8	37	8	39	The other orbital parameters (precession and obliquity) are likely more important for peak warmth during the LIG (e.g. Yin and Berger, Interglacial analogues of the Holocene and its natural near future, QSR, 2015; Langebroek and Nisancioglu, Simulating last interglacial climate with NorESM: role of insolation and greenhouse gases in the timing of peak warmth, CP, 2014) [Petra M. Langebroek, Norway]	The other orbital parameters (precession and obliquity) are likely more important for peak warmth during the LIG (e.g. Yin and Berger, Interglacial analogues of the Holocene and its natural near future, QSR, 2015; Langebroek and Nisancioglu, Simulating last interglacial climate with NorESM: role of insolation and greenhouse gases in the timing of peak warmth, CP, 2014)

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
6315	8	37	8	39	While I agree that the LIG does not provide a direct analogue for future climate change, I think this statement is too negative because the LIG does potentially provide strong regional analogues, for instance warming in the Arctic and Greenland. [Pepijn Bakker, Netherlands]	While I agree that the LIG does not provide a direct analogue for future climate change, I think this statement is too negative because the LIG does potentially provide strong regional analogues, for instance warming in the Arctic and Greenland.
19372	8	37	8	39	The wording in this sentence is somewhat dismissive towards the importance and utility of the LIG as a process analog. A statement should be included highlighting the importance of the LIG for understanding the sensitivities of the ice sheets, millenial-scale variability of climate and sea level, and the sea-level budget. [Gwenaelle GREMION, Canada]	The wording in this sentence is somewhat dismissive towards the importance and utility of the LIG as a process analog. A statement should be included highlighting the importance of the LIG for understanding the sensitivities of the ice sheets, millenial-scale variability of climate and sea level, and the sea-level budget.
52202	8	39	8	39	Would it be useful to mention the Pliocene here, which has very low sensitivity, but as a target for future understanding? [Daniel Gilford, United States of America]	Would it be useful to mention the Pliocene here, which has very low sensitivity, but as a target for future understanding?
56582	8	39	8	41	This sentence is left hanging without any indication of whether such changes could occur in future. Yet this is a question many readers will be interested in. The possibility of abrupt changes is not reflected at all in the bold opening sentence. [Richard Wood, United Kingdom (of Great Britain and Northern Ireland)]	This sentence is left hanging without any indication of whether such changes could occur in future. Yet this is a question many readers will be interested in. The possibility of abrupt changes is not reflected at all in the bold opening sentence.
7536	8	40	8	40	should this read 'over a time period of less than a human lifetime'? [Patrick Hyder, United Kingdom (of Great Britain and Northern Ireland)]	should this read 'over a time period of less than a human lifetime'?
19374	8	40	8	40	Maybe Dansgaard-Oeschger and Younger Dryas are to much jargon for the Excec summary. [Gwenaelle GREMION, Canada]	Maybe Dansgaard-Oeschger and Younger Dryas are to much jargon for the Excec summary.
28568	8	40			Maybe Dansgaard-Oeschger and Younger Dryas are to much jargon for the Excec summary. [Thomas Ronge, Germany]	Maybe Dansgaard-Oeschger and Younger Dryas are to much jargon for the Excec summary.
52208	8	43	8	45	Uncertainties in these processes not only affects Southern Ocean projections, but also sea level rise. These are mentioned directly below, but it might be helpful to add "which influence these projections" after "variety of processes" in line 44 [Daniel Gilford, United States of America]	Uncertainties in these processes not only affects Southern Ocean projections, but also sea level rise. These are mentioned directly below, but it might be helpful to add "which influence these projections" after "variety of processes" in line 44
39170	8	43	8	47	I suppose you plan to refine this when new results are available? It sounds very vague. It could be important for the next to be more precise an make sure processes in ocean, in sea-ice, in ice-shheet and in their coupling are considered separatly, so that we know which models we discuss + have the specific case of CMIP5 to CMIP6 class models and their couplings. [Pascale Braconnot, France]	I suppose you plan to refine this when new results are available? It sounds very vague. It could be important for the next to be more precise an make sure processes in ocean, in sea-ice, in ice-shheet and in their coupling are considered separatly, so that we know which models we discuss + have the specific case of CMIP5 to CMIP6 class models and their couplings.
49442	8	43	8	47	Another key process which is poorly understood and modelled is dense water formation, whether on shelves or in open ocean polynyas. [Sonya Legg, United States of America]	Another key process which is poorly understood and modelled is dense water formation, whether on shelves or in open ocean polynyas.
49282	8	43	8	47	With acknowledgement of lack of process derstanding for the Southern Ocean, it is unclear how the statement of medium confidence on page 9-7, lines 5-17, appears to be inconsistent. [Zelina Zaiton Ibrahim, Malaysia]	With acknowledgement of lack of process derstanding for the Southern Ocean, it is unclear how the statement of medium confidence on page 9-7, lines 5-17, appears to be inconsistent.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
52206	8	43	8	47	Contextualizing these drawbacks relative to AR5 seems important, consistent with the model improvement section above [Daniel Gilford, United States of America]	Contextualizing these drawbacks relative to AR5 seems important, consistent with the model improvement section above
57192	8	46	8	46	Please append “to winds and freshwater, and corresponding […]” as numerous recent studies show a critical role or freshwater input changes for Southern Ocean changes as outlined in the chapter. [F. Alexander Haumann, Germany]	Please append “to winds and freshwater, and corresponding […]” as numerous recent studies show a critical role or freshwater input changes for Southern Ocean changes as outlined in the chapter.
42652	8	48	9	4	The present retreat of the Pine Island and Thwaites glaciers has not exceeded their retreat during the Holocene Thermal Maximum 8000-5000 BP so the statement that there is medium confidence that MISI in currently underway cannot be made. Indeed, it is correctly stated on page 9-44, line 48ff that the Greenland Ice Sheet was smaller during the Holocene Thermal Maximum; a retreat consistent with retreat of glaciers in the Amundsen Sea embayment at that time. Mention is made page 9-58,line 34-36 that retreat of the Pine Island and Thwaites glaciers may have recently stabilised, but the key fact is that such movements are not outside natural variability as seen in their movements during the HTM:Johnson, J, Bentley, M, Smith, J, Finkel, R, Rood, D, Gohl, K, Balco, G, Larter, R, Schaefer, J, 2014, Rapid thinning of Pine Island Glacier in the early Holocene., Science 28, vol. 343, Issue 6173, pp. 999-1001.The rapid thinning on these glaciers in the HTM as described above means that the statement below is not correct as the current retreat is not dissimilar to the glacial retreat in the HTM. [Howard Brady, Australia]	The present retreat of the Pine Island and Thwaites glaciers has not exceeded their retreat during the Holocene Thermal Maximum 8000-5000 BP so the statement that there is medium confidence that MISI in currently underway cannot be made. Indeed, it is correctly stated on page 9-44, line 48ff that the Greenland Ice Sheet was smaller during the Holocene Thermal Maximum; a retreat consistent with retreat of glaciers in the Amundsen Sea embayment at that time. Mention is made page 9-58,line 34-36 that retreat of the Pine Island and Thwaites glaciers may have recently stabilised, but the key fact is that such movements are not outside natural variability as seen in their movements during the HTM:Johnson, J, Bentley, M, Smith, J, Finkel, R, Rood, D, Gohl, K, Balco, G, Larter, R, Schaefer, J, 2014, Rapid thinning of Pine Island Glacier in the early Holocene., Science 28, vol. 343, Issue 6173, pp. 999-1001.The rapid thinning on these glaciers in the HTM as described above means that the statement below is not correct as the current retreat is not dissimilar to the glacial retreat in the HTM.
9182	8	49	8	50	As previously indicated, it is unwise, given all the uncertainties in the science and models, to be making predictions beyond 2100. [Jim O'Brien, Ireland]	As previously indicated, it is unwise, given all the uncertainties in the science and models, to be making predictions beyond 2100.
56584	8	49	9	4	This is an important paragraph where much has changed since AR5 - albeit with deep uncertainty. I think a reader is going to want to know that things have moved on. Specifically: (a) are the processes considered here the same processes that contributed to 'ice sheet dynamical instability' in AR5? (I think the answer is no) (b) If not, what's new here? (c) at some point, the chapter is going to have to integrate the information about these processes into its overall sea level projection assessment. How is this going to be done? [Richard Wood, United Kingdom (of Great Britain and Northern Ireland)]	This is an important paragraph where much has changed since AR5 - albeit with deep uncertainty. I think a reader is going to want to know that things have moved on. Specifically: (a) are the processes considered here the same processes that contributed to 'ice sheet dynamical instability' in AR5? (I think the answer is no) (b) If not, what's new here? (c) at some point, the chapter is going to have to integrate the information about these processes into its overall sea level projection assessment. How is this going to be done?

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
31272	8	49	9	4	I believe the "very low confidence" for attributing the change in Amundsen Sea Embayment to human activities should be upgraded to "low or medium confidence", while the "low confidence" for the potential of MICI to increase the contribution by half metre to sea level rise should be downgraded to "very low confidence" [Jeremie Mouginot, France]	I believe the "very low confidence" for attributing the change in Amundsen Sea Embayment to human activities should be upgraded to "low or medium confidence", while the "low confidence" for the potential of MICI to increase the contribution by half metre to sea level rise should be downgraded to "very low confidence"
8354	8	49	9	4	Ice sheet contribution ito future sea level contributions comes from poor understanding of key ice sheet processes (e.g. MISI, MICI). But, also stems highly (perhaps to an equal degree) from uncertainty in climate sensitivity, and/or polar amplification level. See Fyke et al. (2014, https://link.springer.com/article/10.1007/s00382-014-2050-7) and perhaps forward-cited papers from this reference, for an exploration of GrIS-sourced SLR uncertainty due specifically to climate sensitivity and polar amplification uncertainty. In short, uncertainty in climate sensitivity and polar amplification relate directly to uncertainty in sea level rise projections. [Jeremy Fyke, Canada]	Ice sheet contribution ito future sea level contributions comes from poor understanding of key ice sheet processes (e.g. MISI, MICI). But, also stems highly (perhaps to an equal degree) from uncertainty in climate sensitivity, and/or polar amplification level. See Fyke et al. (2014, https://link.springer.com/article/10.1007/s00382-014-2050-7) and perhaps forward-cited papers from this reference, for an exploration of GrIS-sourced SLR uncertainty due specifically to climate sensitivity and polar amplification uncertainty. In short, uncertainty in climate sensitivity and polar amplification relate directly to uncertainty in sea level rise projections.
13762	8	52	8	52	Perhaps just "likely"?.. [Charalampos Charalampidis, Germany]	Perhaps just "likely"?..
8674	8	52	8	52	Marine ice sheet instability (not shelf?) [Goneri Le Cozannet, France]	Marine ice sheet instability (not shelf?)
7538	8	55	8	55	Given the known large errors in Southern Ocean SSTs and wind stresses (including wind jet latitude) in the models, is the the 'medium confidence' in projected basal melting appropriate? [Patrick Hyder, United Kingdom (of Great Britain and Northern Ireland)]	Given the known large errors in Southern Ocean SSTs and wind stresses (including wind jet latitude) in the models, is the the 'medium confidence' in projected basal melting appropriate?
31238	9	1	9	4	MICI is not well constrained and it is so far not observed in current glacier changes. As shown in Edwards et al. 2019, the MICI hypothesis is not required to reproduce past sea level changes and MICI projections overestimate sea level rise for this century. I would suggest to downgrade it to "very low confidence" on line 3. [Jeremie Mouginot, France]	MICI is not well constrained and it is so far not observed in current glacier changes. As shown in Edwards et al. 2019, the MICI hypothesis is not required to reproduce past sea level changes and MICI projections overestimate sea level rise for this century. I would suggest to downgrade it to "very low confidence" on line 3.
49288	9	7			Observation on the overlaps in topic with that in Chapter 2 section 2.3.2.1 on Sea-ice extent/area and thickness. Please ensure appropriate details should be stated in the respective sections in Chapter 9. As it is now, section 9.2.3.4 refers to section 2.3.2.1, although Chapter 2 is to focus on the global and large-scale change. [Zelina Zaiton Ibrahim, Malaysia]	Observation on the overlaps in topic with that in Chapter 2 section 2.3.2.1 on Sea-ice extent/area and thickness. Please ensure appropriate details should be stated in the respective sections in Chapter 9. As it is now, section 9.2.3.4 refers to section 2.3.2.1, although Chapter 2 is to focus on the global and large-scale change.
44948	9	9			Table 9.1 is a very useful overview. Please note that CH2 includes a substantial presentation, including formal assessments of ocean acidification and deoxygenation, plus all of the cryosphere topics. [Darrell Kaufman, United States of America]	Table 9.1 is a very useful overview. Please note that CH2 includes a substantial presentation, including formal assessments of ocean acidification and deoxygenation, plus all of the cryosphere topics.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
52150	9	21	9	27	Given the inclusion of process time and attribution, both of which are based upon the substantive text it feels a little odd (spoiler) to put table 9.1 here and not use it in a summary instead. You may wish to consider rescoping and placing the results-orientated aspects instead in a summary section? [Peter Thorne, Ireland]	Given the inclusion of process time and attribution, both of which are based upon the substantive text it feels a little odd (spoiler) to put table 9.1 here and not use it in a summary instead. You may wish to consider rescoping and placing the results-orientated aspects instead in a summary section?
37874	9	22			With regard to Table 9.1, there are processes other than marine heatwaves that change near-surface ocean temperatures on timescales of a day. It might be better to remove the timescale of one day from the table. In that case the short-period processes that contribute to extreme sea-level change would be better treated in the text, rather than by table entries. This would avoid the question of whether these three items all merit the reference to them having a seasonal time scale. [Adrian Simmons, United Kingdom (of Great Britain and Northern Ireland)]	With regard to Table 9.1, there are processes other than marine heatwaves that change near-surface ocean temperatures on timescales of a day. It might be better to remove the timescale of one day from the table. In that case the short-period processes that contribute to extreme sea-level change would be better treated in the text, rather than by table entries. This would avoid the question of whether these three items all merit the reference to them having a seasonal time scale.
52914	9	24	9	24	Table 9.1: Do the colors represent anytihing besides what is already stated in words? i.e confidence range and time scales? Either way, it would be helpful to address the color range in the caption. [Abigail Bodner, United States of America]	Table 9.1: Do the colors represent anytihing besides what is already stated in words? i.e confidence range and time scales? Either way, it would be helpful to address the color range in the caption.
30246	9	24	9	25	What is the meaning of the colors in this table? [Frank Pattyn, Belgium]	What is the meaning of the colors in this table?
32324	9	24	9	25	Table 9.1. This is a very useful presentation of results. However, could an extra final column be added showing the confidence level from AR5? Then it would be easy to see at a glance where the assessment has changed between AR5 and AR6. [Simon Josey, United Kingdom (of Great Britain and Northern Ireland)]	Table 9.1. This is a very useful presentation of results. However, could an extra final column be added showing the confidence level from AR5? Then it would be easy to see at a glance where the assessment has changed between AR5 and AR6.
42620	9	24	9	25	What do the colors in Tabple 9.1? [William Gutowski, United States of America]	What do the colors in Tabple 9.1?
16050	9	24	9	25	No human attribution can be assigned to sea level changes due to tides according to Table 9.1, which is inconsistent with the conclusion given in lines 36-38 on p.6 (Executive Summary): "In some locations, changes in tides (high confidence) or surge (low confidence) also contribute. Relative sea-level rise and direct anthropogenic factors, such as dredging, are the primary drivers of observed tidal changes {medium confidence; 9.6.5}." [SAI MING LEE, China]	No human attribution can be assigned to sea level changes due to tides according to Table 9.1, which is inconsistent with the conclusion given in lines 36-38 on p.6 (Executive Summary): "In some locations, changes in tides (high confidence) or surge (low confidence) also contribute. Relative sea-level rise and direct anthropogenic factors, such as dredging, are the primary drivers of observed tidal changes {medium confidence; 9.6.5}."
48200	9	24	9	26	Table 9.1 gives important and relevant information, but I find the consistency for some items listed could be improved. Column 1 and 2 lack a title. The table caption mentions "processes", but not all items listed are processes. For example, a word would need to be added to "Arctic sea ice", if it should be consistent with "mean sea level change". [Sebastian Gerland, Norway]	Table 9.1 gives important and relevant information, but I find the consistency for some items listed could be improved. Column 1 and 2 lack a title. The table caption mentions "processes", but not all items listed are processes. For example, a word would need to be added to "Arctic sea ice", if it should be consistent with "mean sea level change".

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
42644	9	24	9	26	The Table listing forces that contribute to sea level rise (Table 9.1, page 9-9) is an example of the IPCC continuing to ignore articles on the relationship between cosmic radiation, solar magnetic flux and cooling events. Predictions of continued warming and sea level rise as C02 levels rise have, to date, not included caveats that the warming effects of C02 can be over-ridden by other forcings. Historical geologists note such factual changes (cooling events with high C02). The fact of such events is real even though the exact mechanism behind such changes is subject to debate. The existence of high cosmic formed isotopes -(e.g.Be10)- occurring with such cold snaps can no longer be ignored [Howard Brady, Australia]	The Table listing forces that contribute to sea level rise (Table 9.1, page 9-9) is an example of the IPCC continuing to ignore articles on the relationship between cosmic radiation, solar magnetic flux and cooling events. Predictions of continued warming and sea level rise as C02 levels rise have, to date, not included caveats that the warming effects of C02 can be over-ridden by other forcings. Historical geologists note such factual changes (cooling events with high C02). The fact of such events is real even though the exact mechanism behind such changes is subject to debate. The existence of high cosmic formed isotopes -(e.g.Be10)- occurring with such cold snaps can no longer be ignored
8094	9	24	9	26	In Table 9.1, the timescale of change for tides is shown as days only, but in Box 9.2 (page 91) the 4.4 and 18.6 yr tidal cycles are highlighted. This should be reflected in Table 9.1. [Torbjorn Tornqvist, United States of America]	In Table 9.1, the timescale of change for tides is shown as days only, but in Box 9.2 (page 91) the 4.4 and 18.6 yr tidal cycles are highlighted. This should be reflected in Table 9.1.
25274	9	24	9	26	Table 9.1 - more linkages to Chapter 2 should be made, in particular the cryosphere components (except for lake and river ice). Chapter 2 considers the changes in these components over time scales of millenia to decades. Some ocean components listed in sea level section are also covered in Ch 2. (see Cross Chapter Box 2.1, Table 1) [Sharon Smith, Canada]	Table 9.1 - more linkages to Chapter 2 should be made, in particular the cryosphere components (except for lake and river ice). Chapter 2 considers the changes in these components over time scales of millenia to decades. Some ocean components listed in sea level section are also covered in Ch 2. (see Cross Chapter Box 2.1, Table 1)
41420	9	24	9	26	I propose the separation of Greenland ice sheet and Antarctic ice sheet with ice shelves in Table 9.1, but also else where in the report. Until now, it has been customary to include both ice sheets in the same category, due to the same theoretical timescale in which their geometry adjusts to mass-balance changes. However, at this point it is clear that the ice-sheet mass balance is controlled by different processes on each of the two ice sheets. In the case of Table 9.1, the timescales will remain the same, however the human attribution will be able to be constrained better in each case. [Charalampos Charalampidis, Germany]	I propose the separation of Greenland ice sheet and Antarctic ice sheet with ice shelves in Table 9.1, but also else where in the report. Until now, it has been customary to include both ice sheets in the same category, due to the same theoretical timescale in which their geometry adjusts to mass-balance changes. However, at this point it is clear that the ice-sheet mass balance is controlled by different processes on each of the two ice sheets. In the case of Table 9.1, the timescales will remain the same, however the human attribution will be able to be constrained better in each case.
51674	9	24	9	26	Table 9.1 specifies that "ocean acidification" and "ocean doexygenation" will be covered in §9.2.5, which does not appear to be the case. More generally, indications provided in Table 9.1 do not always match the table of content. [Samuel Jaccard, Switzerland]	Table 9.1 specifies that "ocean acidification" and "ocean doexygenation" will be covered in §9.2.5, which does not appear to be the case. More generally, indications provided in Table 9.1 do not always match the table of content.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
8672	9	24	9	26	Table 9,1 is useful but not completely clear: first, the color scale could be used to identify which timescales are most relevant to each process. For example, dayly timescales are most relevant for tides, as shown in the present version of the table, but there are also seasonnal, yearly and decadal (up to 18,6yr) modes of variability. The column on human attribution could be supplemented with a column on the detection of changes. For example, Woodworth (2010) explores recent changes in tidal changes. Note also forthcoming papers (Haigh et al.) on tidal changes, which can provide useful information regarding state of the art in detection/attribution of changes in tidal changes. The column on detection could be relevant for waves too. Woodworth, P. L. "A survey of recent changes in the main components of the ocean tide." Continental shelf research 30.15 (2010): 1680-1691. [Goneri Le Cozannet, France]	Table 9,1 is useful but not completely clear: first, the color scale could be used to identify which timescales are most relevant to each process. For example, dayly timescales are most relevant for tides, as shown in the present version of the table, but there are also seasonnal, yearly and decadal (up to 18,6yr) modes of variability. The column on human attribution could be supplemented with a column on the detection of changes. For example, Woodworth (2010) explores recent changes in tidal changes. Note also forthcoming papers (Haigh et al.) on tidal changes, which can provide useful information regarding state of the art in detectioNot applicablettribution of changes in tidal changes. The column on detection could be relevant for waves too. Woodworth, P. L. "A survey of recent changes in the main components of the ocean tide." Continental shelf research 30.15 (2010): 1680-1691.
49906	9	24	9	26	Not sure I understand the purpose of Table 9.1 and what the colours show. Parts of the AIS (ice streams) respond to tidal forcing (see Gudmundsson, 2006, 2007) and the GrIS has a large seasonal cycle in SMB and ice dynamics just like sea ice and snow so it's not really correct or perhaps I don't understand what it means but if it's included it needs to be correct in a strict sense. [Jonathan Bamber, United Kingdom (of Great Britain and Northern Ireland)]	Not sure I understand the purpose of Table 9.1 and what the colours show. Parts of the AIS (ice streams) respond to tidal forcing (see Gudmundsson, 2006, 2007) and the GrIS has a large seasonal cycle in SMB and ice dynamics just like sea ice and snow so it's not really correct or perhaps I don't understand what it means but if it's included it needs to be correct in a strict sense.
48948	9	24	9	27	I find the purpose of this table unclear. Are the timescales of change referring to natural change, human-induced variability, both? What does "changing processes" mean in terms of timescales and what kinds of changes are being referred to in the human attribution column? Natural variability between ENSO states, increases/decreases in amplitude of ENSOs, etc.? All of the above? [Laura Reynolds, United States of America]	I find the purpose of this table unclear. Are the timescales of change referring to natural change, human-induced variability, both? What does "changing processes" mean in terms of timescales and what kinds of changes are being referred to in the human attribution column? Natural variability between ENSO states, increases/decreases in amplitude of ENSOs, etc.? All of the above?
45894	9	24	9	27	The yellow color is the table changes shade which probably shows which time scales ae more important to a particular process. This should be mentioned in the caption. [Shikha Singh, India]	The yellow color is the table changes shade which probably shows which time scales ae more important to a particular process. This should be mentioned in the caption.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
32250	9	25	9	26	In table 9.1 it is stated that we have low confidence in the human attribution to changing processes for permafrost. I don't agree that our confidence here should be lower than that for snow, for example. In my opinion there is at least medium confidence in human attribution to permafrost change. There are so many recent studies that have documented accelerated permafrost thaw and thermokarst development that I think at least medium confidence can be stated. These studies include but are not limited to : Jones et al., 2016, Presence of rapidly degrading permafrost plateaus in south-central Alaska, Cryosphere, 10, 2673-2692; Liljedahl et al., 2016, Pan-Arctic ice-wedge degradation in warming permafrost and its influence on tundra hydrology, Nature Geoscience, 9, 312-318; Lewkowitcz and Way, 2019, Extremes of summer climate trigger thousands of thermokarst landslides in a High Arctic environment, Nature Communications, 10, 1329; Borge et al., 2017, Strong degradation of palsas and peat plateaus in northern Norway during the last 60 years, Cryosphere, 11, 1-16; Lara et al., 2016, Thermokarst rates intensify due to climate change and forest fragmentation in an Alaskan boreal forest lowland, Global Change Biology, 22, 816-829; Baltzer et al., 2014, Forests on thawing permafrost: fragmentation, edge effects, and net forest loss, Global Change Biology, 20, 824-834. Gibson et al., 2018, Wildfire as a major driver of recent permafrost thaw in boreal peatlands, Nature communications, 9, 3041. [David Olefeldt, Canada]	In table 9.1 it is stated that we have low confidence in the human attribution to changing processes for permafrost. I don't agree that our confidence here should be lower than that for snow, for example. In my opinion there is at least medium confidence in human attribution to permafrost change. There are so many recent studies that have documented accelerated permafrost thaw and thermokarst development that I think at least medium confidence can be stated. These studies include but are not limited to : Jones et al., 2016, Presence of rapidly degrading permafrost plateaus in south-central Alaska, Cryosphere, 10, 2673-2692; Liljedahl et al., 2016, Pan-Arctic ice-wedge degradation in warming permafrost and its influence on tundra hydrology, Nature Geoscience, 9, 312-318; Lewkowitcz and Way, 2019, Extremes of summer climate trigger thousands of thermokarst landslides in a High Arctic environment, Nature Communications, 10, 1329; Borge et al., 2017, Strong degradation of palsas and peat plateaus in northern Norway during the last 60 years, Cryosphere, 11, 1-16; Lara et al., 2016, Thermokarst rates intensify due to climate change and forest fragmentation in an Alaskan boreal forest lowland, Global Change Biology, 22, 816-829; Baltzer et al., 2014, Forests on thawing permafrost: fragmentation, edge effects, and net forest loss, Global Change Biology, 20, 824-834. Gibson et al.,
39796	9	25			Table 9.1 - what does the colour coding indicate in the timescales? Is it true that storm surges only change seasonally and no contribution to interannual processes is (at least theoretically possible? Isn't there a misunderstanding here in how mean sea level and storm surges are separated? [Michael Tsimplis, China]	Table 9.1 - what does the colour coding indicate in the timescales? Is it true that storm surges only change seasonally and no contribution to interannual processes is (at least theoretically possible? Isn't there a misunderstanding here in how mean sea level and storm surges are separated?
25276	9	34	10	5	There have been other recent assessments that are relevant especially for the Arctic and these could also be mentioned. These include the 2017 AMAP update of Snow, Water, Ice and Permafrost in the Arctic (SWIPA 2017) and the AMAP Adaptation Actions for a Changing Arctic regional syntheses. These reports are particularly relevant for cryosphere sections of the report. [Sharon Smith, Canada]	There have been other recent assessments that are relevant especially for the Arctic and these could also be mentioned. These include the 2017 AMAP update of Snow, Water, Ice and Permafrost in the Arctic (SWIPA 2017) and the AMAP Adaptation Actions for a Changing Arctic regional syntheses. These reports are particularly relevant for cryosphere sections of the report.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
38484	9	36	10	5	This part means that the conclusions from the SROCC, Sr1.5 and SRCCL can be used as a baseline for this chapter. Thus, we need to consider any repetition from those previous reports. [Iskhaq Iskandar, Indonesia]	This part means that the conclusions from the SROCC, Sr1.5 and SRCCL can be used as a baseline for this chapter. Thus, we need to consider any repetition from those previous reports.
54310	9	44	9	45	It would be preferable to use the terms 'Southern Australia' and 'Northern Australia' to avoid possible confusion with the state of South Australia (also elsewhere where these terms are used). [Blair Trewin, Australia]	It would be preferable to use the terms 'Southern Australia' and 'Northern Australia' to avoid possible confusion with the state of South Australia (also elsewhere where these terms are used).
8166	10	5	10	5	Why only the "Arctic" ? SROCC also assesses the Antarctic cryosphere. I also think that is is worth mentioning that SROCC assessed the cryosphere only in high mountains and polar regions, hence snow cover outside these two areas was not assessed - this is explicitly mentioned in SROCC to be assessed in AR6 WG1. [Samuel Morin, France]	Why only the "Arctic" ? SROCC also assesses the Antarctic cryosphere. I also think that is is worth mentioning that SROCC assessed the cryosphere only in high mountains and polar regions, hence snow cover outside these two areas was not assessed - this is explicitly mentioned in SROCC to be assessed in AR6 WG1.
40336	10	5			These are the differences in structure and they are useful. Where are the differences in substance and outcomes with AR5 summarised? [Michael Tsimplis, China]	These are the differences in structure and they are useful. Where are the differences in substance and outcomes with AR5 summarised?
52152	10	8			This in the report structure adopted should reside in chapter 1 and not chapter 9 so I would remove this sub-section and refer to chapter 1 from here and / or relevant sections. It should be ensured that everything is captured in chapter 1 first, obviously [Peter Thorne, Ireland]	This in the report structure adopted should reside in chapter 1 and not chapter 9 so I would remove this sub-section and refer to chapter 1 from here and / or relevant sections. It should be ensured that everything is captured in chapter 1 first, obviously
39798	10	10			In the context of Table 9.1 does this statement on improvement, cover every row and column; one or two columns to the right of time scales or only some cells (and which)? More importantly a Table with the changes in the important metrics should be useful: If someone has read the previous report and is interested in the concluding numbers- how differen are these numbers now and, if there are different why? Or how this different striucture interaction changed the outcome - if it has. [Michael Tsimplis, China]	In the context of Table 9.1 does this statement on improvement, cover every row and column; one or two columns to the right of time scales or only some cells (and which)? More importantly a Table with the changes in the important metrics should be useful: If someone has read the previous report and is interested in the concluding numbers- how differen are these numbers now and, if there are different why? Or how this different striucture interaction changed the outcome - if it has.
48694	10	14	10	14	satellites measuring Sea Surface Salinity (i.e. not salinity). This should be to be consistent with the privious Sea Surface Temperature that is not he same as temperature. [Rafael Catany, United Kingdom (of Great Britain and Northern Ireland)]	satellites measuring Sea Surface Salinity (i.e. not salinity). This should be to be consistent with the privious Sea Surface Temperature that is not he same as temperature.
48696	10	14	10	14	Satellite measure Clhorophyl instead of color could be a more siginificant [Rafael Catany, United Kingdom (of Great Britain and Northern Ireland)]	Satellite measure Clhorophyl instead of color could be a more siginificant
48698	10	14	10	14	Satellites are not measuring but instead satellites are inferring, estimating, retrieve, etc. a measure (e.g. SSS, SST, Clhrophyl, etc.) [Rafael Catany, United Kingdom (of Great Britain and Northern Ireland)]	Satellites are not measuring but instead satellites are inferring, estimating, retrieve, etc. a measure (e.g. SSS, SST, Clhrophyl, etc.)
12948	10	14	10	15	AMOC should be removed, or added other programs such as RAMA, PIRATA, TOGA-TAO moorings [RADEN DWI SUSANTO, United States of America]	AMOC should be removed, or added other programs such as RAMA, PIRATA, TOGA-TAO moorings

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
39800	10	15			So these have improved over the period in accuracy? By how much? [Michael Tsimplis, China]	So these have improved over the period in accuracy? By how much?
39802	10	19			Perhaps a Table in the appendix summarising what has "improved" and by how much would be useful. It is obvious that longer time series can reflect to better analysis of some frequencies but not necessary for all frequencies [Michael Tsimplis, China]	Perhaps a Table in the appendix summarising what has "improved" and by how much would be useful. It is obvious that longer time series can reflect to better analysis of some frequencies but not necessary for all frequencies
38486	10	21	10	36	It is good to see strong development for the CMIP6 results included in this chapter. It is expected to have continuous development by incorporating the latest literatures from CMIP6 output. [Iskhaq Iskandar, Indonesia]	It is good to see strong development for the CMIP6 results included in this chapter. It is expected to have continuous development by incorporating the latest literatures from CMIP6 output.
39172	10	22	10	22	please include references to the MIPs you consider when you ref to them Here Eyring et al. (2016) [Pascale Braconnot, France]	please include references to the MIPs you consider when you ref to them Here Eyring et al. (2016)
44438	10	25	10	25	For SSP/scenarios, you may reference chapter 1 section 6. [Anne Marie Treguier, France]	For SSP/scenarios, you may reference chapter 1 section 6.
19376	10	25	10	27	It is better to include a box, table or a figure, which should briefly explain the exact contributions from each MIPs (ScenarioMIP, HighResMIP, OMIP,27 FAFMIP, SIMIP, PMIP4, ISMIP6, and GlacierMIP). [Gwenaelle GREMION, Canada]	It is better to include a box, table or a figure, which should briefly explain the exact contributions from each MIPs (ScenarioMIP, HighResMIP, OMIP,27 FAFMIP, SIMIP, PMIP4, ISMIP6, and GlacierMIP).
19378	10	27	10	28	For a better understanding, "higher resolution ocean components than CMIP5" should be more precise. Give the components in a bracket). [Gwenaelle GREMION, Canada]	For a better understanding, "higher resolution ocean components than CMIP5" should be more precise. Give the components in a bracket).
44434	10	27	10	42	Two annexes (III and II) are mentioned, but I did not find them? Regarding the definition of MIPS, there is a table in chapter 1 that could be referred to. [Anne Marie Treguier, France]	Two annexes (III and II) are mentioned, but I did not find them? Regarding the definition of MIPS, there is a table in chapter 1 that could be referred to.
19380	10	28	10	29	Should be more precise. Give in a bracket, what types of mesoscale oceanic processes were able to resolve with high-resolution outputs from HighResMIP. [Gwenaelle GREMION, Canada]	Should be more precise. Give in a bracket, what types of mesoscale oceanic processes were able to resolve with high-resolution outputs from HighResMIP.
19382	10	28	10	35	Are resolutions and improvements defined somewhere? [Gwenaelle GREMION, Canada]	Are resolutions and improvements defined somewhere?
44364	10	29	10	29	sufficient to resolve (or represent well) at mid-latitudes [Michael Bell, United Kingdom (of Great Britain and Northern Ireland)]	sufficient to resolve (or represent well) at mid-latitudes

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
49220	10	30	10	30	References for HighResMIP are evolving, but papers so far include: Roberts CD et al. (2018), Gutjahr et al. (2019, accepted), Roberts MJ et al. (2019, submitted), Sidorenko et al. (2019, submitted), Haarsma et al. (in prep). Caron et al. (in prep) will give an overview of the multi-model propoerties. Roberts, C. D., Senan, R., Molteni, F., Boussetta, S., Mayer, M., and Keeley, S. P. E., 2018: Climate model configurations of the ECMWF Integrated Forecasting System (ECMWF-IFS cycle 43r1) for HighResMIP. Geosci. Model Dev., 11, 3681-3712, https://doi.org/10.5194/gmd-11-3681-2018. Gutjahr, O., et al.: Max Planck Institute Earth System Model (MPI-ESM) for High-Resolution Model Intercomparison Project (HighResMIP). Geosci. Model Dev., accepted, 2019.Roberts, M. J., Baker, A., Blockley, E. W., Calvert, D., Coward, A., Hewitt, H. T., Jackson, L. C., Kuhlbrodt, T., Mathiot, P., Roberts, C. D., Schiemann, R., Seddon, J., Vannière, B., and Vidale, P. L.: Description of the resolution hierarchy of the global coupled HadGEM3-GC3.1 model as used in CMIP6 HighResMIP experiments, Geosci. Model Dev. Discuss., https://doi.org/10.5194/gmd-2019-148, in review, 2019. Sidorenko, D., and co-authors: Evaluation of FESOM2.0 coupled to ECHAM6.3: Pre-industrial and HighResMIP simulations. J. Adv. Model. Earth Syst., submitted. [Malcolm Roberts, United Kingdom (of Great Britain and Northern Ireland)]	References for HighResMIP are evolving, but papers so far include: Roberts CD et al. (2018), Gutjahr et al. (2019, accepted), Roberts MJ et al. (2019, submitted), Sidorenko et al. (2019, submitted), Haarsma et al. (in prep). Caron et al. (in prep) will give an overview of the multi-model propoerties. Roberts, C. D., Senan, R., Molteni, F., Boussetta, S., Mayer, M., and Keeley, S. P. E., 2018: Climate model configurations of the ECMWF Integrated Forecasting System (ECMWF-IFS cycle 43r1) for HighResMIP. Geosci. Model Dev., 11, 3681-3712, https://doi.org/10.5194/gmd-11-3681-2018. Gutjahr, O., et al.: Max Planck Institute Earth System Model (MPI-ESM) for High-Resolution Model Intercomparison Project (HighResMIP). Geosci. Model Dev., accepted, 2019.Roberts, M. J., Baker, A., Blockley, E. W., Calvert, D., Coward, A., Hewitt, H. T., Jackson, L. C., Kuhlbrodt, T., Mathiot, P., Roberts, C. D., Schiemann, R., Seddon, J., Vannière, B., and Vidale, P. L.: Description of the resolution hierarchy of the global coupled HadGEM3-GC3.1 model as used in CMIP6 HighResMIP experiments, Geosci. Model Dev. Discuss., https://doi.org/10.5194/gmd-2019-148, in review, 2019. Sidorenko, D., and co-authors: Evaluation of FESOM2.0 coupled to ECHAM6.3: Pre-industrial and HighResMIP simulations. J. Adv. Model. Earth Syst., submitted.
26000	10	32	10	32	add citation after “instability mechanisms in Antarctic ice sheet models” [Marius Schaefer, Chile]	add citation after “instability mechanisms in Antarctic ice sheet models”
26002	10	33	10	33	what is “interactive ice sheet coupling”? Explain! [Marius Schaefer, Chile]	what is “interactive ice sheet coupling”? Explain!
39804	10	36			The usefulness of this must reflect in the outcomes. Have these metrics changed? Or are you saying they are expected in the future to be better? If that is the case should this be included if the improvement has not yet materialised? [Michael Tsimplis, China]	The usefulness of this must reflect in the outcomes. Have these metrics changed? Or are you saying they are expected in the future to be better? If that is the case should this be included if the improvement has not yet materialised?
19384	10	38	10	38	Any references concerning see-saw redox implications? [Gwenaelle GREMION, Canada]	Any references concerning see-saw redox implications?
39806	10	38			Why? This is a climate assessment, it is not obvious that the modulations of storm surges as detrmined by models of the past are relevant to the future. The narrative must point out the obvious: they set our understanding of natural variability and the changes brought about by climate change when the climate system was transiting (by different forcing). [Michael Tsimplis, China]	Why? This is a climate assessment, it is not obvious that the modulations of storm surges as detrmined by models of the past are relevant to the future. The narrative must point out the obvious: they set our understanding of natural variability and the changes brought about by climate change when the climate system was transiting (by different forcing).

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
44950	10	39	10	42	I support the use of Annex II for listing datasets used in the paleo reconstructions. Datasets related to sea level during different periods are currently in Annex II. Data related to many of the other paleo topics mentioned here, however, are largely absent. Is it the intention of CH9 authors to further contribute to Annex II? [Darrell Kaufman, United States of America]	I support the use of Annex II for listing datasets used in the paleo reconstructions. Datasets related to sea level during different periods are currently in Annex II. Data related to many of the other paleo topics mentioned here, however, are largely absent. Is it the intention of CH9 authors to further contribute to Annex II?
44084	10	42	10	45	For citation: Burke et al. 2018 (https://www.pnas.org/content/115/52/13288.short) examines past earth states as model systems for future climate scenarios; they find that the mid Pliocene warm period and the Early Eocene Climatic Optimum are the best analogs for near-term climate. [Sara Kahanamoku, United States of America]	For citation: Burke et al. 2018 (https://www.pnas.org/content/115/52/13288.short) examines past earth states as model systems for future climate scenarios; they find that the mid Pliocene warm period and the Early Eocene Climatic Optimum are the best analogs for near-term climate.
57934	10	43	10	43	Technically it is the mid-Piacenzian warm Period, because of the GTS being changed (Pliestocene starts at ~2.6 Myr ago). Please revise throughtout the Chapter. (see e.g. Dowsett et al, Climate of the Past, 2016, doi: 10.5194/cp-12-1519-2016) [Bas de Boer, Netherlands]	Technically it is the mid-Piacenzian warm Period, because of the GTS being changed (Pliestocene starts at ~2.6 Myr ago). Please revise throughtout the Chapter. (see e.g. Dowsett et al, Climate of the Past, 2016, doi: 10.5194/cp-12-1519-2016)
14560	10	43	10	45	Last Interglacial (LIG) is referred to Cross-Chapter Box 1.3, however, in this box there is no definition of LIG [Rivera Andres, Chile]	Last Interglacial (LIG) is referred to Cross-Chapter Box 1.3, however, in this box there is no definition of LIG
44952	10	43			I strongly suggest that we move away from using the “Holocene thermal maximum” to imply a single time period, as is done here. The interval ranges from 11 ka in central Beringia to 5 ka in Greenland and there is little known about the age of maximum warmth in different regions of the Southern Hemisphere. For older interglacial periods, we don’t have a choice but to be looser about which millennium is which, but for the Holocene, we do know that maximum warmth was time transgressive over millennia. I strongly suggest that CH9 focus on the 6 ka time slice (mid-Holocene) as representative of near-peak Holocene GMST. Generally, all occurrences of the term, “HTM” could easily be replaced with “MH.” This also aligns the discussion with long-standing PMIP experiments, which is a goal of this chapter. [Darrell Kaufman, United States of America]	I strongly suggest that we move away from using the “Holocene thermal maximum” to imply a single time period, as is done here. The interval ranges from 11 ka in central Beringia to 5 ka in Greenland and there is little known about the age of maximum warmth in different regions of the Southern Hemisphere. For older interglacial periods, we don’t have a choice but to be looser about which millennium is which, but for the Holocene, we do know that maximum warmth was time transgressive over millennia. I strongly suggest that CH9 focus on the 6 ka time slice (mid-Holocene) as representative of near-peak Holocene GMST. Generally, all occurrences of the term, “HTM” could easily be replaced with “MH.” This also aligns the discussion with long-standing PMIP experiments, which is a goal of this chapter.
28170	10	44	10	44	mPWP' should be changed with 'MPWP'. [Feng SHI, China]	mPWP' should be changed with 'MPWP'.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
39174	10	45	10	45	Same as above for PMIP4. For PMIP the general overview of the different periods is provided in Kageyama, M., Braconnot, P., Harrison, S. P., Haywood, A. M., Jungclaus, J. H., Otto-Bliesner, B. L., Peterschmitt, J. Y., Abe-Ouchi, A., Albani, S., Bartlein, P. J., Brierley, C., Crucifix, M., Dolan, A., Fernandez-Donado, L., Fischer, H., Hopcroft, P. O., Ivanovic, R. F., Lambert, F., Lunt, D. J., Mahowald, N. M., Peltier, W. R., Phipps, S. J., Roche, D. M., Schmidt, G. A., Tarasov, L., Valdes, P. J., Zhang, Q., and Zhou, T. J.: The PMIP4 contribution to CMIP6-Part 1: Overview and over-arching analysis plan, Geoscientific Model Development, 11, 1033-1057, 2018, 10.5194/gmd-11-1033-2018. In the text below I would recommand you use the protocol paper refencing the different simulations where approriate. See GMD PMIP4 special issue https://www.geosci-model-dev.net/special_issue12_888.html (haywiid et al, Kageyama et al. otto-Bliesner et al., Jungclaus et al.,Lundt et al, and Ivanovic et al, for PlioMip, LGM, MH and lIG, last millennium,, DeepMIP, and deglaciation. [Pascale Braconnot, France]	Same as above for PMIP4. For PMIP the general overview of the different periods is provided in Kageyama, M., Braconnot, P., Harrison, S. P., Haywood, A. M., Jungclaus, J. H., Otto-Bliesner, B. L., Peterschmitt, J. Y., Abe-Ouchi, A., Albani, S., Bartlein, P. J., Brierley, C., Crucifix, M., Dolan, A., Fernandez-Donado, L., Fischer, H., Hopcroft, P. O., Ivanovic, R. F., Lambert, F., Lunt, D. J., Mahowald, N. M., Peltier, W. R., Phipps, S. J., Roche, D. M., Schmidt, G. A., Tarasov, L., Valdes, P. J., Zhang, Q., and Zhou, T. J.: The PMIP4 contribution to CMIP6-Part 1: Overview and over-arching analysis plan, Geoscientific Model Development, 11, 1033-1057, 2018, 10.5194/gmd-11-1033-2018. In the text below I would recommand you use the protocol paper refencing the different simulations where approriate. See GMD PMIP4 special issue https://www.geosci-model-dev.net/special_issue12_888.html (haywiid et al, Kageyama et al. otto-Bliesner et al., Jungclaus et al.,Lundt et al, and Ivanovic et al, for PlioMip, LGM, MH and lIG, last millennium,, DeepMIP, and deglaciation.
42622	11	1	11	3	Chapter 9 should also link to Chapter 10's assessment of the production of regional information from a variety of methods, including global and regional models. [William Gutowski, United States of America]	Chapter 9 should also link to Chapter 10's assessment of the production of regional information from a variety of methods, including global and regional models.
19386	11	4	11	5	What is understood by critical? [Gwenaelle GREMION, Canada]	What is understood by critical?
47026	11	15	35	46	Section 9.2 on the ocean is a good start for a First Order Draft, and I like the way that observations, theoretical understanding and simulations of the same processes or phenomena are combined in the same sections. There are, however, many places where this reads as more of a review than an assessment, and where more thought should be given to what message will be taken away by the intended audience of policy-makers. In preparing the Second Order Draft, the committee should try to drive each sub-section towards clear declarative concluding statements with uncertainty bounds in conficence language that can be drawn up to the Executive Summary of this chapter and thence to the overall Summary for Policymakers. [Robert Hallberg, United States of America]	Section 9.2 on the ocean is a good start for a First Order Draft, and I like the way that observations, theoretical understanding and simulations of the same processes or phenomena are combined in the same sections. There are, however, many places where this reads as more of a review than an assessment, and where more thought should be given to what message will be taken away by the intended audience of policy-makers. In preparing the Second Order Draft, the committee should try to drive each sub-section towards clear declarative concluding statements with uncertainty bounds in conficence language that can be drawn up to the Executive Summary of this chapter and thence to the overall Summary for Policymakers.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
47028	11	15	35	46	Reading through the entire section 9.2, I am left with the impression that the description of ocean models and simulations is exceptionally harsh. If I had come into this without any background knowledge, the almost exclusive focus in the text on biases and shortcomings would lead me to utterly dismiss any projections about what will happen in the ocean, except that it will take up heat and carbon. It may be that it is the committee's collective expert assessment that ocean simulations are pretty much worthless, but if not the tone of this section should be recalibrated. [Robert Hallberg, United States of America]	Reading through the entire section 9.2, I am left with the impression that the description of ocean models and simulations is exceptionally harsh. If I had come into this without any background knowledge, the almost exclusive focus in the text on biases and shortcomings would lead me to utterly dismiss any projections about what will happen in the ocean, except that it will take up heat and carbon. It may be that it is the committee's collective expert assessment that ocean simulations are pretty much worthless, but if not the tone of this section should be recalibrated.
47030	11	15	35	46	The overly negative description of ocean models could be softened by spending more time dicussing what features are reasonably well described or putting biases in better context. For example, when discussing a specifc set biases does the committee think that they will lead to order 1%, 10%, 20% or 50% uncertainties in projections that are otherwise qualitatvely robust, or do they lead a complete lack of confidence in the ocean models (as the current language often seems to suggest). There are many reasons why ocean-climate modelers spend most of their time worrying about biases, but for the intended IPCC audience of Policy Makers and the general public, it is important to step back and candidly examine the big-picture question of what aspects of the ocean are captured well enough by ocean models to provide useful guidance, even if there is room for improvement in these models. [Robert Hallberg, United States of America]	The overly negative description of ocean models could be softened by spending more time dicussing what features are reasonably well described or putting biases in better context. For example, when discussing a specifc set biases does the committee think that they will lead to order 1%, 10%, 20% or 50% uncertainties in projections that are otherwise qualitatvely robust, or do they lead a complete lack of confidence in the ocean models (as the current language often seems to suggest). There are many reasons why ocean-climate modelers spend most of their time worrying about biases, but for the intended IPCC audience of Policy Makers and the general public, it is important to step back and candidly examine the big-picture question of what aspects of the ocean are captured well enough by ocean models to provide useful guidance, even if there is room for improvement in these models.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
47032	11	15	35	46	When describing climate models and their biases, use language that differentiates between biases that are found in _all_ CMIP6 models, are common in a subset of older-generation models, are characteristic low-resolution models, or appear in the multi-model mean (but not all models). The climate community has often followed the viewpoint arising from the atmosphere that the multi-model mean is better at reproducing the real world than any individual model, but for many important oceanic features (for example, the vertical structure and watermass properties of the main thermocline), there are individual climate models that have much smaller ocean biases than the multi-model mean (see Dunne et al., 2012, doi:10.1175/JCLI-D-11-00560.1. for one example in a comparison of 2 CMIP5 models with different ocean formulations but identical atmospheres). I anticipate that the same will be true of CMIP6 models. [Robert Hallberg, United States of America]	When describing climate models and their biases, use language that differentiates between biases that are found in _all_ CMIP6 models, are common in a subset of older-generation models, are characteristic low-resolution models, or appear in the multi-model mean (but not all models). The climate community has often followed the viewpoint arising from the atmosphere that the multi-model mean is better at reproducing the real world than any individual model, but for many important oceanic features (for example, the vertical structure and watermass properties of the main thermocline), there are individual climate models that have much smaller ocean biases than the multi-model mean (see Dunne et al., 2012, doi:10.1175/JCLI-D-11-00560.1. for one example in a comparison of 2 CMIP5 models with different ocean formulations but identical atmospheres). I anticipate that the same will be true of CMIP6 models.
19388	11	19	11	22	While no information in this paragraph is incorrect, the sentence seems overloaded with high degree of detail for an introduction. The statement that about 90% of expected warming are believed to be consumed by the ocean needs more clarification or should appear later on. [Gwenaelle GREMION, Canada]	While no information in this paragraph is incorrect, the sentence seems overloaded with high degree of detail for an introduction. The statement that about 90% of expected warming are believed to be consumed by the ocean needs more clarification or should appear later on.
19400	11	19	11	31	Section 9.2.1 could use an overhaul. In its currentform it is lacking desirable features of an introduction and includes in my opinion a high level of detail that are without context at the beginning of the chapter. [Gwenaelle GREMION, Canada]	Section 9.2.1 could use an overhaul. In its currentform it is lacking desirable features of an introduction and includes in my opinion a high level of detail that are without context at the beginning of the chapter.
39808	11	19			are there any simple natural systems? [Michael Tsimplis, China]	are there any simple natural systems?
39810	11	20			So attribution is already known to the extent that attribution in atmospheric T increases is documented earlier in the report. [Michael Tsimplis, China]	So attribution is already known to the extent that attribution in atmospheric T increases is documented earlier in the report.
19404	11	21	11	21	On which confidence level are the given numbers? [Gwenaelle GREMION, Canada]	On which confidence level are the given numbers?
37876	11	21			>90% is not wrong, but other chapters are more precise, quoting 93%. 93% is also quoted in Box 9.2. [Adrian Simmons, United Kingdom (of Great Britain and Northern Ireland)]	>90% is not wrong, but other chapters are more precise, quoting 93%. 93% is also quoted in Box 9.2.
19390	11	22	11	24	A statement about heat capacity could be made to underline the importance of the ocean. Beyond, that the sentence could be restructured so that it its clear that differences in salinity (or biogeochemical properties), density heat uptake etc drive the global conveyor belt of ocean currents. [Gwenaelle GREMION, Canada]	A statement about heat capacity could be made to underline the importance of the ocean. Beyond, that the sentence could be restructured so that it its clear that differences in salinity (or biogeochemical properties), density heat uptake etc drive the global conveyor belt of ocean currents.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
7540	11	24	11	24	Could the quality of Fig 1a be improved? [Patrick Hyder, United Kingdom (of Great Britain and Northern Ireland)]	Could the quality of Fig 1a be improved?
7542	11	24	11	27	Could this sentence be clarified? [Patrick Hyder, United Kingdom (of Great Britain and Northern Ireland)]	Could this sentence be clarified?
19392	11	24	11	29	This paragraph could either be shortened or needs to be elaborated as to how atmospheric signals can propagate into the ocean through air-ocean processes and being re-emitted both spatially and temporally displaced. [Gwenaelle GREMION, Canada]	This paragraph could either be shortened or needs to be elaborated as to how atmospheric signals can propagate into the ocean through air-ocean processes and being re-emitted both spatially and temporally displaced.
46692	11	27	11	28	Assessment on anthropogenic influence on ENSO needs coordination with chapter 3 to avoid inconsistency. [WGI TSU, France]	Assessment on anthropogenic influence on ENSO needs coordination with chapter 3 to avoid inconsistency.
39812	11	28			What does tend mean? Linear trends ? tendencies? [Michael Tsimplis, China]	What does tend mean? Linear trends ? tendencies?
19394	11	30	11	31	add: ‘very likely’ [Gwenaelle GREMION, Canada]	add: ‘very likely’
39814	11	31			are these really oceanic events? the impact that makes them extreme is felt outside the oceanic domain and their generation mostly atmospheric. [Michael Tsimplis, China]	are these really oceanic events? the impact that makes them extreme is felt outside the oceanic domain and their generation mostly atmospheric.
50764	11	36	11	39	I suggest to include the full names of the acronyms (AABW, NADW, etc.) in the caption of Figure 9.1. [Hernan Edgardo Sala, Argentina]	I suggest to include the full names of the acronyms (AABW, NADW, etc.) in the caption of Figure 9.1.
12950	11	38	11	39	Any specific reason why only mentioned Atlantic Ocean?, Better present the whole globe, and draw all the underlying dynamical processes [RADEN DWI SUSANTO, United States of America]	Any specific reason why only mentioned Atlantic Ocean?, Better present the whole globe, and draw all the underlying dynamical processes
39816	11	42			isn't uncertainty partly inerent? This paragraph focuses on limitations of modelling? I would argue that there are deficiencies in the monitoring network and lack of understanding of processes that is the problem. This paragraph gives the impression that the only thing missing is better modelling and I do not think this is the case as the chapter itself says in various subsequent parts. [Michael Tsimplis, China]	isn't uncertainty partly inerent? This paragraph focuses on limitations of modelling? I would argue that there are deficiencies in the monitoring network and lack of understanding of processes that is the problem. This paragraph gives the impression that the only thing missing is better modelling and I do not think this is the case as the chapter itself says in various subsequent parts.
45182	11	43	11	43	I suggest you remove the text "The state of the ocean continues to be monitored" - this text doesn't add any information content to the rest of the sentence. [Matthew Palmer, United Kingdom (of Great Britain and Northern Ireland)]	I suggest you remove the text "The state of the ocean continues to be monitored" - this text doesn't add any information content to the rest of the sentence.
45184	11	43	11	43	Related to the comment immediately above, either in Ch9 or elsewhere, I think it would be useful to summarize the evolution of the ocean observing system over time. I think that much of greater confidence in AR6 relative to AR5 stems from a more complete observing system and sustained time series. Perhaps this could be done as a Chapter Box or FAQ on the ocean observing system? [Matthew Palmer, United Kingdom (of Great Britain and Northern Ireland)]	Related to the comment immediately above, either in Ch9 or elsewhere, I think it would be useful to summarize the evolution of the ocean observing system over time. I think that much of greater confidence in AR6 relative to AR5 stems from a more complete observing system and sustained time series. Perhaps this could be done as a Chapter Box or FAQ on the ocean observing system?

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
7544	11	43	11	45	Could this sentence be modified to mention that (a) adequate observational record for energy flows is extremely short compared to variability, i.e. ARGO period (b) for some projections models fail to adequately represent key processes so projections should not be trusted, e.g. AABW formation and characteristics? [Patrick Hyder, United Kingdom (of Great Britain and Northern Ireland)]	Could this sentence be modified to mention that (a) adequate observational record for energy flows is extremely short compared to variability, i.e. ARGO period (b) for some projections models fail to adequately represent key processes so projections should not be trusted, e.g. AABW formation and characteristics?
19396	11	43	11	45	sentence can be deleted. I would recommend putting a comparison towards CMIP5 pointing out what improvements were made not just on models themselves but also in the experiment design for optimal ensemble sizes as shown by Ribes et al. 2015 (Ribes, A., Gillett, N.P. and Zwiers, F.W., 2015. Designing detection and attribution simulations for CMIP6 to optimize the estimation of greenhouse gas–induced warming. Journal of Climate, 28(8), pp.3435-3438.) [Gwenaelle GREMION, Canada]	sentence can be deleted. I would recommend putting a comparison towards CMIP5 pointing out what improvements were made not just on models themselves but also in the experiment design for optimal ensemble sizes as shown by Ribes et al. 2015 (Ribes, A., Gillett, N.P. and Zwiers, F.W., 2015. Designing detection and attribution simulations for CMIP6 to optimize the estimation of greenhouse gas–induced warming. Journal of Climate, 28(8), pp.3435-3438.)
48488	11	43	12	3	I found this discussion of model deficiencies to be a strange one to have in the introduction. Better here would be two subsections. The first focused on summarizing our vast and increasing ocean observing platforms, with key advances and limitations. The second focused on summarizing the state of ocean modeling, with key advances and limitations. [Kyle Armour, United States of America]	I found this discussion of model deficiencies to be a strange one to have in the introduction. Better here would be two subsections. The first focused on summarizing our vast and increasing ocean observing platforms, with key advances and limitations. The second focused on summarizing the state of ocean modeling, with key advances and limitations.
39818	11	45			isn't parametrisation an issue by itself? How is the "advanced representation measured"? Not really things that should be reported here but really challenging with respect to some aspects of modelling. For example I am not sure that there has been much progress in sea level modelling in climate models despite the increased spatial resolution and the other improvements. [Michael Tsimplis, China]	isn't parametrisation an issue by itself? How is the "advanced representation measured"? Not really things that should be reported here but really challenging with respect to some aspects of modelling. For example I am not sure that there has been much progress in sea level modelling in climate models despite the increased spatial resolution and the other improvements.
7900	11	48	11	51	Does this conflict with summary point (p8, lines 18-30) which suggests that some CMIP6 models are high-resolution? [Laura Jackson, United Kingdom (of Great Britain and Northern Ireland)]	Does this conflict with summary point (p8, lines 18-30) which suggests that some CMIP6 models are high-resolution?
48950	11	49	11	51	This sentence could use clarification on the meaning/implications of resolution (spatial?) and length scale. [Laura Reynolds, United States of America]	This sentence could use clarification on the meaning/implications of resolution (spatial?) and length scale.
39820	11	49			surely this was known much earlier. There is a general issue with the selective referencing in many parts of the chapter. [Michael Tsimplis, China]	surely this was known much earlier. There is a general issue with the selective referencing in many parts of the chapter.
19402	11	50	11	53	Rossby radius and deformation radius are used in this section without describing that they are the same [Gwenaelle GREMION, Canada]	Rossby radius and deformation radius are used in this section without describing that they are the same

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
49274	11	50	12	8	In this lines there are three names for the same concept: 1) Rossby radius, 2) deformation radius and 3) first baroclinic Rossby deformation radius. Maybe, this could be confusing for inexpert readers. [Catalina Aguirre Galaz, Chile]	In this lines there are three names for the same concept: 1) Rossby radius, 2) deformation radius and 3) first baroclinic Rossby deformation radius. Maybe, this could be confusing for inexpert readers.
19398	11	51	11	53	Include reference here. [Gwenaelle GREMION, Canada]	Include reference here.
8314	11	53	11	53	Relate the "deformation radius" to what came before on the Rossby radius for maximum clarity. [Sarah Cooley, United States of America]	Relate the "deformation radius" to what came before on the Rossby radius for maximum clarity.
19406	11	54	11	54	What exactly is "well-resolved"? Any numbers? [Gwenaelle GREMION, Canada]	What exactly is "well-resolved"? Any numbers?
19408	11	54	11	54	Do all models lack the ability? Or are there also some which can do it? [Gwenaelle GREMION, Canada]	Do all models lack the ability? Or are there also some which can do it?
45272	11	54	11	54	· The Rossby radius is not resolved at high latitudes even in the highest res models. There are large open ocean regions (e.g. Weddell gyre , Nordic Seas) where the mesoscale variability is not resolved. This needs to be highlighted here. [Alessandro Silvano, Australia]	· The Rossby radius is not resolved at high latitudes even in the highest res models. There are large open ocean regions (e.g. Weddell gyre , Nordic Seas) where the mesoscale variability is not resolved. This needs to be highlighted here.
42624	11	54	12	3	Papers on Polar CORDEX atmosphere-ocean-ice models should be examined for their ability to represent some of these features. [William Gutowski, United States of America]	Papers on Polar CORDEX atmosphere-ocean-ice models should be examined for their ability to represent some of these features.
39822	11	54			The way this is written drives directly to a need of more detailed modelling and nothing is said on monitoring/observations. This is a major deficiency and gives wrong directions- models can only be improved when observationobservations are available and many processes are not monitored but only observed in specialised experiments. [Michael Tsimplis, China]	The way this is written drives directly to a need of more detailed modelling and nothing is said on monitoring/observations. This is a major deficiency and gives wrong directions- models can only be improved when observationobservations are available and many processes are not monitored but only observed in specialised experiments.
7546	12	1	12	3	change to 'such as in: estuaries….'? [Patrick Hyder, United Kingdom (of Great Britain and Northern Ireland)]	change to 'such as in: estuaries….'?
41422	12	5	12	13	There seems to be a small character problem in panel c of Figure 9.2, where River outflow (?) is misrepresented. [Charalampos Charalampidis, Germany]	There seems to be a small character problem in panel c of Figure 9.2, where River outflow (?) is misrepresented.
19424	12	12	12	12	the caption should be clear, whether it marks flow in or out of the page. [Gwenaelle GREMION, Canada]	the caption should be clear, whether it marks flow in or out of the page.
38514	12	18	14	12	The observed and projected SST increase in the coastal should be assessed. This is evident east of the Eurasia (near Japan), east of CONUS, and the south of the Indian continent. In particular, the SST increase near the east coast of China affects intensification of landfalling TCs. Ref. Mei, W., and S. P. Xie, 2016: Intensification of landfalling typhoons over the northwest Pacific since the late 1970s. Nat. Geosci., 9, 753–757, doi:10.1038/ngeo2792. This paper is referred to in Chap 11 (p.38, L1) and Chap 12 (p.40, L29) where the coastal increase of SST is described. [Masaki Satoh, Japan]	The observed and projected SST increase in the coastal should be assessed. This is evident east of the Eurasia (near Japan), east of CONUS, and the south of the Indian continent. In particular, the SST increase near the east coast of China affects intensification of landfalling TCs. Ref. Mei, W., and S. P. Xie, 2016: Intensification of landfalling typhoons over the northwest Pacific since the late 1970s. Nat. Geosci., 9, 753–757, doi:10.1038/ngeo2792. This paper is referred to in Chap 11 (p.38, L1) and Chap 12 (p.40, L29) where the coastal increase of SST is described.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
54304	12	18	14	22	This section uses HadISST as its primary data set. For monitoring of global trends there may be better options with newer generations of data sets; the data sets used in Chapter 2 for global mean surface temperature generally are primarily ERSSTv5 and HadSST3 (which will be replaced by HadSST4 in SOD). [Blair Trewin, Australia]	This section uses HadISST as its primary data set. For monitoring of global trends there may be better options with newer generations of data sets; the data sets used in Chapter 2 for global mean surface temperature generally are primarily ERSSTv5 and HadSST3 (which will be replaced by HadSST4 in SOD).
38490	12	18	14	22	It would be good to add more literatures for the Indian Ocean warming so that it would be balance the discussion among three oceans. [Iskhaq Iskandar, Indonesia]	It would be good to add more literatures for the Indian Ocean warming so that it would be balance the discussion among three oceans.
48492	12	18	14	22	Note two new papers that may be of relevance for this section: https://doi.org/10.1175/JCLI-D-18-0562.1 and https://doi.org/10.1175/BAMS-D-18-0104.1 [Kyle Armour, United States of America]	Note two new papers that may be of relevance for this section: https://doi.org/10.1175/JCLI-D-18-0562.1 and https://doi.org/10.1175/BAMS-D-18-0104.1
50112	12	18	15	33	9.2.2.1 is a much longer than the following subsections. May it be separated into a few smaller parts? [Hong-Li Ren, China]	9.2.2.1 is a much longer than the following subsections. May it be separated into a few smaller parts?
54312	12	20	12	20	May be better to say "such as" rather than "defined as", since other relative indices exist (although the 90th percentile is by far the most common in the literature). [Blair Trewin, Australia]	May be better to say "such as" rather than "defined as", since other relative indices exist (although the 90th percentile is by far the most common in the literature).
45186	12	20	12	20	The statement "virtually certain" here and elsewhere in Ch9 (and other chapters). I think IPCC needs a new phrase in the calibrated language that means greater than 99% probability. We KNOW that SST has increased since the 1980s. This applies to many obseved changes and represents an issue for the report as a whole. [Matthew Palmer, United Kingdom (of Great Britain and Northern Ireland)]	The statement "virtually certain" here and elsewhere in Ch9 (and other chapters). I think IPCC needs a new phrase in the calibrated language that means greater than 99% probability. We KNOW that SST has increased since the 1980s. This applies to many obseved changes and represents an issue for the report as a whole.
42626	12	20	12	22	There are several places where strong assessment statements appears before presenting any of the suppoorting evidence. This is one example. Such statements, in my view, should come after giving the evidence for them. Otherwise, they read like an unsupported opinion. [William Gutowski, United States of America]	There are several places where strong assessment statements appears before presenting any of the suppoorting evidence. This is one example. Such statements, in my view, should come after giving the evidence for them. Otherwise, they read like an unsupported opinion.
19416	12	20	12	22	Unclear if the plan is already to add citations to these overarching statements, but this would be advised. Obviously there are a ton of articles getting at global SST trends, but one recently published option is Hausfather et al. 2017 (Science Advances). The structure of this section is not very clear. It is difficult to follow on which evidence the results are based. It is jumping between model and observations, different regions, etc. [Gwenaelle GREMION, Canada]	Unclear if the plan is already to add citations to these overarching statements, but this would be advised. Obviously there are a ton of articles getting at global SST trends, but one recently published option is Hausfather et al. 2017 (Science Advances). The structure of this section is not very clear. It is difficult to follow on which evidence the results are based. It is jumping between model and observations, different regions, etc.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
19412	12	20	12	52	Although there is a differenc in certainty, the following two sentences can confuse the reader. "It is virtually certain that global SST has increased since the 1980s." "In the pre-satellite era, there is very high confidence that global SST has increased over the period 1900-2017." [Gwenaelle GREMION, Canada]	Although there is a differenc in certainty, the following two sentences can confuse the reader. "It is virtually certain that global SST has increased since the 1980s." "In the pre-satellite era, there is very high confidence that global SST has increased over the period 1900-2017."
29138	12	20	13	16	The discussion of SST trend for instrumental data only considers one SST product (HadISST) which is known to behave differently from other products, especially for the Pacific zonal SST gradent important for Walker Circulation trends. Although the Solomon papers is mentioned, there are other recent papers highlighting the differences between SST products. Should yopu show several SST products and their uncertainties here? I think it would be a better representation of current knowledge. Fig. 9.3a could be easily modified to include the spread in SST products. [Jens Zinke, United Kingdom (of Great Britain and Northern Ireland)]	The discussion of SST trend for instrumental data only considers one SST product (HadISST) which is known to behave differently from other products, especially for the Pacific zonal SST gradent important for Walker Circulation trends. Although the Solomon papers is mentioned, there are other recent papers highlighting the differences between SST products. Should yopu show several SST products and their uncertainties here? I think it would be a better representation of current knowledge. Fig. 9.3a could be easily modified to include the spread in SST products.
39824	12	22			How different from the previous report is this? does "imprved" refer to the additional period of observation since the previous IPCC report or to the whole period of observations?. [Michael Tsimplis, China]	How different from the previous report is this? does "imprved" refer to the additional period of observation since the previous IPCC report or to the whole period of observations?.
39826	12	23			So a marine heatwave is an extreme in SST but are we talking about daily extremes and what do we mean by extremes? Perhaps an explanation on why these are caused it will be helpful. Scientists will not be the only readers of thee report. [Michael Tsimplis, China]	So a marine heatwave is an extreme in SST but are we talking about daily extremes and what do we mean by extremes? Perhaps an explanation on why these are caused it will be helpful. Scientists will not be the only readers of thee report.
38488	12	24	12	26	May be add add a short discussion on how the intensification of equatorial esterly winds could warm the Indian Ocean. The Indian Ocean is dominated by the monsoonal winds. I wonder if it is worth mentioning here the mechanism proposed by Rao et al. (2012, Climatic Change). [Iskhaq Iskandar, Indonesia]	May be add add a short discussion on how the intensification of equatorial esterly winds could warm the Indian Ocean. The Indian Ocean is dominated by the monsoonal winds. I wonder if it is worth mentioning here the mechanism proposed by Rao et al. (2012, Climatic Change).
26290	12	24	12	27	In fact it is general comment. This fragment is used as an example. An intensification of the equatorial easterly winds over 1980-2017 means that the natural interdecadal signal prevails at this temporal interval because the Walker circulation should weaken in warming climate. It is shortly discussed at the p.13 and in the other places of the FOD. However, it seems to me the problem with separation and relative importance of the natural and anthropogenic signals should be emphasized throughout the chapter because in the many (or even majority) cases the oceanic data sets are to short, sparse and noisy to solve this problem. [Alexander Polonsky, Russian Federation]	In fact it is general comment. This fragment is used as an example. An intensification of the equatorial easterly winds over 1980-2017 means that the natural interdecadal signal prevails at this temporal interval because the Walker circulation should weaken in warming climate. It is shortly discussed at the p.13 and in the other places of the FOD. However, it seems to me the problem with separation and relative importance of the natural and anthropogenic signals should be emphasized throughout the chapter because in the many (or even majority) cases the oceanic data sets are to short, sparse and noisy to solve this problem.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
44366	12	24	12	28	There is quite a lot of duplication with page 17. " warming trends have been associated with ... enhanced eastern Pacific equatorial upwelling " needs rewording [Michael Bell, United Kingdom (of Great Britain and Northern Ireland)]	There is quite a lot of duplication with page 17. " warming trends have been associated with ... enhanced eastern Pacific equatorial upwelling " needs rewording
39828	12	24			Globally? The statement in trends is about global trends. If the increase in the frequency and amplitude of extremes is not global perhaps it should follow the discussion on regional/basin trends. [Michael Tsimplis, China]	Globally? The statement in trends is about global trends. If the increase in the frequency and amplitude of extremes is not global perhaps it should follow the discussion on regional/basin trends.
39830	12	25			SST trends [Michael Tsimplis, China]	SST trends
12952	12	28	12	29	See SROCC Chapter 6.6 and the references [RADEN DWI SUSANTO, United States of America]	See SROCC Chapter 6.6 and the references
52924	12	29	12	29	Should read "The Southern Ocean surface has generally cooled" not ""The surface Southern Ocean has generally cooled" [Abigail Bodner, United States of America]	Should read "The Southern Ocean surface has generally cooled" not ""The surface Southern Ocean has generally cooled"
57200	12	29	12	36	There has been a substantial warming and sea-ice decline in the Southern Ocean (at the surface) since about 2016 (or even earlier). There is not enough publications on this currently, but I suggest to keep this in mind and potentially reformulate this section as publications become available and reassess whether it is still valid to say that the Southern Ocean surface has been cooling when including the most recent years. [F. Alexander Haumann, Germany]	There has been a substantial warming and sea-ice decline in the Southern Ocean (at the surface) since about 2016 (or even earlier). There is not enough publications on this currently, but I suggest to keep this in mind and potentially reformulate this section as publications become available and reassess whether it is still valid to say that the Southern Ocean surface has been cooling when including the most recent years.
19410	12	29	12	36	The section should be a new paragraph. Multiple mechanisms were not related to the first part of the paragraph. [Gwenaelle GREMION, Canada]	The section should be a new paragraph. Multiple mechanisms were not related to the first part of the paragraph.
19422	12	29	13	10	On P12, line 29/30 you mention a cooling trend south of the ACC from 1970 on, later on P13, line 10/11 you mention a cooling trend south of the ACC from 1980 on. Which is the right value? If both are correct you need to make the difference between the two statements clearer. [Gwenaelle GREMION, Canada]	On P12, line 29/30 you mention a cooling trend south of the ACC from 1970 on, later on P13, line 10/11 you mention a cooling trend south of the ACC from 1980 on. Which is the right value? If both are correct you need to make the difference between the two statements clearer.
48490	12	30	12	31	Perhaps cite Fan et al. 2014 here as well. [Kyle Armour, United States of America]	Perhaps cite Fan et al. 2014 here as well.
39236	12	31	12	33	"Multiple mechanisms have been proposed including enhanced northward transport of cold surface waters by strengthened and poleward shift of the surface westerlies associated with a positive trend in the Southern Annular Mode..." - phrase not obvious; is highlighted "and" necessary here? [Dmitry Kovalevsky, Germany]	"Multiple mechanisms have been proposed including enhanced northward transport of cold surface waters by strengthened and poleward shift of the surface westerlies associated with a positive trend in the Southern Annular Mode..." - phrase not obvious; is highlighted "and" necessary here?
39832	12	36			Any of this is new? Is it the same with AR5? Where is the difference/improvement claimed earlier? [Michael Tsimplis, China]	Any of this is new? Is it the same with AR5? Where is the difference/improvement claimed earlier?

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
13702	12	37	13	10	Suggestion: Since this is a summary of the response of the cryosphere on land, it would make sense to mention freshwater ice (lakes, rivers), given that it represents a significant portion of "land" area in the northern mid-to-high latitudes and respond rapidly to climate change. A summary sentence would be enough. [Simon Donner, Canada]	Suggestion: Since this is a summary of the response of the cryosphere on land, it would make sense to mention freshwater ice (lakes, rivers), given that it represents a significant portion of "land" area in the northern mid-to-high latitudes and respond rapidly to climate change. A summary sentence would be enough.
54314	12	45	12	45	I think this point would be clearer using "impact-relevant thresholds" rather than "the relevant thresholds". [Blair Trewin, Australia]	I think this point would be clearer using "impact-relevant thresholds" rather than "the relevant thresholds".
9338	12	51	12	52	"in the pre-satellite era" ought to be deleted when referring to the 1900-2017 period [philippe waldteufel, France]	"in the pre-satellite era" ought to be deleted when referring to the 1900-2017 period
25278	12	51	12	52	This sentence is confusing - Are you combining pre-satellite data with satellite data to get trend 1900-2017? (this time period covers satellite period) [Sharon Smith, Canada]	This sentence is confusing - Are you combining pre-satellite data with satellite data to get trend 1900-2017? (this time period covers satellite period)
37878	12	51	12	52	The sentence that spans these lines needs rewording. The period 1900-2017 includes much of the satellite era, whereas the sentence starts "In the pre-satellite era". The second sentence of the paragraph also needs rewording, for a similar reason. [Adrian Simmons, United Kingdom (of Great Britain and Northern Ireland)]	The sentence that spans these lines needs rewording. The period 1900-2017 includes much of the satellite era, whereas the sentence starts "In the pre-satellite era". The second sentence of the paragraph also needs rewording, for a similar reason.
52930	12	51	14	22	It is unclear to me whether the confidence statements in this section are based on figure 9.3, and if so it is not clear to me how. Or whether it is based on litirature presented in the text. If possible, I think it would be good to structure figure 9.3 so that it will reflect these statements, such as adding confidence intervals to the line plots and stipples to the contour plots. [Abigail Bodner, United States of America]	It is unclear to me whether the confidence statements in this section are based on figure 9.3, and if so it is not clear to me how. Or whether it is based on litirature presented in the text. If possible, I think it would be good to structure figure 9.3 so that it will reflect these statements, such as adding confidence intervals to the line plots and stipples to the contour plots.
19414	12	52	12	53	Should be "global mean SST" [Gwenaelle GREMION, Canada]	Should be "global mean SST"
39176	12	53	12	53	make sure the reader do not mixed up these numbers with the one presented above for 1980-2017. May be make a comment on the fact that the rate is smaller? [Pascale Braconnot, France]	make sure the reader do not mixed up these numbers with the one presented above for 1980-2017. May be make a comment on the fact that the rate is smaller?
41264	12	53	12	53	write "... global SST has increased at ...", instead of "... global SST has been warming at ..." [Moacyr Araujo, Brazil]	write "... global SST has increased at ...", instead of "... global SST has been warming at ..."
52928	12	53	12	53	replace "an" with "a" [Abigail Bodner, United States of America]	replace "an" with "a"
19418	12	53	12	53	Global mean SST? [Gwenaelle GREMION, Canada]	Global mean SST?
19420	12	53	12	55	Here you write that there is a global warming trend but there are also regions with cooling. From Fig. 9.3f you can see that this is also the case for the observation period from 1980-2017 described in the paragraph before. There however, you did not mention that there are also regions of cooling That is a bit confusing. [Gwenaelle GREMION, Canada]	Here you write that there is a global warming trend but there are also regions with cooling. From Fig. 9.3f you can see that this is also the case for the observation period from 1980-2017 described in the paragraph before. There however, you did not mention that there are also regions of cooling That is a bit confusing.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
39834	12	53			uncertainty? Do not use about just put the range of values. [Michael Tsimplis, China]	uncertainty? Do not use about just put the range of values.
41266	12	54	12	54	write "... positive SST trend is ...", instead of "... SST warming trend is ..." [Moacyr Araujo, Brazil]	write "... positive SST trend is ...", instead of "... SST warming trend is ..."
47006	12	54	12	54	Please provide a very likely range of estimates of the rates of SST change if at all possible. [Robert Hallberg, United States of America]	Please provide a very likely range of estimates of the rates of SST change if at all possible.
44440	12	55	12	55	The observed trend over the period 1900-2017 in fig 9.3 is not clear. The contrast between panel e (117y trend) and panel f (37 y trend) of figure 9.3 could be explained better. [Anne Marie Treguier, France]	The observed trend over the period 1900-2017 in fig 9.3 is not clear. The contrast between panel e (117y trend) and panel f (37 y trend) of figure 9.3 could be explained better.
19426	13	1	13	1	It is better to use the word "increased" rather than "strengthened". [Gwenaelle GREMION, Canada]	It is better to use the word "increased" rather than "strengthened".
47008	13	1	13	16	Please be clear as to which of these observed SST trends can be unambiguosly connected to climate change (using confidence language) and which could be due to internally generated variability. [Robert Hallberg, United States of America]	Please be clear as to which of these observed SST trends can be unambiguosly connected to climate change (using confidence language) and which could be due to internally generated variability.
25280	13	1	14	22	Throughout this section there are many pre-AR5 references cited and it is unclear what advancements in knowledge have been made since AR5 with respect to changes in SST over the various time periods considered. It isn't clear if our confidence has increased since AR5 since some of the conclusions appear to be based on information that is pre-AR5. [Sharon Smith, Canada]	Throughout this section there are many pre-AR5 references cited and it is unclear what advancements in knowledge have been made since AR5 with respect to changes in SST over the various time periods considered. It isn't clear if our confidence has increased since AR5 since some of the conclusions appear to be based on information that is pre-AR5.
19434	13	2	13	4	In line 2 you say "slower warming in the eastern equatorial Pacific". In line 4 you say "weak cooling in the equatorial eastern Pacific". This is unclear. Is it warming or cooling there? What evidence are these two statements based on? [Gwenaelle GREMION, Canada]	In line 2 you say "slower warming in the eastern equatorial Pacific". In line 4 you say "weak cooling in the equatorial eastern Pacific". This is unclear. Is it warming or cooling there? What evidence are these two statements based on?
7548	13	3	13	3	Has 'older' water-masses been defined? [Patrick Hyder, United Kingdom (of Great Britain and Northern Ireland)]	Has 'older' water-masses been defined?
24970	13	6	13	7	the "cooling in the subpolar gyre south of greenland" is not apparent in fig. 9.3(f) - could this be made clearer? [Adrian New, United Kingdom (of Great Britain and Northern Ireland)]	the "cooling in the subpolar gyre south of greenland" is not apparent in fig. 9.3(f) - could this be made clearer?
32326	13	6	13	8	'…cooling…may be attributed to a long-term weakening of the AMOC….' A confidence level needs to be added to this statement. [Simon Josey, United Kingdom (of Great Britain and Northern Ireland)]	'…cooling…may be attributed to a long-term weakening of the AMOC….' A confidence level needs to be added to this statement.
52156	13	6	13	9	My understanding is that this remains an open topic in the community so I'm not sure this is sufficiently hedged as stated. [Peter Thorne, Ireland]	My understanding is that this remains an open topic in the community so I'm not sure this is sufficiently hedged as stated.
19436	13	7	13	8	Confidence level? [Gwenaelle GREMION, Canada]	Confidence level?
57202	13	9	13	10	Maybe specificy the depth at which this warming occurred [F. Alexander Haumann, Germany]	Maybe specificy the depth at which this warming occurred
41424	13	9	13	11	"…north of the ACC, whereas…", i.e. unite the two sentences since the latter as it is now sounds like an unfinished clause. [Charalampos Charalampidis, Germany]	"…north of the ACC, whereas…", i.e. unite the two sentences since the latter as it is now sounds like an unfinished clause.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
57204	13	10	13	11	Please specify that this cooling occurred at the surface and that there has been warming at depth [F. Alexander Haumann, Germany]	Please specify that this cooling occurred at the surface and that there has been warming at depth
41426	13	11	13	11	"…the trend since 1950…"; "…the Southern Ocean…"; "…warming slower than…" [Charalampos Charalampidis, Germany]	"…the trend since 1950…"; "…the Southern Ocean…"; "…warming slower than…"
41428	13	12	13	12	"There is medium confidence in…" [Charalampos Charalampidis, Germany]	"There is medium confidence in…"
37880	13	12	13	13	Why do the words "despite sparse observations through the early 20th century" appear here? The confidence statement is one about temperature change since 1950. [Adrian Simmons, United Kingdom (of Great Britain and Northern Ireland)]	Why do the words "despite sparse observations through the early 20th century" appear here? The confidence statement is one about temperature change since 1950.
19428	13	12	13	16	It is better if the authors can clearly establish whether they refer to mean SST change or otherwise. [Gwenaelle GREMION, Canada]	It is better if the authors can clearly establish whether they refer to mean SST change or otherwise.
41430	13	13	13	13	Replace "through" with "in". [Charalampos Charalampidis, Germany]	Replace "through" with "in".
7550	13	14	13	14	Has 'older' water-masses been defined? [Patrick Hyder, United Kingdom (of Great Britain and Northern Ireland)]	Has 'older' water-masses been defined?
44956	13	14	13	44	Paleo SSTs: One way to make better use of WG1 space and to help focus the paleo discussion would be for CH9 to refer to CH2 for the assessment of paleo SSTs and to use the space for a more in-depth discussion of the mechanisms of change as deduced from models and other evidence, a topic that isn't touched in CH2. There must be many model studies of SST during the periods included in these two paragraphs. CH9 could also focus on rates of SST changes during previous warmings, or on SST gradients, topics not mentioned in CH2. [Darrell Kaufman, United States of America]	Paleo SSTs: One way to make better use of WG1 space and to help focus the paleo discussion would be for CH9 to refer to CH2 for the assessment of paleo SSTs and to use the space for a more in-depth discussion of the mechanisms of change as deduced from models and other evidence, a topic that isn't touched in CH2. There must be many model studies of SST during the periods included in these two paragraphs. CH9 could also focus on rates of SST changes during previous warmings, or on SST gradients, topics not mentioned in CH2.
44958	13	14	13	44	Paleo SSTs: Many of the statements are associated with confidence levels, which is great, but the basis of these assigned levels isn't always clear. For example, assigning "high confidence" to assessments when only one study is cited seems unexpected, unless the case is made that the study provides a comprehensive account of the available evidence. I suggest that this section focus on a more comprehensive treatment of fewer statements, especially those that were assessed in AR5. Has recent work supported or refuted AR5 conclusions? [Darrell Kaufman, United States of America]	Paleo SSTs: Many of the statements are associated with confidence levels, which is great, but the basis of these assigned levels isn't always clear. For example, assigning "high confidence" to assessments when only one study is cited seems unexpected, unless the case is made that the study provides a comprehensive account of the available evidence. I suggest that this section focus on a more comprehensive treatment of fewer statements, especially those that were assessed in AR5. Has recent work supported or refuted AR5 conclusions?
7554	13	18	13	18	Is it worth adding an introductory sentence mentioing that SSTs have varied considerably duirng past climates before going into detail of how? [Patrick Hyder, United Kingdom (of Great Britain and Northern Ireland)]	Is it worth adding an introductory sentence mentioing that SSTs have varied considerably duirng past climates before going into detail of how?
19438	13	18	13	18	The abbreviations used here are introduced later on. It would be better to first introduce them and then abbreviate. [Gwenaelle GREMION, Canada]	The abbreviations used here are introduced later on. It would be better to first introduce them and then abbreviate.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
44960	13	18	13	19	What is the intent of the first sentence? Is it meant to imply that the spatial variability in SST during past warm periods was higher than now? That would be important. If this statement is retained, please cite the literature that was used to assign a likelihood level. [Darrell Kaufman, United States of America]	What is the intent of the first sentence? Is it meant to imply that the spatial variability in SST during past warm periods was higher than now? That would be important. If this statement is retained, please cite the literature that was used to assign a likelihood level.
44954	13	18	13	44	Paleo SSTs: I am responsible for assessing SSTs during multiple paleo periods for CH2. Let's work together to make sure that our text agrees and that the assessments are based on a comprehensive account of the most recent literature, which I hope will be documented in Annex II. [Darrell Kaufman, United States of America]	Paleo SSTs: I am responsible for assessing SSTs during multiple paleo periods for CH2. Let's work together to make sure that our text agrees and that the assessments are based on a comprehensive account of the most recent literature, which I hope will be documented in Annex II.
19444	13	18	13	44	They have to move the text to line 1 page 13, to make a proper analisys and evolution of the SST, from pre-satellite era to the present. [Gwenaelle GREMION, Canada]	They have to move the text to line 1 page 13, to make a proper analisys and evolution of the SST, from pre-satellite era to the present.
48952	13	18	13	45	or the different periods, it is easy to conflate the two. I also think it would be wise to add a sentence or phrase about the source of paleo SST records-- just something descriptive like sediment core-derived records or isotopic records... That could also help distinguish between model and geological records. [Laura Reynolds, United States of America]	or the different periods, it is easy to conflate the two. I also think it would be wise to add a sentence or phrase about the source of paleo SST records-- just something descriptive like sediment core-derived records or isotopic records... That could also help distinguish between model and geological records.
44962	13	19	13	27	It's difficult to know what conclude from this paragraph because the HTM represents peak warmth at different times in different places. We have sufficient data to study the actual interval of peak global warming, when some regions were colder and some warmer, rather than lumping all evidence of warmer conditions into a fussy interval. Focusing on 6 ka also facilities comparisons with the PMIP time slice for which there are more paleoclimate simulations than any other period. [Darrell Kaufman, United States of America]	It's difficult to know what conclude from this paragraph because the HTM represents peak warmth at different times in different places. We have sufficient data to study the actual interval of peak global warming, when some regions were colder and some warmer, rather than lumping all evidence of warmer conditions into a fussy interval. Focusing on 6 ka also facilities comparisons with the PMIP time slice for which there are more paleoclimate simulations than any other period.
39178	13	20	13	20	specify what you call the HTM. In practice because of insolation forcing + feedbakcs (from cryosphere mainly) it is not reach at all latitude at the same time. [Pascale Braconnot, France]	specify what you call the HTM. In practice because of insolation forcing + feedbakcs (from cryosphere mainly) it is not reach at all latitude at the same time.
43758	13	21	13	21	Check these 0-4C of warming, it seems too much. According to Marcott et al., 2013, a cooling of 2C may have occurred in the North Atlantic. [Carles Pelejero, Spain]	Check these 0-4C of warming, it seems too much. According to Marcott et al., 2013, a cooling of 2C may have occurred in the North Atlantic.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
13220	13	23	13	27	The Liu et al. (2014) and Marsieck et al. (2018) papers suggest that there are seasonal biases in our proxy records and that the climate models they assessed showed opposing annual temperature trends to what is observed in our "summer" proxy records. Although we do see summer warming in the North Atlantic region, in this section it might be worth noting that we have a poor understanding of winter-spring temperature trends. [Nora Richter, United States of America]	The Liu et al. (2014) and Marsieck et al. (2018) papers suggest that there are seasonal biases in our proxy records and that the climate models they assessed showed opposing annual temperature trends to what is observed in our "summer" proxy records. Although we do see summer warming in the North Atlantic region, in this section it might be worth noting that we have a poor understanding of winter-spring temperature trends.
51676	13	23	13	27	This sentence is somehwat unclear. While proxy records have suggested substantial changes in subsurface current intensities during the early-, mid-Holocene in the Nordic Seas and the Labrador Sea, recent observations report stable AMOC conditions downstream of 45°N (Hoffmann et al., 18 (GRL)). In other words, while tributary currents have been reported to vary as the Earth emerged from the last ice age, these changes may have largely compensated resulting in a stable AMOC conditions throughout the Holocene [Samuel Jaccard, Switzerland]	This sentence is somehwat unclear. While proxy records have suggested substantial changes in subsurface current intensities during the early-, mid-Holocene in the Nordic Seas and the Labrador Sea, recent observations report stable AMOC conditions downstream of 45°N (Hoffmann et al., 18 (GRL)). In other words, while tributary currents have been reported to vary as the Earth emerged from the last ice age, these changes may have largely compensated resulting in a stable AMOC conditions throughout the Holocene
7552	13	29	13	29	elevated atmospheric CO2' compared to when? [Patrick Hyder, United Kingdom (of Great Britain and Northern Ireland)]	elevated atmospheric CO2' compared to when?
8856	13	29	13	29	Important to note that this refers to Annual and Global mean SSTs. Extremes in the LIG temperatures are seasonal. [Petra M. Langebroek, Norway]	Important to note that this refers to Annual and Global mean SSTs. Extremes in the LIG temperatures are seasonal.
19440	13	29	13	29	How much is slightly elevated? [Gwenaelle GREMION, Canada]	How much is slightly elevated?
43760	13	29	13	29	Under a slightly elevated atmospheric CO2' clarify in relation to which period, I guess it's in relation to the Holocene? [Carles Pelejero, Spain]	Under a slightly elevated atmospheric CO2' clarify in relation to which period, I guess it's in relation to the Holocene?
39180	13	29	13	33	It should mentioned first that it cannot be used as a direct analogu of ongoing or future warming, but that during summer, similar processes and feedbacks despite the fact that LIG is drivent by solar forcing (Earth's orbit) whereas ongoing changes is drivent by greenhous gas + variability. If the impact of CO2 is unambigous, why or the level of confidence should be provided / part due to feebacks tthat transform the sesonally varying insolation forcing into an annual mean response. [Pascale Braconnot, France]	It should mentioned first that it cannot be used as a direct analogu of ongoing or future warming, but that during summer, similar processes and feedbacks despite the fact that LIG is drivent by solar forcing (Earth's orbit) whereas ongoing changes is drivent by greenhous gas + variability. If the impact of CO2 is unambigous, why or the level of confidence should be provided / part due to feebacks tthat transform the sesonally varying insolation forcing into an annual mean response.
39182	13	29	13	33	Have Holocene and LIG in the same paragraph because they are similar in terms of forcing (except the magnitude) = primary due to insolation and then the others together? [Pascale Braconnot, France]	Have Holocene and LIG in the same paragraph because they are similar in terms of forcing (except the magnitude) = primary due to insolation and then the others together?
39836	13	29		22	Break up sentence. What is the consequence of models simulations showing weaker or no warming? [Michael Tsimplis, China]	Break up sentence. What is the consequence of models simulations showing weaker or no warming?

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
19430	13	30	12	33	The sentence is confusing. Do the model simulations show extratropical and Arctic warming? The sentence should be split into two for more clarity because model simulations in this sentence only refers to relatively stable or cooling conditions in tropics. [Gwenaelle GREMION, Canada]	The sentence is confusing. Do the model simulations show extratropical and Arctic warming? The sentence should be split into two for more clarity because model simulations in this sentence only refers to relatively stable or cooling conditions in tropics.
8858	13	32	13	32	Possibly a better reference would be: Lunt et al., A multi-model assessment of last interglacial temperatures, CP, 2013; as it shows a model intercomparison, instead of only one (CCSM3) model result [Petra M. Langebroek, Norway]	Possibly a better reference would be: Lunt et al., A multi-model assessment of last interglacial temperatures, CP, 2013; as it shows a model intercomparison, instead of only one (CCSM3) model result
19442	13	32	13	33	"Model simulations showing weaker or no warming". It is not clear what that relates to. Model simulations of what? Weaker than what? It was just mentioned before that there is warming. This is confusing. [Gwenaelle GREMION, Canada]	"Model simulations showing weaker or no warming". It is not clear what that relates to. Model simulations of what? Weaker than what? It was just mentioned before that there is warming. This is confusing.
19228	13	34	13	34	please add Seki et al. 2010 and Dyez et al. 2018. Please also note that there is a species effect in the CO2 reconstructions and the data of Martinez-Boti et al. may be biased towards elevated values (see Dyez et al. 2018) [Baerbel Hoenisch, United States of America]	please add Seki et al. 2010 and Dyez et al. 2018. Please also note that there is a species effect in the CO2 reconstructions and the data of Martinez-Boti et al. may be biased towards elevated values (see Dyez et al. 2018)
37882	13	37			Reference is made here to anomalies. It should be stated what reference period the anomalies relate to. [Adrian Simmons, United Kingdom (of Great Britain and Northern Ireland)]	Reference is made here to anomalies. It should be stated what reference period the anomalies relate to.
44090	13	38	13	40	There is some evidence for heterogenous warming in the eastern Pacific, with anomalous warmth found in upwelling regions during the mid-Pliocene warm period. Temperature estimates derived from alkenones (Uk'37) indicate that warming may have reached +6-8 degrees C above modern (summary in Dowsett et al. 2012 Fig. 1; https://www.nature.com/articles/nclimate1455). [Sara Kahanamoku, United States of America]	There is some evidence for heterogenous warming in the eastern Pacific, with anomalous warmth found in upwelling regions during the mid-Pliocene warm period. Temperature estimates derived from alkenones (Uk'37) indicate that warming may have reached +6-8 degrees C above modern (summary in Dowsett et al. 2012 Fig. 1; https://www.nature.com/articles/nclimate1455).
51678	13	38	13	40	Maybe worth mentioning that a generally diminished meridional SST gradient in the Pacific Ocean associated with altered moisture transport allowed for a second deep overturning cell to be sustained in the North Pacific (PMOC) (Burls et al., 2017 (Sci. Adv.)), with consequences for the meridional redistribution of heat, carbon and nutrients. [Samuel Jaccard, Switzerland]	Maybe worth mentioning that a generally diminished meridional SST gradient in the Pacific Ocean associated with altered moisture transport allowed for a second deep overturning cell to be sustained in the North Pacific (PMOC) (Burls et al., 2017 (Sci. Adv.)), with consequences for the meridional redistribution of heat, carbon and nutrients.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
39838	13	38		41	it is very unclear to me why all this is useful. You start the section by talking about global SST trends, mention regional trends and extremes and you then move in paleoclimatology discussing gradients which have not been discussed for the present as far as I can see. Shouldn't there be a statment linking them. [Michael Tsimplis, China]	it is very unclear to me why all this is useful. You start the section by talking about global SST trends, mention regional trends and extremes and you then move in paleoclimatology discussing gradients which have not been discussed for the present as far as I can see. Shouldn't there be a statment linking them.
13704	13	40	13	42	Assesments of SL and of the oceans and cryosphere are combined here so that the processes can be linked, right (not just to concisely assess)? [Simon Donner, Canada]	Assesments of SL and of the oceans and cryosphere are combined here so that the processes can be linked, right (not just to concisely assess)?
39840	13	43		44	i thought you were discussing SST. Not deep ocean temperatures or ice sheets. There is no linkage and no explanation on why RCP8.5 should be comparable in any way. [Michael Tsimplis, China]	i thought you were discussing SST. Not deep ocean temperatures or ice sheets. There is no linkage and no explanation on why RCP8.5 should be comparable in any way.
47010	13	46	13	47	Unless I am misunderstanding, Figure 9-3 does not show simulated historical SST trends. Perhaps it should do so to help support this top-level statement. [Robert Hallberg, United States of America]	Unless I am misunderstanding, Figure 9-3 does not show simulated historical SST trends. Perhaps it should do so to help support this top-level statement.
48954	13	46	13	55	Throughout the paragraph: differentiate between bias and error, or use consistently. [Laura Reynolds, United States of America]	Throughout the paragraph: differentiate between bias and error, or use consistently.
52514	13	46	14	7	Would be useful to include magnitudes of the SST errors in this paragraph as they can be as large as several degrees. [John Brian Robin Matthews, France]	Would be useful to include magnitudes of the SST errors in this paragraph as they can be as large as several degrees.
47012	13	46	14	7	This is the only paragraph discussing the utility of climate models for projecting or understanding trends in sea surface tempertures. However, by focusing only on areas with biases, based on this discussion one might be tempted to utterly discount the value of Earth system model projections of climate change, if one were so inclined. Perhaps a sentence or two about some of the things that Earth system models get right would help balance the very negative tone of this paragraph. [Robert Hallberg, United States of America]	This is the only paragraph discussing the utility of climate models for projecting or understanding trends in sea surface tempertures. However, by focusing only on areas with biases, based on this discussion one might be tempted to utterly discount the value of Earth system model projections of climate change, if one were so inclined. Perhaps a sentence or two about some of the things that Earth system models get right would help balance the very negative tone of this paragraph.
47014	13	46	14	7	There is a danger in discussing what climate models do, either in general or in a way that makes it sound like every single model has the same problem, based on analyses of older models when the CMIP6 results have not been analyzed. Please be careful to avoid using langauage that tars all clmate models with the same broad-brush, especially in areas where some of the best new CMIP6 models are showing dramatic improvements over previous generations of climate models. [Robert Hallberg, United States of America]	There is a danger in discussing what climate models do, either in general or in a way that makes it sound like every single model has the same problem, based on analyses of older models when the CMIP6 results have not been analyzed. Please be careful to avoid using langauage that tars all clmate models with the same broad-brush, especially in areas where some of the best new CMIP6 models are showing dramatic improvements over previous generations of climate models.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
39842	13	46			Trends over which periods? Paleoclimate trends? What does generally reporduce trends? The sign or the size? [Michael Tsimplis, China]	Trends over which periods? Paleoclimate trends? What does generally reporduce trends? The sign or the size?
7556	13	47	13	47	What do you mean by challenge projections? It is worth stating something along of the lines of 'In several regions large SST biases are symptomatic of errors in representation of important processes, e.g. equatorial Pacific and Atlantic, Southern Ocean, Gulf stream and labrador current. etc. In thse regions, these process errors can make it difficult for the models to reproduce observed historical trends and reduce confidence in projections.' [Patrick Hyder, United Kingdom (of Great Britain and Northern Ireland)]	What do you mean by challenge projections? It is worth stating something along of the lines of 'In several regions large SST biases are symptomatic of errors in representation of important processes, e.g. equatorial Pacific and Atlantic, Southern Ocean, Gulf stream and labrador current. etc. In thse regions, these process errors can make it difficult for the models to reproduce observed historical trends and reduce confidence in projections.'
19432	13	47	13	49	See the following literature eastern Pacific Ocean cooling. Yu Kosaka & Shang-Ping Xie, 2013. Recent global-warming hiatus tied to equatorial Pacific surface cooling. Nature volume 501, 403–407. Authors present a novel method of uncovering mechanisms for global temperature change by prescribing, in addition to radiative forcing, the observed history of sea surface temperature over the central to eastern tropical Pacific in a climate model. [Gwenaelle GREMION, Canada]	See the following literature eastern Pacific Ocean cooling. Yu Kosaka & Shang-Ping Xie, 2013. Recent global-warming hiatus tied to equatorial Pacific surface cooling. Nature volume 501, 403–407. Authors present a novel method of uncovering mechanisms for global temperature change by prescribing, in addition to radiative forcing, the observed history of sea surface temperature over the central to eastern tropical Pacific in a climate model.
39844	13	48		55	meaning? it can be due to starting up biases or to model deficiencies. But why is it a matter for a report on the status of knowledge of our climate to speculate on why some efforts have not yet been productive? I would suggest all these speculative comments should be removed. They are of course scientific work for the future but they do not add relevant information. [Michael Tsimplis, China]	meaning? it can be due to starting up biases or to model deficiencies. But why is it a matter for a report on the status of knowledge of our climate to speculate on why some efforts have not yet been productive? I would suggest all these speculative comments should be removed. They are of course scientific work for the future but they do not add relevant information.
49222	14	4	14	4	Cold North Atlantic biases have been linked to model resolution too, e.g. Small et al. (2014), Roberts CD et al. (2018), Roberts MJ et a. (2019, submitted), and many others. Small, R. J., Justin Small, R., Bacmeister, J., Bailey, D., Baker, A., Bishop, S., Bryan, F., Caron, J., Dennis, J., Gent, P., Hsu, H.-m., Jochum, M., Lawrence, D., Muñoz, E., diNezio, P., Scheitlin, T., Tomas, R., Tribbia, J., Tseng, Y.-. H., & Vertenstein, M. (2014). A new synoptic scale resolving global climate simulation using the Community Earth System Model. Journal of Advances in Modeling Earth Systems, 6, 1065– 1094. https://doi.org/10.1002/2014MS000363. [Malcolm Roberts, United Kingdom (of Great Britain and Northern Ireland)]	Cold North Atlantic biases have been linked to model resolution too, e.g. Small et al. (2014), Roberts CD et al. (2018), Roberts MJ et a. (2019, submitted), and many others. Small, R. J., Justin Small, R., Bacmeister, J., Bailey, D., Baker, A., Bishop, S., Bryan, F., Caron, J., Dennis, J., Gent, P., Hsu, H.?m., Jochum, M., Lawrence, D., Muñoz, E., diNezio, P., Scheitlin, T., Tomas, R., Tribbia, J., Tseng, Y.?. H., & Vertenstein, M. (2014). A new synoptic scale resolving global climate simulation using the Community Earth System Model. Journal of Advances in Modeling Earth Systems, 6, 1065– 1094. https://doi.org/10.1002/2014MS000363.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
41268	14	5	14	6	write "... with warm biases in Pacific and Atlantic cold tongue and upwelling regions that ...", instead of "... with Pacific and Atlantic cold tongue errors that ..." [Moacyr Araujo, Brazil]	write "... with warm biases in Pacific and Atlantic cold tongue and upwelling regions that ...", instead of "... with Pacific and Atlantic cold tongue errors that ..."
7558	14	7	14	7	Change to 'atmospheric model cloud-related short-wave errors' [Patrick Hyder, United Kingdom (of Great Britain and Northern Ireland)]	Change to 'atmospheric model cloud-related short-wave errors'
39846	14	7			Anything new with respect to AR5? [Michael Tsimplis, China]	Anything new with respect to AR5?
42628	14	9	14	10	Same comment as earlier: Shouldn't this statement be given after presenting the evidence supporting it? (and, especially, after discussing model biases that can affect the projections) [William Gutowski, United States of America]	Same comment as earlier: Shouldn't this statement be given after presenting the evidence supporting it? (and, especially, after discussing model biases that can affect the projections)
19446	14	9	14	10	If models fail to replicate eastern Pacific Ocean cooling and Southern Ocean cooling since the 1970s, how the authors suggest that it is virtually certain that global mean SST will increase during the 21st Century at a rate that depends on the future emission scenario. Due to the model failures, projections should have low or medium confidence as a whole. [Gwenaelle GREMION, Canada]	If models fail to replicate eastern Pacific Ocean cooling and Southern Ocean cooling since the 1970s, how the authors suggest that it is virtually certain that global mean SST will increase during the 21st Century at a rate that depends on the future emission scenario. Due to the model failures, projections should have low or medium confidence as a whole.
19448	14	9	14	10	Dieng et al., 2017 show that over 2003–2013, both global land surface temperature and global sea surface temperature have increased at a rate significantly lower than over the previous decades. Further, their study confirms cooling of eastern tropical Pacific during the last decade as reported in several recent studies, the results show that the reduced rate of change of the 2003–2013 time span is a global phenomenon. Thus it is not reasonable to say that "it is virtually certain that global mean SST will increase during the 21st Century at a rate that depends on the future emission scenario." H. B. Dieng, A. Cazenave, B. Meyssignac, K. von Schuckmann and H. Palanisamy 2017. Sea and land surface temperatures, ocean heat content, Earth's energy imbalance and net radiative forcing over the recent years. INTERNATIONAL JOURNAL OF CLIMATOLOGY, 37 (Suppl.1): 218–229. [Gwenaelle GREMION, Canada]	Dieng et al., 2017 show that over 2003–2013, both global land surface temperature and global sea surface temperature have increased at a rate significantly lower than over the previous decades. Further, their study confirms cooling of eastern tropical Pacific during the last decade as reported in several recent studies, the results show that the reduced rate of change of the 2003–2013 time span is a global phenomenon. Thus it is not reasonable to say that "it is virtually certain that global mean SST will increase during the 21st Century at a rate that depends on the future emission scenario." H. B. Dieng, A. Cazenave, B. Meyssignac, K. von Schuckmann and H. Palanisamy 2017. Sea and land surface temperatures, ocean heat content, Earth's energy imbalance and net radiative forcing over the recent years. INTERNATIONAL JOURNAL OF CLIMATOLOGY, 37 (Suppl.1): 218–229.
6343	14	9	14	22	Nmany outdated references (as from year 1993). Please replace with the current literature [Baruch Rinkevich, Israel]	Nmany outdated references (as from year 1993). Please replace with the current literature
39848	14	11			perhaps an explanation at the start explaining what drives SST would be useful to ensure that it is not viewed as an independent parameter. [Michael Tsimplis, China]	perhaps an explanation at the start explaining what drives SST would be useful to ensure that it is not viewed as an independent parameter.
19450	14	12	14	14	To avoid vagueness, it may be better to indicate when the Southern Ocean starts to show warming according to model results. [Gwenaelle GREMION, Canada]	To avoid vagueness, it may be better to indicate when the Southern Ocean starts to show warming according to model results.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
39850	14	13			No new papers. No progress then here? [Michael Tsimplis, China]	No new papers. No progress then here?
39184	14	14	14	14	woule it be possible to avoid the wordin El-Nino like ? and find another way to say this? [Pascale Braconnot, France]	woule it be possible to avoid the wordin El-Nino like ? and find another way to say this?
48494	14	14	14	14	Could cite Rugenstein et al. (2019) LongRunMIP paper(s) here as well, showing multicentennial-scale Southern Ocean warming. [Kyle Armour, United States of America]	Could cite Rugenstein et al. (2019) LongRunMIP paper(s) here as well, showing multicentennial-scale Southern Ocean warming.
56566	14	14	14	15	The projected change is in the opposite direction to the past change (see [13, 1-5]). I think this needs some discussion. I think there is some literature on this but don't have the references to hand. [Richard Wood, United Kingdom (of Great Britain and Northern Ireland)]	The projected change is in the opposite direction to the past change (see [13, 1-5]). I think this needs some discussion. I think there is some literature on this but don't have the references to hand.
44370	14	14	14	19	There is uncertainty about whether the pattern of warming will be El-Nino like or not. It is a very important issue whether the models are reliable in this respect. [Michael Bell, United Kingdom (of Great Britain and Northern Ireland)]	There is uncertainty about whether the pattern of warming will be El-Nino like or not. It is a very important issue whether the models are reliable in this respect.
44368	14	16	14	16	It is unusual to talk about a western equatorial Pacific cold tongue. Could the words "cold tongue" be omitted ? [Michael Bell, United Kingdom (of Great Britain and Northern Ireland)]	It is unusual to talk about a western equatorial Pacific cold tongue. Could the words "cold tongue" be omitted ?
15370	14	19	14	20	Please add, that SST rising effect is especially manifested in the Barents Sea, which is the only from Arctic Seas half-free from ice (up to 2/3) whole year and will be completelly ice free around the year according to CMIP5 simulations. The survey was conducted by Sergey Gulev - WGI Chapter 2 CLA. Verezemskaya, P. C., Gulev, S. K., Selivanova, Yu. V., Tilinina, N. D., Markina, M. J., Krinitsky, M. A., Sharmar, V. D. (2019). Projections and Analysis of Climate Change in the Russian Part of the Barents Sea. Moscow: WWF-Russia: https://wwf.ru/resources/publications/booklets/prognoz-i-analiz-izmeneniy-klimata-v-rossiyskoy-chasti-barentseva-morya/ [Oksana Lipka, Russian Federation]	Please add, that SST rising effect is especially manifested in the Barents Sea, which is the only from Arctic Seas half-free from ice (up to 2/3) whole year and will be completelly ice free around the year according to CMIP5 simulations. The survey was conducted by Sergey Gulev - WGI Chapter 2 CLA. Verezemskaya, P. C., Gulev, S. K., Selivanova, Yu. V., Tilinina, N. D., Markina, M. J., Krinitsky, M. A., Sharmar, V. D. (2019). Projections and Analysis of Climate Change in the Russian Part of the Barents Sea. Moscow: WWF-Russia: https://wwf.ru/resources/publications/booklets/prognoz-i-analiz-izmeneniy-klimata-v-rossiyskoy-chasti-barentseva-morya/
41432	14	20	14	20	Replace "to be" with "being". [Charalampos Charalampidis, Germany]	Replace "to be" with "being".
39852	14	22			These are projections based on models that have deficiencies (previous paragraphs) so how much of this is expert judgement? [Michael Tsimplis, China]	These are projections based on models that have deficiencies (previous paragraphs) so how much of this is expert judgement?
52384	14	27	34	47	A discussion of marine heatwave frequency and severity within coastal marine embayments, in particular, could be added to Cross-Chapter Box 9.1 or added into 9.2.4.6 on Coastal Oceans; specific mention of coastal embayments is warranted because of their greater thermal ranges (in relation to offshore marine waters) and their importance for many marine species including seagrass and species supporting fisheries; these habitats are also heavily impacted by human development and of great interest to policy-makers. [Emily Orzechowski, United States of America]	A discussion of marine heatwave frequency and severity within coastal marine embayments, in particular, could be added to Cross-Chapter Box 9.1 or added into 9.2.4.6 on Coastal Oceans; specific mention of coastal embayments is warranted because of their greater thermal ranges (in relation to offshore marine waters) and their importance for many marine species including seagrass and species supporting fisheries; these habitats are also heavily impacted by human development and of great interest to policy-makers.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
47016	14	32	14	34	It is essential that the definition be provided for a Marine Heat Wave. The definition that has become prevalent in the literature is based on anomalies relative to a fixed historical climalogy. Most of the trends in MHWs can be traced back to this particular choice of an invariant reference period, rather than using something like an average over the previous 30 years (the usual WMO definition of "climate"), and it is essential that the reader is able to put all of these statements about MHWs into context. This is a difference between the misinterpretation that the ocean "weather" is getting more extreme, as opposed to the simpler and more accuarate statement that the ocean "climate" is changing. [Robert Hallberg, United States of America]	It is essential that the definition be provided for a Marine Heat Wave. The definition that has become prevalent in the literature is based on anomalies relative to a fixed historical climalogy. Most of the trends in MHWs can be traced back to this particular choice of an invariant reference period, rather than using something like an average over the previous 30 years (the usual WMO definition of "climate"), and it is essential that the reader is able to put all of these statements about MHWs into context. This is a difference between the misinterpretation that the ocean "weather" is getting more extreme, as opposed to the simpler and more accuarate statement that the ocean "climate" is changing.
48956	14	32	14	35	Switch the order of these first two sentences. Define first, describe importance second. [Laura Reynolds, United States of America]	Switch the order of these first two sentences. Define first, describe importance second.
13222	14	32	14	45	What is the maximum depth that marine heat waves reach, i.e., what are "near-seas surface temperatures" defined as based on depth in the water column? [Nora Richter, United States of America]	What is the maximum depth that marine heat waves reach, i.e., what are "near-seas surface temperatures" defined as based on depth in the water column?
13224	14	32	14	45	Do marine heat waves typically occur along coastlines or do they also occur in the middle of the ocean? What is the spatial distribution of marine heatwaves? [Nora Richter, United States of America]	Do marine heat waves typically occur along coastlines or do they also occur in the middle of the ocean? What is the spatial distribution of marine heatwaves?
44372	14	36	14	36	"the climatological mean SST" is the mean for a particular period. In order to avoid ambiguity it would be useful to either indicate the period or insert the word "historical" before "SST" [Michael Bell, United Kingdom (of Great Britain and Northern Ireland)]	"the climatological mean SST" is the mean for a particular period. In order to avoid ambiguity it would be useful to either indicate the period or insert the word "historical" before "SST"
24972	14	37	14	37	please explain what the "local difference" means here. [Adrian New, United Kingdom (of Great Britain and Northern Ireland)]	please explain what the "local difference" means here.
19452	14	39	14	42	The decline in aquaculture and fish catch is a result of the impacts on marine ecosystems due to marine heatwaves. The sentence should be modified for better understanding. [Gwenaelle GREMION, Canada]	The decline in aquaculture and fish catch is a result of the impacts on marine ecosystems due to marine heatwaves. The sentence should be modified for better understanding.
39186	14	39	14	43	tell that different definition of heat wave are used depending on the specific use and vulnerability criteria.? [Pascale Braconnot, France]	tell that different definition of heat wave are used depending on the specific use and vulnerability criteria.?
39854	14	39		43	perhaps an explanation on the depth to which these can have an effect? Afterall they are defined as SST extremes . [Michael Tsimplis, China]	perhaps an explanation on the depth to which these can have an effect? Afterall they are defined as SST extremes .

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
42418	14	41	14	42	The wording in this sentence is a bit confusing. Coupling "loss of biodiversity and toxic algal bloom, to decline in aquaculture and fisheries catch" make the message seem as though there is a loss in toxic algal blooms and a decline in fisheries catch, as though that is a negative result of MHWs. Perhaps change the wording to "loss of biodiversity and increases in toxic algal blooms" for example. [Elizabeth Fard, United States of America]	The wording in this sentence is a bit confusing. Coupling "loss of biodiversity and toxic algal bloom, to decline in aquaculture and fisheries catch" make the message seem as though there is a loss in toxic algal blooms and a decline in fisheries catch, as though that is a negative result of MHWs. Perhaps change the wording to "loss of biodiversity and increases in toxic algal blooms" for example.
6341	14	42			add SROCC Chapter 5 [Baruch Rinkevich, Israel]	add SROCC Chapter 5
19456	14	47	14	47	Does the medium confidence level also refer to more intense? [Gwenaelle GREMION, Canada]	Does the medium confidence level also refer to more intense?
39238	14	50	14	51	"MHWs also increased in intensity (0.085°C)..." - a brief definition of MHW intensity could probably be provided here; what 0.085°C means exactly? [Dmitry Kovalevsky, Germany]	"MHWs also increased in intensity (0.085°C)..." - a brief definition of MHW intensity could probably be provided here; what 0.085°C means exactly?
19454	14	51	14	52	The anthropogenic cause may be better than anthropogenic component or write the sentence more clearly. [Gwenaelle GREMION, Canada]	The anthropogenic cause may be better than anthropogenic component or write the sentence more clearly.
39240	14	54	14	55	Should the time periods be probably swapped here? Proposed correction: "Extending the satellite data using reanalysis SSTs shows a 54% increase in annual MHW days between the 1987-2016 period compared to 1925-1954 (Oliver et al., 2018)." [Dmitry Kovalevsky, Germany]	Should the time periods be probably swapped here? Proposed correction: "Extending the satellite data using reanalysis SSTs shows a 54% increase in annual MHW days between the 1987-2016 period compared to 1925-1954 (Oliver et al., 2018)."
19458	15	1	15	1	Confidence level of the trend? [Gwenaelle GREMION, Canada]	Confidence level of the trend?
39242	15	9	15	11	"ENSO combined with decadal climate modes (Pacific Decadal Oscillation (PDO) and Atlantic Multi-decadal Oscillation (AMO)) explain 18% of MHW frequency, 56% of duration and 36% of total days (Oliver et al., 2018)." - Is there no contradiction of the highlighted percentages with the earlier phrase (Chapter 9, page 14, lines 51-52): "Today, about 87% of the MHWs have been shown to have an anthropogenic component"? Does not the latter phrase suggest that the variability (ENSO, PDO, AMO) explains less than 100%-87%=13% of MHW? [Dmitry Kovalevsky, Germany]	"ENSO combined with decadal climate modes (Pacific Decadal Oscillation (PDO) and Atlantic Multi-decadal Oscillation (AMO)) explain 18% of MHW frequency, 56% of duration and 36% of total days (Oliver et al., 2018)." - Is there no contradiction of the highlighted percentages with the earlier phrase (Chapter 9, page 14, lines 51-52): "Today, about 87% of the MHWs have been shown to have an anthropogenic component"? Does not the latter phrase suggest that the variability (ENSO, PDO, AMO) explains less than 100%-87%=13% of MHW?
39856	15	13			Should the link of global warming with modes be mentioned or cross referenced to the relevant part of the report? [Michael Tsimplis, China]	Should the link of global warming with modes be mentioned or cross referenced to the relevant part of the report?
8676	15	25	15	33	Is there any relevant information on future marine heat waves in semi-enclodsed seas such as the Mediterranean and Baltic sea? (large potential impacts on ecosystems) [Goneri Le Cozannet, France]	Is there any relevant information on future marine heat waves in semi-enclodsed seas such as the Mediterranean and Baltic sea? (large potential impacts on ecosystems)

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
39858	15	25		32	I am unclear on whether these are globally hapennning. It is clear that they are not globally important. Reading through the report EVERYTHING needs more research despite the fact that in some areas there has not been much improvement in the understanding and modelling of the parameters we measure. For MHWs of course it is not the SST that matters but the heat propagating to the relevant deapth the SST is only an indicator easier to measure. [Michael Tsimplis, China]	I am unclear on whether these are globally hapennning. It is clear that they are not globally important. Reading through the report EVERYTHING needs more research despite the fact that in some areas there has not been much improvement in the understanding and modelling of the parameters we measure. For MHWs of course it is not the SST that matters but the heat propagating to the relevant deapth the SST is only an indicator easier to measure.
56564	15	26	15	27	Why are the largest changes projected to occur in the W Pacific, considering the 'El Nino-like' pattern of projected SST warming, which suggests larger changes in the E Pacific? This is surprising and I think needs a comment/explanation. [Richard Wood, United Kingdom (of Great Britain and Northern Ireland)]	Why are the largest changes projected to occur in the W Pacific, considering the 'El Nino-like' pattern of projected SST warming, which suggests larger changes in the E Pacific? This is surprising and I think needs a comment/explanation.
6345	15	29	15	30	Need to clarify why 'particularly in regions with high biodiversity'? Why 'needs to be improved'? [Baruch Rinkevich, Israel]	Need to clarify why 'particularly in regions with high biodiversity'? Why 'needs to be improved'?
42420	15	30	15	32	After the sentence "The availability of high temporal and spatial resolution ocean temperature data would aid in identifying small-scale MHWs", would it be possible to add where the most robust and reliable measurements are currently collected from in order to do the IPCC analyses? [Elizabeth Fard, United States of America]	After the sentence "The availability of high temporal and spatial resolution ocean temperature data would aid in identifying small-scale MHWs", would it be possible to add where the most robust and reliable measurements are currently collected from in order to do the IPCC analyses?
39860	15	32			Statement above said anthrobogenic attribution as given. This casts doubt. Decide which way it is or clarify why there is an apparent contradiction, [Michael Tsimplis, China]	Statement above said anthrobogenic attribution as given. This casts doubt. Decide which way it is or clarify why there is an apparent contradiction,
7560	15	39	15	55	Is it worth mentioning the role of sea-ice in influencing SSS in the Southern Ocean? [Patrick Hyder, United Kingdom (of Great Britain and Northern Ireland)]	Is it worth mentioning the role of sea-ice in influencing SSS in the Southern Ocean?
48700	15	39	16	4	This section should include the most recent review on Sea Surface Salinity. Suggest citing the following (also to clarify the differenece between Salinity and Sea Surface Salinity): Reul N., Arias M., Boutin J., Catany R., Chapron B., D'Amico F., Dinnat E., Donlon C., Fore A., Fournier S., Grodsky S.A., Guimbard S., Hasson A., Kolodziejczyk N., Lagerloef G., Lee T., LeVine D., Lindstrom E., Maes C., Mecklenburg S., Meissner T., Olmedo E., Sabia R., Turiel A., Tenerelli J., Thouvenin-Masson C., Vergely J.L., Vinogradova N., Wentz F., and Yueh S. (2019) Sea Surface Salinity estimates from Spaceborne L-band radiometers: an overview of the first 9 years of observations (2010-2018). Remote Sensing of Environment, Special issue on 50 years of Sea Surface Salinity, in review [Rafael Catany, United Kingdom (of Great Britain and Northern Ireland)]	This section should include the most recent review on Sea Surface Salinity. Suggest citing the following (also to clarify the differenece between Salinity and Sea Surface Salinity): Reul N., Arias M., Boutin J., Catany R., Chapron B., D'Amico F., Dinnat E., Donlon C., Fore A., Fournier S., Grodsky S.A., Guimbard S., Hasson A., Kolodziejczyk N., Lagerloef G., Lee T., LeVine D., Lindstrom E., Maes C., Mecklenburg S., Meissner T., Olmedo E., Sabia R., Turiel A., Tenerelli J., Thouvenin-Masson C., Vergely J.L., Vinogradova N., Wentz F., and Yueh S. (2019) Sea Surface Salinity estimates from Spaceborne L-band radiometers: an overview of the first 9 years of observations (2010-2018). Remote Sensing of Environment, Special issue on 50 years of Sea Surface Salinity, in review

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
32328	15	42	15	47	The text states first that salinity changes are extremely likely but then only assigns medium confidence to those changes. Shouldn't it be a higher confidence level? Some clarification is needed here. [Simon Josey, United Kingdom (of Great Britain and Northern Ireland)]	The text states first that salinity changes are extremely likely but then only assigns medium confidence to those changes. Shouldn't it be a higher confidence level? Some clarification is needed here.
41434	15	45	15	47	Relocate "medium confidence" at the end of the sentence. [Charalampos Charalampidis, Germany]	Relocate "medium confidence" at the end of the sentence.
19460	15	47	15	47	Surface changes of SSS --> Surface is already implied in SSS [Gwenaelle GREMION, Canada]	Surface changes of SSS --> Surface is already implied in SSS
39244	15	47	15	47	"Surface changes of SSS propagate…" - Is the word "surface" really necessary here? [Dmitry Kovalevsky, Germany]	"Surface changes of SSS propagate…" - Is the word "surface" really necessary here?
25282	15	47	15	47	Anything new since 2010 (pre-AR5 ref) - Ch 2 cites more recent Durak papers [Sharon Smith, Canada]	Anything new since 2010 (pre-AR5 ref) - Ch 2 cites more recent Durak papers
42422	15	47	15	48	"Surface changes of SSS propagate in the interior ocean along circulation pathways". This sentence is not very clear, and is not expanded upon from what I can see in Section 9.2.3.2. For someone interested in understanding how sea surface salinity is spread throughout ocean depths, I do not have a better understanding with this sentence. Perhaps this concept can be expanded and made more clear to non-expert audiences. [Elizabeth Fard, United States of America]	"Surface changes of SSS propagate in the interior ocean along circulation pathways". This sentence is not very clear, and is not expanded upon from what I can see in Section 9.2.3.2. For someone interested in understanding how sea surface salinity is spread throughout ocean depths, I do not have a better understanding with this sentence. Perhaps this concept can be expanded and made more clear to non-expert audiences.
32330	15	50	15	53	The cited publications (Li et al., 2015c; Liu et al., 2018) are concerned with land evaporation and SST respectively so it's not clear how they 'clearly demonstrate mechanistic links' between near surface salinity and terrestrial rainfall. Can the text be clarified on this point? [Simon Josey, United Kingdom (of Great Britain and Northern Ireland)]	The cited publications (Li et al., 2015c; Liu et al., 2018) are concerned with land evaporation and SST respectively so it's not clear how they 'clearly demonstrate mechanistic links' between near surface salinity and terrestrial rainfall. Can the text be clarified on this point?
39862	15	50		52	globally? I appreciate that SSS has started been measured recently and there are scientific discoveries to be made- BUT in the context of climate change why any of these statements are relevant? [Michael Tsimplis, China]	globally? I appreciate that SSS has started been measured recently and there are scientific discoveries to be made- BUT in the context of climate change why any of these statements are relevant?
54316	15	55	16	1	This sentence doesn't make sense as written - there may be a word or words missing? [Blair Trewin, Australia]	This sentence doesn't make sense as written - there may be a word or words missing?
38492	16	2	16	4	Do the CMIP5 models give different projection or are they just strengthen the observational records? [Iskhaq Iskandar, Indonesia]	Do the CMIP5 models give different projection or are they just strengthen the observational records?
19466	16	3	16	3	Confidence level? [Gwenaelle GREMION, Canada]	Confidence level?
39864	16	4			In essence,the report says, SSS is not measured properly and thus not well analysed and thus not well projected. - In essence we follow the E-P pattern. But why is this useful for a climate assessment. And what impacts does it have anyway relevant to this assessment? [Michael Tsimplis, China]	In essence,the report says, SSS is not measured properly and thus not well analysed and thus not well projected. - In essence we follow the E-P pattern. But why is this useful for a climate assessment. And what impacts does it have anyway relevant to this assessment?

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
48498	16	7	17	50	This section would benefit from a discussion of the spatial pattern of anomalous surface heat fluxes and what sets it. Observations have large uncertainties, but models show in general that pattern of surface heat fluxes largely mirrors changes in sensible and latent fluxes, and greatest heat uptake occurs in the North Atlantic and Southern Ocean (over historical and projections) where SSTs are slow to warm relative to the atmosphere above. [Kyle Armour, United States of America]	This section would benefit from a discussion of the spatial pattern of anomalous surface heat fluxes and what sets it. Observations have large uncertainties, but models show in general that pattern of surface heat fluxes largely mirrors changes in sensible and latent fluxes, and greatest heat uptake occurs in the North Atlantic and Southern Ocean (over historical and projections) where SSTs are slow to warm relative to the atmosphere above.
45188	16	7	17	50	Section 9.2.2.3 Air-sea fluxes and winds. This section starts with net air-sea fluxes as inferred from changes in ocean heat content and duplicates information from section 9.2.3 and also Chapter 7. I suggest that the text direct the reader to other sections of the report for a discussion of total net air-sea flux inferred from ocean heat storage changes. [Matthew Palmer, United Kingdom (of Great Britain and Northern Ireland)]	Section 9.2.2.3 Air-sea fluxes and winds. This section starts with net air-sea fluxes as inferred from changes in ocean heat content and duplicates information from section 9.2.3 and also Chapter 7. I suggest that the text direct the reader to other sections of the report for a discussion of total net air-sea flux inferred from ocean heat storage changes.
45190	16	7	17	50	Section 9.2.2.3 In my opinion, this section should focus on our knowledge of the spatial patterns of fluxes and the different components - and give an appraisal of current capability and challenges. I don't think I see any statement on the changes in air-sea fluxes in the long-term projections (?) Presumably the results from FAFMIP will be relevant to this section and can be incorporated later? [Matthew Palmer, United Kingdom (of Great Britain and Northern Ireland)]	Section 9.2.2.3 In my opinion, this section should focus on our knowledge of the spatial patterns of fluxes and the different components - and give an appraisal of current capability and challenges. I don't think I see any statement on the changes in air-sea fluxes in the long-term projections (?) Presumably the results from FAFMIP will be relevant to this section and can be incorporated later?
32332	16	9	16	12	Unlike the other studies cited, Resplandy did not use observed ocean warming to infer the mean air-sea heat flux. Instead they employed changes in atmospheric CO2 and O2. This should be corrected for accuracy. [Simon Josey, United Kingdom (of Great Britain and Northern Ireland)]	Unlike the other studies cited, Resplandy did not use observed ocean warming to infer the mean air-sea heat flux. Instead they employed changes in atmospheric CO2 and O2. This should be corrected for accuracy.
32334	16	9	16	12	Also, the published Resplandy number is 0.83 Wm-2 which is higher than the range stated in the text. They have subsequently acknowledged problems with their method which will lead to a revision of this number so this needs to be considered in the text here. [Simon Josey, United Kingdom (of Great Britain and Northern Ireland)]	Also, the published Resplandy number is 0.83 Wm-2 which is higher than the range stated in the text. They have subsequently acknowledged problems with their method which will lead to a revision of this number so this needs to be considered in the text here.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
47018	16	9	16	24	Heat fluxes derived from changes in ocean heat content are often taken as averages over the surface of the Earth, not the surface area of the ocean. Describing the fluxes in this passage as global mean air-sea heat fluxes and then comparing them with satellite estimates of fluxes would tend to suggest that these values are averages over the surface area of the ocean, perhaps exclusive of sea-ice covered areas. Please clarify what area is used for these heat fluxes (based on the magnitude of the values, I am pretty sure that these are averaged over the area of the Earth). [Robert Hallberg, United States of America]	Heat fluxes derived from changes in ocean heat content are often taken as averages over the surface of the Earth, not the surface area of the ocean. Describing the fluxes in this passage as global mean air-sea heat fluxes and then comparing them with satellite estimates of fluxes would tend to suggest that these values are averages over the surface area of the ocean, perhaps exclusive of sea-ice covered areas. Please clarify what area is used for these heat fluxes (based on the magnitude of the values, I am pretty sure that these are averaged over the area of the Earth).
7562	16	10	16	11	The two quoted uncertainties of 0.02 Wm-2 seem very small . Is it worth explaining why they are so small (assuming that they are correct)? [Patrick Hyder, United Kingdom (of Great Britain and Northern Ireland)]	The two quoted uncertainties of 0.02 Wm-2 seem very small . Is it worth explaining why they are so small (assuming that they are correct)?
39866	16	10			huge difference in uncertainty- is this a typo? If not some comment should be made because- if correct only the one with the large uncertainty is close to the CMIP5 models. [Michael Tsimplis, China]	huge difference in uncertainty- is this a typo? If not some comment should be made because- if correct only the one with the large uncertainty is close to the CMIP5 models.
19476	16	12	16	13	If we are sure about the anthopogenic effect, please include reference instead to send us to another section. [Gwenaelle GREMION, Canada]	If we are sure about the anthopogenic effect, please include reference instead to send us to another section.
19468	16	15	16	15	On what are the estimates based? Model or observation? [Gwenaelle GREMION, Canada]	On what are the estimates based? Model or observation?
7564	16	15	16	42	Is it worth adding an clear introductory sentence at the start stating something along the lines of 'Although the air-sea heat (and freshwater) flux products may have improved in some ways since AR5, substantial uncertainties remain which limit our ability to understand the global energy budget and adequately assess models.' [Patrick Hyder, United Kingdom (of Great Britain and Northern Ireland)]	Is it worth adding an clear introductory sentence at the start stating something along the lines of 'Although the air-sea heat (and freshwater) flux products may have improved in some ways since AR5, substantial uncertainties remain which limit our ability to understand the global energy budget and adequately assess models.'
39868	16	15			uncertainties here? [Michael Tsimplis, China]	uncertainties here?
19462	16	16	16	16	Delete. apparently [Gwenaelle GREMION, Canada]	Delete. apparently
41436	16	18	16	18	"...annual and decadal spatial variability overwhelms..." [Charalampos Charalampidis, Germany]	"...annual and decadal spatial variability overwhelms..."
32336	16	18	16	19	‘Air-sea heat flux datasets were too uncertain in AR5 to detect warming fluxes directly.’ The text following this statement describes updates to flux datasets since AR5. However, it doesn’t say whether the flux datasets are still too uncertain to detect warming fluxes directly. So, this needs to be clarified here. [Simon Josey, United Kingdom (of Great Britain and Northern Ireland)]	‘Air-sea heat flux datasets were too uncertain in AR5 to detect warming fluxes directly.’ The text following this statement describes updates to flux datasets since AR5. However, it doesn’t say whether the flux datasets are still too uncertain to detect warming fluxes directly. So, this needs to be clarified here.
48496	16	18	16	19	Is it not still true that air-sea heat fluxes are still too uncertain to quantify global surface flux trends directly? (thus the need for ocean warming to do so.) [Kyle Armour, United States of America]	Is it not still true that air-sea heat fluxes are still too uncertain to quantify global surface flux trends directly? (thus the need for ocean warming to do so.)

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
41438	16	18	16	19	Replace "data sets" were "remotely-sensed observations". [Charalampos Charalampidis, Germany]	Replace "data sets" were "remotely-sensed observations".
19470	16	21	16	24	It does not get clear what the conclusion is here. Have the estimates improved or not? Is there higher confidence about warming trends? What about the uncertainties? [Gwenaelle GREMION, Canada]	It does not get clear what the conclusion is here. Have the estimates improved or not? Is there higher confidence about warming trends? What about the uncertainties?
39870	16	23		24	Improved uncertainty estimations: by how much? Most have global energey mbalances exceeding … :by how much. What is the consequence then? [Michael Tsimplis, China]	Improved uncertainty estimations: by how much? Most have global energey mbalances exceeding … :by how much. What is the consequence then?
19472	16	31	16	31	"Fair agreement' is not an IPCC certainty language term [Gwenaelle GREMION, Canada]	"Fair agreement' is not an IPCC certainty language term
39872	16	31			What is the meaning of fair agreement? Quantification would be helpful. Is the agreeent on global or regional scales and on what time periods? What does differe substantially? Again the usefulness of this assessment is problematic. Essentially we do not know much and despite what it was said at the beginning there is no progress for AR5 as far as I can see despite the longer datasets and the more recent analysis. The fact that there are new datasets are not really informative in relation to the current climate assessment. They could be relevant if there was a systematic assessment to prioritise what we need to know and how to do it best but this is not pat of this report I believe. [Michael Tsimplis, China]	What is the meaning of fair agreement? Quantification would be helpful. Is the agreeent on global or regional scales and on what time periods? What does differe substantially? Again the usefulness of this assessment is problematic. Essentially we do not know much and despite what it was said at the beginning there is no progress for AR5 as far as I can see despite the longer datasets and the more recent analysis. The fact that there are new datasets are not really informative in relation to the current climate assessment. They could be relevant if there was a systematic assessment to prioritise what we need to know and how to do it best but this is not pat of this report I believe.
19464	16	36	16	37	“Based on these observations,…” maybe reiterate what ‘these’ are. [Gwenaelle GREMION, Canada]	“Based on these observations,…” maybe reiterate what ‘these’ are.
38494	16	41	16	42	Does it due to a short data records? [Iskhaq Iskandar, Indonesia]	Does it due to a short data records?
19474	16	42	16	42	Confidence level? [Gwenaelle GREMION, Canada]	Confidence level?
48500	16	45	16	56	I'm having trouble understanding this figure. Do blue colors show heat fluxes into or out of the ocean? [Kyle Armour, United States of America]	I'm having trouble understanding this figure. Do blue colors show heat fluxes into or out of the ocean?
41440	16	47	16	49	Delete "(left)"; Difficult sentence. Please, reformulate; Remember that the same changes should be applied on page 203. [Charalampos Charalampidis, Germany]	Delete "(left)"; Difficult sentence. Please, reformulate; Remember that the same changes should be applied on page 203.
25284	17	3	18	54	Many pre-AR5 refs (background?) - Focus on advancements made since AR5. [Sharon Smith, Canada]	Many pre-AR5 refs (background?) - Focus on advancements made since AR5.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
32338	17	5	17	7	'In the Southern Ocean we have high confidence that the zonal wind stress increased from the early 1980s to the 1990s'. AR5 Chapter 3 concluded with 'medium confidence that Southern Ocean wind stress has strengthened since the early 1980s.' No new studies are reported in the AR6 text here so how has the level of confidence been increased from medium to high? Note the cited paper of Jones et al. (2011) makes use of a combination of theory and idealized numerical simulations so does not provide any observational basis for increased confidence in the zonal wind stress trend. [Simon Josey, United Kingdom (of Great Britain and Northern Ireland)]	'In the Southern Ocean we have high confidence that the zonal wind stress increased from the early 1980s to the 1990s'. AR5 Chapter 3 concluded with 'medium confidence that Southern Ocean wind stress has strengthened since the early 1980s.' No new studies are reported in the AR6 text here so how has the level of confidence been increased from medium to high? Note the cited paper of Jones et al. (2011) makes use of a combination of theory and idealized numerical simulations so does not provide any observational basis for increased confidence in the zonal wind stress trend.
24974	17	7	17	23	the statement in lines 7-8 that the N Atlantic westerly winds have weakened seems to contradict the statement in lines 22-23 that a more positive phase of the NAM means that the westerly winds (in the northern hemisphere) would be increasing [Adrian New, United Kingdom (of Great Britain and Northern Ireland)]	the statement in lines 7-8 that the N Atlantic westerly winds have weakened seems to contradict the statement in lines 22-23 that a more positive phase of the NAM means that the westerly winds (in the northern hemisphere) would be increasing
19482	17	8	17	8	On what evidence is it based that the trade winds also weakened? [Gwenaelle GREMION, Canada]	On what evidence is it based that the trade winds also weakened?
48502	17	11	17	15	Some repeated language from a couple pages before. [Kyle Armour, United States of America]	Some repeated language from a couple pages before.
44374	17	11	17	16	There is duplication with page 12. [Michael Bell, United Kingdom (of Great Britain and Northern Ireland)]	There is duplication with page 12.
6347	17	12	17	14	Cite publications after year 2014, if available [Baruch Rinkevich, Israel]	Cite publications after year 2014, if available
19484	17	12	17	15	The exact same has already been said on page 12, line 27-29, but there without mentioning the high confidence. Also, maybe reference on page 12 that on page 17 will be given a more thorough explanation. [Gwenaelle GREMION, Canada]	The exact same has already been said on page 12, line 27-29, but there without mentioning the high confidence. Also, maybe reference on page 12 that on page 17 will be given a more thorough explanation.
12954	17	16	17	16	Add reference Makarim et al., Scientific Report, 9 (1), 7364, 2019, Susanto and Song, JGR, Oceans, 2015 [RADEN DWI SUSANTO, United States of America]	Add reference Makarim et al., Scientific Report, 9 (1), 7364, 2019, Susanto and Song, JGR, Oceans, 2015
7566	17	37	17	37	Should you mention that substantial observational air-sea heat flux uncertainties limit our ability to adequately assess models? [Patrick Hyder, United Kingdom (of Great Britain and Northern Ireland)]	Should you mention that substantial observational air-sea heat flux uncertainties limit our ability to adequately assess models?
19480	17	37	17	41	"Air-sea flux biases result from common causes in most models." This sentence is followed by a statement implying that the 'common cause' is a resolution problem. So one could aswell lead with that. [Gwenaelle GREMION, Canada]	"Air-sea flux biases result from common causes in most models." This sentence is followed by a statement implying that the 'common cause' is a resolution problem. So one could aswell lead with that.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
39188	17	47	17	47	This might not be the right place but, Hourdin et al. 2015 and Gainusa-Bogdan et al 2018 discuss the relationship between errors in the latent heat flux (found in atmospheric simulations) and SST biases in coupled simulations in the tropical regions. Hourdin, F., Gainusa-Bogdan, A., Braconnot, P., Dufresne, J. L., Traore, A. K., and Rio, C.: Air moisture control on ocean surface temperature, hidden key to the warm bias enigma, Geophysical Research Letters, 42, 2015, 10.1002/2015gl066764. ; Găinuşă-Bogdan, A., Hourdin, F., Traore, A. K., and Braconnot, P.: Omens of coupled model biases in the CMIP5 AMIP simulations, Climate Dynamics, doi: 10.1007/s00382-017-4057-3, 2018. 2018, 10.1007/s00382-017-4057-3. [Pascale Braconnot, France]	This might not be the right place but, Hourdin et al. 2015 and Gainusa-Bogdan et al 2018 discuss the relationship between errors in the latent heat flux (found in atmospheric simulations) and SST biases in coupled simulations in the tropical regions. Hourdin, F., Gainusa-Bogdan, A., Braconnot, P., Dufresne, J. L., Traore, A. K., and Rio, C.: Air moisture control on ocean surface temperature, hidden key to the warm bias enigma, Geophysical Research Letters, 42, 2015, 10.1002/2015gl066764. ; G?inu??-Bogdan, A., Hourdin, F., Traore, A. K., and Braconnot, P.: Omens of coupled model biases in the CMIP5 AMIP simulations, Climate Dynamics, doi: 10.1007/s00382-017-4057-3, 2018. 2018, 10.1007/s00382-017-4057-3.
39190	17	49	17	49	Torres et al. 2019, show how different parameterization depending of their global or regional differences affect the whole coupled system from atmospher and coupled ocean-atmosphere simulations. Torres, O., Braconnot, P., Marti, O., and Gential, L.: Impact of air-sea drag coefficient for latent heat flux on large scale climate in coupled and atmosphere stand-alone simulations, Climate Dynamics, 52, 2125-2144, 2019, 10.1007/s00382-018-4236-x. [Pascale Braconnot, France]	Torres et al. 2019, show how different parameterization depending of their global or regional differences affect the whole coupled system from atmospher and coupled ocean-atmosphere simulations. Torres, O., Braconnot, P., Marti, O., and Gential, L.: Impact of air-sea drag coefficient for latent heat flux on large scale climate in coupled and atmosphere stand-alone simulations, Climate Dynamics, 52, 2125-2144, 2019, 10.1007/s00382-018-4236-x.
54318	17	54	17	54	Better to refer to an intense El Nino rather than an intense ENSO (the ENSO term encompasses both El Nino and La Nina). [Blair Trewin, Australia]	Better to refer to an intense El Nino rather than an intense ENSO (the ENSO term encompasses both El Nino and La Nina).
19478	17	55	18	2	It is better to identify the distinction between tides and wind waves. Therefore, tides also should be included here. [Gwenaelle GREMION, Canada]	It is better to identify the distinction between tides and wind waves. Therefore, tides also should be included here.
12956	17	55	18	4	should include tidal mixing (see i.e. Ray and Susanto, GRL, 43, doi:10.1002/2016GL069485, 2016) and its impacts on air sea interaction explained in previous section (see i.e. refs . Ray and Susanto, Geoscience Letters, 6:6, https://doi.org/10.1186/s40562-019-0135-1, 2019) [RADEN DWI SUSANTO, United States of America]	should include tidal mixing (see i.e. Ray and Susanto, GRL, 43, doi:10.1002/2016GL069485, 2016) and its impacts on air sea interaction explained in previous section (see i.e. refs . Ray and Susanto, Geoscience Letters, 6:6, https://doi.org/10.1186/s40562-019-0135-1, 2019)
19486	17	55	18	54	Sect. 9.2.2.4.: How does that work together, that there is high confidence, that North Atlantic and Southern Ocean deep convection is shoaling, when also there is high confidence of deep bias in these regions? Isn't that somewhat contrary? Alos more precisely refer to the subplots in Fig.9.6 [Gwenaelle GREMION, Canada]	Sect. 9.2.2.4.: How does that work together, that there is high confidence, that North Atlantic and Southern Ocean deep convection is shoaling, when also there is high confidence of deep bias in these regions? Isn't that somewhat contrary? Alos more precisely refer to the subplots in Fig.9.6

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
19492	18	2	18	4	That sounds as if the upper ocean mixing reduces because of the worldwide upper-ocean warming etc. and not that the stratification increases because of the upper-ocean warming. Also, worldwide is misleading because you have shown before, that the surface ocean is also cooling in places. So something like mean warming would be better. [Gwenaelle GREMION, Canada]	That sounds as if the upper ocean mixing reduces because of the worldwide upper-ocean warming etc. and not that the stratification increases because of the upper-ocean warming. Also, worldwide is misleading because you have shown before, that the surface ocean is also cooling in places. So something like mean warming would be better.
19494	18	10	18	10	Instead of consistently use agreement/evidence terminology [Gwenaelle GREMION, Canada]	Instead of consistently use agreement/evidence terminology
44442	18	19	18	25	Is a recent version of the observational dataset used for figure 9.6? What is the best way to compare observations and CMIP models regarding the mixed layer depth (profile-based climatology or mixed layer computed from a "Levitus-like" climatology?) [Anne Marie Treguier, France]	Is a recent version of the observational dataset used for figure 9.6? What is the best way to compare observations and CMIP models regarding the mixed layer depth (profile-based climatology or mixed layer computed from a "Levitus-like" climatology?)
19496	18	30	18	30	the font size is different within word "biases". [Gwenaelle GREMION, Canada]	the font size is different within word "biases".
38496	18	30	18	54	Discussion on bias correction in this section is excellent! [Iskhaq Iskandar, Indonesia]	Discussion on bias correction in this section is excellent!
6349	18	35	18	41	Many of the references are outdated. Cite the last 5 years publications [Baruch Rinkevich, Israel]	Many of the references are outdated. Cite the last 5 years publications
41270	18	39	18	39	write " ... (Craig and Banner, 1994; Araujo et al., 2001; Huang and Qiao, 2010), near-inertial ...", instead of (Craig and Banner, 1994; Huang and Qiao, 2010), near-inertial ..." [Moacyr Araujo, Brazil]	write " ... (Craig and Banner, 1994; Araujo et al., 2001; Huang and Qiao, 2010), near-inertial ...", instead of (Craig and Banner, 1994; Huang and Qiao, 2010), near-inertial ..."
19488	18	41	18	43	Give some examples of mixed layer properties improved due to CMIP6 models. [Gwenaelle GREMION, Canada]	Give some examples of mixed layer properties improved due to CMIP6 models.
44378	18	48	18	48	A reference to Chanut et al 2008 https://doi.org/10.1175/2008JPO3485.1 would be appropriate here [Michael Bell, United Kingdom (of Great Britain and Northern Ireland)]	A reference to Chanut et al 2008 https://doi.org/10.1175/2008JPO3485.1 would be appropriate here
19490	18	48	18	52	The deep model bias would be more meaningful for this long sentence. [Gwenaelle GREMION, Canada]	The deep model bias would be more meaningful for this long sentence.
49444	18	53	18	53	For additional evidence of the impact of overflow representation on North Atlantic and Labrador Sea convection, see Wang, He, Sonya Legg, and Robert Hallberg, February 2015: Representations of the Nordic Seas overflows and their large scale climate impact in coupled models. Ocean Modelling, 86, DOI:10.1016/j.ocemod.2014.12.005. [Sonya Legg, United States of America]	For additional evidence of the impact of overflow representation on North Atlantic and Labrador Sea convection, see Wang, He, Sonya Legg, and Robert Hallberg, February 2015: Representations of the Nordic Seas overflows and their large scale climate impact in coupled models. Ocean Modelling, 86, DOI:10.1016/j.ocemod.2014.12.005.
39874	18	54			this paragraph is about model assessment. Useful for understanding the extent to which projection are to be trusted but not truly saying much about climate change. How these can be improved are not at all relevant in my humble opinion. [Michael Tsimplis, China]	this paragraph is about model assessment. Useful for understanding the extent to which projection are to be trusted but not truly saying much about climate change. How these can be improved are not at all relevant in my humble opinion.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
44444	19	1	19	1	Personnally, I find "freshwater" misleading when talking about ocean water which is salty. Why not "Ocean salt content" for the title of this subsection 9.2.3?? [Anne Marie Treguier, France]	Personnally, I find "freshwater" misleading when talking about ocean water which is salty. Why not "Ocean salt content" for the title of this subsection 9.2.3??
38498	19	3	21	47	There are some ovelapping between this section and section 9.2.2.1. I would suggest to remove repetition in this section [Iskhaq Iskandar, Indonesia]	There are some ovelapping between this section and section 9.2.2.1. I would suggest to remove repetition in this section
6355	19	3	25	5	The text is read as a textbook chapter. Reduce wording and focus on last 5 years outcomes [Baruch Rinkevich, Israel]	The text is read as a textbook chapter. Reduce wording and focus on last 5 years outcomes
25286	19	3			Section 9.2.3.1 - Ch 2 (2.3.3.1) covers trends in OHC so reference should also be made to Ch 2 [Sharon Smith, Canada]	Section 9.2.3.1 - Ch 2 (2.3.3.1) covers trends in OHC so reference should also be made to Ch 2
52932	19	5	19	5	Replace "is" with "are" ? [Abigail Bodner, United States of America]	Replace "is" with "are" ?
19498	19	5	19	7	Global observed ocean heat content (OHC), which changes on annual and longer time-scale is assessed elsewhere.... [Gwenaelle GREMION, Canada]	Global observed ocean heat content (OHC), which changes on annual and longer time-scale is assessed elsewhere....
52160	19	6			also in chapter 2 and for completeness that reference should be given also. [Peter Thorne, Ireland]	also in chapter 2 and for completeness that reference should be given also.
50766	19	11	19	21	The reference "Section 7.2.2.2" is mentioned four times in this paragraph, consider to mention it just one or two times. [Hernan Edgardo Sala, Argentina]	The reference "Section 7.2.2.2" is mentioned four times in this paragraph, consider to mention it just one or two times.
37884	19	11			Comment 309 concerning the >90% value applies here also. [Adrian Simmons, United Kingdom (of Great Britain and Northern Ireland)]	Comment 309 concerning the >90% value applies here also.
39876	19	12			Why 1971-2010? It is already 2019. [Michael Tsimplis, China]	Why 1971-2010? It is already 2019.
48958	19	14	19	15	Although this is explained elsewhere in more detail, it would be good to have a more descriptive phrase or additional sentence repeated here describing the "novel estimates" for readers who have not read Section 7. [Laura Reynolds, United States of America]	Although this is explained elsewhere in more detail, it would be good to have a more descriptive phrase or additional sentence repeated here describing the "novel estimates" for readers who have not read Section 7.
19500	19	15	19	17	"It is likely that the global ocean warmed between the 1870s to 1971 (medium confidence) and virtually certain that the global ocean warmed between 1971 to present (Section 7.2.2.2)." The comment 5 on SST is applicable to this sentence too. It is required to homogenize the idea. The time span indicated in this sentence would be more appropriate for previous sentences considered under comment 5. [Gwenaelle GREMION, Canada]	"It is likely that the global ocean warmed between the 1870s to 1971 (medium confidence) and virtually certain that the global ocean warmed between 1971 to present (Section 7.2.2.2)." The comment 5 on SST is applicable to this sentence too. It is required to homogenize the idea. The time span indicated in this sentence would be more appropriate for previous sentences considered under comment 5.
52162	19	16			Given how spectacularly wrong we would need to be to call into question the warming should this not be a statement of fact rather than couched in likelihood language? [Peter Thorne, Ireland]	Given how spectacularly wrong we would need to be to call into question the warming should this not be a statement of fact rather than couched in likelihood language?
24976	19	17	19	17	"observing" rather than "observating" [Adrian New, United Kingdom (of Great Britain and Northern Ireland)]	"observing" rather than "observating"

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
12972	19	19	19	19	“The combination of tide and surge is referred to as still water level”. Add “at a given instant”. Previous ARs have referred to this as storm tide as well. [Roshanka Ranasinghe, Netherlands]	“The combination of tide and surge is referred to as still water level”. Add “at a given instant”. Previous ARs have referred to this as storm tide as well.
52934	19	19	19	19	Unclear what is meant by "vertical layers" [Abigail Bodner, United States of America]	Unclear what is meant by "vertical layers"
19504	19	21	19	21	Why is it necessary to also mention 2005-present as it is included in 1971-present? What is the relevance of that? Is there a difference in heating rate? [Gwenaelle GREMION, Canada]	Why is it necessary to also mention 2005-present as it is included in 1971-present? What is the relevance of that? Is there a difference in heating rate?
12974	19	23	19	23	“The wave contribution can be characterized as wave setup or wave runup”. Delete runup. It doesn’t contribute to a water level. [Roshanka Ranasinghe, Netherlands]	“The wave contribution can be characterized as wave setup or wave runup”. Delete runup. It doesn’t contribute to a water level.
45192	19	24	19	36	Figure 9.7. In oder to characterise the spatial patterns of ocean heat content change in the long-term projections, I think the following would be helpful: 1) a spatial plot of the column-integrated OHC change (or trend) to show geographically where the 93% of absorbed heat accumulates; 2) a zonally-integrated depth-vs-latitude plot of OHC change (or trend) to show where this change resides in the vertical. I support the idea of contrasting a low and high emissions scenario (as the current Figure 9.7 does). It may be useful to show the SST response alonside the colum-integrated OHC? [Matthew Palmer, United Kingdom (of Great Britain and Northern Ireland)]	Figure 9.7. In oder to characterise the spatial patterns of ocean heat content change in the long-term projections, I think the following would be helpful: 1) a spatial plot of the column-integrated OHC change (or trend) to show geographically where the 93% of absorbed heat accumulates; 2) a zonally-integrated depth-vs-latitude plot of OHC change (or trend) to show where this change resides in the vertical. I support the idea of contrasting a low and high emissions scenario (as the current Figure 9.7 does). It may be useful to show the SST response alonside the colum-integrated OHC?
12976	19	27	19	27	“and associated flood risk”. Better stay away from using the word risk unless you really mean risk as in hazard probability x damage. [Roshanka Ranasinghe, Netherlands]	“and associated flood risk”. Better stay away from using the word risk unless you really mean risk as in hazard probability x damage.
12978	19	28	19	28	“Variations in tides, surges and waves influence the frequency and magnitude of ESL”. A few studies have shown that the RSLR is the biggest contributor increasing the frequency of ESLs (1:100 today becomes 1:10 in year 2100, for e.g.). So maybe delete frequency here but add that to lines 30-31 where the effect of RSL on ESLs are mentioned. [Roshanka Ranasinghe, Netherlands]	“Variations in tides, surges and waves influence the frequency and magnitude of ESL”. A few studies have shown that the RSLR is the biggest contributor increasing the frequency of ESLs (1:100 today becomes 1:10 in year 2100, for e.g.). So maybe delete frequency here but add that to lines 30-31 where the effect of RSL on ESLs are mentioned.
48504	19	41	19	41	I believe this is also true of the Southern Ocean, at least north of the ACC (e.g., Armour et al. 2016). Cooling SSTs south of the ACC do overly warming waters below, as noted just below this, but the overall pattern of ocean warming over 700 meters does mirror the SSTs at least qualitatively throughout the Southern Ocean. [Kyle Armour, United States of America]	I believe this is also true of the Southern Ocean, at least north of the ACC (e.g., Armour et al. 2016). Cooling SSTs south of the ACC do overly warming waters below, as noted just below this, but the overall pattern of ocean warming over 700 meters does mirror the SSTs at least qualitatively throughout the Southern Ocean.
37886	19	41	19	43	The sentence that starts "Surface cooling …" can begin "Cooling …" as the rest of the sentence refers to the cooling being limited to the surface layer. [Adrian Simmons, United Kingdom (of Great Britain and Northern Ireland)]	The sentence that starts "Surface cooling …" can begin "Cooling …" as the rest of the sentence refers to the cooling being limited to the surface layer.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
56562	19	42	19	43	The cooling is not visible at all in Fig.9.8, at least in my printout. In any case can a way be found to make the figure clearer for comparison with Fig.9.3? (e.g. expand vertical scale near surface?) [Richard Wood, United Kingdom (of Great Britain and Northern Ireland)]	The cooling is not visible at all in Fig.9.8, at least in my printout. In any case can a way be found to make the figure clearer for comparison with Fig.9.3? (e.g. expand vertical scale near surface?)
19502	19	42	19	44	Maybe rephrased: Southern Ocean cooling is limited to the surface layer with little change in the underlying layer (Figures 9.3, 9.7, 9.8). [Gwenaelle GREMION, Canada]	Maybe rephrased: Southern Ocean cooling is limited to the surface layer with little change in the underlying layer (Figures 9.3, 9.7, 9.8).
37888	19	54			As "anthropogenetic warming" is not a quantity that is stored, the text needs changing to something like "anthropogenic added heat". [Adrian Simmons, United Kingdom (of Great Britain and Northern Ireland)]	As "anthropogenetic warming" is not a quantity that is stored, the text needs changing to something like "anthropogenic added heat".
54320	20	1	20	2	In addition to the issues raised here, in many cases daily or sub-daily exist on paper but not in digital form, making them effectively unavailable for use in analyses. [Blair Trewin, Australia]	In addition to the issues raised here, in many cases daily or sub-daily exist on paper but not in digital form, making them effectively unavailable for use in analyses.
24978	20	3	20	4	the cooling the N Atlantic region since 2006 does not seem to be apparent in fig 9.7 (e) [Adrian New, United Kingdom (of Great Britain and Northern Ireland)]	the cooling the N Atlantic region since 2006 does not seem to be apparent in fig 9.7 (e)
7902	20	3	20	4	subpolar North Atlantic not the whole North Atlantic [Laura Jackson, United Kingdom (of Great Britain and Northern Ireland)]	subpolar North Atlantic not the whole North Atlantic
37890	20	3	20	6	What point is this sentence trying to convey? It talks about ocean cooling since 2006, but cold atmospheric conditions only since 2014. [Adrian Simmons, United Kingdom (of Great Britain and Northern Ireland)]	What point is this sentence trying to convey? It talks about ocean cooling since 2006, but cold atmospheric conditions only since 2014.
7904	20	3	20	6	There are various problems wrong with this sentence and the references. McCarthy 2015 is about the AMOC array and not really anything to do with this point. I assume it should be Robson (2016) (since 2014 deals with changes in the 60s) - this paper and Smeed (2014) talk about the AMOC weakening since 2006 with some suggestion that this could have cooled the region more widely from 2006. The only paper dealing with the strong atmospheric coolingsince 2014 is Josey (2018) [Laura Jackson, United Kingdom (of Great Britain and Northern Ireland)]	There are various problems wrong with this sentence and the references. McCarthy 2015 is about the AMOC array and not really anything to do with this point. I assume it should be Robson (2016) (since 2014 deals with changes in the 60s) - this paper and Smeed (2014) talk about the AMOC weakening since 2006 with some suggestion that this could have cooled the region more widely from 2006. The only paper dealing with the strong atmospheric coolingsince 2014 is Josey (2018)
54322	20	17	20	29	It would be useful to have one or more citations for the order of operations problem in gridded data sets. One useful one is Avila et al 2015, https://doi.org/10.1016/j.wace.2015.06.003 [Blair Trewin, Australia]	It would be useful to have one or more citations for the order of operations problem in gridded data sets. One useful one is Avila et al 2015, https://doi.org/10.1016/j.wace.2015.06.003
48960	20	19	20	20	Why is this true? Maybe add one more sentence to clarify after this one. [Laura Reynolds, United States of America]	Why is this true? Maybe add one more sentence to clarify after this one.
19506	20	31	20	31	What are the sub-basins? Maybe specifilaly mention them. [Gwenaelle GREMION, Canada]	What are the sub-basins? Maybe specifilaly mention them.
54324	20	31	20	31	Should this read "better agreement between data sets"? [Blair Trewin, Australia]	Should this read "better agreement between data sets"?
6351	20	31	20	39	Provide detailed numbers and refrain from general statements [Baruch Rinkevich, Israel]	Provide detailed numbers and refrain from general statements
26436	20	32	20	40	For the South Pacific Ocean, there is a new publication; https://doi.org/10.1029/2018JC014775 [Katsuro Katsumata, Japan]	For the South Pacific Ocean, there is a new publication; https://doi.org/10.1029/2018JC014775

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
19508	20	43	20	43	It is not clear why this sentence is "consistent" with the previous one. [Gwenaelle GREMION, Canada]	It is not clear why this sentence is "consistent" with the previous one.
26438	20	46	20	48	Given the inhomogeneity of the ocean circulation, I am not sure if it is worth while to mention the difference between "59%" and "48%" here. [Katsuro Katsumata, Japan]	Given the inhomogeneity of the ocean circulation, I am not sure if it is worth while to mention the difference between "59%" and "48%" here.
40450	20	48	20	53	From a longer paleo perspective, including Rosenthal et al., 2013 (Pacific Ocean Heat Content During the Past 10,000 Years) can demostrate that changes in ocean heat content in the upper 700 m can be rapid and large. [Heather Ford, United Kingdom (of Great Britain and Northern Ireland)]	From a longer paleo perspective, including Rosenthal et al., 2013 (Pacific Ocean Heat Content During the Past 10,000 Years) can demostrate that changes in ocean heat content in the upper 700 m can be rapid and large.
6353	20	55	21	8	Too general, written like a text book, present the new data [Baruch Rinkevich, Israel]	Too general, written like a text book, present the new data
45274	21	3	21	3	· I would include a couple of sentences to “describe” the atmospheric forcing variability that affects the convection and therefore the cooling/warming in the North Atlantic. This is important also for the cold blob in the northern North Atlantic (Line 36 from page 9-21). [Alessandro Silvano, Australia]	· I would include a couple of sentences to “describe” the atmospheric forcing variability that affects the convection and therefore the cooling/warming in the North Atlantic. This is important also for the cold blob in the northern North Atlantic (Line 36 from page 9-21).
48506	21	4	21	5	I haven't read these papers, but the fact that data-assimilating models disagree even more than those just forced at the surface is quite surprising and could use some explanation. [Kyle Armour, United States of America]	I haven't read these papers, but the fact that data-assimilating models disagree even more than those just forced at the surface is quite surprising and could use some explanation.
7906	21	4	21	5	In a paper under revision at the moment (Jackson et al), we found that there is consistency in the AMOC in reanalyses over more recent time periods [Laura Jackson, United Kingdom (of Great Britain and Northern Ireland)]	In a paper under revision at the moment (Jackson et al), we found that there is consistency in the AMOC in reanalyses over more recent time periods
56586	21	5	21	5	A recenty submitted paper by Jackson et al. shows greater consistency among more recent reanalysis products, albeit focused on the post-1992 period. [Richard Wood, United Kingdom (of Great Britain and Northern Ireland)]	A recenty submitted paper by Jackson et al. shows greater consistency among more recent reanalysis products, albeit focused on the post-1992 period.
19520	21	10	21	15	Ability of CMIP5 models to capture short term cooling from vulcanic eruptions manifested in slow down in Arctic sea ice decline was also shown by Mueller, B.L., Gillett, N.P., Monahan, A.H. and Zwiers, F.W., 2018. Attribution of Arctic Sea Ice Decline from 1953 to 2012 to Influences from Natural, Greenhouse Gas, and Anthropogenic Aerosol Forcing. Journal of Climate, 31(19), pp.7771-7787. [Gwenaelle GREMION, Canada]	Ability of CMIP5 models to capture short term cooling from vulcanic eruptions manifested in slow down in Arctic sea ice decline was also shown by Mueller, B.L., Gillett, N.P., Monahan, A.H. and Zwiers, F.W., 2018. Attribution of Arctic Sea Ice Decline from 1953 to 2012 to Influences from Natural, Greenhouse Gas, and Anthropogenic Aerosol Forcing. Journal of Climate, 31(19), pp.7771-7787.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
54326	21	10	21	17	This section doesn't really address the potential use of reanalyses for temperature extremes - there are clear limitations for precipitation as outlined in the text, but the question of the usefulness of reanalyses for temperature extremes (especially post-1979) needs to be addressed - reanalyses are increasingly used for operational monitoring of indices such as Tx90x, and whilst they have homogeneity issues, this may be offset by their spatial coverage. [Blair Trewin, Australia]	This section doesn't really address the potential use of reanalyses for temperature extremes - there are clear limitations for precipitation as outlined in the text, but the question of the usefulness of reanalyses for temperature extremes (especially post-1979) needs to be addressed - reanalyses are increasingly used for operational monitoring of indices such as Tx90x, and whilst they have homogeneity issues, this may be offset by their spatial coverage.
56588	21	12	21	12	This is too simplistic - there is a huge spread in the CMIP5 model simulations of historical heat uptake. Just discussing the multi-model mean underplays the model spread. [Richard Wood, United Kingdom (of Great Britain and Northern Ireland)]	This is too simplistic - there is a huge spread in the CMIP5 model simulations of historical heat uptake. Just discussing the multi-model mean underplays the model spread.
56590	21	15	21	16	This is too simplistic - there is a huge spread in the CMIP5 model simulations of historical heat uptake. Just discussing the multi-model mean underplays the model spread. [Richard Wood, United Kingdom (of Great Britain and Northern Ireland)]	This is too simplistic - there is a huge spread in the CMIP5 model simulations of historical heat uptake. Just discussing the multi-model mean underplays the model spread.
50774	21	19	21	20	In the sentence: "Historical model runs have different phasing of natural variability than observations", consider to replace "have" by "simulate". [Hernan Edgardo Sala, Argentina]	In the sentence: "Historical model runs have different phasing of natural variability than observations", consider to replace "have" by "simulate".
19510	21	22	21	24	It should be confirmed whether the warming time limit (i.e. 2300) is the same for all the emission scenarios. [Gwenaelle GREMION, Canada]	It should be confirmed whether the warming time limit (i.e. 2300) is the same for all the emission scenarios.
19512	21	22	21	24	Can the ocean warming up to 2300 relate to the time limit that SST of Southern Ocean will start to show eventual warming? See comment 13. [Gwenaelle GREMION, Canada]	Can the ocean warming up to 2300 relate to the time limit that SST of Southern Ocean will start to show eventual warming? See comment 13.
52164	21	22			Again, I'm not sure where any equivocation arises from this finding that requires couching this in a likelihood framework. It is surely beyond any doubt that the ocean will accrue heat this coming Century? [Peter Thorne, Ireland]	Again, I'm not sure where any equivocation arises from this finding that requires couching this in a likelihood framework. It is surely beyond any doubt that the ocean will accrue heat this coming Century?
19514	21	24	21	24	Explain why the dependence on scenarios begins only after 2040. [Gwenaelle GREMION, Canada]	Explain why the dependence on scenarios begins only after 2040.
24980	21	24	21	24	I do not think the dependence on the scenarios which begins after about 2040 is apparent in fig 9.7 as claimed. [Adrian New, United Kingdom (of Great Britain and Northern Ireland)]	I do not think the dependence on the scenarios which begins after about 2040 is apparent in fig 9.7 as claimed.
19516	21	24	21	26	In this paragraph, the authors talk about even beyond the 21st Century. Therefore, the phrase " end of the century" may be confusing. Thus, "end of the year 2100" may be appropriate. [Gwenaelle GREMION, Canada]	In this paragraph, the authors talk about even beyond the 21st Century. Therefore, the phrase " end of the century" may be confusing. Thus, "end of the year 2100" may be appropriate.
39878	21	24			differentiation between scenarios is possible only after... [Michael Tsimplis, China]	differentiation between scenarios is possible only after...

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
44380	21	27	21	31	This is one of the Executive Summary points. It is backed up only by one reference that is 2 pages long and that does not contain the uncertainty estimates given. [Michael Bell, United Kingdom (of Great Britain and Northern Ireland)]	This is one of the Executive Summary points. It is backed up only by one reference that is 2 pages long and that does not contain the uncertainty estimates given.
24982	21	29	21	29	I think the order of the 16 and 35 cm sea level rises should be reversed ie so that the larger change (35 cm) is associated with the RCP8.5 scenario etc [Adrian New, United Kingdom (of Great Britain and Northern Ireland)]	I think the order of the 16 and 35 cm sea level rises should be reversed ie so that the larger change (35 cm) is associated with the RCP8.5 scenario etc
42630	21	33	21	35	At least some of the observatonal studies supporting this statement should be cited. (especially given the strong statement in the Executive Summary that implies that this bevahor is extremely likely) . See comment regarding P6, lines 13-14). [William Gutowski, United States of America]	At least some of the observatonal studies supporting this statement should be cited. (especially given the strong statement in the Executive Summary that implies that this bevahor is extremely likely) . See comment regarding P6, lines 13-14).
39880	21	33		47	this is all too vague. Trends with uncertainties in parentheses after each statement will be helpful. [Michael Tsimplis, China]	this is all too vague. Trends with uncertainties in parentheses after each statement will be helpful.
26440	21	34	21	34	"subtropical" → "subantarctic" mode water in the Southern Ocean? [Katsuro Katsumata, Japan]	"subtropical" ? "subantarctic" mode water in the Southern Ocean?
56592	21	35	21	36	A recent study by Menary & Wood 2017 Cl Dyn doi: 10.1007/s00382-017-3793-8 adds substantial evidence that the so-called N Atlantic warming hole is driven by AMOC weakening rather than vertical mixing of the local warning signal, at least in projections. [Richard Wood, United Kingdom (of Great Britain and Northern Ireland)]	A recent study by Menary & Wood 2017 Cl Dyn doi: 10.1007/s00382-017-3793-8 adds substantial evidence that the so-called N Atlantic warming hole is driven by AMOC weakening rather than vertical mixing of the local warning signal, at least in projections.
48508	21	35	21	41	Perhaps cite Marshall et al. 2015 on these points doi: 10.1007/s00382-014-2308-0 [Kyle Armour, United States of America]	Perhaps cite Marshall et al. 2015 on these points doi: 10.1007/s00382-014-2308-0
45276	21	37	21	37	Include Armour et al. 2016 (Southern Ocean warming delayed by circumpolar upwelling and equatorward transport, Nature Geos.). [Alessandro Silvano, Australia]	Include Armour et al. 2016 (Southern Ocean warming delayed by circumpolar upwelling and equatorward transport, Nature Geos.).
44382	21	41	21	46	The grammar is so poor here, I can't work out what the text is intended to mean. [Michael Bell, United Kingdom (of Great Britain and Northern Ireland)]	The grammar is so poor here, I can't work out what the text is intended to mean.
19522	21	42	21	42	Which depth is greater depth. It would be good to be more precise there. [Gwenaelle GREMION, Canada]	Which depth is greater depth. It would be good to be more precise there.
49446	21	43	21	44	This sentence is incomplete. [Sonya Legg, United States of America]	This sentence is incomplete.
19524	21	43	21	44	This sentence makes no sense. It sounds like half of the sentence is missing. [Gwenaelle GREMION, Canada]	This sentence makes no sense. It sounds like half of the sentence is missing.
19518	21	46	21	47	When will the greenhouse gas emission cease and give possible reasons for the cessation? [Gwenaelle GREMION, Canada]	When will the greenhouse gas emission cease and give possible reasons for the cessation?
48510	21	46	21	47	"and recover" is confusing here since the ocean would continue to take up heat (not "recover") in this scenario. [Kyle Armour, United States of America]	"and recover" is confusing here since the ocean would continue to take up heat (not "recover") in this scenario.
37892	21	49	21	50	"Global surface ocean warming" …[is] …"surface intensified" reads strangely. Should at least the first occurrence of the word "surface" be deleted? [Adrian Simmons, United Kingdom (of Great Britain and Northern Ireland)]	"Global surface ocean warming" …[is] …"surface intensified" reads strangely. Should at least the first occurrence of the word "surface" be deleted?
44446	21	52	21	52	9.2.3.2: Why not "Ocean salt content" for the title of this subsection? [Anne Marie Treguier, France]	9.2.3.2: Why not "Ocean salt content" for the title of this subsection?

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
37894	21	52			Similarly, does the word "bottom" have to appear twice? [Adrian Simmons, United Kingdom (of Great Britain and Northern Ireland)]	Similarly, does the word "bottom" have to appear twice?
19528	22	1	22	1	Is the salinity meaurment coverage gloablly? If not, what is the spatial extent? [Gwenaelle GREMION, Canada]	Is the salinity meaurment coverage gloablly? If not, what is the spatial extent?
39882	22	1		10	i cannot see how the anthropogenic forcing of the changes is more certain than the changes themselves. This section also reads contradictory to what was said earlier in relation to SSS. [Michael Tsimplis, China]	i cannot see how the anthropogenic forcing of the changes is more certain than the changes themselves. This section also reads contradictory to what was said earlier in relation to SSS.
44384	22	5	22	8	As they stand, these two sentences are logically inconsistent. They need to be re-written to be consistent. [Michael Bell, United Kingdom (of Great Britain and Northern Ireland)]	As they stand, these two sentences are logically inconsistent. They need to be re-written to be consistent.
19530	22	7	22	8	is the conclusion that changes are a consequence of anthropogenic forcing model or observation based? [Gwenaelle GREMION, Canada]	is the conclusion that changes are a consequence of anthropogenic forcing model or observation based?
44386	22	8	22	10	Lines 37-41 of page 16 is difficult to reconcile with this statement; a brief explanation of how the different strands of evidence relate to each other would be helpful. [Michael Bell, United Kingdom (of Great Britain and Northern Ireland)]	Lines 37-41 of page 16 is difficult to reconcile with this statement; a brief explanation of how the different strands of evidence relate to each other would be helpful.
42632	22	8	22	10	Another example of a strong statement made before presenting the supporting evidence (See comment regarding P12, lines 20-22.) [William Gutowski, United States of America]	Another example of a strong statement made before presenting the supporting evidence (See comment regarding P12, lines 20-22.)
44388	22	12	19	27	I find this sentence very difficult to absorb. It would help if the references could be split into references for specific processes (even if this leads to some references being repeated). [Michael Bell, United Kingdom (of Great Britain and Northern Ireland)]	I find this sentence very difficult to absorb. It would help if the references could be split into references for specific processes (even if this leads to some references being repeated).
39884	22	12		22	So many more publications confirming AR5 conclusions but modelling still remains with low confidence. Perhaps shorten? [Michael Tsimplis, China]	So many more publications confirming AR5 conclusions but modelling still remains with low confidence. Perhaps shorten?
19532	22	13	22	13	Above you mention improved measurement coverage since 1999, now you talk about changes since 1950. Does that mean these results are based on sparse observations compared to the later period? It does not get quite clear on what evidence these results are based. [Gwenaelle GREMION, Canada]	Above you mention improved measurement coverage since 1999, now you talk about changes since 1950. Does that mean these results are based on sparse observations compared to the later period? It does not get quite clear on what evidence these results are based.
57206	22	16	22	16	Please distinguish between freshening at the surface in the open ocean, the coastal ocean, and the bottom water, since different processes might be at work here and only one is mentioned [F. Alexander Haumann, Germany]	Please distinguish between freshening at the surface in the open ocean, the coastal ocean, and the bottom water, since different processes might be at work here and only one is mentioned
57208	22	16	22	16	Please note that the wind-driven sea-ice export is not the only explanation/contribution to the freshening. Other processes include changes in precipitation and land-ice melting from Antarctica [F. Alexander Haumann, Germany]	Please note that the wind-driven sea-ice export is not the only explanation/contribution to the freshening. Other processes include changes in precipitation and land-ice melting from Antarctica
45278	22	16	22	22	Southern Ocean freshening is partly ascribable to ice sheet melting (Jacobs and Giulivi 2010 jclim, Bintanja et al., 2013 nat geosc.). [Alessandro Silvano, Australia]	Southern Ocean freshening is partly ascribable to ice sheet melting (Jacobs and Giulivi 2010 jclim, Bintanja et al., 2013 nat geosc.).

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
26442	22	17	22	19	I believe https://doi.org/10.1038/ngeo2749 is one of the first papers to demonstrate the role of sea ice in the freshwater budget in the Southern Ocean. [Katsuro Katsumata, Japan]	I believe https://doi.org/10.1038/ngeo2749 is one of the first papers to demonstrate the role of sea ice in the freshwater budget in the Southern Ocean.
47020	22	17	22	19	This is an assessment, not a review, and undifferentiated lists of more than about 4 references generally do not add greater credibility to a statement (here there are 13), but do degrade thre readability of the text. Out of consideration for your intended audience, please consider selecting only the 4 most relevant, readable, or recent references to support this point; otherwise if these references are all necessary to support all of the regional sub-clauses in this sentence, consider distributing the references among the sub-clauses, and perhaps breaking up a very long sentence into multiple sentences. [Robert Hallberg, United States of America]	This is an assessment, not a review, and undifferentiated lists of more than about 4 references generally do not add greater credibility to a statement (here there are 13), but do degrade thre readability of the text. Out of consideration for your intended audience, please consider selecting only the 4 most relevant, readable, or recent references to support this point; otherwise if these references are all necessary to support all of the regional sub-clauses in this sentence, consider distributing the references among the sub-clauses, and perhaps breaking up a very long sentence into multiple sentences.
44390	22	22	22	22	"CMIP5 historical processes show similar processes" is a sweeping statement and it is not obvious nor explained how Figure 9.8 supports it. The whole paragraph needs to present more specific evidence. [Michael Bell, United Kingdom (of Great Britain and Northern Ireland)]	"CMIP5 historical processes show similar processes" is a sweeping statement and it is not obvious nor explained how Figure 9.8 supports it. The whole paragraph needs to present more specific evidence.
13706	22	23	22	35	The material here is fine but doesn't flow as well. I'd recommend leading with the key results (changes in E-P over the N Pacific, once the SSS data is in), then explaining the drivers and the influence on deepwater formation. [Simon Donner, Canada]	The material here is fine but doesn't flow as well. I'd recommend leading with the key results (changes in E-P over the N Pacific, once the SSS data is in), then explaining the drivers and the influence on deepwater formation.
19534	22	29	22	29	What are these new studies? It would be good to cite them as well if you mention them. [Gwenaelle GREMION, Canada]	What are these new studies? It would be good to cite them as well if you mention them.
19526	22	29	22	31	A few examples would be useful for understanding the varieties of mechanisms of near-surface salinity change in oceans. [Gwenaelle GREMION, Canada]	A few examples would be useful for understanding the varieties of mechanisms of near-surface salinity change in oceans.
39886	22	29		31	I think this needs explanation. If the models cannot get the trend and the variability right getting anthropogenic forcing as the cause may be an outcome of model experiments but can it seriously be argued as virtually certain? [Michael Tsimplis, China]	I think this needs explanation. If the models cannot get the trend and the variability right getting anthropogenic forcing as the cause may be an outcome of model experiments but can it seriously be argued as virtually certain?
19536	22	31	22	32	It does not get clear, that these are things which are observed and that it is therefore desirable to find the same results in models. [Gwenaelle GREMION, Canada]	It does not get clear, that these are things which are observed and that it is therefore desirable to find the same results in models.
7568	22	31	22	33	Clarify sentence? [Patrick Hyder, United Kingdom (of Great Britain and Northern Ireland)]	Clarify sentence?
7908	22	33	22	35	Which region are you talking about here? If global then it would make sense to be before previous sentence. [Laura Jackson, United Kingdom (of Great Britain and Northern Ireland)]	Which region are you talking about here? If global then it would make sense to be before previous sentence.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
13708	22	35	22	52	Here deep water formation is discussed again at the end, having already been explained in lines 22-35; perhaps integrate the deepwater formation material into the previous paragraphs, and end the section with the freshwater flux section with the paleo data instead. [Simon Donner, Canada]	Here deep water formation is discussed again at the end, having already been explained in lines 22-35; perhaps integrate the deepwater formation material into the previous paragraphs, and end the section with the freshwater flux section with the paleo data instead.
42634	22	38	22	40	This statement is made without supporting evidence. Are there figures or citations that yield this conclusion? [William Gutowski, United States of America]	This statement is made without supporting evidence. Are there figures or citations that yield this conclusion?
38500	22	38	22	42	No literature is cited here [Iskhaq Iskandar, Indonesia]	No literature is cited here
26444	22	38	33	38	"fresher gets fresher, saltier gets saltier" or "fresh gets fresher, salty gets saltier" is more symmetric. [Katsuro Katsumata, Japan]	"fresher gets fresher, saltier gets saltier" or "fresh gets fresher, salty gets saltier" is more symmetric.
19538	22	40	22	40	Here I would suggest to either add confidence level of the statement or citations of the study finding these results. [Gwenaelle GREMION, Canada]	Here I would suggest to either add confidence level of the statement or citations of the study finding these results.
42636	22	47	22	49	Another example of a strong statement made before presenting the supporting evidence (See comment regarding P12, lines 20-22.) [William Gutowski, United States of America]	Another example of a strong statement made before presenting the supporting evidence (See comment regarding P12, lines 20-22.)
19540	22	49	22	49	It does not make much sense to say that the surface ocean warming is surface intensified. That is doubling up. [Gwenaelle GREMION, Canada]	It does not make much sense to say that the surface ocean warming is surface intensified. That is doubling up.
39888	22	50		52	some papers before the report period why some other earlier papers ignored in other parts of the report? [Michael Tsimplis, China]	some papers before the report period why some other earlier papers ignored in other parts of the report?
47022	23	6	23	6	Ocean stratification is very sensitive to numerical diapycnal mixing that arises from discretization errors, as well as mixing from intentional parameterizations. See SROCC section 5.2.2.2.4 for a discussion of this point. [Robert Hallberg, United States of America]	Ocean stratification is very sensitive to numerical diapycnal mixing that arises from discretization errors, as well as mixing from intentional parameterizations. See SROCC section 5.2.2.2.4 for a discussion of this point.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
49448	23	6	23	20	There has been a lot of work in recent years on the spatial distribution of mixing due to internal waves, and the impact of this mixing (in the stratified interior ocean) on stratification. Suitable references are Melet, Angelique, Sonya Legg, and Robert Hallberg, May 2016: Climatic impacts of parameterized local and remote tidal mixing. Journal of Climate, 29(10), DOI:10.1175/JCLI-D-15-0153.1. and MacKinnon, J A., M H Alford, J K Ansong, B K Arbic, A Barna, B P Briegleb, F O Bryan, M C Buijsman, E P Chassignet, G Danabasoglu, S Diggs, Stephen M Griffies, Robert Hallberg, S R Jayne, M Jochum, J Klymak, E Kunze, W G Large, Sonya Legg, B Mater, and Angelique Melet, et al., November 2017: Climate Process Team on Internal-Wave Driven Ocean Mixing. Bulletin of the American Meteorological Society, 98(11), DOI:10.1175/BAMS-D-16-0030.1. [Sonya Legg, United States of America]	There has been a lot of work in recent years on the spatial distribution of mixing due to internal waves, and the impact of this mixing (in the stratified interior ocean) on stratification. Suitable references are Melet, Angelique, Sonya Legg, and Robert Hallberg, May 2016: Climatic impacts of parameterized local and remote tidal mixing. Journal of Climate, 29(10), DOI:10.1175/JCLI-D-15-0153.1. and MacKinnon, J A., M H Alford, J K Ansong, B K Arbic, A Barna, B P Briegleb, F O Bryan, M C Buijsman, E P Chassignet, G Danabasoglu, S Diggs, Stephen M Griffies, Robert Hallberg, S R Jayne, M Jochum, J Klymak, E Kunze, W G Large, Sonya Legg, B Mater, and Angelique Melet, et al., November 2017: Climate Process Team on Internal-Wave Driven Ocean Mixing. Bulletin of the American Meteorological Society, 98(11), DOI:10.1175/BAMS-D-16-0030.1.
47024	23	7	23	7	I am not sure exactly what point in this sentence is being drawn from Hallberg (2013), which is about the resolutions needed to resolve eddy processes, but perhaps the intended reference here is Hallberg et al (2013), which is a close comparison of the stratification and heat uptake in two CMIP5 models with identical atmospheres but very different oceans. The full reference to that paper is: Hallberg, R, A. Adcroft, J. P. Dunne, J. P. Krasting, and R. J. Stouffer, 2013: Sensitivity of Twenty-First-Century Global-Mean Steric Sea Level Rise to Ocean Model Formulation. Journal of Climate, 26(9), DOI:10.1175/JCLI-D-12-00506.1. [Robert Hallberg, United States of America]	I am not sure exactly what point in this sentence is being drawn from Hallberg (2013), which is about the resolutions needed to resolve eddy processes, but perhaps the intended reference here is Hallberg et al (2013), which is a close comparison of the stratification and heat uptake in two CMIP5 models with identical atmospheres but very different oceans. The full reference to that paper is: Hallberg, R, A. Adcroft, J. P. Dunne, J. P. Krasting, and R. J. Stouffer, 2013: Sensitivity of Twenty-First-Century Global-Mean Steric Sea Level Rise to Ocean Model Formulation. Journal of Climate, 26(9), DOI:10.1175/JCLI-D-12-00506.1.
19542	23	12	23	12	Progress since when? Since the AR5 or since a specific year? [Gwenaelle GREMION, Canada]	Progress since when? Since the AR5 or since a specific year?
13710	23	15			Minor suggestion: You could very briefly mention the influence of wind stress changes on upwelling strength, and point to the upcoming upwelling section. [Simon Donner, Canada]	Minor suggestion: You could very briefly mention the influence of wind stress changes on upwelling strength, and point to the upcoming upwelling section.
19544	23	16	23	19	Will the stratification continue to increase globally or regioanlly different? It would be good to make that a bit clearer. [Gwenaelle GREMION, Canada]	Will the stratification continue to increase globally or regioanlly different? It would be good to make that a bit clearer.
19552	23	20	23	20	remove 'however' [Gwenaelle GREMION, Canada]	remove 'however'
29140	23	23	24	55	The mode waters abbreviations are confusing to me. It would be better to write them out. [Jens Zinke, United Kingdom (of Great Britain and Northern Ireland)]	The mode waters abbreviations are confusing to me. It would be better to write them out.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
40404	23	23	24	55	In section 9.2.3.4 (water masses), there is no mention of Circumpolar Deep Water (CDW). I guess it's missing because CDW is a mix of several water masses rather than a pure water mass formed at the surface, but given the importance of CDW for many processes around the Antarctic ice sheet, it might be worth adding 1 or 2 sentences about CDW. The evolution of CDW properties in CMIP5 projections was described by Sallée et al. (2013). Reference already in ch. 9. [Nicolas Jourdain, France]	In section 9.2.3.4 (water masses), there is no mention of Circumpolar Deep Water (CDW). I guess it's missing because CDW is a mix of several water masses rather than a pure water mass formed at the surface, but given the importance of CDW for many processes around the Antarctic ice sheet, it might be worth adding 1 or 2 sentences about CDW. The evolution of CDW properties in CMIP5 projections was described by Sallée et al. (2013). Reference already in ch. 9.
38502	23	23	25	4	This section looks more like a review than assessment [Iskhaq Iskandar, Indonesia]	This section looks more like a review than assessment
25288	23	25	23	50	Background information - could this be shorter? [Sharon Smith, Canada]	Background information - could this be shorter?
7572	23	28	23	28	Is it worth also mentioning 'other dissolved gases'? [Patrick Hyder, United Kingdom (of Great Britain and Northern Ireland)]	Is it worth also mentioning 'other dissolved gases'?
19550	23	29	23	29	Thermocline or thermohaline. Thermohaline defines better water masses circulation by effects of temperature and salinity instead of just temperature. [Gwenaelle GREMION, Canada]	Thermocline or thermohaline. Thermohaline defines better water masses circulation by effects of temperature and salinity instead of just temperature.
26450	23	34	23	37	Circumpolar Deep Water (CDW) plays an important role when discussing basal melting of land-based ice in the Antarctic (sec.9.4.5.2). It might be useful to introduce CDW here; "Deep water masses in the Atlantic ocean ventilate ... (NADW), while the deep layer in the Indian and Pacific oceans are filled with an "old" water mass upwelled from AABW, which circumnavigates the Antarctica above the topographic barriers thus called CDW etc." Decadal variability of CDW in the Southern Ocean was discussed in doi:10.1029/2004GL022220 [Katsuro Katsumata, Japan]	Circumpolar Deep Water (CDW) plays an important role when discussing basal melting of land-based ice in the Antarctic (sec.9.4.5.2). It might be useful to introduce CDW here; "Deep water masses in the Atlantic ocean ventilate ... (NADW), while the deep layer in the Indian and Pacific oceans are filled with an "old" water mass upwelled from AABW, which circumnavigates the Antarctica above the topographic barriers thus called CDW etc." Decadal variability of CDW in the Southern Ocean was discussed in doi:10.1029/2004GL022220
7574	23	38	23	38	monitoring 'global climate change' (as the ocean obviously also moves heat laterally so the regional surface fluxes do not correspond to the regional column integrated heat content tendencies)? [Patrick Hyder, United Kingdom (of Great Britain and Northern Ireland)]	monitoring 'global climate change' (as the ocean obviously also moves heat laterally so the regional surface fluxes do not correspond to the regional column integrated heat content tendencies)?
48962	23	40	23	50	Define/clarify spin up and spin down. [Laura Reynolds, United States of America]	Define/clarify spin up and spin down.
19546	23	42	23	42	What is meant by "remaining consistent with wind stress curl"? Do you mean consistent with the previously mentioned trend in wind stress curl? I would say that more clearly. [Gwenaelle GREMION, Canada]	What is meant by "remaining consistent with wind stress curl"? Do you mean consistent with the previously mentioned trend in wind stress curl? I would say that more clearly.
19548	23	46	23	47	It was not mentioned before in the Sea Surface Temperature section that in the WBC extensions the surface warming is approximately double the global average. However, I think it should be mentioned there. [Gwenaelle GREMION, Canada]	It was not mentioned before in the Sea Surface Temperature section that in the WBC extensions the surface warming is approximately double the global average. However, I think it should be mentioned there.
49284	23	50			Reference for Wang et al. 2015b is not found in the reference list [Zelina Zaiton Ibrahim, Malaysia]	Reference for Wang et al. 2015b is not found in the reference list

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
19556	24	3	24	3	no hyphen is needed between "time scale" [Gwenaelle GREMION, Canada]	no hyphen is needed between "time scale"
13714	24	6			There's some blending of historical data and projections in the text of several sub-sections (e.g. page 25, lines 43-50). When the CMIP6 results are added, you may want to more clearly separate the two. [Simon Donner, Canada]	There's some blending of historical data and projections in the text of several sub-sections (e.g. page 25, lines 43-50). When the CMIP6 results are added, you may want to more clearly separate the two.
44392	24	10	24	11	This first sentence is (I think) intended to summarise the paragraph as a whole. On first reading it appears to make unsubstantiated statements. The style of the paragraph needs to be re-visited (perhaps the summary sentence could be moved to the end of the paragraph and be preceded by the words "In summary" [Michael Bell, United Kingdom (of Great Britain and Northern Ireland)]	This first sentence is (I think) intended to summarise the paragraph as a whole. On first reading it appears to make unsubstantiated statements. The style of the paragraph needs to be re-visited (perhaps the summary sentence could be moved to the end of the paragraph and be preceded by the words "In summary"
39890	24	14			the last two decades of the period 1970-2009 or the period 1999-2019? [Michael Tsimplis, China]	the last two decades of the period 1970-2009 or the period 1999-2019?
39894	24	21		29	no change since AR5? [Michael Tsimplis, China]	no change since AR5?
39892	24	21			no studies since last report? [Michael Tsimplis, China]	no studies since last report?
19554	24	23	24	36	I think this sections legibility is a little hampered by the excessive use of acronymns. [Gwenaelle GREMION, Canada]	I think this sections legibility is a little hampered by the excessive use of acronymns.
7910	24	25	24	27	Based on observations since when. This statement may not be true if we had a 50 year time series! [Laura Jackson, United Kingdom (of Great Britain and Northern Ireland)]	Based on observations since when. This statement may not be true if we had a 50 year time series!
7912	24	27	24	29	Again, over what period [Laura Jackson, United Kingdom (of Great Britain and Northern Ireland)]	Again, over what period
7576	24	31	24	31	Is it worth being clearer to state something along the lines of 'most models cannnot capture key North Atlantic overflow processes so cannot adequately simulate the lower NADW or its future change'? [Patrick Hyder, United Kingdom (of Great Britain and Northern Ireland)]	Is it worth being clearer to state something along the lines of 'most models cannnot capture key North Atlantic overflow processes so cannot adequately simulate the lower NADW or its future change'?
48512	24	31	24	32	My understanding is that the AMOC decline and associated decrease in deep convection in models occurs primarily due to reduced surface heat loss (anomalous heat uptake) as the atmosphere warms rather than freshwater fluxes. There can be surface cooling associated with AMOC decline, but this leads to even more anomalous heat uptake, contributing to the AMOC decline rather than compensating it. [Kyle Armour, United States of America]	My understanding is that the AMOC decline and associated decrease in deep convection in models occurs primarily due to reduced surface heat loss (anomalous heat uptake) as the atmosphere warms rather than freshwater fluxes. There can be surface cooling associated with AMOC decline, but this leads to even more anomalous heat uptake, contributing to the AMOC decline rather than compensating it.
44394	24	31	24	36	Northern N Atlantic surface waters generally warm under climate change. It is difficult to untangle whether salinity changes drive or are driven by changes in the MOC. So "driven by freshening" on line 35 seems debatable to me. [Michael Bell, United Kingdom (of Great Britain and Northern Ireland)]	Northern N Atlantic surface waters generally warm under climate change. It is difficult to untangle whether salinity changes drive or are driven by changes in the MOC. So "driven by freshening" on line 35 seems debatable to me.
7914	24	34	24	34	decrease in volume [Laura Jackson, United Kingdom (of Great Britain and Northern Ireland)]	decrease in volume

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
7916	24	35	24	36	What is this statement based on? It seems likely to me but needs some justification [Laura Jackson, United Kingdom (of Great Britain and Northern Ireland)]	What is this statement based on? It seems likely to me but needs some justification
39896	24	36			If decadal variability is the dominant factor is there any indication of changing in its energetics. It is very strange to try to describe changes in a system not by reference to what is the dominant characteristics but to that which is not really detectable. [Michael Tsimplis, China]	If decadal variability is the dominant factor is there any indication of changing in its energetics. It is very strange to try to describe changes in a system not by reference to what is the dominant characteristics but to that which is not really detectable.
19558	24	49	24	49	a global mean trend of 0.53 m°C year^-1"-> delete "m" [Gwenaelle GREMION, Canada]	a global mean trend of 0.53 m°C year^-1"-> delete "m"
39898	24	49			uncertainty/error bar for the trend stated? [Michael Tsimplis, China]	uncertainty/error bar for the trend stated?
45212	25	1	34	1	Section 9.2.4 Regional Ocean Circulation. One of the aspects that I feel is missing in Ch9 is the connection between ocean circulation and the assoaciated horizontal transports - particuarly of heat and freshwater. Changes in the transports in future are some of the key determinants of the future SST and sea level response. [Matthew Palmer, United Kingdom (of Great Britain and Northern Ireland)]	Section 9.2.4 Regional Ocean Circulation. One of the aspects that I feel is missing in Ch9 is the connection between ocean circulation and the assoaciated horizontal transports - particuarly of heat and freshwater. Changes in the transports in future are some of the key determinants of the future SST and sea level response.
19578	25	3	25	3	0.19°C ±0.07°C -> 0.19± 0.07°C [Gwenaelle GREMION, Canada]	0.19°C ±0.07°C -> 0.19± 0.07°C
40452	25	7	27	44	It would be good to include a short paragraph on longer paleo datasets that show AMOC has changed during the LGM, mPWP and Eocene. This would also include a possible PMOC. Citations include Burls et al, 2017, Thomas 2004, Howe et al., 2017, Zhang et al., 2013 to name a few. [Heather Ford, United Kingdom (of Great Britain and Northern Ireland)]	It would be good to include a short paragraph on longer paleo datasets that show AMOC has changed during the LGM, mPWP and Eocene. This would also include a possible PMOC. Citations include Burls et al, 2017, Thomas 2004, Howe et al., 2017, Zhang et al., 2013 to name a few.
7956	25	7	27	44	Need to check what is included in Ch 4 and what is included here to make sure no gaps/overlaps. It would make sense to discuss projections in more detail in Ch 4 and use this section to discuss processes/details. [Laura Jackson, United Kingdom (of Great Britain and Northern Ireland)]	Need to check what is included in Ch 4 and what is included here to make sure no gaps/overlaps. It would make sense to discuss projections in more detail in Ch 4 and use this section to discuss processes/details.
6357	25	9	29	45	The text is read as a textbook chapter. Reduce wording and focus on last 5 years models and outcomes [Baruch Rinkevich, Israel]	The text is read as a textbook chapter. Reduce wording and focus on last 5 years models and outcomes
44964	25	9			I might be mistaken, but I believe that this is the most complete presentation of AMOC in the WG 1 report. As such, I was expecting an extensive discussion of AMOC fluctuations during paleo periods, updating AR5 and SROCC. D-O events are mentioned in the first sentence and YD freshwater later on, but wouldn't this be the place for a compressive update of key assessment statements regarding paleo AMOC? Can a figure be added to illustrate AMOC fluctuations based on paleo evidence? [Darrell Kaufman, United States of America]	I might be mistaken, but I believe that this is the most complete presentation of AMOC in the WG 1 report. As such, I was expecting an extensive discussion of AMOC fluctuations during paleo periods, updating AR5 and SROCC. D-O events are mentioned in the first sentence and YD freshwater later on, but wouldn't this be the place for a compressive update of key assessment statements regarding paleo AMOC? Can a figure be added to illustrate AMOC fluctuations based on paleo evidence?

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
33114	25	11	25	14	"the subsequent discovery of the prominent role the AMOC played" in the D-O events: While I think AMOC variability is probably the most likely scenario, and there have been strong links made between AMOC and DO events in modelling studies, the direct observational evidence for AMOC changes over the D-O events is still scarce (Lynch-Stieglitz, J., 2017, Annual Reviews of Marine Science, 9, 83-104). I would say that for the Younger Dryas and HS1, there are much better documented changes in AMOC and also large climate transitions, so maybe a more robust example to cite here. [Jean Lynch-Stieglitz, United States of America]	"the subsequent discovery of the prominent role the AMOC played" in the D-O events: While I think AMOC variability is probably the most likely scenario, and there have been strong links made between AMOC and DO events in modelling studies, the direct observational evidence for AMOC changes over the D-O events is still scarce (Lynch-Stieglitz, J., 2017, Annual Reviews of Marine Science, 9, 83-104). I would say that for the Younger Dryas and HS1, there are much better documented changes in AMOC and also large climate transitions, so maybe a more robust example to cite here.
19562	25	11	25	14	The first sentence appears slightly contradictory/confusing in that it emphasizes that AMOC was found to be important to D-O transitions, but then also says that it was only found to be important at a later stage. Rearranging the sentence to read (from line 12): climate was demonstrated by the discovery of the important role that AMOC played in shaping the large climate transitions between cold stadial and warm interstadial phases, or "Dansgaard-Oeschger (D-O) events," which are unrelated to orbital forcing (Dansgaard et al. 1993). [Gwenaelle GREMION, Canada]	The first sentence appears slightly contradictory/confusing in that it emphasizes that AMOC was found to be important to D-O transitions, but then also says that it was only found to be important at a later stage. Rearranging the sentence to read (from line 12): climate was demonstrated by the discovery of the important role that AMOC played in shaping the large climate transitions between cold stadial and warm interstadial phases, or "Dansgaard-Oeschger (D-O) events," which are unrelated to orbital forcing (Dansgaard et al. 1993).
48514	25	11	25	23	I found this to be a jarring introduction to AMOC and its changes. This is an example of where I think the paleo discussion should come later in this subsection, after historical obervations and modeled changes. Perhaps also say a bit about what AMOC is (how is it defined, what's its relationship with the Gulf Stream, why is there and AMOC and not a PMOC in the first place -- see recent review by David Ferreira on this). [Kyle Armour, United States of America]	I found this to be a jarring introduction to AMOC and its changes. This is an example of where I think the paleo discussion should come later in this subsection, after historical obervations and modeled changes. Perhaps also say a bit about what AMOC is (how is it defined, what's its relationship with the Gulf Stream, why is there and AMOC and not a PMOC in the first place -- see recent review by David Ferreira on this).

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
19564	25	15	25	16	Although Alley et al. (1999) identifies three modes of AMOC, (modern, vigorous deep-water formation; partial deepwater formation during glacials; and reduced/shutdown deepwater formation meltwater mode), many studies choose just to identify two modes in the model, which Böhm et al. (2015) does (not identifying a reversal as such). Klockmann et al. (2018) gives a good summary of these two modes (LGM - shallow AMOC, AABW reaches further into N. Atlantic), and also talks about AMOC strength vs CO2 concentrations (inverse strengths - deep overturning at high CO2, shallow overturning at low CO2). [Gwenaelle GREMION, Canada]	Although Alley et al. (1999) identifies three modes of AMOC, (modern, vigorous deep-water formation; partial deepwater formation during glacials; and reduced/shutdown deepwater formation meltwater mode), many studies choose just to identify two modes in the model, which Böhm et al. (2015) does (not identifying a reversal as such). Klockmann et al. (2018) gives a good summary of these two modes (LGM - shallow AMOC, AABW reaches further into N. Atlantic), and also talks about AMOC strength vs CO2 concentrations (inverse strengths - deep overturning at high CO2, shallow overturning at low CO2).
19566	25	16	25	16	"(low confidence)" could maybe be removed as the statement is already indicating uncertainty (Line 15: It is still unclear (low confidence) whether these mode switches were triggered…) [Gwenaelle GREMION, Canada]	"(low confidence)" could maybe be removed as the statement is already indicating uncertainty (Line 15: It is still unclear (low confidence) whether these mode switches were triggered…)
37896	25	16	25	17	It's not clear to me that adding "low confidence" adds anything here. Simply stating "it is unclear whether…" seems enough. [Adrian Simmons, United Kingdom (of Great Britain and Northern Ireland)]	It's not clear to me that adding "low confidence" adds anything here. Simply stating "it is unclear whether…" seems enough.
48964	25	16	25	23	I found this confusing-- it is clear to me why an increase in CO2 would decrease AMOC, but not clear why it would increase AMOC (and on what time scales). Can you clarify? [Laura Reynolds, United States of America]	I found this confusing-- it is clear to me why an increase in CO2 would decrease AMOC, but not clear why it would increase AMOC (and on what time scales). Can you clarify?
19568	25	17	25	17	"freshwater release from northern hemisphere icecaps" is maybe moe correct than "freshwater and iceberg release" [Gwenaelle GREMION, Canada]	"freshwater release from northern hemisphere icecaps" is maybe moe correct than "freshwater and iceberg release"
19570	25	18	25	19	"changing reltaion over time scale between AMOC and CO2" to "changing relation between AMOC and CO2 concentration over time" [Gwenaelle GREMION, Canada]	"changing reltaion over time scale between AMOC and CO2" to "changing relation between AMOC and CO2 concentration over time"
45282	25	18	25	21	“because increasing CO2 concentrations increase the freshwater release that acts to decrease the AMOC, the response of the AMOC to increasing CO2 may be opposite in decadal-centennial timescales to the centennial-millennial response”. Clarify what you mean by “opposite”: opposite to what? How this can create an opposite effect? [Alessandro Silvano, Australia]	“because increasing CO2 concentrations increase the freshwater release that acts to decrease the AMOC, the response of the AMOC to increasing CO2 may be opposite in decadal-centennial timescales to the centennial-millennial response”. Clarify what you mean by “opposite”: opposite to what? How this can create an opposite effect?
7918	25	18	25	21	Please rewrite since I don't understand the point [Laura Jackson, United Kingdom (of Great Britain and Northern Ireland)]	Please rewrite since I don't understand the point
56594	25	19	25	21	I appreciate the need for brevity, but I couldn't understand this sentence. I think it needs a bit more explanation of these feedbacks, which aren't defined anyuwhere else. [Richard Wood, United Kingdom (of Great Britain and Northern Ireland)]	I appreciate the need for brevity, but I couldn't understand this sentence. I think it needs a bit more explanation of these feedbacks, which aren't defined anyuwhere else.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
39900	25	21		23	how is the consensus measured? What does increasing consensus mean in this context? More than half the scientists, all scientists more certain? And what does the "at least" means in the context of consensus. [Michael Tsimplis, China]	how is the consensus measured? What does increasing consensus mean in this context? More than half the scientists, all scientists more certain? And what does the "at least" means in the context of consensus.
33112	25	22	25	23	I'm not sure what is being referred to by the "AMOC-CO2 feedback" in this sentence. Could this be clarified, or a reference added? [Jean Lynch-Stieglitz, United States of America]	I'm not sure what is being referred to by the "AMOC-CO2 feedback" in this sentence. Could this be clarified, or a reference added?
19572	25	26	25	26	Add "meaningful long-term" between 'discern a' and 'trend.' [Gwenaelle GREMION, Canada]	Add "meaningful long-term" between 'discern a' and 'trend.'
7920	25	26	25	26	discern a trend' A trend can be (and has previously been) seen. I think you mean too short to detect an anthropogenically forced trend [Laura Jackson, United Kingdom (of Great Britain and Northern Ireland)]	discern a trend' A trend can be (and has previously been) seen. I think you mean too short to detect an anthropogenically forced trend
52166	25	26			Suggest adding robust prior to trend as tautologically a trend can be calculated and what you actually mean is that it is hard to make robust inferences given the short length and the noise? [Peter Thorne, Ireland]	Suggest adding robust prior to trend as tautologically a trend can be calculated and what you actually mean is that it is hard to make robust inferences given the short length and the noise?
19574	25	27	25	30	Add in values for scale reference; mean AMOC for 2004-2007 is 18.5 Sv (McCarthy et al. 2012). Addition of McCarthy to sentence; oiginal study. You introduced 3 different states before to classify AMOC. Now you are describing a state of AMOC which is none of the 3 states. This is controversial. Either classify it as one of the initial 3 states or do not call it state in this context. [Gwenaelle GREMION, Canada]	Add in values for scale reference; mean AMOC for 2004-2007 is 18.5 Sv (McCarthy et al. 2012). Addition of McCarthy to sentence; oiginal study. You introduced 3 different states before to classify AMOC. Now you are describing a state of AMOC which is none of the 3 states. This is controversial. Either classify it as one of the initial 3 states or do not call it state in this context.
7922	25	28	25	29	Also Jackson et al (2016) doi:10.1038/ngeo2715 and Jackson et al (2018: Journal of Operational Oceanography , 11:sup1, S65-S66, 10.1080/1755876X.2018.1489208) have suggested that this shift followed a strengthening and is likely from variability, though this could be superimposed on a gradual weakening [Laura Jackson, United Kingdom (of Great Britain and Northern Ireland)]	Also Jackson et al (2016) doi:10.1038/ngeo2715 and Jackson et al (2018: Journal of Operational Oceanography , 11:sup1, S65-S66, 10.1080/1755876X.2018.1489208) have suggested that this shift followed a strengthening and is likely from variability, though this could be superimposed on a gradual weakening
56596	25	29	25	29	There is some additional context here. Recent reanalysis results (Jackson et al. 2016 Nature Geosci. 9, 518-521, Jackson et al subm 2019) suggest that there was a gradual increase of the AMOC between the mid-90s and mid-2000s [Richard Wood, United Kingdom (of Great Britain and Northern Ireland)]	There is some additional context here. Recent reanalysis results (Jackson et al. 2016 Nature Geosci. 9, 518-521, Jackson et al subm 2019) suggest that there was a gradual increase of the AMOC between the mid-90s and mid-2000s
52168	25	29	25	37	There is a minor inconsistency here with chapter 2 that appears to relate to confidence in the three studies (in reality two methods though) and caveats arising from other literature (I'm working offline so don't have the details to hand). This led to a greater degree of hedging over this indirect evidence than is the case here. This will need to be resolved (and should be simple to do so) for the next draft. [Peter Thorne, Ireland]	There is a minor inconsistency here with chapter 2 that appears to relate to confidence in the three studies (in reality two methods though) and caveats arising from other literature (I'm working offline so don't have the details to hand). This led to a greater degree of hedging over this indirect evidence than is the case here. This will need to be resolved (and should be simple to do so) for the next draft.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
51680	25	29	25	37	These recent changes are remarkable in that the AMOC appears to have remained stable/resilient throughout most of the Holocene (cf. comment 5; Hoffmann et al., 2018 (GRL)), despite pronounced freshwater perturbations (e.g. 8.2 kyr event). [Samuel Jaccard, Switzerland]	These recent changes are remarkable in that the AMOC appears to have remained stable/resilient throughout most of the Holocene (cf. comment 5; Hoffmann et al., 2018 (GRL)), despite pronounced freshwater perturbations (e.g. 8.2 kyr event).
19576	25	31	25	32	Confidence level? [Gwenaelle GREMION, Canada]	Confidence level?
37898	25	31			Would "weaker" be better than "lower"? [Adrian Simmons, United Kingdom (of Great Britain and Northern Ireland)]	Would "weaker" be better than "lower"?
32106	25	35	25	37	This assessment is not consistent with all the literature, e.g. Robson et al, Nature Geoscience, 2016 https://doi.org/10.1038/ngeo2727 [Rowan Sutton, United Kingdom (of Great Britain and Northern Ireland)]	This assessment is not consistent with all the literature, e.g. Robson et al, Nature Geoscience, 2016 https://doi.org/10.1038/ngeo2727
7924	25	36	25	37	Given that forced ocean models (mentioned below) show a strengthening since 1950, and some coupled climate models show little change in the AMOC over the historical period, despite showing a wramring hole (Drijfhout et al 2012, doi: 10.1175/jcli-d-12-00490.1), I think the 'likely' and 'medium confidence' is too strong [Laura Jackson, United Kingdom (of Great Britain and Northern Ireland)]	Given that forced ocean models (mentioned below) show a strengthening since 1950, and some coupled climate models show little change in the AMOC over the historical period, despite showing a wramring hole (Drijfhout et al 2012, doi: 10.1175/jcli-d-12-00490.1), I think the 'likely' and 'medium confidence' is too strong
41272	25	40	25	40	insert in line 40: "In the tropical Atlantic, the western boundary current system off Brazil is a key region for diagnosing variations of the AMOC and the southern subtropical cell. Since 2013 a mooring array was installed off the coast at 11°S similar to an array installed between 2000 and 2004 at the same location (Schott et al., 2005 ; Hummels et al., 2015) . Average transports of the North Brazil Undercurrent (NBUC) and the Deep Western Boundary Current (DWBC) have not changed between the observational periods. DWBC eddies that are predicted to disappear with a weakening AMOC are still present (Dengler et al., 2004; Schott et al., 2005; Hummels et al., 2015). Upper layer changes in salinity and oxygen within the last decade are consistent with an increased Agulhas leakage, while at depths water mass changes are likely related to changes in the North Atlantic as well as tropical circulation changes (Hummels et al., 2015)." [Moacyr Araujo, Brazil]	insert in line 40: "In the tropical Atlantic, the western boundary current system off Brazil is a key region for diagnosing variations of the AMOC and the southern subtropical cell. Since 2013 a mooring array was installed off the coast at 11°S similar to an array installed between 2000 and 2004 at the same location (Schott et al., 2005 ; Hummels et al., 2015) . Average transports of the North Brazil Undercurrent (NBUC) and the Deep Western Boundary Current (DWBC) have not changed between the observational periods. DWBC eddies that are predicted to disappear with a weakening AMOC are still present (Dengler et al., 2004; Schott et al., 2005; Hummels et al., 2015). Upper layer changes in salinity and oxygen within the last decade are consistent with an increased Agulhas leakage, while at depths water mass changes are likely related to changes in the North Atlantic as well as tropical circulation changes (Hummels et al., 2015)."
19580	25	42	25	42	26.5N->26.5°N [Gwenaelle GREMION, Canada]	26.5N->26.5°N
13712	25	43	25	45	The Canadian Basin trend is too short to be meaningful here. The trend is only over five years, and likely driven entirely by the NE Pacific marine heat wave ("the blob") at the end of the period. [Simon Donner, Canada]	The Canadian Basin trend is too short to be meaningful here. The trend is only over five years, and likely driven entirely by the NE Pacific marine heat wave ("the blob") at the end of the period.
19560	25	50	25	50	Add ” in AMOC/ volumetric flow/ ‘’ to “CMIP5 models display a weak negative trend XXX over the historical period...” [Gwenaelle GREMION, Canada]	Add ” in AMOC/ volumetric flow/ ‘’ to “CMIP5 models display a weak negative trend XXX over the historical period...”

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
54686	25	50	25	53	Mentioned are (i) a long-term decline (1850-2005), (ii) an increase (1958-1990) followed by a decline (1990-2008), and (iii) a 60-year variabillity "on top of this trend" - How is (ii) a long-term trend; and how do we know it's not part of a 60-year variability? Maybe this sentence could be clarified. [Sabine Undorf, United Kingdom (of Great Britain and Northern Ireland)]	Mentioned are (i) a long-term decline (1850-2005), (ii) an increase (1958-1990) followed by a decline (1990-2008), and (iii) a 60-year variabillity "on top of this trend" - How is (ii) a long-term trend; and how do we know it's not part of a 60-year variability? Maybe this sentence could be clarified.
56598	25	50	26	18	I really hope it will be possible to show more models than were used in AR5. The AR5 figures include too few models to give a full picture. This will depend on data submission to ESGF and accurate processing of the data on the ocean grids. However if the authors have difficulty generating enough AMOC timeseries from the submitted data I'm sure many modelling centres would be willing to senfd the processed timeseries. Indeed getting the data from the centres may make QC easier (see recent paper by Mecking et al 2017 Tellus B) [Richard Wood, United Kingdom (of Great Britain and Northern Ireland)]	I really hope it will be possible to show more models than were used in AR5. The AR5 figures include too few models to give a full picture. This will depend on data submission to ESGF and accurate processing of the data on the ocean grids. However if the authors have difficulty generating enough AMOC timeseries from the submitted data I'm sure many modelling centres would be willing to senfd the processed timeseries. Indeed getting the data from the centres may make QC easier (see recent paper by Mecking et al 2017 Tellus B)
7930	25	52	25	52	Need to make it clear that the decline to 2008 is because the experiment stops then, not that the decline definitely does [Laura Jackson, United Kingdom (of Great Britain and Northern Ireland)]	Need to make it clear that the decline to 2008 is because the experiment stops then, not that the decline definitely does
54688	25	53	25	54	"attributed to variations in aerosol forcing over the historical period" - add either a reference to Chapter 3, Section 3.7.7 or literature references? [Sabine Undorf, United Kingdom (of Great Britain and Northern Ireland)]	"attributed to variations in aerosol forcing over the historical period" - add either a reference to Chapter 3, Section 3.7.7 or literature references?
7926	25	53	25	54	What is the ref for this statement? It isn't in Danabasoglu et al 2016 [Laura Jackson, United Kingdom (of Great Britain and Northern Ireland)]	What is the ref for this statement? It isn't in Danabasoglu et al 2016
7928	25	55	25	55	More recent studies (Jackson et al, under review) show that reanalyses are more consistent in recent years where there is more data to assimilate. It is likely that the disagreement over the last 50 years from reanalyses is beacuse of competition between individual model dynamics and occaisional obs leading to spurious results [Laura Jackson, United Kingdom (of Great Britain and Northern Ireland)]	More recent studies (Jackson et al, under review) show that reanalyses are more consistent in recent years where there is more data to assimilate. It is likely that the disagreement over the last 50 years from reanalyses is beacuse of competition between individual model dynamics and occaisional obs leading to spurious results
25290	26	1	27	10	Many pre-AR5 refs cited - focus on advancments, improvements since AR5 [Sharon Smith, Canada]	Many pre-AR5 refs cited - focus on advancments, improvements since AR5
39902	26	1		10	if the focus is on the weakening or not of the AMOC the fact that the CMIP5 does not improve over CMIP3 or reduce the bias means that the localised improvements are not important enough to resolve the issue so why are they referred to? [Michael Tsimplis, China]	if the focus is on the weakening or not of the AMOC the fact that the CMIP5 does not improve over CMIP3 or reduce the bias means that the localised improvements are not important enough to resolve the issue so why are they referred to?
49224	26	2	26	2	The HighResMIP-PRIMAVERA group plan a paper on AMOC performance in the 7 coupled models, both historic and future, at different resolutions, by the deadline. [Malcolm Roberts, United Kingdom (of Great Britain and Northern Ireland)]	The HighResMIP-PRIMAVERA group plan a paper on AMOC performance in the 7 coupled models, both historic and future, at different resolutions, by the deadline.
19600	26	2	26	2	Say more clearly what sort of models you are talking about here. Is it CMIP5 models? If so, say it. [Gwenaelle GREMION, Canada]	Say more clearly what sort of models you are talking about here. Is it CMIP5 models? If so, say it.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
7932	26	2	26	2	mean or standard deviation varies with a factor of 2? [Laura Jackson, United Kingdom (of Great Britain and Northern Ireland)]	mean or standard deviation varies with a factor of 2?
19582	26	2	26	5	What models? Is the variation by a factor of 2 applicable to all models. The sentence is a confusing one. [Gwenaelle GREMION, Canada]	What models? Is the variation by a factor of 2 applicable to all models. The sentence is a confusing one.
49450	26	4	26	5	Additional reference for the impact of overflows on AMOC: Wang, He, Sonya Legg, and Robert Hallberg, February 2015: Representations of the Nordic Seas overflows and their large scale climate impact in coupled models. Ocean Modelling, 86, DOI:10.1016/j.ocemod.2014.12.005. [Sonya Legg, United States of America]	Additional reference for the impact of overflows on AMOC: Wang, He, Sonya Legg, and Robert Hallberg, February 2015: Representations of the Nordic Seas overflows and their large scale climate impact in coupled models. Ocean Modelling, 86, DOI:10.1016/j.ocemod.2014.12.005.
19584	26	9	26	11	"the tight relation" is not an appropriate term. [Gwenaelle GREMION, Canada]	"the tight relation" is not an appropriate term.
48516	26	9	26	18	This may be an appropriate place to discuss the debate in the recent literature regarding the role of AMOC in the AMO (Amy Clement, Mark Cane, Rong Zhang, Robert Wills, O'Reilly and Zanna set of papers, and others). There seems to be an emerging concensus that AMO is linked to AMOC under internal variability, but that historical AMO changes may be mainly forced. [Kyle Armour, United States of America]	This may be an appropriate place to discuss the debate in the recent literature regarding the role of AMOC in the AMO (Amy Clement, Mark Cane, Rong Zhang, Robert Wills, O'Reilly and Zanna set of papers, and others). There seems to be an emerging concensus that AMO is linked to AMOC under internal variability, but that historical AMO changes may be mainly forced.
7934	26	12	26	12	produce [Laura Jackson, United Kingdom (of Great Britain and Northern Ireland)]	produce
19602	26	14	26	14	It is not clear here if the timescale of the simulation is supporting or opposing the results. [Gwenaelle GREMION, Canada]	It is not clear here if the timescale of the simulation is supporting or opposing the results.
7936	26	14	26	15	Various CMIP5 studies are missing: doi:10.1007/s00382-018-4529-0 , 10.1002/jgrc.20390 , 10.1007/s00382-014-2056-1 [Laura Jackson, United Kingdom (of Great Britain and Northern Ireland)]	Various CMIP5 studies are missing: doi:10.1007/s00382-018-4529-0 , 10.1002/jgrc.20390 , 10.1007/s00382-014-2056-1
56600	26	15	26	18	Menary et al. 2015 GRL 42, 5926-5934 show that in fact the different machanisms in the literature can be broadly classified, and are strongly dependent on the sign of model T and S biases in the subpolar gyre. [Richard Wood, United Kingdom (of Great Britain and Northern Ireland)]	Menary et al. 2015 GRL 42, 5926-5934 show that in fact the different machanisms in the literature can be broadly classified, and are strongly dependent on the sign of model T and S biases in the subpolar gyre.
7938	26	17	26	18	Are you saying low confidence that the AMO is/can be driven by the AMOC? I don't think I agree with that. What do you mean by simulated degree of linkage [Laura Jackson, United Kingdom (of Great Britain and Northern Ireland)]	Are you saying low confidence that the AMO is/can be driven by the AMOC? I don't think I agree with that. What do you mean by simulated degree of linkage
19592	26	20	26	20	Perhaps use "The strength of AMOC is very likely to decrease by 2100, and larger decreases in volume are expected between 2100 and 2300 with high emission scenarios (Figure 9.9)." As it stands, it is unclear what aspect of the AMOC is decreasing. [Gwenaelle GREMION, Canada]	Perhaps use "The strength of AMOC is very likely to decrease by 2100, and larger decreases in volume are expected between 2100 and 2300 with high emission scenarios (Figure 9.9)." As it stands, it is unclear what aspect of the AMOC is decreasing.
19586	26	20	26	27	It is better to include the reasons for the very likely decrease in the AMOC in high emission scenarios. [Gwenaelle GREMION, Canada]	It is better to include the reasons for the very likely decrease in the AMOC in high emission scenarios.
19604	26	24	26	24	Do not use "very uncertain" but the IPCC certainty language instead. [Gwenaelle GREMION, Canada]	Do not use "very uncertain" but the IPCC certainty language instead.
19606	26	25	26	25	There is no new information in this sentence. It is just repeating the previous sentence. [Gwenaelle GREMION, Canada]	There is no new information in this sentence. It is just repeating the previous sentence.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
48966	26	29	26	33	Not having read the paper cited here, I find this sentence confusing-- how is there greater "intrusion" of AABW north from the tropical Atlantic, while less transport of AABW north from the Southern Ocean? Does this indicate that eventually there will be less northern transport overall? [Laura Reynolds, United States of America]	Not having read the paper cited here, I find this sentence confusing-- how is there greater "intrusion" of AABW north from the tropical Atlantic, while less transport of AABW north from the Southern Ocean? Does this indicate that eventually there will be less northern transport overall?
7940	26	30	26	33	This sentence is very clunky [Laura Jackson, United Kingdom (of Great Britain and Northern Ireland)]	This sentence is very clunky
45284	26	30	26	33	· "In CMIP5 AMOC decline is generally associated with an increased intrusion of modified AABW (low confidence), which is colder and fresher than NADW, to enter the North Atlantic from the tropical Atlantic, and (low confidence) a concomitant overall decreased northward export of AABW from the Southern Ocean (Heuzé et al., 2015)." Just a curiosity: is there divergence of AABW in the tropical Atlantic? If so, does NADW fills the gap in CMIP5 models? It might be worth including a sentence on this aspect. [Alessandro Silvano, Australia]	· "In CMIP5 AMOC decline is generally associated with an increased intrusion of modified AABW (low confidence), which is colder and fresher than NADW, to enter the North Atlantic from the tropical Atlantic, and (low confidence) a concomitant overall decreased northward export of AABW from the Southern Ocean (Heuzé et al., 2015)." Just a curiosity: is there divergence of AABW in the tropical Atlantic? If so, does NADW fills the gap in CMIP5 models? It might be worth including a sentence on this aspect.
44396	26	32	26	33	Should this be "a concomitant overall increased" rather than "decreased"? [Michael Bell, United Kingdom (of Great Britain and Northern Ireland)]	Should this be "a concomitant overall increased" rather than "decreased"?
19590	26	35	26	36	The following model study shows the inflows from the North Atlantic to the Arctic Ocean. The North Atlantic inflow to the Arctic Ocean: High-resolution model study. Aksenov, Y., Bacon, S., Coward, A.C., Nurser, A.J.G., 2010. The North Atlantic inflow to the Arctic Ocean: High-resolution model study. Journal of Marine Systems 79, 1–22. [Gwenaelle GREMION, Canada]	The following model study shows the inflows from the North Atlantic to the Arctic Ocean. The North Atlantic inflow to the Arctic Ocean: High-resolution model study. Aksenov, Y., Bacon, S., Coward, A.C., Nurser, A.J.G., 2010. The North Atlantic inflow to the Arctic Ocean: High-resolution model study. Journal of Marine Systems 79, 1–22.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
15372	26	35	26	42	Pleas add some information about the most Eastern part of AMOC in the Barents Sea. Changes in Ocean Temperature in the Barents Sea in the Twenty-First Century. In recent decades, observations also show increased Atlantic water inflow and associated heat transport into the Barents Sea through the Barents Sea Opening (Skagseth et al. 2008; Årthun et al. 2012). The annual upward trend in heat flux is 2.5 TW, which is due to a positive trend in the water volume transport combined with an increase in ocean temperature (Skagseth et al. 2008; Årthun et al. 2012). Although the CIOM simulation shows an increase in the heat transport through the Barents Sea Opening, its magnitude is significantly underestimated. The simulated heat transport increases from about 58 TW in the late 1990s to about 63 TW in the mid-2010s with an annual increase of about 0.5 TW (Fig. 4b). https://journals.ametsoc.org/doi/full/10.1175/JCLI-D-16-0415.1 [Oksana Lipka, Russian Federation]	Pleas add some information about the most Eastern part of AMOC in the Barents Sea. Changes in Ocean Temperature in the Barents Sea in the Twenty-First Century. In recent decades, observations also show increased Atlantic water inflow and associated heat transport into the Barents Sea through the Barents Sea Opening (Skagseth et al. 2008; Årthun et al. 2012). The annual upward trend in heat flux is 2.5 TW, which is due to a positive trend in the water volume transport combined with an increase in ocean temperature (Skagseth et al. 2008; Årthun et al. 2012). Although the CIOM simulation shows an increase in the heat transport through the Barents Sea Opening, its magnitude is significantly underestimated. The simulated heat transport increases from about 58 TW in the late 1990s to about 63 TW in the mid-2010s with an annual increase of about 0.5 TW (Fig. 4b). https://journals.ametsoc.org/doi/full/10.1175/JCLI-D-16-0415.1
7942	26	38	26	41	Are there any more recent studies? These all refer to trends ending a decade ago [Laura Jackson, United Kingdom (of Great Britain and Northern Ireland)]	Are there any more recent studies? These all refer to trends ending a decade ago
49452	26	41	26	42	References for biases in overflows: Wang, He, Sonya Legg, and Robert Hallberg, February 2015: Representations of the Nordic Seas overflows and their large scale climate impact in coupled models. Ocean Modelling, 86, DOI:10.1016/j.ocemod.2014.12.005; Legg, Sonya, et al., May 2009: Improving oceanic overflow representation in climate models: The gravity current entrainment climate process team. Bulletin of the American Meteorological Society, 90(5), DOI:10.1175/2008BAMS2667.1. [Sonya Legg, United States of America]	References for biases in overflows: Wang, He, Sonya Legg, and Robert Hallberg, February 2015: Representations of the Nordic Seas overflows and their large scale climate impact in coupled models. Ocean Modelling, 86, DOI:10.1016/j.ocemod.2014.12.005; Legg, Sonya, et al., May 2009: Improving oceanic overflow representation in climate models: The gravity current entrainment climate process team. Bulletin of the American Meteorological Society, 90(5), DOI:10.1175/2008BAMS2667.1.
7944	26	44	26	44	saltier not fresher [Laura Jackson, United Kingdom (of Great Britain and Northern Ireland)]	saltier not fresher
19594	26	44	26	44	Isn't Agulhas leakage a source of saline water into the Atlantic, not fresher? [Gwenaelle GREMION, Canada]	Isn't Agulhas leakage a source of saline water into the Atlantic, not fresher?
24988	26	44	26	44	Isnt't the Agulhas leakage bringing warmer and saltier water to the Atlantic Ocean? [Leticia Cotrim da Cunha, Brazil]	Isnt't the Agulhas leakage bringing warmer and saltier water to the Atlantic Ocean?
6317	26	44	26	44	Should this be ‘a source of saltier water’? [Pepijn Bakker, Netherlands]	Should this be ‘a source of saltier water’?
14954	26	44	26	45	FOD says: "Agulhas leakage from the Indian to the Atlantic Ocean is a source of fresher water affecting the AMOC...". This is wrong. The Agulhas leakage is a source of warmer and saltier water affecting the AMOC (e.g. Beal et al., 2011). [Jo Brendryen, Norway]	FOD says: "Agulhas leakage from the Indian to the Atlantic Ocean is a source of fresher water affecting the AMOC...". This is wrong. The Agulhas leakage is a source of warmer and saltier water affecting the AMOC (e.g. Beal et al., 2011).

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
19588	26	44	26	45	A brief explanation of the Agulhas leakage is appropriate here for better understanding. [Gwenaelle GREMION, Canada]	A brief explanation of the Agulhas leakage is appropriate here for better understanding.
19596	26	44	26	53	Although a direct link between leakage strength and AMOC hasn't been found, there are palaeoceanographic studies which suggest a relationship. If you want to add a palaeo- focus to the leakage discussion, for instance, Marino et al. (2013) finds leakage as a source of negative buoyancy for AMOC, whilst Caley et al. (2012) used faunal assemblages and found that Agulhas transfer of heat/salt increased at peak ice-volume. What is the conclusion of that? Does that make the model results which suggest strengthening less likely? [Gwenaelle GREMION, Canada]	Although a direct link between leakage strength and AMOC hasn't been found, there are palaeoceanographic studies which suggest a relationship. If you want to add a palaeo- focus to the leakage discussion, for instance, Marino et al. (2013) finds leakage as a source of negative buoyancy for AMOC, whilst Caley et al. (2012) used faunal assemblages and found that Agulhas transfer of heat/salt increased at peak ice-volume. What is the conclusion of that? Does that make the model results which suggest strengthening less likely?
44448	26	44	26	53	Should the link between agulhas leakage and AMO be mentioned here? (biastoch et al, nature communications, 2015) [Anne Marie Treguier, France]	Should the link between agulhas leakage and AMO be mentioned here? (biastoch et al, nature communications, 2015)
39904	26	44		53	all this section is inconclusive. The point made is that there is variability few observations available and deficient models. So no trends have been detected we do not know whether they exist and that is all. [Michael Tsimplis, China]	all this section is inconclusive. The point made is that there is variability few observations available and deficient models. So no trends have been detected we do not know whether they exist and that is all.
49226	26	53	26	53	PRIMAVERA is trying to find someone to look at Agulhas leakage in the HighResMIP models but we have nothing planned currently. [Malcolm Roberts, United Kingdom (of Great Britain and Northern Ireland)]	PRIMAVERA is trying to find someone to look at Agulhas leakage in the HighResMIP models but we have nothing planned currently.
19598	26	55	27	2	What freshwater flux variation is seen with warming? (ie. Increase/decrease/uncertainty in studies). Would that not fit better in the freshwater chapter? It seems a bit out of context here after describing the impact of the Aghulas leakage on the AMOC and is a paragraph mostly focusing on freshwater fluxes. [Gwenaelle GREMION, Canada]	What freshwater flux variation is seen with warming? (ie. Increase/decrease/uncertainty in studies). Would that not fit better in the freshwater chapter? It seems a bit out of context here after describing the impact of the Aghulas leakage on the AMOC and is a paragraph mostly focusing on freshwater fluxes.
44092	27	1	27	2	Citation, example, or further explanation of "paleo tracers that track ocean circulation" earlier on in this paragraph may clarify what paleo data can measure and how that can be interpreted in a modern framework. [Sara Kahanamoku, United States of America]	Citation, example, or further explanation of "paleo tracers that track ocean circulation" earlier on in this paragraph may clarify what paleo data can measure and how that can be interpreted in a modern framework.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
49454	27	1	27	44	This section should also include a discussion of the impact of different pathways for freshwater input, whether from the Arctic or from melting Greenland icesheet. Several recent studies have shown that the impact on Labrador Sea convection and AMOC depends on whether the freshwater enters the East Greenland current, or the Labrador Current. For examples, see Wang et al, 2018: DOI:10.1175/JCLI-D-17-0629.1; Kawasaki, T., and H. Hasumi, 2014: Effect of freshwater from the West Greenland Current on the winter deep convection in the Labrador Sea. Ocean Modell., 75, 51–64, https://doi.org/10.1016/j.ocemod.2014.01.003; Huo et al, 2016 https://doi.org/10.1038/ngeo2708. [Sonya Legg, United States of America]	This section should also include a discussion of the impact of different pathways for freshwater input, whether from the Arctic or from melting Greenland icesheet. Several recent studies have shown that the impact on Labrador Sea convection and AMOC depends on whether the freshwater enters the East Greenland current, or the Labrador Current. For examples, see Wang et al, 2018: DOI:10.1175/JCLI-D-17-0629.1; Kawasaki, T., and H. Hasumi, 2014: Effect of freshwater from the West Greenland Current on the winter deep convection in the Labrador Sea. Ocean Modell., 75, 51–64, https://doi.org/10.1016/j.ocemod.2014.01.003; Huo et al, 2016 https://doi.org/10.1038/ngeo2708.
39906	27	1		10	this paragraph is not really about what we know. [Michael Tsimplis, China]	this paragraph is not really about what we know.
13716	27	2	27	5	"the exception of the equatorial and tropical Pacific where trends are heavily influenced by ENSO" - by ENSO or more accureate to say by Pacific decadal variability (IPO, PDO)? [Simon Donner, Canada]	"the exception of the equatorial and tropical Pacific where trends are heavily influenced by ENSO" - by ENSO or more accureate to say by Pacific decadal variability (IPO, PDO)?
39192	27	4	27	9	ou could also consider the work by Ivanovic et al. 2016; Ivanovic, R. F., L. J. Gregoire, A. D. Wickert, P. J. Valdes, and A. Burke (2017), Collapse of the North American ice saddle 14,500 years ago caused widespread cooling and reduced ocean overturning circulation, Geophys. Res. Lett., 44, 383–392, doi:10.1002/ 2016GL071849. [Pascale Braconnot, France]	ou could also consider the work by Ivanovic et al. 2016; Ivanovic, R. F., L. J. Gregoire, A. D. Wickert, P. J. Valdes, and A. Burke (2017), Collapse of the North American ice saddle 14,500 years ago caused widespread cooling and reduced ocean overturning circulation, Geophys. Res. Lett., 44, 383–392, doi:10.1002/ 2016GL071849.
39194	27	4	27	9	Progresses have also been made for the 8.2 ka event. Matero et al. 2017, https://doi.org/10.1016/j.epsl.2017.06.011 [Pascale Braconnot, France]	Progresses have also been made for the 8.2 ka event. Matero et al. 2017, https://doi.org/10.1016/j.epsl.2017.06.011

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
14956	27	4	27	10	A new paper (Brendryen et al, in review in Nature Geoscience) is challenging the widely-held notion that enhanced glacial meltwater flux to the Northern oceans (North Atlantic, Nordic Seas and Arctic Ocean) inhibits the AMOC. In this paper, a new deglaciation reconstruction of the marine based sectors of the Eurasian Ice Sheet suggest that the ice sheet abruptly collapsed at the Bølling transition, 14700 years BP. The ice sheet collapse caused a meltwater flux of 0.2 Sverdrups over 300 years to the Nordic Seas and the Arctic ocean at a time where independent evidence (McManus et al., 2004) suggest a strong intensification of the AMOC. This apparent contradiction where a strong AMOC is coinciding with a large meltwater pulse is pertinent for the current discussion on how the future AMOC will evolve in a scenario with increasing ice melt on Greenland. Our new results show that there still are large gaps in our understanding of the relationship between the AMOC and glacial meltwater. Reference: Brendryen J., Haflidason H., Yokoyama Y., Haaga K. A., & Hannisdal B. Collapse of Eurasian ice sheets 14,600 years ago was a major source of global Meltwater Pulse 1a. In review in Nature Geoscience. [Jo Brendryen, Norway]	A new paper (Brendryen et al, in review in Nature Geoscience) is challenging the widely-held notion that enhanced glacial meltwater flux to the Northern oceans (North Atlantic, Nordic Seas and Arctic Ocean) inhibits the AMOC. In this paper, a new deglaciation reconstruction of the marine based sectors of the Eurasian Ice Sheet suggest that the ice sheet abruptly collapsed at the Bølling transition, 14700 years BP. The ice sheet collapse caused a meltwater flux of 0.2 Sverdrups over 300 years to the Nordic Seas and the Arctic ocean at a time where independent evidence (McManus et al., 2004) suggest a strong intensification of the AMOC. This apparent contradiction where a strong AMOC is coinciding with a large meltwater pulse is pertinent for the current discussion on how the future AMOC will evolve in a scenario with increasing ice melt on Greenland. Our new results show that there still are large gaps in our understanding of the relationship between the AMOC and glacial meltwater. Reference: Brendryen J., Haflidason H., Yokoyama Y., Haaga K. A., & Hannisdal B. Collapse of Eurasian ice sheets 14,600 years ago was a major source of global Meltwater Pulse 1a. In review in Nature Geoscience.
44966	27	10			It's unlikely that many PMIP4 experiments will be completed in time for the WG1 report, especially transient runs. Meanwhile, there are many studies of AMOC based on PMIP3 models published since AR5. Please include the significant results from available literature rather than expecting that major new findings will be published in time. [Darrell Kaufman, United States of America]	It's unlikely that many PMIP4 experiments will be completed in time for the WG1 report, especially transient runs. Meanwhile, there are many studies of AMOC based on PMIP3 models published since AR5. Please include the significant results from available literature rather than expecting that major new findings will be published in time.
7946	27	12	27	33	This paragraph needs some more work to make it more readable [Laura Jackson, United Kingdom (of Great Britain and Northern Ireland)]	This paragraph needs some more work to make it more readable

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
7952	27	12	27	44	Somewhere needs to mention that some climate models have shown a hysteresis in response to idealised freshwater forcing (Hawkins et al, 2011 doi: 10.1029/2011GL047208 , Mecking et al, 2016 doi:10.1007/s00382-016-2975-0 , Jackson + Wood 2018 doi:10.1029/2018GL078104). It's also worth pointing out that in Jackson et al 2018, the amount of FW needed is less than in previous studies, although it is still very large compared to prediction of future icee melt from Greenland. [Laura Jackson, United Kingdom (of Great Britain and Northern Ireland)]	Somewhere needs to mention that some climate models have shown a hysteresis in response to idealised freshwater forcing (Hawkins et al, 2011 doi: 10.1029/2011GL047208 , Mecking et al, 2016 doi:10.1007/s00382-016-2975-0 , Jackson + Wood 2018 doi:10.1029/2018GL078104). It's also worth pointing out that in Jackson et al 2018, the amount of FW needed is less than in previous studies, although it is still very large compared to prediction of future icee melt from Greenland.
39908	27	12		13	So 2 models show a complete collapse but we do know that we should believe the others? Why? I am sorry but if the argument of using several models is to get a feeling of the pothential solutions how is it decided what is likely or unlikely. How many more models should show similar behaviour? And how does the next sentence stating that there is suspicion that the models are too stable is to be taken in this context? [Michael Tsimplis, China]	So 2 models show a complete collapse but we do know that we should believe the others? Why? I am sorry but if the argument of using several models is to get a feeling of the pothential solutions how is it decided what is likely or unlikely. How many more models should show similar behaviour? And how does the next sentence stating that there is suspicion that the models are too stable is to be taken in this context?
48518	27	14	27	30	The Liu et al. 2017 Sci Advances paper has an interesting hypothesis that could be discussed here: mean state biases in CMIP models make them too stable. [Kyle Armour, United States of America]	The Liu et al. 2017 Sci Advances paper has an interesting hypothesis that could be discussed here: mean state biases in CMIP models make them too stable.
19616	27	15	27	15	"however" is not used in this way. [Gwenaelle GREMION, Canada]	"however" is not used in this way.
45286	27	15	27	16	include a citation here (e.g. Mouginot et al, 2019 PNAS) [Alessandro Silvano, Australia]	include a citation here (e.g. Mouginot et al, 2019 PNAS)
56698	27	16	27	16	The introduced acronym "(GrIs)" for "Greenland ice sheet" is not used in other sections of the chapter. It may be clarified if the use of the acronym is needed for consistency. [Kilkis Siir, Turkey]	The introduced acronym "(GrIs)" for "Greenland ice sheet" is not used in other sections of the chapter. It may be clarified if the use of the acronym is needed for consistency.
7948	27	18	27	22	Boning state that they find no evidence that the GrIS melt has affected the AMOC and their simulations show little impact on the AMOC for the rest of the run (till 2018). This contradicts Rahmstorf and Yang and this needs to be made clear. [Laura Jackson, United Kingdom (of Great Britain and Northern Ireland)]	Boning state that they find no evidence that the GrIS melt has affected the AMOC and their simulations show little impact on the AMOC for the rest of the run (till 2018). This contradicts Rahmstorf and Yang and this needs to be made clear.
7950	27	22	27	23	GrIS melt is partly accounted for in some models (ie HadGEM2 for CMIP5 and HadGEM3 for CMIP6) which give a surface melt. There is no change in iceberg calving, though as the glaciers retreat this becomes a smaller impact for Greenland [Laura Jackson, United Kingdom (of Great Britain and Northern Ireland)]	GrIS melt is partly accounted for in some models (ie HadGEM2 for CMIP5 and HadGEM3 for CMIP6) which give a surface melt. There is no change in iceberg calving, though as the glaciers retreat this becomes a smaller impact for Greenland
45288	27	24	27	24	“simulations”. [Alessandro Silvano, Australia]	“simulations”.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
56602	27	26	27	28	Mecking et al 2017 Tellus B evaluates the biases in Mov at 30S explicitly. However, Mov at 30S may determine bistability but this is not the same thing as the distance from the threshold.Jackson, Smith and Wood 2017 Cl. Dyn., and Wood et al. 2019 submitted, show that Mov at 26N plays a key role in detrminig the threshold. [Richard Wood, United Kingdom (of Great Britain and Northern Ireland)]	Mecking et al 2017 Tellus B evaluates the biases in Mov at 30S explicitly. However, Mov at 30S may determine bistability but this is not the same thing as the distance from the threshold.Jackson, Smith and Wood 2017 Cl. Dyn., and Wood et al. 2019 submitted, show that Mov at 26N plays a key role in detrminig the threshold.
48520	27	31	27	33	What does this sentence mean? Of course model biases will limit the accuracy of their simulations in some way, but the degree to which this affects projections should be assessed. [Kyle Armour, United States of America]	What does this sentence mean? Of course model biases will limit the accuracy of their simulations in some way, but the degree to which this affects projections should be assessed.
39910	27	34			So 9 of 40 is believable? Is there consistency in which RCPgave changes? I find all this section as not one of assessing the knowlegde (or the lack of it) but just trying to cover all fronts and possibilities. If there is no consensus between scientists (based on the model results) then it must be stated clearly and the section should be simplified. [Michael Tsimplis, China]	So 9 of 40 is believable? Is there consistency in which RCPgave changes? I find all this section as not one of assessing the knowlegde (or the lack of it) but just trying to cover all fronts and possibilities. If there is no consensus between scientists (based on the model results) then it must be stated clearly and the section should be simplified.
19614	27	35	27	42	I would put this paragraph after the paragraph ending on page 26 in line 42. It makes more sense from the reading flow to firstly talk about everything happening in the northern hemisphere and then talking about the Aghulas leakage and a general collaps than jumping back and forth. S.27, L42-44 should still be the last sentence of 9.2.4.1. [Gwenaelle GREMION, Canada]	I would put this paragraph after the paragraph ending on page 26 in line 42. It makes more sense from the reading flow to firstly talk about everything happening in the northern hemisphere and then talking about the Aghulas leakage and a general collaps than jumping back and forth. S.27, L42-44 should still be the last sentence of 9.2.4.1.
25292	27	36	27	38	Do you mean 2°C over the entire century (be clear on time period). Several degress - is this >2°C? [Sharon Smith, Canada]	Do you mean 2°C over the entire century (be clear on time period). Several degress - is this >2°C?
48522	27	42	27	44	Aren't there quite a few observational studies linking the AMO to impacts (hurricanes, drought, temperature extremes over land, etc)? [Kyle Armour, United States of America]	Aren't there quite a few observational studies linking the AMO to impacts (hurricanes, drought, temperature extremes over land, etc)?
39912	27	49			How strong? give a number with eror bars. [Michael Tsimplis, China]	How strong? give a number with eror bars.
44398	27	50	27	50	should be "the world's three main" [Michael Bell, United Kingdom (of Great Britain and Northern Ireland)]	should be "the world's three main"
19608	27	50	27	50	"which connects the world's three main ocean basins" rather than "three main world's ocean basins" [Gwenaelle GREMION, Canada]	"which connects the world's three main ocean basins" rather than "three main world's ocean basins"
19610	27	50	27	51	Rather use the term 'regional' or 'more localised' in describing the Southern Ocean's overturning system (not weaker). Ie. "… and a more localised overturning circulation, which helps ventilate the ocean by introducing newly oxygenated water into a system where bottom waters have become depleted in oxygen." [Gwenaelle GREMION, Canada]	Rather use the term 'regional' or 'more localised' in describing the Southern Ocean's overturning system (not weaker). Ie. "… and a more localised overturning circulation, which helps ventilate the ocean by introducing newly oxygenated water into a system where bottom waters have become depleted in oxygen."
37900	27	50			"world's three main" would be better than "three main world's" [Adrian Simmons, United Kingdom (of Great Britain and Northern Ireland)]	"world's three main" would be better than "three main world's"
39914	27	50			Weaker? Number should be stated. [Michael Tsimplis, China]	Weaker? Number should be stated.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
19612	27	53	27	54	It isn't very clear here what is meant by heat gain. It may be better to say/add that the heat content of the oceans is important because its variation in the ocean's upper layers is what influences the characteristics of the overlying atmosphere. The ocean's heat content over the period 2006 - 2013 (not 2015) has increased, with the Southern hemisphere extratropical ocean regions responsible for 67 to 98% of the total gain in the upper 2000 m. [Gwenaelle GREMION, Canada]	It isn't very clear here what is meant by heat gain. It may be better to say/add that the heat content of the oceans is important because its variation in the ocean's upper layers is what influences the characteristics of the overlying atmosphere. The ocean's heat content over the period 2006 - 2013 (not 2015) has increased, with the Southern hemisphere extratropical ocean regions responsible for 67 to 98% of the total gain in the upper 2000 m.
40408	28	2	28	5	This sentence is not very clear to me: (i) there is not a unique Ice Shelf, but many ice shelves, (ii) "stability of the Antarctic ice sheet" is not clear in this sentence, does it refer to increased iceberg calving rates that may affect the Southern Ocean? (iii) there are different types of feedbacks : the regional feedbacks between ice-shelf melting and heat transport from the deep Southern Ocean to that ice shelf (i.e. across the continental shelf, e.g. Hellmer et al. 2012; Donat-Magnin et al. 2017), and the feedbacks at a planetary scale between ice-shelf melting around Antarctica and the stratificaton of the entire Southern Ocean (Bronselaer et al. 2018; Golledge et al. 2019). References already in ch. 9. [Nicolas Jourdain, France]	This sentence is not very clear to me: (i) there is not a unique Ice Shelf, but many ice shelves, (ii) "stability of the Antarctic ice sheet" is not clear in this sentence, does it refer to increased iceberg calving rates that may affect the Southern Ocean? (iii) there are different types of feedbacks : the regional feedbacks between ice-shelf melting and heat transport from the deep Southern Ocean to that ice shelf (i.e. across the continental shelf, e.g. Hellmer et al. 2012; Donat-Magnin et al. 2017), and the feedbacks at a planetary scale between ice-shelf melting around Antarctica and the stratificaton of the entire Southern Ocean (Bronselaer et al. 2018; Golledge et al. 2019). References already in ch. 9.
51682	28	2	28	5	It is worth noting that paleo-evidence suggests a link between Antarctic ice-sheet melting (buoyancy forcing) and a transient (2-3 kyrs) decrease in Southern Ocean overturning (Hayes et al., 2014 (Science)) during the LIG when temperatures (and possibly atmospheric CO2 concentrations) were higher than pre-industrial. [Samuel Jaccard, Switzerland]	It is worth noting that paleo-evidence suggests a link between Antarctic ice-sheet melting (buoyancy forcing) and a transient (2-3 kyrs) decrease in Southern Ocean overturning (Hayes et al., 2014 (Science)) during the LIG when temperatures (and possibly atmospheric CO2 concentrations) were higher than pre-industrial.
45290	28	3	28	3	“Antarctic ice shelves”. [Alessandro Silvano, Australia]	“Antarctic ice shelves”.
14584	28	4	28	5	The topic of feedback between Antarctic Ice Shelf and ocean circulation is broader than the mechanism analysed in Bronselaer et al. (2018) alone (see for instance the review proposed in Fyke et al. 2018, already cited in the chpater). The low confidence mentioned here is for this mechanism only I guess while it can be interpreted from the sentence that it is for the all the feedbacks related ice shelf ocean interactions (see also page 44, lines 25-26 in the same chapter). [Hugues Goosse, Belgium]	The topic of feedback between Antarctic Ice Shelf and ocean circulation is broader than the mechanism analysed in Bronselaer et al. (2018) alone (see for instance the review proposed in Fyke et al. 2018, already cited in the chpater). The low confidence mentioned here is for this mechanism only I guess while it can be interpreted from the sentence that it is for the all the feedbacks related ice shelf ocean interactions (see also page 44, lines 25-26 in the same chapter).

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
45292	28	5	28	5	add to Bronselaer et al. 2018 also 1) Fogwill et al. 2015 (Sensitivity of the Southern Ocean to enhanced regional Antarctic ice sheet meltwater input, Earth's Future), 2) Silvano et al. 2018 (Science Advances) and Golledge et al. 2019 (Nature). [Alessandro Silvano, Australia]	add to Bronselaer et al. 2018 also 1) Fogwill et al. 2015 (Sensitivity of the Southern Ocean to enhanced regional Antarctic ice sheet meltwater input, Earth's Future), 2) Silvano et al. 2018 (Science Advances) and Golledge et al. 2019 (Nature).
40406	28	10	28	15	The text mentions CDW and refers to Fig. 9.2, so it would be easier to follow if CDW was indicated in Fig. 9.2. [Nicolas Jourdain, France]	The text mentions CDW and refers to Fig. 9.2, so it would be easier to follow if CDW was indicated in Fig. 9.2.
19618	28	17	28	17	What does the "confirm" relate to? Confirm whom or what? [Gwenaelle GREMION, Canada]	What does the "confirm" relate to? Confirm whom or what?
45294	28	18	28	18	Figure 9.4 reports winds and not ACC transport. Better to remove the reference to Figure 9.4 here. [Alessandro Silvano, Australia]	Figure 9.4 reports winds and not ACC transport. Better to remove the reference to Figure 9.4 here.
57210	28	20	28	23	Is it certain that this higher (more recent) numbers are more accurate than older numbers or is there just a larger uncertainty? I would recommened being more careful in the formulation here. [F. Alexander Haumann, Germany]	Is it certain that this higher (more recent) numbers are more accurate than older numbers or is there just a larger uncertainty? I would recommened being more careful in the formulation here.
19626	28	25	28	28	Is not clear the way how present the relation between the isopycnal slope and the ACC barotropic transport. Please clarify. [Gwenaelle GREMION, Canada]	Is not clear the way how present the relation between the isopycnal slope and the ACC barotropic transport. Please clarify.
13718	28	31			There's repetition between Section 9.2.2.3 and 9.2.3.2 that could be eliminated to save space. [Simon Donner, Canada]	There's repetition between Section 9.2.2.3 and 9.2.3.2 that could be eliminated to save space.
19620	28	37	28	37	What does the "confirm" relate to? Confirm whom or what? [Gwenaelle GREMION, Canada]	What does the "confirm" relate to? Confirm whom or what?
48702	28	44	28	46	It is necessary to be more especific about the limitation of the simulations of the Southern Ocean circulation. Why are these simulations limited? What observation are missing? Re: In situ observation are scarce and are not homogenously distribute. This is especially true for salinity observations. Water column in polar regions is heavily estratified due to a very especial salnity configuration of the water column. [Rafael Catany, United Kingdom (of Great Britain and Northern Ireland)]	It is necessary to be more especific about the limitation of the simulations of the Southern Ocean circulation. Why are these simulations limited? What observation are missing? Re: In situ observation are scarce and are not homogenously distribute. This is especially true for salinity observations. Water column in polar regions is heavily estratified due to a very especial salnity configuration of the water column.
19622	28	46	28	50	I would suggest to reformulate the sentence (beginning in line 46 "Still,..."). Currently it sound like this statement is opposing the previous statement but it is actually supporting it. [Gwenaelle GREMION, Canada]	I would suggest to reformulate the sentence (beginning in line 46 "Still,..."). Currently it sound like this statement is opposing the previous statement but it is actually supporting it.
19624	28	53	28	53	Rather than refering to Fig. 9.2 I would suggest to refer to the section where these processes where previously described. [Gwenaelle GREMION, Canada]	Rather than refering to Fig. 9.2 I would suggest to refer to the section where these processes where previously described.
39918	29	1		10	much of what is said here is irrelevant to an assessment report [Michael Tsimplis, China]	much of what is said here is irrelevant to an assessment report

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
39916	29	1			If some models behave better shouldn't the estimates be based on these only? I find this discussion on how many models do well not very robust and only saying that we do not have much skill in modelling the particular processes discussed. So predictions must, arguably, not be made in these respects [Michael Tsimplis, China]	If some models behave better shouldn't the estimates be based on these only? I find this discussion on how many models do well not very robust and only saying that we do not have much skill in modelling the particular processes discussed. So predictions must, arguably, not be made in these respects
49456	29	5	29	8	Another process which is poorly represented in numerical models, leading to deficiencies in the lower overturning cell in the Southern Ocean is dense overflows from the Antarctic shelves feeding into the Antarctic Bottom Water. See for example Snow et al, 2015; Sensitivity of abyssal water masses to overflow parameterisations https://doi.org/10.1016/j.ocemod.2015.03.004; Dufour et al, 2017: Preconditioning of the Weddell Sea Polynya by the Ocean Mesoscale and Dense Water Overflows, https://doi.org/10.1175/JCLI-D-16-0586.1; [Sonya Legg, United States of America]	Another process which is poorly represented in numerical models, leading to deficiencies in the lower overturning cell in the Southern Ocean is dense overflows from the Antarctic shelves feeding into the Antarctic Bottom Water. See for example Snow et al, 2015; Sensitivity of abyssal water masses to overflow parameterisations https://doi.org/10.1016/j.ocemod.2015.03.004; Dufour et al, 2017: Preconditioning of the Weddell Sea Polynya by the Ocean Mesoscale and Dense Water Overflows, https://doi.org/10.1175/JCLI-D-16-0586.1;
57212	29	7	29	7	I do not think that there is any reference for a poor freshwater flux representation associated with sea ice in climate models. If so, please append or reformulate. [F. Alexander Haumann, Germany]	I do not think that there is any reference for a poor freshwater flux representation associated with sea ice in climate models. If so, please append or reformulate.
40410	29	7	29	8	"freshwater fluxes associated with sea-ice, ice shelves" AND ICEBERGS (Bronselaer et a. 2018; Schloesser et al. 2019). Reference: Schloesser, F., Friedrich, T., Timmermann, A., DeConto, R. M. and Pollard, D. (2019). Antarctic Iceberg impacts on future Southern Hemisphere Climate. Nature Climate Change (accepted). [Nicolas Jourdain, France]	"freshwater fluxes associated with sea-ice, ice shelves" AND ICEBERGS (Bronselaer et a. 2018; Schloesser et al. 2019). Reference: Schloesser, F., Friedrich, T., Timmermann, A., DeConto, R. M. and Pollard, D. (2019). Antarctic Iceberg impacts on future Southern Hemisphere Climate. Nature Climate Change (accepted).
19628	29	10	29	10	This has already been said a couple of time before. [Gwenaelle GREMION, Canada]	This has already been said a couple of time before.
19630	29	14	29	17	This is unclear. Before you've been talking about low confidence and unlikely that ACC is increasing, still you were not talking about a decrease. Now there is low confidence that ACC will decrease. Is the conclusion of that that a decrease and increase are both similarly likely and both unlikely? [Gwenaelle GREMION, Canada]	This is unclear. Before you've been talking about low confidence and unlikely that ACC is increasing, still you were not talking about a decrease. Now there is low confidence that ACC will decrease. Is the conclusion of that that a decrease and increase are both similarly likely and both unlikely?
25294	29	14	29	22	Seems to be mostly pre-AR5 refs - what is new since AR5? [Sharon Smith, Canada]	Seems to be mostly pre-AR5 refs - what is new since AR5?
39920	29	14			what is weak? And how much south? [Michael Tsimplis, China]	what is weak? And how much south?
19632	29	17	29	19	Before you already mentioned that there is weak/no relation between wind and ACC which is theoretically well understood. Maybe it could to be written more clearly when you are talking about strength in transport and strength in the eddy field etc. [Gwenaelle GREMION, Canada]	Before you already mentioned that there is weak/no relation between wind and ACC which is theoretically well understood. Maybe it could to be written more clearly when you are talking about strength in transport and strength in the eddy field etc.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
57242	29	17	29	22	Maybe add a reference that specifically looks at the relation between changes in heat and freshwater fluxes and the ACC transport, e.g. Stössel et al. (2015). [F. Alexander Haumann, Germany]	Maybe add a reference that specifically looks at the relation between changes in heat and freshwater fluxes and the ACC transport, e.g. Stössel et al. (2015).
39922	29	17		46	again very vague text. What does the assesment gain by this? [Michael Tsimplis, China]	again very vague text. What does the assesment gain by this?
48968	29	23	29	26	This paragraph (and section) could use some sort of summary statement [Laura Reynolds, United States of America]	This paragraph (and section) could use some sort of summary statement
19634	29	24	29	28	Maybe bring that together with page 28, line 32-35 where you make a similar statement already. [Gwenaelle GREMION, Canada]	Maybe bring that together with page 28, line 32-35 where you make a similar statement already.
49458	29	32	29	35	No reference is given for this statement. One study of the impact of IPCC scenarios on mesoscale-eddies and lee-wave induced mixing shows a decline of energy going into lee-waves, not an increase (Melet, Angelique, Robert Hallberg, Alistair Adcroft, M Nikurashin, and Sonya Legg, March 2015: Energy flux into internal lee waves: sensitivity to future climate changes using linear theory and a climate model. Journal of Climate, 28(6), DOI:10.1175/JCLI-D-14-00432.1.) [Sonya Legg, United States of America]	No reference is given for this statement. One study of the impact of IPCC scenarios on mesoscale-eddies and lee-wave induced mixing shows a decline of energy going into lee-waves, not an increase (Melet, Angelique, Robert Hallberg, Alistair Adcroft, M Nikurashin, and Sonya Legg, March 2015: Energy flux into internal lee waves: sensitivity to future climate changes using linear theory and a climate model. Journal of Climate, 28(6), DOI:10.1175/JCLI-D-14-00432.1.)
26446	29	32	29	35	Beautiful demonstration of the association between eddy and deep mixing can be found at https://doi.org/10.1038/ngeo2200 [Katsuro Katsumata, Japan]	Beautiful demonstration of the association between eddy and deep mixing can be found at https://doi.org/10.1038/ngeo2200
45296	29	38	29	40	It would be worth mentioning either here or few paragraphs before that the actual importance of the Weddell Polynya (open ocean polynya) for the lower limb of the overturning circulation remain largely unknown from an observational point of view. [Alessandro Silvano, Australia]	It would be worth mentioning either here or few paragraphs before that the actual importance of the Weddell Polynya (open ocean polynya) for the lower limb of the overturning circulation remain largely unknown from an observational point of view.
14586	29	42	29	46	The sentence is not clear to me. The cited references all insist on the role of multidecadal-to-centennial variability but only some of them relate it to the variability in deep convection. [Hugues Goosse, Belgium]	The sentence is not clear to me. The cited references all insist on the role of multidecadal-to-centennial variability but only some of them relate it to the variability in deep convection.
25296	29	49			Section 9.2.4.3 - Many pre-AR5 references cited - give AR5 conclusion instead and focus on what is new since then. [Sharon Smith, Canada]	Section 9.2.4.3 - Many pre-AR5 references cited - give AR5 conclusion instead and focus on what is new since then.
44400	29	54	30	1	the latitudes or range of latitudes for these heat fluxes needs to be an indicated to make these statements unambiguous [Michael Bell, United Kingdom (of Great Britain and Northern Ireland)]	the latitudes or range of latitudes for these heat fluxes needs to be an indicated to make these statements unambiguous
52170	30	4	30	5	Chapter 7 also discussed this in some detail with respect to ECS and may be worth cross-referencing here? [Peter Thorne, Ireland]	Chapter 7 also discussed this in some detail with respect to ECS and may be worth cross-referencing here?
12958	30	6	30	6	SROCC Chapter 6.5 and 6.6 [RADEN DWI SUSANTO, United States of America]	SROCC Chapter 6.5 and 6.6
44094	30	7	30	8	"evident" repeated twice in this sentence [Sara Kahanamoku, United States of America]	"evident" repeated twice in this sentence

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
19642	30	8	30	10	It is not clear what you want to say in this sentence. [Gwenaelle GREMION, Canada]	It is not clear what you want to say in this sentence.
44450	30	15	30	37	Need to coordinate with chapter 3 (Pages 37 and 38) where other references are given. For example, Atlantic SST biases (Hourdin et al 2015, Richter 2015) [Anne Marie Treguier, France]	Need to coordinate with chapter 3 (Pages 37 and 38) where other references are given. For example, Atlantic SST biases (Hourdin et al 2015, Richter 2015)
19636	30	16	30	17	which generation of CMIP is the author referring to here. Also is there a chance for systematic biases and mmodel-co-dependencies e.g. sharing same ocen- or ice-model. Which CMIP? CMIP5 or CMIP6 or all? [Gwenaelle GREMION, Canada]	which generation of CMIP is the author referring to here. Also is there a chance for systematic biases and mmodel-co-dependencies e.g. sharing same ocen- or ice-model. Which CMIP? CMIP5 or CMIP6 or all?
38504	30	16	30	19	Which CMIP is referred in this sentence? [Iskhaq Iskandar, Indonesia]	Which CMIP is referred in this sentence?
49228	30	22	30	22	Resolution is surely one of these reasons? Vanniere et al (2018) shows how hte precipitation errors can be significantly reduced. Vanniere, B., P. L. Vidale, M.-E. Demory, R. Schiemann, M. J. Roberts, C. D. Roberts, M. Matsueda, L. Terray, T. Koenigk, R. Senan, 2018: Multi-model evaluation of the sensitivity of the global energy budget and hydrological cycle to resolution. Climate Dynamics, doi: https://doi.org/10.1007/s00382-018-4547-y. [Malcolm Roberts, United Kingdom (of Great Britain and Northern Ireland)]	Resolution is surely one of these reasons? Vanniere et al (2018) shows how hte precipitation errors can be significantly reduced. Vanniere, B., P. L. Vidale, M.-E. Demory, R. Schiemann, M. J. Roberts, C. D. Roberts, M. Matsueda, L. Terray, T. Koenigk, R. Senan, 2018: Multi-model evaluation of the sensitivity of the global energy budget and hydrological cycle to resolution. Climate Dynamics, doi: https://doi.org/10.1007/s00382-018-4547-y.
44402	30	22	30	22	A reference to Graham 2014 https://doi.org/10.1016/j.ocemod.2014.04.005 could be cited after "tropical instability waves" [Michael Bell, United Kingdom (of Great Britain and Northern Ireland)]	A reference to Graham 2014 https://doi.org/10.1016/j.ocemod.2014.04.005 could be cited after "tropical instability waves"
38506	30	24	30	27	It was projected increase in extreme El Ninos and extreme La Ninas (Cai et al 2014; Cai et al 2015; Cai et al 2017) based on CMIP5 output. In the Indian Ocean, positive IOD like event was projected more frequently occur (Zheng et al., 2013, j. clim) [Iskhaq Iskandar, Indonesia]	It was projected increase in extreme El Ninos and extreme La Ninas (Cai et al 2014; Cai et al 2015; Cai et al 2017) based on CMIP5 output. In the Indian Ocean, positive IOD like event was projected more frequently occur (Zheng et al., 2013, j. clim)
38508	30	40	35	38	This section is more like a review paper rather than an assessment report. [Iskhaq Iskandar, Indonesia]	This section is more like a review paper rather than an assessment report.
25298	30	40			Section 9.2.4.4 - Same comment as above - Reduce pre-AR5 refs and focus on new results since AR5 [Sharon Smith, Canada]	Section 9.2.4.4 - Same comment as above - Reduce pre-AR5 refs and focus on new results since AR5
19638	30	44	30	47	sentence unclear. Maybe split into two separate sentences. [Gwenaelle GREMION, Canada]	sentence unclear. Maybe split into two separate sentences.
19640	30	54	31	1	sentence unclear. Is this a statement about an observation consisting of a trend/ mean overlayed with turbulence or signal-to-noise? Sentence could be re-arranged. [Gwenaelle GREMION, Canada]	sentence unclear. Is this a statement about an observation consisting of a trend/ mean overlayed with turbulence or signal-to-noise? Sentence could be re-arranged.
37902	31	1	31	3	It is hard to understand how not knowing winds well before the satellite era results in the likelihood statement as to the nature of the variability observed in the few decades that comprise the satellite era. [Adrian Simmons, United Kingdom (of Great Britain and Northern Ireland)]	It is hard to understand how not knowing winds well before the satellite era results in the likelihood statement as to the nature of the variability observed in the few decades that comprise the satellite era.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
19644	31	3	31	5	Could be calrified. So is this a known bias? So the increase in boundary current strengh is driven by a very uncertain wind forcing? [Gwenaelle GREMION, Canada]	Could be calrified. So is this a known bias? So the increase in boundary current strengh is driven by a very uncertain wind forcing?
19646	31	19	31	19	Maybe add if it is all models in CMIP5 or CMIP6 ? [Gwenaelle GREMION, Canada]	Maybe add if it is all models in CMIP5 or CMIP6 ?
7954	31	22	31	22	Some CMIP5 (and CMIP6) models have higher resolution [Laura Jackson, United Kingdom (of Great Britain and Northern Ireland)]	Some CMIP5 (and CMIP6) models have higher resolution
39924	31	25		40	OK so increased resolution gives better representation - but this is not really an assessment of the climate change. perhaps the only relevant issue is that it cn lead to reliance only on high resolution models. [Michael Tsimplis, China]	OK so increased resolution gives better representation - but this is not really an assessment of the climate change. perhaps the only relevant issue is that it cn lead to reliance only on high resolution models.
49232	31	37	31	37	Ean example of eddy resolving coupled models and decadal variability would be Siqueira et al. (2016). Siqueira, L., and B. P. Kirtman (2016), Atlantic near-term climate variability and the role of a resolved Gulf Stream, Geophys. Res. Lett., 43, 3964–3972, doi:10.1002/2016GL068694. [Malcolm Roberts, United Kingdom (of Great Britain and Northern Ireland)]	Ean example of eddy resolving coupled models and decadal variability would be Siqueira et al. (2016). Siqueira, L., and B. P. Kirtman (2016), Atlantic near-term climate variability and the role of a resolved Gulf Stream, Geophys. Res. Lett., 43, 3964–3972, doi:10.1002/2016GL068694.
19648	31	42	32	1	I would suggest to combine this paragraph with the second paragraph of this section, starting on page 30, line 49, to avoid doubling of content as parts of the later paragraph have already been mentioned in the previous paragraph [Gwenaelle GREMION, Canada]	I would suggest to combine this paragraph with the second paragraph of this section, starting on page 30, line 49, to avoid doubling of content as parts of the later paragraph have already been mentioned in the previous paragraph
19650	31	50	31	50	What is the super-gyre? That has not been introduced before when talking about circulation. [Gwenaelle GREMION, Canada]	What is the super-gyre? That has not been introduced before when talking about circulation.
29580	32	10	32	12	coastal upwelling and wind stress curl driven upwelling are mechanistically different processes, so their connection here is unclear [Jason Holt, United Kingdom (of Great Britain and Northern Ireland)]	coastal upwelling and wind stress curl driven upwelling are mechanistically different processes, so their connection here is unclear
13720	32	22	32	27	It'd make sense to move the oxygen and deoxygenation material to after the carbon uptake and acidification material; it could be a separate sub-section [Simon Donner, Canada]	It'd make sense to move the oxygen and deoxygenation material to after the carbon uptake and acidification material; it could be a separate sub-section
19652	32	23	32	23	add to caption :stream fucntion (sf) [Gwenaelle GREMION, Canada]	add to caption :stream fucntion (sf)
49234	32	31	32	31	It seems slightly odd in this section about EBUS that ther eis no mention of how poorly currentl models simulate these upwelling regions, due to not resolving the key wind/cloud/ocean processes. [Malcolm Roberts, United Kingdom (of Great Britain and Northern Ireland)]	It seems slightly odd in this section about EBUS that ther eis no mention of how poorly currentl models simulate these upwelling regions, due to not resolving the key wind/cloud/ocean processes.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
49230	32	32	32	32	"A high resolution study..." is not cited, which study? There are other references for the tropical Atlantic bias, including Small et al. (2015), and Roberts MJ et al. (2019, submitted). Small, R. J., E. Curchitser, K. Hedstrom, B. G. Kauffman, and W. G. Large, 2015: The Benguela upwelling system: Quantifying the sensitivity to resolution and coastal wind representation in a global climate model. Journal of Climate, 28, 9409-9432, doi:10.1175/JCLI-D-15-0192.1. Roberts, M. J., Baker, A., Blockley, E. W., Calvert, D., Coward, A., Hewitt, H. T., Jackson, L. C., Kuhlbrodt, T., Mathiot, P., Roberts, C. D., Schiemann, R., Seddon, J., Vannière, B., and Vidale, P. L.: Description of the resolution hierarchy of the global coupled HadGEM3-GC3.1 model as used in CMIP6 HighResMIP experiments, Geosci. Model Dev. Discuss., https://doi.org/10.5194/gmd-2019-148, in review, 2019 [Malcolm Roberts, United Kingdom (of Great Britain and Northern Ireland)]	"A high resolution study..." is not cited, which study? There are other references for the tropical Atlantic bias, including Small et al. (2015), and Roberts MJ et al. (2019, submitted). Small, R. J., E. Curchitser, K. Hedstrom, B. G. Kauffman, and W. G. Large, 2015: The Benguela upwelling system: Quantifying the sensitivity to resolution and coastal wind representation in a global climate model. Journal of Climate, 28, 9409-9432, doi:10.1175/JCLI-D-15-0192.1. Roberts, M. J., Baker, A., Blockley, E. W., Calvert, D., Coward, A., Hewitt, H. T., Jackson, L. C., Kuhlbrodt, T., Mathiot, P., Roberts, C. D., Schiemann, R., Seddon, J., Vannière, B., and Vidale, P. L.: Description of the resolution hierarchy of the global coupled HadGEM3-GC3.1 model as used in CMIP6 HighResMIP experiments, Geosci. Model Dev. Discuss., https://doi.org/10.5194/gmd-2019-148, in review, 2019
19656	32	33	33	32	With the uncertainties in EBUS observations and models, there is potential for palaeoclimatic analogues. Some studies exist which comment on the strength up upwelling systems during glacial and interglacials (although these too can be of low confidence). Also, Garcia-Reyes (2015) gives a good synthesis of what changes can be expected in eastern bundary currents, with a useful table of confidence levels (https://www.frontiersin.org/articles/10.3389/fmars.2015.00109/full). Some of these ideas would make good references, especially with regards to why EBUS are important. [Gwenaelle GREMION, Canada]	With the uncertainties in EBUS observations and models, there is potential for palaeoclimatic analogues. Some studies exist which comment on the strength up upwelling systems during glacial and interglacials (although these too can be of low confidence). Also, Garcia-Reyes (2015) gives a good synthesis of what changes can be expected in eastern bundary currents, with a useful table of confidence levels (https://www.frontiersin.org/articles/10.3389/fmars.2015.00109/full). Some of these ideas would make good references, especially with regards to why EBUS are important.
39926	32	33		56	few new studies, what has improved? [Michael Tsimplis, China]	few new studies, what has improved?
29582	32	34	32	34	add to first sentance a statement of the narrow spatial scale e.g. '…in a narrow bands constrained by the local baroclinic Rossby radius ' (Huthnance 1995 Circulation, exchange and water masses at the ocean margin: the role of physical processes at the shelf edge, Progress in Oceanography https://doi.org/10.1016/0079-6611(95)80003-C) [Jason Holt, United Kingdom (of Great Britain and Northern Ireland)]	add to first sentance a statement of the narrow spatial scale e.g. '…in a narrow bands constrained by the local baroclinic Rossby radius ' (Huthnance 1995 Circulation, exchange and water masses at the ocean margin: the role of physical processes at the shelf edge, Progress in Oceanography https://doi.org/10.1016/0079-6611(95)80003-C)
29578	32	38	32	38	Sea surface height gradients are dynamic responses to currents rather than drivers of them. In this case an 'along shore pressure or stress gradient' is more correct [Jason Holt, United Kingdom (of Great Britain and Northern Ireland)]	Sea surface height gradients are dynamic responses to currents rather than drivers of them. In this case an 'along shore pressure or stress gradient' is more correct

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
38510	32	48	32	55	The SST in the eastern equatorial Pacific is projected to decrease due to enhanced eastern Pacific equatorial umpwelling associated with an intensification of the equatorial easterly winds. [Iskhaq Iskandar, Indonesia]	The SST in the eastern equatorial Pacific is projected to decrease due to enhanced eastern Pacific equatorial umpwelling associated with an intensification of the equatorial easterly winds.
26292	32	48	33	6	It is another example of the prevoius general comment. The long-term EBUS tendencies (associated with the global warming) cannot be extracted at the significant level due to the lack of data. So - called theoretical works and simulation results are not reliable as a result of poor quality of the boundary conditions (in the long-term ocean-only simulations) and insufficient resolution/inadequacy of some parameterizations of the coupled models. I'd suggest to add some more or less recent relevant publications. Two of them are done below (see the next two comments please). The other and more recent appropriate references can be added some later (e.g., into the revised SOD). [Alexander Polonsky, Russian Federation]	It is another example of the prevoius general comment. The long-term EBUS tendencies (associated with the global warming) cannot be extracted at the significant level due to the lack of data. So - called theoretical works and simulation results are not reliable as a result of poor quality of the boundary conditions (in the long-term ocean-only simulations) and insufficient resolution/inadequacy of some parameterizations of the coupled models. I'd suggest to add some more or less recent relevant publications. Two of them are done below (see the next two comments please). The other and more recent appropriate references can be added some later (e.g., into the revised SOD).
39928	32	48		52	this appears qualitative, how much change , important for humans. High confidence based on strong link with trade winds - and high confidence in their change. tha numbers appear below so just move them here. [Michael Tsimplis, China]	this appears qualitative, how much change , important for humans. High confidence based on strong link with trade winds - and high confidence in their change. tha numbers appear below so just move them here.
49276	32	54	32	55	I think it will be useful add here the following reference: Wang, D., Gouhier, T. C., Menge, B. A. & Ganguly, A. R. 2015. Intensification and spatial homogenization of coastal upwelling under climate change. Nature 518, 390-394, doi:10.1038/nature14235. [Catalina Aguirre Galaz, Chile]	I think it will be useful add here the following reference: Wang, D., Gouhier, T. C., Menge, B. A. & Ganguly, A. R. 2015. Intensification and spatial homogenization of coastal upwelling under climate change. Nature 518, 390-394, doi:10.1038/nature14235.
12960	32	54	32	56	update with new references [RADEN DWI SUSANTO, United States of America]	update with new references
19654	32	55	32	55	more recent reference maybe : Wang, D., Gouhier, T.C., Menge, B.A. and Ganguly, A.R., 2015. Intensification and spatial homogenization of coastal upwelling under climate change. Nature, 518(7539), p.390. [Gwenaelle GREMION, Canada]	more recent reference maybe : Wang, D., Gouhier, T.C., Menge, B.A. and Ganguly, A.R., 2015. Intensification and spatial homogenization of coastal upwelling under climate change. Nature, 518(7539), p.390.
39930	33	9			does this mean that no models are between +10 and -10 %. [Michael Tsimplis, China]	does this mean that no models are between +10 and -10 %.
39932	33	12		16	what is the usefulness of the last sentence? [Michael Tsimplis, China]	what is the usefulness of the last sentence?
19666	33	14	33	14	lack of a comma: "...(...;Sylla et al., 2019), however,..." [Gwenaelle GREMION, Canada]	lack of a comma: "...(...;Sylla et al., 2019), however,..."
19660	33	15	33	15	Scarce availability of what? [Gwenaelle GREMION, Canada]	Scarce availability of what?
39934	33	20		24	this paragraph is about impact - not in this part of the report perhaps? [Michael Tsimplis, China]	this paragraph is about impact - not in this part of the report perhaps?
19662	33	22	33	22	How uncertain are vertical fluxes? Use IPCC uncertainty language here. [Gwenaelle GREMION, Canada]	How uncertain are vertical fluxes? Use IPCC uncertainty language here.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
39936	33	29		32	isn't this a circular argument? [Michael Tsimplis, China]	isn't this a circular argument?
30986	33	44	34	48	This is my area of expertise and I didn't like this section. It felt written from the point of view of a particular region, rather than giving an overview for all coastal oceans. It also felt biased towards a certain point of view. It certainty didn't feel like it was very relevent to my region (NW European Shelf Seas) or the considerable research undertaken within my region. [Jonathan Tinker, United Kingdom (of Great Britain and Northern Ireland)]	This is my area of expertise and I didn't like this section. It felt written from the point of view of a particular region, rather than giving an overview for all coastal oceans. It also felt biased towards a certain point of view. It certainty didn't feel like it was very relevent to my region (NW European Shelf Seas) or the considerable research undertaken within my region.
30988	33	44	34	48	The author is very keen on downscaling with coupled regional atmosphere ocean models. This maybe important in some regions, but for the North Sea, coupled and uncoupled projections have been shown to give the same projections (although the coupled models do have larger uncertainty ranges (NOSCCA, 2016). I think this section should be highlighting that GCMs often have poor representation of the shelf seas, rather than undermining a large body of dynamically downscaled shelf climate projections with uncoupled models, especially as coupling is not essential in all regions. Section 6.3.2 in NOSCCA. (2016). North Sea Region Climate Change Assessment. (M. Quante & F. Colijn, Eds.). Springer International Publishing. http://doi.org/10.1007/978-3-319-39745-0. [Jonathan Tinker, United Kingdom (of Great Britain and Northern Ireland)]	The author is very keen on downscaling with coupled regional atmosphere ocean models. This maybe important in some regions, but for the North Sea, coupled and uncoupled projections have been shown to give the same projections (although the coupled models do have larger uncertainty ranges (NOSCCA, 2016). I think this section should be highlighting that GCMs often have poor representation of the shelf seas, rather than undermining a large body of dynamically downscaled shelf climate projections with uncoupled models, especially as coupling is not essential in all regions. Section 6.3.2 in NOSCCA. (2016). North Sea Region Climate Change Assessment. (M. Quante & F. Colijn, Eds.). Springer International Publishing. http://doi.org/10.1007/978-3-319-39745-0.
6359	33	45	35	22	Much of the text is relative old, a background and not the new outcomes. Suggest to specify where new outcomes are missing and gaps of knowledge [Baruch Rinkevich, Israel]	Much of the text is relative old, a background and not the new outcomes. Suggest to specify where new outcomes are missing and gaps of knowledge
45298	33	46	33	54	Canyons are not mentioned here. They are a major “pathway’ for cross-shelf exchange. Consider including a sentence about this plus some citation (e.g. Allen et al. 2009, Ocean Science: A review of the role of submarine canyons in deep-ocean exchange with the shelf). [Alessandro Silvano, Australia]	Canyons are not mentioned here. They are a major “pathway’ for cross-shelf exchange. Consider including a sentence about this plus some citation (e.g. Allen et al. 2009, Ocean Science: A review of the role of submarine canyons in deep-ocean exchange with the shelf).
39938	33	46		55	Needs rewritting. Starts with a general statement about shallow continental shelves- which are quite extensive in parts of the world. It then it mentions some unspoecified "normal" cicumstances and then goes to the Antrcit self. Also, in llines 50-51 the interaction with the sea bed should be mentioned. [Michael Tsimplis, China]	Needs rewritting. Starts with a general statement about shallow continental shelves- which are quite extensive in parts of the world. It then it mentions some unspoecified "normal" cicumstances and then goes to the Antrcit self. Also, in llines 50-51 the interaction with the sea bed should be mentioned.
19664	33	47	33	47	What is meant here by "normal circumstances"? [Gwenaelle GREMION, Canada]	What is meant here by "normal circumstances"?

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
9336	33	47	33	48	While I have no doubt that this conclusion (more difficult to transport fluid across than along a shelf) is correct; still, I wonder whether it is relevant to assess a confidence level to it. I suspect we have here a property rather general and well understood in fluid mechanics. [philippe waldteufel, France]	While I have no doubt that this conclusion (more difficult to transport fluid across than along a shelf) is correct; still, I wonder whether it is relevant to assess a confidence level to it. I suspect we have here a property rather general and well understood in fluid mechanics.
30990	33	48	33	48	It is more difficult to transport fluid across slopes than along slopes. But it is not difficult to tranport fluid across shelf. [Jonathan Tinker, United Kingdom (of Great Britain and Northern Ireland)]	It is more difficult to transport fluid across slopes than along slopes. But it is not difficult to tranport fluid across shelf.
29584	33	49	33	49	"The process that facilitate…" Huthnance 1995 (above) in an appropriate reference here. This statement regarding the nature of these processes is only partly true. Many of the processes are frictional boundary layer processes e.g. ekman winds and benthic ekman transport, so the representation/observation of these frictional processes (e.g. tides, vertical mixing and vertical resolution) are as or more important than the horizontal resolution. [Jason Holt, United Kingdom (of Great Britain and Northern Ireland)]	"The process that facilitate…" Huthnance 1995 (above) in an appropriate reference here. This statement regarding the nature of these processes is only partly true. Many of the processes are frictional boundary layer processes e.g. ekman winds and benthic ekman transport, so the representation/observation of these frictional processes (e.g. tides, vertical mixing and vertical resolution) are as or more important than the horizontal resolution.
8356	33	51	33	51	"ice shelf-ocean interaction" -> "Antarctic ice shelf-ocean interaction" [Jeremy Fyke, Canada]	"ice shelf-ocean interaction" -> "Antarctic ice shelf-ocean interaction"
30992	33	51	33	52	Change "For this reason" to "For example"? As it is, its giving too specific an example too soon, suggesting that this is the only point of this text. It jars as you read it. [Jonathan Tinker, United Kingdom (of Great Britain and Northern Ireland)]	Change "For this reason" to "For example"? As it is, its giving too specific an example too soon, suggesting that this is the only point of this text. It jars as you read it.
40414	33	53	33	53	I would call FESOM (used in Hellmer et al. 2012) a model with an unstructured grid (or finite-element model) rather than a nested model (which may refer to a secondary high-resolution grid embedded in the main grid). "Models with locally refined grid" may be an option to include all possible refinement methods. [Nicolas Jourdain, France]	I would call FESOM (used in Hellmer et al. 2012) a model with an unstructured grid (or finite-element model) rather than a nested model (which may refer to a secondary high-resolution grid embedded in the main grid). "Models with locally refined grid" may be an option to include all possible refinement methods.
29586	33	54	33	55	River and estuarine plume…' The interaction of these with the open ocean is highly depdendent on the size of the river and the latitutde. Large, low latitude rivers interact directly with the ocean basin, so this needs to be rephrased. See Sharples et al 2017 What proportion of riverine nutrients reaches the open ocean?, Global Biogeochemical Cycles, doi:10.1002/2016GB005483 [Jason Holt, United Kingdom (of Great Britain and Northern Ireland)]	River and estuarine plume…' The interaction of these with the open ocean is highly depdendent on the size of the river and the latitutde. Large, low latitude rivers interact directly with the ocean basin, so this needs to be rephrased. See Sharples et al 2017 What proportion of riverine nutrients reaches the open ocean?, Global Biogeochemical Cycles, doi:10.1002/2016GB005483

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19658	33	54	34	1	Modelling river and estuarine plumes and exchanges with shelf water is complex as the nearshore bathymetry (compared to the shelf and deep ocean bathymetry) vary rapidly due to waves and tides. Thus, the freshwater flumes are not properly modelled in large scale models. This aspect should be included here. [Gwenaelle GREMION, Canada]	Modelling river and estuarine plumes and exchanges with shelf water is complex as the nearshore bathymetry (compared to the shelf and deep ocean bathymetry) vary rapidly due to waves and tides. Thus, the freshwater flumes are not properly modelled in large scale models. This aspect should be included here.
29602	33	55	33	55	Also not clear what 'water level' is refered to here. [Jason Holt, United Kingdom (of Great Britain and Northern Ireland)]	Also not clear what 'water level' is refered to here.
29590	34	1	34	1	I think this (and other parts of this section) present an overly negative view of our capability for modest resolution ocean models. At a 1/4 deg the barotropic Rossby radius is resolved for ~70% of the global coastal ocean (Holt et al 2017 doi:10.5194/gmd-10-499-2017). This implies tidal dynamics can be reasonably well simulated and so can seasonal vertical mixing processes. The seasonal cycle of stratification is a key dynamic process for many shelf seas, often controlling their phytoplankton production and so some mention of this here is appropriate. [Jason Holt, United Kingdom (of Great Britain and Northern Ireland)]	I think this (and other parts of this section) present an overly negative view of our capability for modest resolution ocean models. At a 1/4 deg the barotropic Rossby radius is resolved for ~70% of the global coastal ocean (Holt et al 2017 doi:10.5194/gmd-10-499-2017). This implies tidal dynamics can be reasonably well simulated and so can seasonal vertical mixing processes. The seasonal cycle of stratification is a key dynamic process for many shelf seas, often controlling their phytoplankton production and so some mention of this here is appropriate.
48970	34	1	34	5	And what sort of impact does this have on model results? I.e., is this a big deal or not in the scheme of the uncertainties that exist? [Laura Reynolds, United States of America]	And what sort of impact does this have on model results? I.e., is this a big deal or not in the scheme of the uncertainties that exist?
39940	34	1		10	This part of the chapter (as well as others) reads as the concern is not climate but modelling capability. The approach needs to be changed I believe. [Michael Tsimplis, China]	This part of the chapter (as well as others) reads as the concern is not climate but modelling capability. The approach needs to be changed I believe.
39942	34	1		13	I do not think this statement is correct. Barotropic tides can be modeled "accurately" but baroclinic tides and tidal dissipation are not well described. In any case some of the marginal seas have very small tides in most parts of it. Even regional climate models do not have the tidal signal and they do not really need them in some of the basin. All this paragraph needs careful reconsideration: it is a collection of statements that are not all true, are not properly referenced and their importance is unclear. So, for example, why would deep water formation in the Mediterranean Sea be important for climate change and its impact? [Michael Tsimplis, China]	I do not think this statement is correct. Barotropic tides can be modeled "accurately" but baroclinic tides and tidal dissipation are not well described. In any case some of the marginal seas have very small tides in most parts of it. Even regional climate models do not have the tidal signal and they do not really need them in some of the basin. All this paragraph needs careful reconsideration: it is a collection of statements that are not all true, are not properly referenced and their importance is unclear. So, for example, why would deep water formation in the Mediterranean Sea be important for climate change and its impact?
30994	34	4	34	4	"to fully capture the impact of rivers requires coupled models" - really? I don' think this is correct, and it isn't supported by a reference. Remove? [Jonathan Tinker, United Kingdom (of Great Britain and Northern Ireland)]	"to fully capture the impact of rivers requires coupled models" - really? I don' think this is correct, and it isn't supported by a reference. Remove?

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
29588	34	4	34	4	to fully capture the impacts of rivers requires coupled models'. I think this is incorrect, but its unclear what kind of coupled models are needed. Coupled O-A models or coupled ocean-hydrological, neither are necessarily required to caputre the impact of rivers. Instead I would say accruate freshwater flow information modulated by estuarine processes, suffificently high coastal ocean resolution with appropriate boundary layer dynamics. [Jason Holt, United Kingdom (of Great Britain and Northern Ireland)]	to fully capture the impacts of rivers requires coupled models'. I think this is incorrect, but its unclear what kind of coupled models are needed. Coupled O-A models or coupled ocean-hydrological, neither are necessarily required to caputre the impact of rivers. Instead I would say accruate freshwater flow information modulated by estuarine processes, suffificently high coastal ocean resolution with appropriate boundary layer dynamics.
41290	34	7	34	9	"The semi-enclosed basins, such as marginal seas (e.g., Mediterranean, Labrador, Otkhosk, Ross, and Weddell Seas" and Caribbean, we may add), "climate change has been observed and affects the formation of water masses within these seas." It is true, but by different ways (transport variability and trend through channels and straits that connect with the ocean, temperature increase, etc.); these and other marginal seas may affect ocean waters in distant regions, as it happens between the Intra Americas Sea (Caribbean + Gulf of Mexico) and the adjacent Atlantic Ocean from the Florida Strait northward. This exchange between marginal seas and the ocean should be approached with greater emphasis on the context of knowledge about climate change. [Marcelino Hernández González, Cuba]	"The semi-enclosed basins, such as marginal seas (e.g., Mediterranean, Labrador, Otkhosk, Ross, and Weddell Seas" and Caribbean, we may add), "climate change has been observed and affects the formation of water masses within these seas." It is true, but by different ways (transport variability and trend through channels and straits that connect with the ocean, temperature increase, etc.); these and other marginal seas may affect ocean waters in distant regions, as it happens between the Intra Americas Sea (Caribbean + Gulf of Mexico) and the adjacent Atlantic Ocean from the Florida Strait northward. This exchange between marginal seas and the ocean should be approached with greater emphasis on the context of knowledge about climate change.
39944	34	7		23	most of the statement made are not only true for the marginal seas but all coastal regions in any case some marginal seas have very small tides so perhaps the discussion is misleading in that respect. And why is there a need to set a confidence level for centennial climate change in marginal seas in general? has there been such a statemnt for all other regions coastal or not and for other timescales? How is this differ with what was said earlier about the AMOC and the ACC? [Michael Tsimplis, China]	most of the statement made are not only true for the marginal seas but all coastal regions in any case some marginal seas have very small tides so perhaps the discussion is misleading in that respect. And why is there a need to set a confidence level for centennial climate change in marginal seas in general? has there been such a statemnt for all other regions coastal or not and for other timescales? How is this differ with what was said earlier about the AMOC and the ACC?
29592	34	10	34	10	I would disagree that it is difficult to observe these basins from satellites . [Jason Holt, United Kingdom (of Great Britain and Northern Ireland)]	I would disagree that it is difficult to observe these basins from satellites .

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
19668	34	13	34	17	In addition to the resolution issues, it is better to discuss nesting issues such as issues of incompatibility in assumptions and boundary conditions between global-scale models and regional models. References: 1) Eric Blayo, Laurent Debreu. Nesting ocean models. E. Chassignet and J. Verron. An Integrated View of Oceanography: Ocean Weather Forecasting in the 21st Century, Kluwer, 2006. inria-00187576; 2) Nash, S., Hartnett, M., 2014. Development of a nested coastal circulation model: Boundary error reduction. Environmental Modelling & Software 53, 65-80. [Gwenaelle GREMION, Canada]	In addition to the resolution issues, it is better to discuss nesting issues such as issues of incompatibility in assumptions and boundary conditions between global-scale models and regional models. References: 1) Eric Blayo, Laurent Debreu. Nesting ocean models. E. Chassignet and J. Verron. An Integrated View of Oceanography: Ocean Weather Forecasting in the 21st Century, Kluwer, 2006. inria-00187576; 2) Nash, S., Hartnett, M., 2014. Development of a nested coastal circulation model: Boundary error reduction. Environmental Modelling & Software 53, 65-80.
19672	34	15	34	17	The sentence mentions unstructured grids as one option for zooming into a region within a model, but another option is adaptive mesh refinement (e.g. Mandli and Dawson 2014, although that's specifically about storm surge) or simply nested resolutions (fixed rather than adaptive). Nested regional climate models are referred to later, citing some challenges, but I think it would make sense to include them here alongside unstructured grids as an alternative approach for representing particular small-scale processes in the locations where they occur. [Gwenaelle GREMION, Canada]	The sentence mentions unstructured grids as one option for zooming into a region within a model, but another option is adaptive mesh refinement (e.g. Mandli and Dawson 2014, although that's specifically about storm surge) or simply nested resolutions (fixed rather than adaptive). Nested regional climate models are referred to later, citing some challenges, but I think it would make sense to include them here alongside unstructured grids as an alternative approach for representing particular small-scale processes in the locations where they occur.
49236	34	17	34	17	While I agree that HighResMIP model will probably not improve simuulation of most coastal processes, I don't see why this sentence is here with no evidence. Moreton et al. (2019, submitted) does suggest that eddies formed at open ocean coastal boundaries are more frequenct and hence agree better with observations. In addition, in the next paragraphs ther eis mention of Euro-CORDEX, but no mention of the resolutions deployed - I think they are also typically 10km or lower resolution. Moreton, S., D. Ferreira, M. Roberts, H. Hewitt, 2018: Evaluating surface eddy properties in climate simulations with 'eddy-present' and 'eddy-rich' ocean resolution. Ocean Modelling, submitte. [Malcolm Roberts, United Kingdom (of Great Britain and Northern Ireland)]	While I agree that HighResMIP model will probably not improve simuulation of most coastal processes, I don't see why this sentence is here with no evidence. Moreton et al. (2019, submitted) does suggest that eddies formed at open ocean coastal boundaries are more frequenct and hence agree better with observations. In addition, in the next paragraphs ther eis mention of Euro-CORDEX, but no mention of the resolutions deployed - I think they are also typically 10km or lower resolution. Moreton, S., D. Ferreira, M. Roberts, H. Hewitt, 2018: Evaluating surface eddy properties in climate simulations with 'eddy-present' and 'eddy-rich' ocean resolution. Ocean Modelling, submitte.

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29598	34	17	34	17	A comment on the utility of these downscale simulations is importnant. For example:' Regional downscale coastal ocean models develop our understanding of how local systems reponse to large scale change, for example changes in open ocean stratficiation impacting on shelf sea ciculation (Holt et al 2018. Climate-Driven Change in the North Atlantic and Arctic Oceans Can Greatly Reduce the Circulation of the North Sea, Geophysical Research Letters, doi:doi:10.1029/2018GL078878.). By relating these local process back to large scale properties, statsitical models can inform the likelihood of these changes occuring (supplement in Holt et al 2018) [Jason Holt, United Kingdom (of Great Britain and Northern Ireland)]	A comment on the utility of these downscale simulations is importnant. For example:' Regional downscale coastal ocean models develop our understanding of how local systems reponse to large scale change, for example changes in open ocean stratficiation impacting on shelf sea ciculation (Holt et al 2018. Climate-Driven Change in the North Atlantic and Arctic Oceans Can Greatly Reduce the Circulation of the North Sea, Geophysical Research Letters, doi:doi:10.1029/2018GL078878.). By relating these local process back to large scale properties, statsitical models can inform the likelihood of these changes occuring (supplement in Holt et al 2018)
29594	34	18	34	18	Near coastal phenomena may not be well respoved by 10km scale, but coastal ocean processes are well represented at this scale. For example the NW European shelf operational forecast system has a resolution of ~7km (O'Dea et al 2017 The CO5 configuration of the 7 km Atlantic Margin Model: large-scale biases and sensitivity to forcing, physics options and vertical resolution, Geosci. Model Dev., doi:10.5194/gmd-10-2947-2017.) and demonstrable skill and is not far from that of these global models. [Jason Holt, United Kingdom (of Great Britain and Northern Ireland)]	Near coastal phenomena may not be well respoved by 10km scale, but coastal ocean processes are well represented at this scale. For example the NW European shelf operational forecast system has a resolution of ~7km (O'Dea et al 2017 The CO5 configuration of the 7?km Atlantic Margin Model: large-scale biases and sensitivity to forcing, physics options and vertical resolution, Geosci. Model Dev., doi:10.5194/gmd-10-2947-2017.) and demonstrable skill and is not far from that of these global models.
19670	34	19	34	20	Resolution should definitely be much finner for adequately representing the features near to the land-ocean interface such as river and estuarine inputs and tides 1) Altaie, H., 2018. A Multiply Nested Model for Non-Linear Shallow Water Model. Research Reports on Mathematics, 2:1, 1-9; 2) Trotta, F., Pinardi, N., Fenu, E., Grandi, A., Lyubartsev, V., 2017. Multi-nest high-resolution model of submesoscale circulation features in the Gulf of Taranto. Ocean Dynamics. 67:1609–1625. https://doi.org/10.1007/s10236-017-1110-z; 3) Janekovic, I., Powell, B., 2012.Analysis of imposing tidal dynamics to nested numerical models. Continental Shelf Research 34, 30–40; 4) Greenberg, D.A., Dupont, F., Lyard, F.H., Lynch, D.R., Werner, F.E., 2007. Resolution issues in numerical models of oceanic and coastal circulation. Continental Shelf Research 27, 1317–1343. [Gwenaelle GREMION, Canada]	Resolution should definitely be much finner for adequately representing the features near to the land-ocean interface such as river and estuarine inputs and tides 1) Altaie, H., 2018. A Multiply Nested Model for Non-Linear Shallow Water Model. Research Reports on Mathematics, 2:1, 1-9; 2) Trotta, F., Pinardi, N., Fenu, E., Grandi, A., Lyubartsev, V., 2017. Multi-nest high-resolution model of submesoscale circulation features in the Gulf of Taranto. Ocean Dynamics. 67:1609–1625. https://doi.org/10.1007/s10236-017-1110-z; 3) Janekovic, I., Powell, B., 2012.Analysis of imposing tidal dynamics to nested numerical models. Continental Shelf Research 34, 30–40; 4) Greenberg, D.A., Dupont, F., Lyard, F.H., Lynch, D.R., Werner, F.E., 2007. Resolution issues in numerical models of oceanic and coastal circulation. Continental Shelf Research 27, 1317–1343.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
29596	34	20	34	21	The case for requiring coupled ocean-atmosphere dynamics in the shelf sea context has not been made. There are a few study that demonstrate the importance of O-A coupling but many more show good results without it. Most present day shelf sea forecast systems (e.g. the European copernicus services) rely on uncoupled ocean models and have demonstrable skill against contemporary observations. From this we can infer that the same models driven by climate model atmopsheric and oceanic components will have the same intrinstic skill, but regional inaccuracies in the climate model will propogate into the downscaled model. These issues are disucsased in detail in Holt et al 2016 Potential impacts of climate change on the primary production of regional seas: a comparative analysis of five European seas Progress in Oceanography http://dx.doi.org/10.1016/j.pocean.2015.11.004 [Jason Holt, United Kingdom (of Great Britain and Northern Ireland)]	The case for requiring coupled ocean-atmosphere dynamics in the shelf sea context has not been made. There are a few study that demonstrate the importance of O-A coupling but many more show good results without it. Most present day shelf sea forecast systems (e.g. the European copernicus services) rely on uncoupled ocean models and have demonstrable skill against contemporary observations. From this we can infer that the same models driven by climate model atmopsheric and oceanic components will have the same intrinstic skill, but regional inaccuracies in the climate model will propogate into the downscaled model. These issues are disucsased in detail in Holt et al 2016 Potential impacts of climate change on the primary production of regional seas: a comparative analysis of five European seas Progress in Oceanography http://dx.doi.org/10.1016/j.pocean.2015.11.004
30996	34	22	33	23	This is not true in the North West European Shelf Seas. Perhaps you meant "… where regional dynamical downscaling has not been implemented". I would tend to agree with this. GCM's are very poor at representing the North West European Shelf Seas, so dynamic downscaling is essnetial, and has been around for a long time (e.g. Adlandsvik, Friocourt, Holt, Mathis, Tinker). Downscaling with regional coupled atmosphere-ocean models is more important in some regions that other. It is imporntant in the Baltic Sea, where SSTs can be close to the sea ice formation threshold, and capturing the ocean atmosphere feedback is important. In the North Sea, it seems to be much less important. Comparing a projections with coupled and uncoupled regional models gave similar projections, although with a greater uncertainty ranges in the coupled models (NOSCCA, 2016, comparing the models of Bulow, wakelin, Mathis and Mathis and Pohlmann) References in next cell [Jonathan Tinker, United Kingdom (of Great Britain and Northern Ireland)]	This is not true in the North West European Shelf Seas. Perhaps you meant "… where regional dynamical downscaling has not been implemented". I would tend to agree with this. GCM's are very poor at representing the North West European Shelf Seas, so dynamic downscaling is essnetial, and has been around for a long time (e.g. Adlandsvik, Friocourt, Holt, Mathis, Tinker). Downscaling with regional coupled atmosphere-ocean models is more important in some regions that other. It is imporntant in the Baltic Sea, where SSTs can be close to the sea ice formation threshold, and capturing the ocean atmosphere feedback is important. In the North Sea, it seems to be much less important. Comparing a projections with coupled and uncoupled regional models gave similar projections, although with a greater uncertainty ranges in the coupled models (NOSCCA, 2016, comparing the models of Bulow, wakelin, Mathis and Mathis and Pohlmann) References in next cell

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
30998	34	22	33	23	Continued from previous comment: References: Ådlandsvik, B. (2008). Marine downscaling of a future climate scenario for the North Sea. Tellus A, 60, 451–458. Friocourt, Y. F., Skogen, M. D., Stolte, W., & Albretsen, J. (2012). Marine downscaling of a future climate scenario in the North Sea and possible effects on dinoflagellate harmful algal blooms. Food Additives & Contaminants: Part A, 29(10), 1630–1646. http://doi.org/doi:10.1080/19440049.2012.714079. Holt, J., Wakelin, S., & Huthnance, J. (2009). Down-welling circulation of the northwest European continental shelf: A driving mechanism for the continental shelf carbon pump. Geophysical Research Letters, 36. http://doi.org/L14602 10.1029/2009gl038997. Mathis, M., & Pohlmann, H. (2014). Projection of physical conditions in the North Sea for the 21st century. Climate Research, 61, 1–17. http://doi.org/doi:10.3354/cr01232. Tinker,	Continued from previous comment: References:
15374	34	25	34	31	Please add also results of high resolution CMIP5 modelling PCP4.5 and RCP8.5) for the Barents Sea with simulations for SST, temperature extreams, precipitation, winds, waves, tides, etc. he survey was conducted by Sergey Gulev - WGI Chapter 2 CLA. Verezemskaya, P. C., Gulev, S. K., Selivanova, Yu. V., Tilinina, N. D., Markina, M. J., Krinitsky, M. A., Sharmar, V. D. (2019). Projections and Analysis of Climate Change in the Russian Part of the Barents Sea. Moscow: WWF-Russia: https://wwf.ru/resources/publications/booklets/prognoz-i-analiz-izmeneniy-klimata-v-rossiyskoy-chasti-barentseva-morya/ [Oksana Lipka, Russian Federation]	Please add also results of high resolution CMIP5 modelling PCP4.5 and RCP8.5) for the Barents Sea with simulations for SST, temperature extreams, precipitation, winds, waves, tides, etc. he survey was conducted by Sergey Gulev - WGI Chapter 2 CLA. Verezemskaya, P. C., Gulev, S. K., Selivanova, Yu. V., Tilinina, N. D., Markina, M. J., Krinitsky, M. A., Sharmar, V. D. (2019). Projections and Analysis of Climate Change in the Russian Part of the Barents Sea. Moscow: WWF-Russia: https://wwf.ru/resources/publications/booklets/prognoz-i-analiz-izmeneniy-klimata-v-rossiyskoy-chasti-barentseva-morya/
39946	34	25		31	relevance of this paragraph? [Michael Tsimplis, China]	relevance of this paragraph?

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
31000	34	29	33	29	After the Baltic Sea Section. I.e. after "over the 21st century…" add text along the lines of:These were followed by projections for the North West European Shelf Seas (NWS) and its constituent basins (Adlandsvik 2008, Holt et al. 2010, Olbert et al. 2012,Groger et al. 2013, Mathis and Pohlmann, 2014 Tinker et al. 2016, Mathis et al. 2018). Coupling is less important for the NWS (e.g. sea ice largely absent), and coupling has limited impact on the mean of the projections (NOSCCA, 2016, Bulow et al. 2014, Wakelin et al. 2012) but does increase uncertainty, and few of the many NWS Climate projections are based on coupled systems (Bulow et al. 2014, Mathis et al. 2018). Despite the range of methodologies, the projections show a relatively good agreement in the projected changes of temperature etc. Few studies have assessed the uncertainty associated with the projections, with Tinker et al.(2016) presenting the first systematic assessment of an aspect of climate projection uncertainty for the NWS. Ådlandsvik, B. (2008). "Marine downscaling of a future climate scenario for the North Sea." Tellus A 60: 451-458. Bülow, K., Dieterich, C., Heinrich, H., Hüttl-Kabus, S., Klein, B., Mayer, B., Meier, H. E. M., Mikolajewicz, U., Narayan, N., Pohlmann, T., Rosenhagen, G., Sein, D. and Su, J. (2014). Comparison of 3 coupled models in the North Sea region under todays and future climate conditions, KLIWAS. Gröger, M., Maier-Reimer, E., Mikolajewicz, U., Moll, A. and Sein, D. (2013). "NW European shelf under climate warming: implications for open ocean – shelf exchange, primary production, and carbon absorption." Biogeosciences 10: 3767-3792 doi:10.5194/bg-10-3767-2013. Holt, J., Wakelin, S., Lowe, J. A. and Tinker, J. (2010). "The potential impacts of climate change on the hydrography of the northwest European continental shelf." Progress In Oceanography 86(3-4): 361-379 doi:10.1016/j.pocean.2010.05.003. Mathis, M., Elizalde, A. and Mikolajewicz, U. (2018). "Which complexity of regional climate system models is essential for downscaling anthropogenic climate change in the Northwest European Shelf?" Climate Dynamics 50(7-8): 2637-2659	After the Baltic Sea Section. I.e. after "over the 21st century…" add text along the lines of:These were followed by projections for the North West European Shelf Seas (NWS) and its constituent basins (Adlandsvik 2008, Holt et al. 2010, Olbert et al. 2012,Groger et al. 2013, Mathis and Pohlmann, 2014 Tinker et al. 2016, Mathis et al. 2018). Coupling is less important for the NWS (e.g. sea ice largely absent), and coupling has limited impact on the mean of the projections (NOSCCA, 2016, Bulow et al. 2014, Wakelin et al. 2012) but does increase uncertainty, and few of the many NWS Climate projections are based on coupled systems (Bulow et al. 2014, Mathis et al. 2018). Despite the range of methodologies, the projections show a relatively good agreement in the projected changes of temperature etc. Few studies have assessed the uncertainty associated with the projections, with Tinker et al.(2016) presenting the first systematic assessment of an aspect of climate projection uncertainty for the NWS. Ådlandsvik, B. (2008). "Marine downscaling of a future climate scenario for the North Sea." Tellus A 60: 451-458. Bülow, K., Dieterich, C., Heinrich, H., Hüttl-Kabus, S., Klein, B., Mayer, B., Meier, H. E. M., Mikolajewicz, U., Narayan, N., Pohlmann, T., Rosenhagen, G., Sein, D. and Su, J. (2014). Comparison of 3 coupled models in the North Sea region under todays and future climate
42638	34	33	34	47	I suggest considering Artici CORDEX simulations that have included coupled ocean-ice-atmosphere models. [William Gutowski, United States of America]	I suggest considering Artici CORDEX simulations that have included coupled ocean-ice-atmosphere models.
39948	34	33		37	a) What do we mean by high resolution, what kind of features how strong was the amplification and which part of Europe was affected at what frequencies and why is this relevant to the state of the climate? Isn't this paragraph contradictory with what was said earlier about marginal oceans? [Michael Tsimplis, China]	a) What do we mean by high resolution, what kind of features how strong was the amplification and which part of Europe was affected at what frequencies and why is this relevant to the state of the climate? Isn't this paragraph contradictory with what was said earlier about marginal oceans?

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
19674	34	37	34	40	This sentence outlines 3 uses for regional high-res models (a) projections, which it says they are not typically used for; (b) improving dynamical detail of simulations; and (c) repredocing observed data better. I would argue that (b) is inherent in all use cases, and the papers cited here are more linked by the goal of "understanding small-scale processes and their impacts". While this is achieved through improving the dynamical detail of the simulations, the latter is more a mechanism than a use case. [Gwenaelle GREMION, Canada]	This sentence outlines 3 uses for regional high-res models (a) projections, which it says they are not typically used for; (b) improving dynamical detail of simulations; and (c) repredocing observed data better. I would argue that (b) is inherent in all use cases, and the papers cited here are more linked by the goal of "understanding small-scale processes and their impacts". While this is achieved through improving the dynamical detail of the simulations, the latter is more a mechanism than a use case.
39950	34	37		44	This chapter reads more and more as an an assessment of climate models rather than an assessment of climate. [Michael Tsimplis, China]	This chapter reads more and more as an an assessment of climate models rather than an assessment of climate.
29600	34	45	34	45	Replace "regional coupled" with "regional downscaled", given argument above [Jason Holt, United Kingdom (of Great Britain and Northern Ireland)]	Replace "regional coupled" with "regional downscaled", given argument above
39952	34	45		47	See previous comments. To be blunt: who cares whether regional models have skills? Is this report about science funding and priorities? To what extent these coastal change is important globally (not as a matter of impacts but as a matter of affecting the global climate? I believe that there were studies presented at the same time as Somot 2008 and in the same framework by L. Li (France) showning that the Mediterranean sea only affected a very narrow strip of the Mediterranean overall. Therefore I assume that all this paragraph perhaps links to deep water formation and/or resolution of storms generated within the Mediterranean (a small part of the climate but with potential impacts). Not sure that any of the above is accurate enough, quantifiable or indeed relevant to the task of the report. [Michael Tsimplis, China]	See previous comments. To be blunt: who cares whether regional models have skills? Is this report about science funding and priorities? To what extent these coastal change is important globally (not as a matter of impacts but as a matter of affecting the global climate? I believe that there were studies presented at the same time as Somot 2008 and in the same framework by L. Li (France) showning that the Mediterranean sea only affected a very narrow strip of the Mediterranean overall. Therefore I assume that all this paragraph perhaps links to deep water formation and/or resolution of storms generated within the Mediterranean (a small part of the climate but with potential impacts). Not sure that any of the above is accurate enough, quantifiable or indeed relevant to the task of the report.
6732	34	49	35	1	Structure? 9.2.5 small section on effect of temperature on SSH - move to section 9.6? [Joanne Williams, United Kingdom (of Great Britain and Northern Ireland)]	Structure? 9.2.5 small section on effect of temperature on SSH - move to section 9.6?
48524	34	49	35	49	A figure and discussion to consider adding is a comparison of SSH trends observed from satellite (since 1993) against thermosteric and halosteric contributions inferred from ocean warming and freshening. This shows a strong correspondence in the pattern, demonstrating that much of the pattern is due to ocean warming, but off by a factor of 3 due to mass redistribution. [Kyle Armour, United States of America]	A figure and discussion to consider adding is a comparison of SSH trends observed from satellite (since 1993) against thermosteric and halosteric contributions inferred from ocean warming and freshening. This shows a strong correspondence in the pattern, demonstrating that much of the pattern is due to ocean warming, but off by a factor of 3 due to mass redistribution.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
37904	34	49			Almost everywhere in the chapters of the WG1 FOD, the reference is to sea level, but here it is to sea-surface height in some places and sea level in others. I understand there is a difference - and note that there is a later reference to altimeters measuring geocentric sea level, which I take to be another name for sea-surface height. Is it really necessary to start talking about sea-surface height rather than sea level here? [Adrian Simmons, United Kingdom (of Great Britain and Northern Ireland)]	Almost everywhere in the chapters of the WG1 FOD, the reference is to sea level, but here it is to sea-surface height in some places and sea level in others. I understand there is a difference - and note that there is a later reference to altimeters measuring geocentric sea level, which I take to be another name for sea-surface height. Is it really necessary to start talking about sea-surface height rather than sea level here?
39954	34	49			is it an impact or an association? Ocean changes are physically linked with SSH changes they occur together and one can not occur without the other. [Michael Tsimplis, China]	is it an impact or an association? Ocean changes are physically linked with SSH changes they occur together and one can not occur without the other.
39956	34	51		52	see previous comment. [Michael Tsimplis, China]	see previous comment.
39958	34	54			Apart from the implied physical causation which is incorrect and misleading there is an additional problem: In many parts of the previous sections where the oceanic changes are discussed the conclusions are that neither we are certain about changes due to various reasons nor can we model them properly (although many models indicate direction of change). So I wonder how, on the basis of the uncertainty involved, this section could be anything but a reflection of the uncertainties involved in the previous sections and thus not really more than saying: Changes in oceanic circulation (which have in most parts high uncertainty) are effected accompanied by changes in SSH which are, thus, equally uncertain. [Michael Tsimplis, China]	Apart from the implied physical causation which is incorrect and misleading there is an additional problem: In many parts of the previous sections where the oceanic changes are discussed the conclusions are that neither we are certain about changes due to various reasons nor can we model them properly (although many models indicate direction of change). So I wonder how, on the basis of the uncertainty involved, this section could be anything but a reflection of the uncertainties involved in the previous sections and thus not really more than saying: Changes in oceanic circulation (which have in most parts high uncertainty) are effected accompanied by changes in SSH which are, thus, equally uncertain.
39960	35	3			Surely this is more than a statistical correlation and surely this was not made known in 2008. [Michael Tsimplis, China]	Surely this is more than a statistical correlation and surely this was not made known in 2008.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
39966	35	7		16	What exactly does this mean? You start the paragraph by pointing out that there is a spread in the models especially in the deeper layers - with respect to patterns (I assume spatial or do you mean temporal)? You then give a commitment of m per degree of (mean atmospheric temperature?) rise overall with RCP (I assume all versions) give something closer to the lower part of this range (so why not confine it to lower values?) So the high confidence means that all models give such values (but are not tested in their physics for such time scales) at a time scale of 2000 years (no spread here- but surely rates would be very much dependant on this.). Why then it is only likely that this is the range? (other studies?) The only study updating last report is closer to the lower range but you chose to keep the wider range although this comes for earlier experiments with lower quality models (if I understood your earlier statements.). [Michael Tsimplis, China]	What exactly does this mean? You start the paragraph by pointing out that there is a spread in the models especially in the deeper layers - with respect to patterns (I assume spatial or do you mean temporal)? You then give a commitment of m per degree of (mean atmospheric temperature?) rise overall with RCP (I assume all versions) give something closer to the lower part of this range (so why not confine it to lower values?) So the high confidence means that all models give such values (but are not tested in their physics for such time scales) at a time scale of 2000 years (no spread here- but surely rates would be very much dependant on this.). Why then it is only likely that this is the range? (other studies?) The only study updating last report is closer to the lower range but you chose to keep the wider range although this comes for earlier experiments with lower quality models (if I understood your earlier statements.).
39962	35	7			What policy makers (and the public) is interested is whether there is high confidence that SSH changes (OBSERVED) are caused by increases in OHC change. But for someone reading the whole chapter it is striking that here the multi-model mean is referred to while earlier the model results were discussed on how many model show one thing and how many another etc. in OHC (observed), whether the models can simulated SO AS to have confidence in what they say for the future. [Michael Tsimplis, China]	What policy makers (and the public) is interested is whether there is high confidence that SSH changes (OBSERVED) are caused by increases in OHC change. But for someone reading the whole chapter it is striking that here the multi-model mean is referred to while earlier the model results were discussed on how many model show one thing and how many another etc. in OHC (observed), whether the models can simulated SO AS to have confidence in what they say for the future.
39964	35	9			Where? overall in the upper or the lower layers? [Michael Tsimplis, China]	Where? overall in the upper or the lower layers?
26154	35	14	35	16	Thermosteric rise is stated here with high confidence to be 0.2 to 0.6m/°C. Now figs 9.38 shows thermosteric rise as roughly 50% of total contribution to sea-level rise for next 100 years. So that should make a rise of 0.4 to 1.2m per degC. So how come Fig 9.40 shows a graph of total contribution with slope 10m/°C. By your own figures this is surely ten times too big. [Stephen Taylor, United Kingdom (of Great Britain and Northern Ireland)]	Thermosteric rise is stated here with high confidence to be 0.2 to 0.6m/°C. Now figs 9.38 shows thermosteric rise as roughly 50% of total contribution to sea-level rise for next 100 years. So that should make a rise of 0.4 to 1.2m per degC. So how come Fig 9.40 shows a graph of total contribution with slope 10m/°C. By your own figures this is surely ten times too big.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
39968	35	18		20	Unclear what you say: what is accurate ? Also: surely there must be more than high confidence about the basin scale patterns - is there a study that doubts them? If continuous observation leads to only high confidence then perhaps you have to revise all statements about oceanic observations which are orders of magnitude fewer. [Michael Tsimplis, China]	Unclear what you say: what is accurate ? Also: surely there must be more than high confidence about the basin scale patterns - is there a study that doubts them? If continuous observation leads to only high confidence then perhaps you have to revise all statements about oceanic observations which are orders of magnitude fewer.
39970	35	18		24	Are you suggesting that the "natural modes of variability" are not affected by anthropogenic change? I think the last two sentences are misleading. The status is that there is currently no studies establishing or attribution of anthorpogenic change to the patterns. This is a report,being brutal with what we know and what we do not, instead of including all possible speculation which may or may not be proven right is the way to go. [Michael Tsimplis, China]	Are you suggesting that the "natural modes of variability" are not affected by anthropogenic change? I think the last two sentences are misleading. The status is that there is currently no studies establishing or attribution of anthorpogenic change to the patterns. This is a report,being brutal with what we know and what we do not, instead of including all possible speculation which may or may not be proven right is the way to go.
39972	35	26		29	This is again an assessment for the models NOT what we know: what is larger scale and how much of the (observed/modelled) variability is at these frequencies - in other words is it of any benefit for SSH knowledge that there are more robust (whatever this means when compared with something of low confidence) or are these so small that are in essence within the uncertainty range of the higher frequency variability? Clearly are important fro model assessment but not for the state of the climate or climate knowledge. [Michael Tsimplis, China]	This is again an assessment for the models NOT what we know: what is larger scale and how much of the (observed/modelled) variability is at these frequencies - in other words is it of any benefit for SSH knowledge that there are more robust (whatever this means when compared with something of low confidence) or are these so small that are in essence within the uncertainty range of the higher frequency variability? Clearly are important fro model assessment but not for the state of the climate or climate knowledge.
39974	35	29		32	Perhaps a statement that both the uptake of heat and the oceanic response to atmospheric changes are not consistent in models there is also low confidence in all model features except the globally averaged SSH? [Michael Tsimplis, China]	Perhaps a statement that both the uptake of heat and the oceanic response to atmospheric changes are not consistent in models there is also low confidence in all model features except the globally averaged SSH?
39976	35	33			most? You mention three patterns in the previous paragraph . So most is two? In any case what is the significance of this? That the SSH changes will primarily be in the global average thus preserving the patterns? If there is confidence in this then what is the point of higher resolution models for SSH? [Michael Tsimplis, China]	most? You mention three patterns in the previous paragraph . So most is two? In any case what is the significance of this? That the SSH changes will primarily be in the global average thus preserving the patterns? If there is confidence in this then what is the point of higher resolution models for SSH?
39978	35	36		38	The sentence makes no sense to me (models agreeing with models) and the last part expresses belief/hope. Is this really necessary? [Michael Tsimplis, China]	The sentence makes no sense to me (models agreeing with models) and the last part expresses belief/hope. Is this really necessary?

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
31160	35	50	35	50	The parameters treated in this section on Sea Ice are area/concentration, thickness/volume and drift. Studies since AR5 have made increasing use of other parameters that make more sense both from a physical point of view but also for users of sea ice information, like duration of open water season, date of advance/retreat. I would suggest to consider including them as indicators of long term changes in their own right. [François Massonnet, Belgium]	The parameters treated in this section on Sea Ice are area/concentration, thickness/volume and drift. Studies since AR5 have made increasing use of other parameters that make more sense both from a physical point of view but also for users of sea ice information, like duration of open water season, date of advance/retreat. I would suggest to consider including them as indicators of long term changes in their own right.
19676	35	50	43	23	Get consistent with the spelling of the word sea ice / sea-ice / Sea-Ice / Sea Ice / Sea ice. [Gwenaelle GREMION, Canada]	Get consistent with the spelling of the word sea ice / sea-ice / Sea-Ice / Sea Ice / Sea ice.
39980	35	50			perhaps a sentence why this quantity is important and for what it isn't. [Michael Tsimplis, China]	perhaps a sentence why this quantity is important and for what it isn't.
44968	35	50			The section on paleo sea ice extent in the Arctic is especially strong. Would this be the place to include information about simulated sea ice extent (for both polar regions) as it is represented in model simulations from paleo periods? [Darrell Kaufman, United States of America]	The section on paleo sea ice extent in the Arctic is especially strong. Would this be the place to include information about simulated sea ice extent (for both polar regions) as it is represented in model simulations from paleo periods?
48850	35	50			For the FOD, I think the sea ice section reads very well. I have a few comments focused on consistency with SROCC. But overall, this is in good shape. [Chris Derksen, Canada]	For the FOD, I think the sea ice section reads very well. I have a few comments focused on consistency with SROCC. But overall, this is in good shape.
32396	36	1	36	2	What does “strengthening the AR5 finding of very likely anthropogenic impact since 1979” actually mean? Are you saying that AR5 said "very likely" and AR6 is saying the same but with higher confidence? Or is AR6 saying it is now more likely than “very likely”? [Ed Blockley, United Kingdom (of Great Britain and Northern Ireland)]	What does “strengthening the AR5 finding of very likely anthropogenic impact since 1979” actually mean? Are you saying that AR5 said "very likely" and AR6 is saying the same but with higher confidence? Or is AR6 saying it is now more likely than “very likely”?
39982	36	1			Perhaps mentioning the physical mechanisms involved and linking them with the anthropogenic forcing of the forcing factors would make more sense. [Michael Tsimplis, China]	Perhaps mentioning the physical mechanisms involved and linking them with the anthropogenic forcing of the forcing factors would make more sense.
39984	36	1			strengthening the AR5 finding: so this is altered to very likely or have not yet overcome the uncertainty to go to the next level ? [Michael Tsimplis, China]	strengthening the AR5 finding: so this is altered to very likely or have not yet overcome the uncertainty to go to the next level ?
41442	36	3	36	3	Delete last "a". [Charalampos Charalampidis, Germany]	Delete last "a".
52410	36	4	36	4	Add, "and for longer periods of time, potentially July-October." [Pam Pearson, Sweden]	Add, "and for longer periods of time, potentially July-October."
39986	36	4			meaning of substantially increased? [Michael Tsimplis, China]	meaning of substantially increased?
48526	36	11	39	4	Consider adding a discussion of whether CMIP models are underestimating the observed rate of Arctic sea ice loss. An active area of research in recent years with some arguing that much of the difference could be natural variability, and others (Rosenblum and Eisenman) arguing that models that get it correct do so for the wrong reasons. [Kyle Armour, United States of America]	Consider adding a discussion of whether CMIP models are underestimating the observed rate of Arctic sea ice loss. An active area of research in recent years with some arguing that much of the difference could be natural variability, and others (Rosenblum and Eisenman) arguing that models that get it correct do so for the wrong reasons.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
25300	36	11			Section 9.3.1.1 - I didn't notice any comments regarding area of multi-year ice vs first year ice in this section - should there be more explicit discussion regarding change in ice type? [Sharon Smith, Canada]	Section 9.3.1.1 - I didn't notice any comments regarding area of multi-year ice vs first year ice in this section - should there be more explicit discussion regarding change in ice type?
48852	36	11			Sea ice area is used as the metric for sea ice cover. This is a departure from AR5 and SROCC which focus on the much more commonly used sea ice extent. Why the change to sea ice area? [Chris Derksen, Canada]	Sea ice area is used as the metric for sea ice cover. This is a departure from AR5 and SROCC which focus on the much more commonly used sea ice extent. Why the change to sea ice area?
31162	36	13	36	13	The wording "pan-Arctic sea-ice evolution" is misleading, since passive microwave satellite sensors only have provided data for specific geopysical parameters since 1979. Consider adding "areal properties" or something like that. [François Massonnet, Belgium]	The wording "pan-Arctic sea-ice evolution" is misleading, since passive microwave satellite sensors only have provided data for specific geopysical parameters since 1979. Consider adding "areal properties" or something like that.
48854	36	13	36	13	Strange word choice: 'evolution' [Chris Derksen, Canada]	Strange word choice: 'evolution'
8068	36	14	36	15	change "passive" to "thermal" because it better describes what it actually is. Also add "brightness" between "microwave" and "temperature". [Rasmus Tonboe, Denmark]	change "passive" to "thermal" because it better describes what it actually is. Also add "brightness" between "microwave" and "temperature".
19678	36	14	36	17	I guess the uncertainty by passive microwave satellites is very small compared to the actual change in Arctic sea ice cover. Is there any estimate on the uncertainty by the satellites? It could also be useful to mention that there are differences between different satellite products. [Gwenaelle GREMION, Canada]	I guess the uncertainty by passive microwave satellites is very small compared to the actual change in Arctic sea ice cover. Is there any estimate on the uncertainty by the satellites? It could also be useful to mention that there are differences between different satellite products.
48856	36	19	36	21	Why average these three months together? What's the meaning of an August through October average? Is there a citation for this? [Chris Derksen, Canada]	Why average these three months together? What's the meaning of an August through October average? Is there a citation for this?
44452	36	26	36	30	Why the choice of the 1979-2008 period as a reference rather than the full series (1979-2017)? [Anne Marie Treguier, France]	Why the choice of the 1979-2008 period as a reference rather than the full series (1979-2017)?
41444	36	35	36	35	"…season; it is most…" [Charalampos Charalampidis, Germany]	"…season; it is most…"
19680	36	35	36	42	The mention of an "expansion of the seasonal ice zone" is open to misinterpretation- I read it as the area of ice that melts seasonally is larger (but not the annual ice extent), whereas it could also be taken to mean that the ice remaining in the summer is growing. [Gwenaelle GREMION, Canada]	The mention of an "expansion of the seasonal ice zone" is open to misinterpretation- I read it as the area of ice that melts seasonally is larger (but not the annual ice extent), whereas it could also be taken to mean that the ice remaining in the summer is growing.
39988	36	35		42	The arctic is already a small region. Perhaps an explanation of why the report goes to such small scales here is required- or staying consistent by mentioning larger scale change. [Michael Tsimplis, China]	The arctic is already a small region. Perhaps an explanation of why the report goes to such small scales here is required- or staying consistent by mentioning larger scale change.
6667	36	42	36	43	The statement about positive trend in Bering Sea is correct. A sentence pointing at the recent “regime shift” (much lower regional extents than average) could be added, especially linking to WGII assessment (impact on local communities). [Thomas Lavergne, Norway]	The statement about positive trend in Bering Sea is correct. A sentence pointing at the recent “regime shift” (much lower regional extents than average) could be added, especially linking to WGII assessment (impact on local communities).

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
50768	36	47	36	54	Please, consider to reword in order to avoid repeating "over the three satellite products" several times. [Hernan Edgardo Sala, Argentina]	Please, consider to reword in order to avoid repeating "over the three satellite products" several times.
48858	37	3	37	10	High confidence is attached to sea ice changes over the past 150 years, but medium confidence for the past 1450 years. Note the submitted SROCC SPM contains this sentence: "September sea ice reductions in the Arctic during the satellite era (1979-2018; very likely 12.8 ± 2.3% per decade) have resulted in unprecedented low sea ice extent for at least 1000 years (high confidence)." [Chris Derksen, Canada]	High confidence is attached to sea ice changes over the past 150 years, but medium confidence for the past 1450 years. Note the submitted SROCC SPM contains this sentence: "September sea ice reductions in the Arctic during the satellite era (1979-2018; very likely 12.8 ± 2.3% per decade) have resulted in unprecedented low sea ice extent for at least 1000 years (high confidence)."
39990	37	3		10	Nothing new here then. Why should there be so much effort in rewriting the aspects of a report already valid is puzzling to me. [Michael Tsimplis, China]	Nothing new here then. Why should there be so much effort in rewriting the aspects of a report already valid is puzzling to me.
31164	37	4	37	4	Add "summer" before 2012 [François Massonnet, Belgium]	Add "summer" before 2012
37906	37	7			In comment 124, relating to Fig. 2.21, it is noted that the maximum Arctic sea-ce cover can occur in February, and that consideration could be given to changing Fig 2.21 so that it showed the lowest and highest monthly values for each year rather than necessarily the September and March values. This would fit in better with the way the figure is referred to in the text. [Adrian Simmons, United Kingdom (of Great Britain and Northern Ireland)]	In comment 124, relating to Fig. 2.21, it is noted that the maximum Arctic sea-ce cover can occur in February, and that consideration could be given to changing Fig 2.21 so that it showed the lowest and highest monthly values for each year rather than necessarily the September and March values. This would fit in better with the way the figure is referred to in the text.
39992	37	17			"subtantially" means what? that the observed change is within the range of natural variability? In any case I do not see the reason why such a pargraph is needed. [Michael Tsimplis, China]	"subtantially" means what? that the observed change is within the range of natural variability? In any case I do not see the reason why such a pargraph is needed.
39198	37	19	27	33	compaison of polar amplification for analyses of surface sensitivity and role of ice is also an ongoing focus from PMIP and CMIP simulations. See for example or example Yoshimori et al CPD, 2019 [Pascale Braconnot, France]	compaison of polar amplification for analyses of surface sensitivity and role of ice is also an ongoing focus from PMIP and CMIP simulations. See for example or example Yoshimori et al CPD, 2019
39196	37	19	37	33	Normally there should be updates from analyses of the PMIP4 simulations for the different ime intervalls [Pascale Braconnot, France]	Normally there should be updates from analyses of the PMIP4 simulations for the different ime intervalls
39994	37	19			Delete the word "usually", raises the question on what is usual. [Michael Tsimplis, China]	Delete the word "usually", raises the question on what is usual.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
14958	37	23	37	25	Please consider adding the Arctic Ocean north of Greenland to this list with reference to Funder et al (2011, Science 333, p747-750) who found that: "Multiyear sea ice reached a minimum between ~8500 and 6000 years ago, when the limit of year-round sea ice at the coast of Greenland was located ~1000 kilometers to the north of its present position." Also, in relation to discussing the early Holocene it would be good to note that the Holocene thermal maximum and retreated summer sea ice in the Arctic occured when the summer insolation in the Northern Hemisphere were higher than today [Jo Brendryen, Norway]	Please consider adding the Arctic Ocean north of Greenland to this list with reference to Funder et al (2011, Science 333, p747-750) who found that: "Multiyear sea ice reached a minimum between ~8500 and 6000 years ago, when the limit of year-round sea ice at the coast of Greenland was located ~1000 kilometers to the north of its present position." Also, in relation to discussing the early Holocene it would be good to note that the Holocene thermal maximum and retreated summer sea ice in the Arctic occured when the summer insolation in the Northern Hemisphere were higher than today
39996	37	33			Not sure this paragraph says anything relevant. In any case if this is already discussed in chapters 2 and 4 delete it and take the conclusion of whatever level of confidence here (i.e. the last sentence) and link it to whatever you are trying to say in this section. I would have thought it should be linking oceanic change with arctic ice reduction but have to wait to see. [Michael Tsimplis, China]	Not sure this paragraph says anything relevant. In any case if this is already discussed in chapters 2 and 4 delete it and take the conclusion of whatever level of confidence here (i.e. the last sentence) and link it to whatever you are trying to say in this section. I would have thought it should be linking oceanic change with arctic ice reduction but have to wait to see.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
12882	37	35	37	46	Emphasize that reduced Arctic sea ice allows not only greater radiation in the region, but also greater swell of waves in the Arctic Ocean, which can further disrupt sea ice and accelerate breaking up of ice; all of which can be positive feedback loops. Thomson J. & Rogers W. E. (2014) Swell and sea in the emerging Arctic Ocean, GEOPHYSICAL RESEARCH LETTERS 41:3136–3140, 3136 ("Ocean surface waves (sea and swell) are generated by winds blowing over a distance (fetch) for a duration of time. In the Arctic Ocean, fetch varies seasonally from essentially zero in winter to hundreds of kilometers in recent summers. Using in situ observations of waves in the central Beaufort Sea, combined with a numerical wave model and satellite sea ice observations, we show that wave energy scales with fetch throughout the seasonal ice cycle. Furthermore, we show that the increased open water of 2012 allowed waves to develop beyond pure wind seas and evolve into swells. The swells remain tied to the available fetch, however, because fetch is a proxy for the basin size in which the wave evolution occurs. Thus, both sea and swell depend on the open water fetch in the Arctic, because the swell is regionally driven. This suggests that further reductions in seasonal ice cover in the future will result in larger waves, which in turn provide a mechanism to break up sea ice and accelerate ice retreat."). At the same time, reduced sea ice provides favorable conditions for cyclone development and increased intensity of cyclones, which can also facilitate break-up of sea ice; see Day J. J. & Hodges K. I. (2018) Growing Land-Sea Temperature Contrast and the Intensification of Arctic Cyclones, GEOPHYSICAL RESEARCH LETTERS 45:3673–3681, 3680 ("Further, because climate change is increasing land-sea contrasts in the Arctic, it seems highly likely that the circulation patterns typical of years with strong AFZ will become more common as the climate warms. Indeed, strengthening of the mean temperature gradients in the AFZ is a robust feature of future climate projections as is an increase in the strength of the Arctic Front Jet (Mann et al., 2017; Nishii et al., 2014). This study shows that this linkage between surface temperature gradients and atmospheric circulation is important for Arctic cyclones, adding weight to previous studies."). Loss of Arctic sea ice	Emphasize that reduced Arctic sea ice allows not only greater radiation in the region, but also greater swell of waves in the Arctic Ocean, which can further disrupt sea ice and accelerate breaking up of ice; all of which can be positive feedback loops. Thomson J. & Rogers W. E. (2014) Swell and sea in the emerging Arctic Ocean, GEOPHYSICAL RESEARCH LETTERS 41:3136–3140, 3136 ("Ocean surface waves (sea and swell) are generated by winds blowing over a distance (fetch) for a duration of time. In the Arctic Ocean, fetch varies seasonally from essentially zero in winter to hundreds?of kilometers in recent summers. Using in situ observations of waves in the central Beaufort Sea, combined with a numerical wave model and satellite sea ice observations, we show that wave energy scales with fetch throughout the seasonal ice cycle. Furthermore, we show that the increased open water of 2012 allowed waves to develop beyond pure wind seas and evolve into swells. The swells remain tied to the available fetch, however, because fetch is a proxy for the basin size in which the wave evolution occurs. Thus, both sea and swell depend on the open water fetch in the Arctic, because the swell is regionally driven. This suggests that further reductions in seasonal ice cover in the future will result in larger waves, which in turn provide a mechanism to break up sea ice and accelerate ice retreat."). At the same time, reduced
48528	37	35	37	46	Worth noting that this high correlation is in fact a nearly linear relationship in model simulations (Winton et al. 2011, Armour et al. 2011, Ridley et al. 2011, etc). [Kyle Armour, United States of America]	Worth noting that this high correlation is in fact a nearly linear relationship in model simulations (Winton et al. 2011, Armour et al. 2011, Ridley et al. 2011, etc).

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
32402	37	35	37	46	It's not clear to me what (on L46) "substantial part of the observed Arctic sea-ice loss is anthropogenic" means because "substantial" is not very specific. Does it mean "at least half"? There are some very specific numbers in the studies cited (and some not) as follows: - Ding et al. (2017): decline is approx.. 30-50% internal variability. - Song et al., (2016): natural variability explains no more than 42.3% decline in satellite obs (1979–2013). - Stroeve et al, (2012): approx.. 60% of observed decline from 1979–2011 is externally forced. - Kay et al., (2011): 56% of the observed September trend is externally forced and approximately half results from internal variability. - Stroeve et al, (2007): forced contribution in 47–57% range for 1979–2006 September trends The SROCC 1st draft (not sure about final draft) concluded with “high confidence” that approximately 50 to 60% of the observed sea ice loss is driven by external forcing. Is there something a bit more concrete that could be said here? [Ed Blockley, United Kingdom (of Great Britain and Northern Ireland)]	It's not clear to me what (on L46) "substantial part of the observed Arctic sea-ice loss is anthropogenic" means because "substantial" is not very specific. Does it mean "at least half"? There are some very specific numbers in the studies cited (and some not) as follows: - Ding et al. (2017): decline is approx.. 30-50% internal variability. - Song et al., (2016): natural variability explains no more than 42.3% decline in satellite obs (1979–2013). - Stroeve et al, (2012): approx.. 60% of observed decline from 1979–2011 is externally forced. - Kay et al., (2011): 56% of the observed September trend is externally forced and approximately half results from internal variability. - Stroeve et al, (2007): forced contribution in 47–57% range for 1979–2006 September trends The SROCC 1st draft (not sure about final draft) concluded with “high confidence” that approximately 50 to 60% of the observed sea ice loss is driven by external forcing. Is there something a bit more concrete that could be said here?

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
12712	37	35	37	46	Emphasize that reduced Arctic sea ice allows greater radiation in the region and also greater swell of waves in the Arctic Ocean, which can further disrupt sea ice and accelerate breaking up of ice; all of which can be positive feedback loops. Thomson J. & Rogers W. E. (2014) Swell and sea in the emerging Arctic Ocean, GEOPHYSICAL RESEARCH LETTERS 41:3136–3140, 3136 (“Ocean surface waves (sea and swell) are generated by winds blowing over a distance (fetch) for a duration of time. In the Arctic Ocean, fetch varies seasonally from essentially zero in winter to hundreds of kilometers in recent summers. Using in situ observations of waves in the central Beaufort Sea, combined with a numerical wave model and satellite sea ice observations, we show that wave energy scales with fetch throughout the seasonal ice cycle. Furthermore, we show that the increased open water of 2012 allowed waves to develop beyond pure wind seas and evolve into swells. The swells remain tied to the available fetch, however, because fetch is a proxy for the basin size in which the wave evolution occurs. Thus, both sea and swell depend on the open water fetch in the Arctic, because the swell is regionally driven. This suggests that further reductions in seasonal ice cover in the future will result in larger waves, which in turn provide a mechanism to break up sea ice and accelerate ice retreat.”). At the same time, reduced sea ice provides favorable conditions for cyclone development and increased intensity of cyclones, which can also facilitate break-up of sea ice; see Day J. J. & Hodges K. I. (2018) Growing Land-Sea Temperature Contrast and the Intensification of Arctic Cyclones, GEOPHYSICAL RESEARCH LETTERS 45:3673–3681, 3680 (“Further, because climate change is increasing land-sea contrasts in the Arctic, it seems highly likely that the circulation patterns typical of years with strong AFZ will become more common as the climate warms. Indeed, strengthening of the mean temperature gradients in the AFZ is a robust feature of future climate projections as is an increase in the strength of the Arctic Front Jet (Mann et al., 2017; Nishii et al., 2014). This study shows that this linkage between surface temperature gradients and atmospheric circulation is important for Arctic cyclones, adding weight to previous studies.”). Loss of Arctic sea ice	Emphasize that reduced Arctic sea ice allows greater radiation in the region and also greater swell of waves in the Arctic Ocean, which can further disrupt sea ice and accelerate breaking up of ice; all of which can be positive feedback loops. Thomson J. & Rogers W. E. (2014) Swell and sea in the emerging Arctic Ocean, GEOPHYSICAL RESEARCH LETTERS 41:3136–3140, 3136 (“Ocean surface waves (sea and swell) are generated by winds blowing over a distance (fetch) for a duration of time. In the Arctic Ocean, fetch varies seasonally from essentially zero in winter to hundreds?of kilometers in recent summers. Using in situ observations of waves in the central Beaufort Sea, combined with a numerical wave model and satellite sea ice observations, we show that wave energy scales with fetch throughout the seasonal ice cycle. Furthermore, we show that the increased open water of 2012 allowed waves to develop beyond pure wind seas and evolve into swells. The swells remain tied to the available fetch, however, because fetch is a proxy for the basin size in which the wave evolution occurs. Thus, both sea and swell depend on the open water fetch in the Arctic, because the swell is regionally driven. This suggests that further reductions in seasonal ice cover in the future will result in larger waves, which in turn provide a mechanism to break up sea ice and accelerate ice retreat.”). At the same time, reduced
39998	37	35		36	hemispheric or regional T not correlated? [Michael Tsimplis, China]	hemispheric or regional T not correlated?
41446	37	39	37	39	I suggest instead of period the use of semicolon, i.e. "…insolation (reference); modern Northern Hemisphere sea-ice...". In this way, the reader knows that the comparative at line 40 (i.e. "more strongly") is in reference to the previous statement. [Charalampos Charalampidis, Germany]	I suggest instead of period the use of semicolon, i.e. "…insolation (reference); modern Northern Hemisphere sea-ice...". In this way, the reader knows that the comparative at line 40 (i.e. "more strongly") is in reference to the previous statement.
40000	37	39			Which period corresponds to "modern"? [Michael Tsimplis, China]	Which period corresponds to "modern"?
40002	37	46			What is "substantial"? [Michael Tsimplis, China]	What is "substantial"?
31166	37	51	37	51	sea-ice not "sea ice" [François Massonnet, Belgium]	sea-ice not "sea ice"
13226	38	4	38	5	What is meant by "internal variability"? Does this refer to changes in sea-ice driven by the NAO or AMO or something else? [Nora Richter, United States of America]	What is meant by "internal variability"? Does this refer to changes in sea-ice driven by the NAO or AMO or something else?

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
48860	38	4	38	14	I realize this (and following paragraph) is essentially placeholder text in advance of CMIP6 literature, but in SROCC, the contribution of internal variabily is quantified (with high confidence), based on CMIP5 simulations and recent literature focused on the large initial condition ensembles. Low confidence is used here for estimates of internal variability. [Chris Derksen, Canada]	I realize this (and following paragraph) is essentially placeholder text in advance of CMIP6 literature, but in SROCC, the contribution of internal variabily is quantified (with high confidence), based on CMIP5 simulations and recent literature focused on the large initial condition ensembles. Low confidence is used here for estimates of internal variability.
31168	38	9	38	10	The sentence leaves the impression that there is no good understanding on the drivers (forced ones vs internal climate variability) on sea ice retreat. But Chapter 03, page 30, line 44 onwards, suggests that the split is well quantified. It would be useful to harmonize the assessments. [François Massonnet, Belgium]	The sentence leaves the impression that there is no good understanding on the drivers (forced ones vs internal climate variability) on sea ice retreat. But Chapter 03, page 30, line 44 onwards, suggests that the split is well quantified. It would be useful to harmonize the assessments.
28204	38	16	38	26	This is a good place to make reference to radiative feedbacks tied to ice loss (e.g., Section 7.4.2.3: Surface albedo feedback). [Chad Thackeray, United States of America]	This is a good place to make reference to radiative feedbacks tied to ice loss (e.g., Section 7.4.2.3: Surface albedo feedback).
48216	38	16	38	26	A new publication deals with the role of storms for Arctic sea ice in the Atlantic sector (Graham et al. in press). I suggest to consider this work in connection with the discussion of drivers in this paragraph. Reference: Graham et al. (in press): Winter storms accelerate the demise of sea ice in the Atlantic Sector of the Arctic Ocean. Nature Scientific Reports. [Sebastian Gerland, Norway]	A new publication deals with the role of storms for Arctic sea ice in the Atlantic sector (Graham et al. in press). I suggest to consider this work in connection with the discussion of drivers in this paragraph. Reference: Graham et al. (in press): Winter storms accelerate the demise of sea ice in the Atlantic Sector of the Arctic Ocean. Nature Scientific Reports.
40004	38	16		26	How all these factors boil down to strong correlation with global T? Do they all co-vary? If they do does the last sentence make physically any sense? [Michael Tsimplis, China]	How all these factors boil down to strong correlation with global T? Do they all co-vary? If they do does the last sentence make physically any sense?
19682	38	18			Kwon is not the first author of this paper, the first author is H.J. Lee [Gwenaelle GREMION, Canada]	Kwon is not the first author of this paper, the first author is H.J. Lee
19684	38	20			The first author of this paper is J. Mortin [Gwenaelle GREMION, Canada]	The first author of this paper is J. Mortin
48902	38	21	38	21	The major role of downwelling longwave radiation was detected already by Maksimovich and Vihma (2012). Reference: Maksimovich, E., and T. Vihma (2012), The effect of surface heat fluxes on interannual variability in the spring onset of snow melt in the central Arctic Ocean, J. Geophys. Res., 117, C07012, doi:10.1029/2011JC007220. [Timo Vihma, Finland]	The major role of downwelling longwave radiation was detected already by Maksimovich and Vihma (2012). Reference: Maksimovich, E., and T. Vihma (2012), The effect of surface heat fluxes on interannual variability in the spring onset of snow melt in the central Arctic Ocean, J. Geophys. Res., 117, C07012, doi:10.1029/2011JC007220.
26168	38	22			The role of "oceanic heat flux" has been described in Nakanowatari et al. (2014). This paper is relevant to cite here. Nakanowatari, T., K. Sato, and J. Inoue (2014), Predictability of the Barents sea ice in early winter: Remote effects of oceanic and atmospheric thermal conditions from the North Atlantic. Journal of Climate, 27, 8884-8901. [Jun Inoue, Japan]	The role of "oceanic heat flux" has been described in Nakanowatari et al. (2014). This paper is relevant to cite here. Nakanowatari, T., K. Sato, and J. Inoue (2014), Predictability of the Barents sea ice in early winter: Remote effects of oceanic and atmospheric thermal conditions from the North Atlantic. Journal of Climate, 27, 8884-8901.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
31170	38	28	38	28	Add reference Docquier et al, 2019 (https://doi.org/10.1007/s00382-019-04840-y) [François Massonnet, Belgium]	Add reference Docquier et al, 2019 (https://doi.org/10.1007/s00382-019-04840-y)
37908	38	28	38	29	This could be taken as a statement of high confidence that there will be Arctic summer sea ice in the future. Otherwise, the statement should be qualified as holding only as long as there is Arctic summer sea ice. [Adrian Simmons, United Kingdom (of Great Britain and Northern Ireland)]	This could be taken as a statement of high confidence that there will be Arctic summer sea ice in the future. Otherwise, the statement should be qualified as holding only as long as there is Arctic summer sea ice.
40006	38	28		42	This paragraph needs simplification and clarification. Last two sentences are confusing. [Michael Tsimplis, China]	This paragraph needs simplification and clarification. Last two sentences are confusing.
28206	38	30	38	42	Given the large intermodel uncertainty in projections of Arctic sea ice area some brief discussion of this seems warranted. Perhaps tie in the use of observational constraints to give "best estimates" as for AR5 (Figure 12.31). [Chad Thackeray, United States of America]	Given the large intermodel uncertainty in projections of Arctic sea ice area some brief discussion of this seems warranted. Perhaps tie in the use of observational constraints to give "best estimates" as for AR5 (Figure 12.31).
32392	38	32	38	33	Regarding the impact of 2C warming vs 1.5C warming for a nearly-ice-free Arctic: As well as the 2 cited modelling studies here (CESM=Jahn et al.; CanESM=Sigmond et al.) there was a 3rd modelling study performed at the same time using HadGEM2-ES: Ridley & Blockley (2018). The top-level conclusion is in agreement with the other stuides - that there is a very low (<1%) chance of a nearly-ice-free-Arctic with 1.5C warming and a much higher likelihood (~40%) at 2.0 C warming. Including this citation would strengthen this statement further. [Ed Blockley, United Kingdom (of Great Britain and Northern Ireland)]	Regarding the impact of 2C warming vs 1.5C warming for a nearly-ice-free Arctic: As well as the 2 cited modelling studies here (CESM=Jahn et al.; CanESM=Sigmond et al.) there was a 3rd modelling study performed at the same time using HadGEM2-ES: Ridley & Blockley (2018). The top-level conclusion is in agreement with the other stuides - that there is a very low (<1%) chance of a nearly-ice-free-Arctic with 1.5C warming and a much higher likelihood (~40%) at 2.0 C warming. Including this citation would strengthen this statement further.
19686	38	37	38	38	"...which will occur some time after the first near ice-free day." Rather vague, better Indicate at least an approximate time for the phenomenon to occur. [Gwenaelle GREMION, Canada]	"...which will occur some time after the first near ice-free day." Rather vague, better Indicate at least an approximate time for the phenomenon to occur.
19690	38	37	38	38	The difference between 'near ice-free conditions' and and 'near ice-free day' should be clarified. How many ice-free days are needed for ice-free conditions? [Gwenaelle GREMION, Canada]	The difference between 'near ice-free conditions' and and 'near ice-free day' should be clarified. How many ice-free days are needed for ice-free conditions?
52172	38	40	38	42	Are there a sufficient number of independent lines of evidence here to justify use of likelihood and medium confidence? [Peter Thorne, Ireland]	Are there a sufficient number of independent lines of evidence here to justify use of likelihood and medium confidence?
31172	38	44	38	45	The Chevallier et al. 2017 is suited for the "reanalysis" part of the sentence, but a reference is missing for the "CMIP5" part for sea ice concentrations. [François Massonnet, Belgium]	The Chevallier et al. 2017 is suited for the "reanalysis" part of the sentence, but a reference is missing for the "CMIP5" part for sea ice concentrations.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
32394	38	44	38	50	Re. concerns about modelled processes making Arctic shipping route projections low confidence being updated with CMIP6 models: It's worth noting that even if CMIP6 models do a much better job than CMIP5 models with respect to the modelled processes in this paragraph, it should not be forgotten that the low model resolution would still mean that Northwest passage projections should be taken with a pinch of salt. Even at CMIP6, many ocean models are using 1 degree resolution for which topography of the Canadian Arctic Archipelago is very poorly resolved. [Ed Blockley, United Kingdom (of Great Britain and Northern Ireland)]	Re. concerns about modelled processes making Arctic shipping route projections low confidence being updated with CMIP6 models: It's worth noting that even if CMIP6 models do a much better job than CMIP5 models with respect to the modelled processes in this paragraph, it should not be forgotten that the low model resolution would still mean that Northwest passage projections should be taken with a pinch of salt. Even at CMIP6, many ocean models are using 1 degree resolution for which topography of the Canadian Arctic Archipelago is very poorly resolved.
31176	38	44	38	50	It is strange to find a discussion on sea ice volume in this sections called "Arctic sea-ice coverage" (the next section is on volume). Consider moving the paragraph around. [François Massonnet, Belgium]	It is strange to find a discussion on sea ice volume in this sections called "Arctic sea-ice coverage" (the next section is on volume). Consider moving the paragraph around.
40008	38	44		50	Is this consistent with the previous paragraph? Why shipping routes need to be mentioned here? [Michael Tsimplis, China]	Is this consistent with the previous paragraph? Why shipping routes need to be mentioned here?
25302	38	48	38	50	The last part of the sentence deals with impact - perhaps phrase more in terms of regional change rather than the use of the region. [Sharon Smith, Canada]	The last part of the sentence deals with impact - perhaps phrase more in terms of regional change rather than the use of the region.
19688	38	52	39	1	critical threshold? Indicate what critical threshold for clarity. [Gwenaelle GREMION, Canada]	critical threshold? Indicate what critical threshold for clarity.
40010	38	52			paragraph starting - Unclear to what this paragraph is trying to say. Rephrase or simplify? [Michael Tsimplis, China]	paragraph starting - Unclear to what this paragraph is trying to say. Rephrase or simplify?
48530	38	54	38	55	Perhaps also cite Eisenman 2012 doi:10.1029/2011JD016164 [Kyle Armour, United States of America]	Perhaps also cite Eisenman 2012 doi:10.1029/2011JD016164
48532	39	1	39	4	Perhaps note that some but not all models show this wintertime behaviro (CCSM3 does not -- Armour et al. 2011). [Kyle Armour, United States of America]	Perhaps note that some but not all models show this wintertime behaviro (CCSM3 does not -- Armour et al. 2011).
26170	39	7	39	30	The role of snow depthe on sea ice and its uncertainty in reanalses and numerical models should be included in this secion because sea-ice grow rate, in particular, thin ice heavily depends on the snow depth. Although methods to measure snow and sea ice thickness are very limited, significant effort to deplying the Ice Mass Balance buoys should be mentioned. Sato et al. (2018) ivalidated the uncertainty of snow depth in a reanaysis using IMB buoys, which is relevant to consider generating an additinal paragraoh in this topic. Sato, K. and J. Inoue (2018), Comparison of Arctic sea ice thickness and snow depth estimates from CFSR with in situ observations. Climate Dynamics, 50, 289-301. [Jun Inoue, Japan]	The role of snow depthe on sea ice and its uncertainty in reanalses and numerical models should be included in this secion because sea-ice grow rate, in particular, thin ice heavily depends on the snow depth. Although methods to measure snow and sea ice thickness are very limited, significant effort to deplying the Ice Mass Balance buoys should be mentioned. Sato et al. (2018) ivalidated the uncertainty of snow depth in a reanaysis using IMB buoys, which is relevant to consider generating an additinal paragraoh in this topic. Sato, K. and J. Inoue (2018), Comparison of Arctic sea ice thickness and snow depth estimates from CFSR with in situ observations. Climate Dynamics, 50, 289-301.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
48202	39	7	39	30	I suggest to include in this subsection information about observations of changes of (regional) Arctic fast ice thickness. Thickness of landfast sea ice is indirectly mentioned in 9.3.1.1, page 38, lines 45-46, but I could not see this dealt with somewhere explicitely. In this context, results from different regions were published recently: Howell et al. (2016) describe landfast ice thickness in the Canadian Archipelago: Howell et al. (2016): Landfast ice thickness in the Canadian Arctic Archipelago from observations and models. The Cryosphere, 10, 1463–1475, www.the-cryosphere.net/10/1463/2016/, doi:10.5194/tc-10-1463-2016. Haas and Howell (2015) describe ice thickness in the Northwest Passage: Haas and Howell (2015): Ice thickness in the Northwest Passage, Geophys. Res. Lett., 42, 7673–7680, doi:10.1002/2015GL065704. Pavlova et al. (2019) describe the development of landfast sea ice in Kongsfjorden, Svalbard: Pavlova et al. (2019): Changes in sea-ice extent and thickness in Kongsfjorden, Svalbard, and related ecological implications. Advances in Polar Ecology. In: Hop H., Wiencke C. (eds.) The Ecosystem of Kongsfjorden, Svalbard. Advances in Polar Ecology 2, 105-136. Springer, Cham. https://doi.org/10.1007/978-3-319-46425-1_4. [Sebastian Gerland, Norway]	I suggest to include in this subsection information about observations of changes of (regional) Arctic fast ice thickness. Thickness of landfast sea ice is indirectly mentioned in 9.3.1.1, page 38, lines 45-46, but I could not see this dealt with somewhere explicitely. In this context, results from different regions were published recently: Howell et al. (2016) describe landfast ice thickness in the Canadian Archipelago: Howell et al. (2016): Landfast ice thickness in the Canadian Arctic Archipelago from observations and models. The Cryosphere, 10, 1463–1475, www.the-cryosphere.net/10/1463/2016/, doi:10.5194/tc-10-1463-2016. Haas and Howell (2015) describe ice thickness in the Northwest Passage: Haas and Howell (2015): Ice thickness in the Northwest Passage, Geophys. Res. Lett., 42, 7673–7680, doi:10.1002/2015GL065704. Pavlova et al. (2019) describe the development of landfast sea ice in Kongsfjorden, Svalbard: Pavlova et al. (2019): Changes in sea-ice extent and thickness in Kongsfjorden, Svalbard, and related ecological implications. Advances in Polar Ecology. In: Hop H., Wiencke C. (eds.) The Ecosystem of Kongsfjorden, Svalbard. Advances in Polar Ecology 2, 105-136. Springer, Cham. https://doi.org/10.1007/978-3-319-46425-1_4.
48862	39	7	39	30	What about reporting on the changes in sea ice age distribution across the Arctic? Observed thinning is intrinsically related to the replacement of perennial ice with seasonal ice. [Chris Derksen, Canada]	What about reporting on the changes in sea ice age distribution across the Arctic? Observed thinning is intrinsically related to the replacement of perennial ice with seasonal ice.
8070	39	9	39	9	change "measurements" to "estimates" because ice thickness is not actually measured. The radar or laser freeboard is measured and the ice thickness is derived from this. [Rasmus Tonboe, Denmark]	change "measurements" to "estimates" because ice thickness is not actually measured. The radar or laser freeboard is measured and the ice thickness is derived from this.
19698	39	9	39	20	The mention of "neglecting changes" (line 14) isn't 100% true, e.g. CPOM do make adjustments in their algorithm to try and bring the Warren climatology up to date by halving snow over first year ice. However, it's just as important to state that we don't know the initial snow thickness, let alone the changes- Warren is based on extrapolation of sparse meaurements so even if we knew the exact change in snow thickness we may still have the actual snow thickness (and therefore ice thickness) incorrect. [Gwenaelle GREMION, Canada]	The mention of "neglecting changes" (line 14) isn't 100% true, e.g. CPOM do make adjustments in their algorithm to try and bring the Warren climatology up to date by halving snow over first year ice. However, it's just as important to state that we don't know the initial snow thickness, let alone the changes- Warren is based on extrapolation of sparse meaurements so even if we knew the exact change in snow thickness we may still have the actual snow thickness (and therefore ice thickness) incorrect.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
19696	39	9	39	30	It would be nice to give information on the consequences of shrinking sea ice and thinning sea ice, to show why it is also important to not only look at satellites but also to get knowledge on the sea ice thickness. [Gwenaelle GREMION, Canada]	It would be nice to give information on the consequences of shrinking sea ice and thinning sea ice, to show why it is also important to not only look at satellites but also to get knowledge on the sea ice thickness.
19692	39	10	39	13	It would be appropriate to indicate the rate of the reduction of Arctic sea-ice volume from 1979 to 2018 [Gwenaelle GREMION, Canada]	It would be appropriate to indicate the rate of the reduction of Arctic sea-ice volume from 1979 to 2018
40012	39	10			how confident are we in respect of these products? [Michael Tsimplis, China]	how confident are we in respect of these products?
40016	39	13		17	What do we mean by precise quantitative change? Give some numbers please [Michael Tsimplis, China]	What do we mean by precise quantitative change? Give some numbers please
40014	39	13			an explanation linking the two periods would be useful. Is this simply a matter of reduced confidence due to a shorter period? [Michael Tsimplis, China]	an explanation linking the two periods would be useful. Is this simply a matter of reduced confidence due to a shorter period?
8072	39	14	39	14	after "on" add "ice thickness" [Rasmus Tonboe, Denmark]	after "on" add "ice thickness"
31174	39	17	39	20	Sentence is unclear grammatically speaking, please rephrase. [François Massonnet, Belgium]	Sentence is unclear grammatically speaking, please rephrase.
25304	39	19	39	19	You should probably be clear on the time period with respect to CryoSat2 (period) [Sharon Smith, Canada]	You should probably be clear on the time period with respect to CryoSat2 (period)
40018	39	20			If the inferred observational estimates are considered unreliable this should be stated. However it is problematic to rely on reanalyses without validation. [Michael Tsimplis, China]	If the inferred observational estimates are considered unreliable this should be stated. However it is problematic to rely on reanalyses without validation.
25306	39	22	39	24	Revision suggested: " Analysis of submarine data indicates that sea ice has become thinner n the central Arctic Ocean over the past 60 years (high confidence)." [Sharon Smith, Canada]	Revision suggested: " Analysis of submarine data indicates that sea ice has become thinner n the central Arctic Ocean over the past 60 years (high confidence)."
48204	39	22	39	30	Relevant references about (regional) Arctic sea ice thickness changes over recent decades that are not yet included in this discussion, but could be considered, are: Changes derived from upward looking sonars in Fram Strait, see Hansen et al. (2013): Thinning of Arctic sea ice observed in Fram Strait: 1990-2011. Journal of Geophysical Research - Oceans. Vol. 118, doi:10.1002/jgrc.20393; changes derived from in situ and airborne observations in Fram Strait, see Renner et al. (2014): Evidence of Arctic sea ice thinning from direct observations. Geophysical Research Letters 41, 5029–5036, doi:10.1002/2014GL060369, and sea ice thickness north of the Canadian Archipelago, see Haas et al. (2017): Ice and snow thickness variability and change in the high Arctic Ocean observed by in situ measurements. Geophysical Research Letters, 44, 10,462–10,469. https://doi.org/10.1002/2017GL075434. [Sebastian Gerland, Norway]	Relevant references about (regional) Arctic sea ice thickness changes over recent decades that are not yet included in this discussion, but could be considered, are: Changes derived from upward looking sonars in Fram Strait, see Hansen et al. (2013): Thinning of Arctic sea ice observed in Fram Strait: 1990-2011. Journal of Geophysical Research - Oceans. Vol. 118, doi:10.1002/jgrc.20393; changes derived from in situ and airborne observations in Fram Strait, see Renner et al. (2014): Evidence of Arctic sea ice thinning from direct observations. Geophysical Research Letters 41, 5029–5036, doi:10.1002/2014GL060369, and sea ice thickness north of the Canadian Archipelago, see Haas et al. (2017): Ice and snow thickness variability and change in the high Arctic Ocean observed by in situ measurements. Geophysical Research Letters, 44, 10,462–10,469. https://doi.org/10.1002/2017GL075434.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
31178	39	22	39	30	Nothing is said on projections of volume in this section. In addition, there has been literature showing that changes in volume are correlated to the baseline mean state: van der Linden and Bintanja, 2014 (https://journals.ametsoc.org/doi/full/10.1175/JCLI-D-12-00617.1), Massonnet et al. 2018 (https://www.nature.com/articles/s41558-018-0204-z) [François Massonnet, Belgium]	Nothing is said on projections of volume in this section. In addition, there has been literature showing that changes in volume are correlated to the baseline mean state: van der Linden and Bintanja, 2014 (https://journals.ametsoc.org/doi/full/10.1175/JCLI-D-12-00617.1), Massonnet et al. 2018 (https://www.nature.com/articles/s41558-018-0204-z)
19694	39	24	39	26	It would be appropriate to indicate the impact of the reduction of Arctic sea-ice volume and thining in terms of the magnitude of change in sea-level. [Gwenaelle GREMION, Canada]	It would be appropriate to indicate the impact of the reduction of Arctic sea-ice volume and thining in terms of the magnitude of change in sea-level.
25308	39	25	39	26	What is meant by "initial ice thickness" - the thickness 60 years ago? [Sharon Smith, Canada]	What is meant by "initial ice thickness" - the thickness 60 years ago?
40020	39	27			what period is this referred to? [Michael Tsimplis, China]	what period is this referred to?
26172	39	28			The avility of sea-ice thickness representativeness depends on the location and season. Nakanowatari et al. (2018) did a complehensive validation for sea ice thickness by using Ice Mass Balance buoys, satellite based ice thickenss prodeucs, and reanalsysis. This paper should beincluded in here. Nakanowatari, T., J. Inoue, K. Sato, L Bertino, J. Xie, M. Matsueda, A. Yamagami, T. Sugimura, H. Yabuki, and N. Otsuka (2018), Medium-range predictability of early summer sea ice thickness distribution in the East Siberian Sea based on the TOPAZ4 ice-ocean data assimilation system. The Cryosphere, 12, 2005-2020. [Jun Inoue, Japan]	The avility of sea-ice thickness representativeness depends on the location and season. Nakanowatari et al. (2018) did a complehensive validation for sea ice thickness by using Ice Mass Balance buoys, satellite based ice thickenss prodeucs, and reanalsysis. This paper should beincluded in here. Nakanowatari, T., J. Inoue, K. Sato, L Bertino, J. Xie, M. Matsueda, A. Yamagami, T. Sugimura, H. Yabuki, and N. Otsuka (2018), Medium-range predictability of early summer sea ice thickness distribution in the East Siberian Sea based on the TOPAZ4 ice-ocean data assimilation system. The Cryosphere, 12, 2005-2020.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
48206	39	31	39	32	I suggest considering adding information on (regional) changes of snow covering sea ice in the Arctic. The role of snow for sea ice is mentioned in a more technical context (page 39, line 14), but including information about observed changes and uncertainties of the snow cover as an important factor for seasonal sea ice processes would enrich the discussion of Arctic sea ice volume and thickness (see for example Webster et al. (2018): Snow in the Changing Sea-ice Systems. Nature Climate Change 8, 946-953. DOI: 10.1038/s41558-018-0286-7; Kwok and Markus (2018): Potential basin-scale estimates of Arctic snow depth with sea ice freeboards from CryoSat-2 and ICESat-2: An exploratory analysis. Advances in Space Research 62 (2018) 1243–1250); and Haas et al. (2017): Ice and snow thickness variability and change in the high Arctic Ocean observed by in situ measurements. Geophysical Research Letters, 44, 10,462–10,469. https://doi.org/10.1002/2017GL075434. Further, ICESat-2 results might add more information to this in the near future. [Sebastian Gerland, Norway]	I suggest considering adding information on (regional) changes of snow covering sea ice in the Arctic. The role of snow for sea ice is mentioned in a more technical context (page 39, line 14), but including information about observed changes and uncertainties of the snow cover as an important factor for seasonal sea ice processes would enrich the discussion of Arctic sea ice volume and thickness (see for example Webster et al. (2018): Snow in the Changing Sea-ice Systems. Nature Climate Change 8, 946-953. DOI: 10.1038/s41558-018-0286-7; Kwok and Markus (2018): Potential basin-scale estimates of Arctic snow depth with sea ice freeboards from CryoSat-2 and ICESat-2: An exploratory analysis. Advances in Space Research 62 (2018) 1243–1250); and Haas et al. (2017): Ice and snow thickness variability and change in the high Arctic Ocean observed by in situ measurements. Geophysical Research Letters, 44, 10,462–10,469. https://doi.org/10.1002/2017GL075434. Further, ICESat-2 results might add more information to this in the near future.
6669	39	35	39	38	A citation to Kwok et al. 2013 (doi:10.1002/jgrc.20191) could be added for a contribution from the satellite record. [Thomas Lavergne, Norway]	A citation to Kwok et al. 2013 (doi:10.1002/jgrc.20191) could be added for a contribution from the satellite record.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
48904	39	35	39	44	The increased ice drift speeds were already observed by Hakkinen et al. (2008), Spreen et al. (2011) and Vihma et al. (2012). Further, it depends on the time scale whether wind is of lesser or larger importance than ice thickness. Considering changes from 1950s to about 2005, Hakkinen et al. (2008) attributed the faster drift to increased winds, whereas Vihma et al. (2012) found that winds did not explain the increasing trend in the ice drift speed during 1989-2009, and Spreen et al. (2011) found a smaller contribution from winds than from ice thickness. References: Hakkinen, S., A. Proshutinsky, and I. Ashik (2008), Sea ice drift in the Arctic since the 1950s, Geophys. Res. Lett., 35, L19704, doi:10.1029/2008GL034791. Spreen, G., R. Kwok, and D. Menemenlis (2011), Trends in Arctic sea ice drift and role of wind forcing: 1992–2009, Geophys. Res. Lett., 38, L19501, doi:10.1029/2011GL048970. Vihma, T., P. Tisler, and P. Uotila (2012), Atmospheric forcing on the drift of Arctic sea ice in 1989–2009, Geophys. Res. Lett., 39, L02501, doi:10.1029/2011GL050118. [Timo Vihma, Finland]	The increased ice drift speeds were already observed by Hakkinen et al. (2008), Spreen et al. (2011) and Vihma et al. (2012). Further, it depends on the time scale whether wind is of lesser or larger importance than ice thickness. Considering changes from 1950s to about 2005, Hakkinen et al. (2008) attributed the faster drift to increased winds, whereas Vihma et al. (2012) found that winds did not explain the increasing trend in the ice drift speed during 1989-2009, and Spreen et al. (2011) found a smaller contribution from winds than from ice thickness. References: Hakkinen, S., A. Proshutinsky, and I. Ashik (2008), Sea ice drift in the Arctic since the 1950s, Geophys. Res. Lett., 35, L19704, doi:10.1029/2008GL034791. Spreen, G., R. Kwok, and D. Menemenlis (2011), Trends in Arctic sea ice drift and role of wind forcing: 1992–2009, Geophys. Res. Lett., 38, L19501, doi:10.1029/2011GL048970. Vihma, T., P. Tisler, and P. Uotila (2012), Atmospheric forcing on the drift of Arctic sea ice in 1989–2009, Geophys. Res. Lett., 39, L02501, doi:10.1029/2011GL050118.
8074	39	42	39	42	Do you mean "extent" instead of "sea-ice concentration"? [Rasmus Tonboe, Denmark]	Do you mean "extent" instead of "sea-ice concentration"?
41448	39	42	39	43	Replace "of lesser importance" by "less important". [Charalampos Charalampidis, Germany]	Replace "of lesser importance" by "less important".
49286	39	51	40	3	This section is specifically on Antarctic Sea Ice, however, it refers to the more generic section in Chapter 2, 2.3.2.1 on Sea-ice extent/area and thickness, for details. This is confusing. Recommend that details should be placed in the section dedicated for the geographic area, and that a summary be provided in the generic chapter section, with reference to the details in the specific geographoc section. That is section 2.3.2.1 should cross refer to this section 9.3.2 instead of the other way around. [Zelina Zaiton Ibrahim, Malaysia]	This section is specifically on Antarctic Sea Ice, however, it refers to the more generic section in Chapter 2, 2.3.2.1 on Sea-ice extent/area and thickness, for details. This is confusing. Recommend that details should be placed in the section dedicated for the geographic area, and that a summary be provided in the generic chapter section, with reference to the details in the specific geographoc section. That is section 2.3.2.1 should cross refer to this section 9.3.2 instead of the other way around.
31182	39	53	39	53	"Multiyear" change --> interannual variability? Year-to-year change? [François Massonnet, Belgium]	"Multiyear" change --> interannual variability? Year-to-year change?
41450	39	53	39	53	Replace "multiyear" by "multiannual". [Charalampos Charalampidis, Germany]	Replace "multiyear" by "multiannual".
48864	40	1	40	1	In SROCC, recent Antarctic sea ice anomalies through 2018 are noted (not 2017). [Chris Derksen, Canada]	In SROCC, recent Antarctic sea ice anomalies through 2018 are noted (not 2017).

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
19700	40	1	40	2	Possible correlation between forcing parameters and the sea-ice area would be useful for understanding the substantial decline in the sea-ice area in all months since 2016. [Gwenaelle GREMION, Canada]	Possible correlation between forcing parameters and the sea-ice area would be useful for understanding the substantial decline in the sea-ice area in all months since 2016.
26448	40	1	40	3	With the recent movement to abondone p-values, it might be less misleading, particularly for readers from other disciplines, if we could avoid using "statistically significant at X". See, e.g., https://www.nature.com/articles/d41586-019-00857-9 [Katsuro Katsumata, Japan]	With the recent movement to abondone p-values, it might be less misleading, particularly for readers from other disciplines, if we could avoid using "statistically significant at X". See, e.g., https://www.nature.com/articles/d41586-019-00857-9
19704	40	1	40	3	The statement " However, substantial decline in sea-ice area in all months since 2016 imply that the trend over the period 1979 to 2018 is not statistically significant at the 5% level (Section 2.3.2.1)" can be re-written as it is confusing. [Gwenaelle GREMION, Canada]	The statement " However, substantial decline in sea-ice area in all months since 2016 imply that the trend over the period 1979 to 2018 is not statistically significant at the 5% level (Section 2.3.2.1)" can be re-written as it is confusing.
8076	40	8	40	8	change "passive" to "thermal". [Rasmus Tonboe, Denmark]	change "passive" to "thermal".
19702	40	8	42	24	In the section on Antarctica sea ice coverage there should be one paragraph on the Weddell sea polynya as it changes the sea ice extent and the ocean circulation substentially but is still a poorly understood phenomenon. [Gwenaelle GREMION, Canada]	In the section on Antarctica sea ice coverage there should be one paragraph on the Weddell sea polynya as it changes the sea ice extent and the ocean circulation substentially but is still a poorly understood phenomenon.
40024	40	8			it reads ike you relied on reanalyses in the Arctic and played down the signals for observations This starts differently. [Michael Tsimplis, China]	it reads ike you relied on reanalyses in the Arctic and played down the signals for observations This starts differently.
40026	40	10			what does slightly mean? If it is not statistically significant then it has not increased despite what authors may have said. [Michael Tsimplis, China]	what does slightly mean? If it is not statistically significant then it has not increased despite what authors may have said.
40028	40	14		18	Different periods mentioned. Very confusing trying to make sense. [Michael Tsimplis, China]	Different periods mentioned. Very confusing trying to make sense.
31180	40	16	40	18	Consider rewriting the sentence like "Sea ice has retreated twice as rapidly in 2016-2018 as it has advanced over 1979-2016" [François Massonnet, Belgium]	Consider rewriting the sentence like "Sea ice has retreated twice as rapidly in 2016-2018 as it has advanced over 1979-2016"
40030	40	18			So the conclusion must be that there is NO TREND and this is a change with respect to the previous report. [Michael Tsimplis, China]	So the conclusion must be that there is NO TREND and this is a change with respect to the previous report.
40032	40	32			If there is NO TREND there are NO large scale changes but large interannual or interdecadal variability. [Michael Tsimplis, China]	If there is NO TREND there are NO large scale changes but large interannual or interdecadal variability.
41452	40	38	40	38	Remove colon after figure number. [Charalampos Charalampidis, Germany]	Remove colon after figure number.
50770	40	38	40	39	Consider adding "(e.g. coastal morphology or coastal embayment)" in the following way: "...although bathymetry and topography (e.g. coastal morphology or coastal embayment) limits the fluctuations...". [Hernan Edgardo Sala, Argentina]	Consider adding "(e.g. coastal morphology or coastal embayment)" in the following way: "...although bathymetry and topography (e.g. coastal morphology or coastal embayment) limits the fluctuations...".

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
40034	40	39		44	last two sentences can be omitted if indeed the "trends" are statistically insignificant. No reason to explain a non-significant trend by claiming regionally non-significant trends. [Michael Tsimplis, China]	last two sentences can be omitted if indeed the "trends" are statistically insignificant. No reason to explain a non-significant trend by claiming regionally non-significant trends.
40022	40				So is then the conclusion that there is no change in Antarctic sea ice? What is the level of confidence? [Michael Tsimplis, China]	So is then the conclusion that there is no change in Antarctic sea ice? What is the level of confidence?
40416	41	4	41	26	I would add 2 things to this paragraph: (1) temporally and spatially remote linkages due to sea-ice drift (Pope et al. 2017) make the understanding of regional trends even more complex; (2) in the Amundsen Sea, the overturning circulation induced by very strong ice-shelf melting can warm the surface and melt sea ice due to entrainment of CDW by the buoyancy driven circulation in the ice-shelf cavity (medium confidence), by contrast to other regions where ice-shelf melting increases the ocean stratification (Merino et al. 2018; Jourdain et al. 2017). References already included in ch. 9, except:Pope, J. O., Holland, P. R., Orr, A., Marshall, G. J., & Phillips, T. (2017). The impacts of El Niño on the observed sea ice budget of West Antarctica. Geophysical Research Letters, 44(12), 6200-6208. [Nicolas Jourdain, France]	I would add 2 things to this paragraph: (1) temporally and spatially remote linkages due to sea-ice drift (Pope et al. 2017) make the understanding of regional trends even more complex; (2) in the Amundsen Sea, the overturning circulation induced by very strong ice-shelf melting can warm the surface and melt sea ice due to entrainment of CDW by the buoyancy driven circulation in the ice-shelf cavity (medium confidence), by contrast to other regions where ice-shelf melting increases the ocean stratification (Merino et al. 2018; Jourdain et al. 2017). References already included in ch. 9, except:Pope, J. O., Holland, P. R., Orr, A., Marshall, G. J., & Phillips, T. (2017). The impacts of El Niño on the observed sea ice budget of West Antarctica. Geophysical Research Letters, 44(12), 6200-6208.
37910	41	4			Delete "has". [Adrian Simmons, United Kingdom (of Great Britain and Northern Ireland)]	Delete "has".
45300	41	17	41	17	Add Bintanja et al., 2013 Nat. Geos. (Important role for ocean warming and increased ice-shelf melt in Antarctic sea-ice expansion) [Alessandro Silvano, Australia]	Add Bintanja et al., 2013 Nat. Geos. (Important role for ocean warming and increased ice-shelf melt in Antarctic sea-ice expansion)
48534	41	24	41	26	This struck me as a strange statement. Sea ice and ocean temperature are tightly coupled, so it doesn't make sense to ask whether the sea ice increaase results from ocean cooling. But there are good questions about whether sea ice expansion has contributed (perhaps through increased melt?) to the surface cooling beyond the wintertime ice edge. Perhaps be more explicit about what is meant here. [Kyle Armour, United States of America]	This struck me as a strange statement. Sea ice and ocean temperature are tightly coupled, so it doesn't make sense to ask whether the sea ice increaase results from ocean cooling. But there are good questions about whether sea ice expansion has contributed (perhaps through increased melt?) to the surface cooling beyond the wintertime ice edge. Perhaps be more explicit about what is meant here.
19706	41	28	41	32	If the Antarctic sea-ice coverage shows an obsereved increasing trend from 1979 to 2015, can the substantial decline in the sea-ice area in all months since 2016 be due to the long term (multi-year) cyclic fluctuation or is it an anthropogenic forcing driven response of the system? A clarification would be useful. [Gwenaelle GREMION, Canada]	If the Antarctic sea-ice coverage shows an obsereved increasing trend from 1979 to 2015, can the substantial decline in the sea-ice area in all months since 2016 be due to the long term (multi-year) cyclic fluctuation or is it an anthropogenic forcing driven response of the system? A clarification would be useful.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
40036	41	28		32	I would suggest that you replace the two paragraphs by stating that there are various mechansims that have been argued both for the increase and the decreases observed but to the extent that there is no statistical trend these are more appropriate to a regional assessment of sea ice variation rather than to a global assessment. [Michael Tsimplis, China]	I would suggest that you replace the two paragraphs by stating that there are various mechansims that have been argued both for the increase and the decreases observed but to the extent that there is no statistical trend these are more appropriate to a regional assessment of sea ice variation rather than to a global assessment.
48536	41	34	41	34	Perhaps the place to talk about recent Antarctic sea ice trends in the context of observations since 1950. Fan et al. 2014 and Armour and Bitz 2015 suggest that ice extent was large in the 1950s, declined, then increased since the 1970s, though confidence is low due to lack of observations except for a few months of sattelite observations of ice extent in the 60s and 70s. [Kyle Armour, United States of America]	Perhaps the place to talk about recent Antarctic sea ice trends in the context of observations since 1950. Fan et al. 2014 and Armour and Bitz 2015 suggest that ice extent was large in the 1950s, declined, then increased since the 1970s, though confidence is low due to lack of observations except for a few months of sattelite observations of ice extent in the 60s and 70s.
19710	41	34	41	38	This paragarph is quite short. There could be more references to pre-satellite studies that used observations on sea ice from ships and whaling [Gwenaelle GREMION, Canada]	This paragarph is quite short. There could be more references to pre-satellite studies that used observations on sea ice from ships and whaling
40040	41	34		38	This paragraph adds very little. [Michael Tsimplis, China]	This paragraph adds very little.
40038	41	34			what are "longer" time scales? [Michael Tsimplis, China]	what are "longer" time scales?
15008	41	35	41	35	It is important that this continues to read "during the last glacial period" and not "during the LGM", because these papers indicate that the main advance of sea ice occurred before the global LGM. Instead, the late stages of MIS 3 and early MIS 2 saw advance of sea ice especially in the Atlantic sector. See also Collins et al. 2012 PALEOCEANOGRAPHY, VOL. 27, PA3217, doi:10.1029/2011PA002264, [Erin McClymont, United Kingdom (of Great Britain and Northern Ireland)]	It is important that this continues to read "during the last glacial period" and not "during the LGM", because these papers indicate that the main advance of sea ice occurred before the global LGM. Instead, the late stages of MIS 3 and early MIS 2 saw advance of sea ice especially in the Atlantic sector. See also Collins et al. 2012 PALEOCEANOGRAPHY, VOL. 27, PA3217, doi:10.1029/2011PA002264,
6365	41	39	42	25	Why the extensive discussion on the CMIP5 models is important? Suggest to reduce to minimum [Baruch Rinkevich, Israel]	Why the extensive discussion on the CMIP5 models is important? Suggest to reduce to minimum
19708	41	40	41	44	The sentence is confusing. An explanation is warranted for understanding reasons for the mean seasonal cycle in sea-ice coverage agrees well with observation even If CMIP5 models misrepresent the seasonal cycle in sea-ice coverage. [Gwenaelle GREMION, Canada]	The sentence is confusing. An explanation is warranted for understanding reasons for the mean seasonal cycle in sea-ice coverage agrees well with observation even If CMIP5 models misrepresent the seasonal cycle in sea-ice coverage.
50772	41	41	40	41	Aiming to distinguish the internal variability of the models from the natural variability of the observed sea ice coverage, consider to replace: "simulate more internal variability than in the observational record" by: "have more internal variability than the natural variability in the observational record". [Hernan Edgardo Sala, Argentina]	Aiming to distinguish the internal variability of the models from the natural variability of the observed sea ice coverage, consider to replace: "simulate more internal variability than in the observational record" by: "have more internal variability than the natural variability in the observational record".

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
49238	41	52	41	52	There is good evidence that eddies play a key role in the Southern Ocean circulation, but CMIP5 models completely lack an explicit representation of them. Is that not one of the possible causes of other poorly represented processes such as sea-ice? [Malcolm Roberts, United Kingdom (of Great Britain and Northern Ireland)]	There is good evidence that eddies play a key role in the Southern Ocean circulation, but CMIP5 models completely lack an explicit representation of them. Is that not one of the possible causes of other poorly represented processes such as sea-ice?
40042	42	1		4	Pargraph ending line 4 - This paragraph is not relevant. Models show no trend and they may be right about this as observations show no trend either. So if one were to assess sea ice in antarctica she/he should say no observed or modelled change, no confidence in models and great interannual/interdecadal variability so either very no confidence on any systematic change OR equal chance of increase or decrease. [Michael Tsimplis, China]	Pargraph ending line 4 - This paragraph is not relevant. Models show no trend and they may be right about this as observations show no trend either. So if one were to assess sea ice in antarctica she/he should say no observed or modelled change, no confidence in models and great interannual/interdecadal variability so either very no confidence on any systematic change OR equal chance of increase or decrease.
6301	42	6	42	6	They are connected to the near-surface wind changes associated with the passage of extratropical cylones and blocks and hence connected to changes in this weather systems on decadel time scales (Schemm 2018, doi 10.1029/2018GL079109) [Sebastian Schemm, Switzerland]	They are connected to the near-surface wind changes associated with the passage of extratropical cylones and blocks and hence connected to changes in this weather systems on decadel time scales (Schemm 2018, doi 10.1029/2018GL079109)
40044	42	6		24	last two paragraphs of no consequence. [Michael Tsimplis, China]	last two paragraphs of no consequence.
48538	42	21	42	22	Perhaps note that we do not know the sign of the sea ice response to wind changes, thus there is low confidence in whether ozone recovery would mitigate future loss. [Kyle Armour, United States of America]	Perhaps note that we do not know the sign of the sea ice response to wind changes, thus there is low confidence in whether ozone recovery would mitigate future loss.
48208	42	27	42	48	A recent publication by Kwok and Kacimi (2018) reports about Antarctic sea ice thickness information for the Weddell Sea region for three years (2011, 2014, 2016), derived from airborne and satellite observations. Kwok and Kamici (2018): Three years of sea ice freeboard, snow depth, and ice thickness of the Weddell Sea from Operation IceBridge and CryoSat-2. The Cryosphere, 12, 2789–2801, 2018. https://doi.org/10.5194/tc-12-2789-2018. I suggest considering to incluce this in this subsection. [Sebastian Gerland, Norway]	A recent publication by Kwok and Kacimi (2018) reports about Antarctic sea ice thickness information for the Weddell Sea region for three years (2011, 2014, 2016), derived from airborne and satellite observations. Kwok and Kamici (2018): Three years of sea ice freeboard, snow depth, and ice thickness of the Weddell Sea from Operation IceBridge and CryoSat-2. The Cryosphere, 12, 2789–2801, 2018. https://doi.org/10.5194/tc-12-2789-2018. I suggest considering to incluce this in this subsection.
40046	42	27			No data, no modelling skill no confidence - we do not know and no progress from previous report- is what I get from this. [Michael Tsimplis, China]	No data, no modelling skill no confidence - we do not know and no progress from previous report- is what I get from this.
25310	42	29	42	36	Pre AR5 refs - Is this background or summary of AR5 conclusions? [Sharon Smith, Canada]	Pre AR5 refs - Is this background or summary of AR5 conclusions?
19712	42	29	42	48	It would be appropriate to indicate the impact of the reduction of Antarctic sea-ice volume and thining in terms of the magnitude of change in sea-level in the future. [Gwenaelle GREMION, Canada]	It would be appropriate to indicate the impact of the reduction of Antarctic sea-ice volume and thining in terms of the magnitude of change in sea-level in the future.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
19716	42	30	42	30	ICESat-1 is a data from laser altimetry and not radar altimetry [Gwenaelle GREMION, Canada]	ICESat-1 is a data from laser altimetry and not radar altimetry
8078	42	30	42	30	What is meant with "campaign", IceSat-1 was a satellite mission not a campaign. [Rasmus Tonboe, Denmark]	What is meant with "campaign", IceSat-1 was a satellite mission not a campaign.
19714	42	32	42	32	'Antarctic Peninsular' instead of 'West Antarctica Peninsular', also in p.42, line 46 [Gwenaelle GREMION, Canada]	Antarctic Peninsular' instead of 'West Antarctica Peninsular', also in p.42, line 46
50776	42	32	42	32	Delete "West" in "West Antarctic Peninsula". [Hernan Edgardo Sala, Argentina]	Delete "West" in "West Antarctic Peninsula".
8080	42	42	42	42	"the unknown snow thickness" is just one of a number of uncertainty sources when deriving ice thickness using radar altimetry (others are: snow/ice density, snow/ice roughness, snow internal layering and salinity, sub-footprint diversity). See e.g. Tonboe, R. T., L. T. Pedersen, and C. Haas. Simulation of the Cryosat-2 satellite radar altimeter sea ice thickness retrieval uncertainty. Canadian Journal of Remote Sensing 36(1), 55-67, 2010. [Rasmus Tonboe, Denmark]	"the unknown snow thickness" is just one of a number of uncertainty sources when deriving ice thickness using radar altimetry (others are: snow/ice density, snow/ice roughness, snow internal layering and salinity, sub-footprint diversity). See e.g. Tonboe, R. T., L. T. Pedersen, and C. Haas. Simulation of the Cryosat-2 satellite radar altimeter sea ice thickness retrieval uncertainty. Canadian Journal of Remote Sensing 36(1), 55-67, 2010.
6303	42	53	42	53	The anomalies in this ice drift is perfectly correlated with the frequencies of low and high pressure systems in remote regions (Schemm 2018, doi 10.1029/2018GL079109) [Sebastian Schemm, Switzerland]	The anomalies in this ice drift is perfectly correlated with the frequencies of low and high pressure systems in remote regions (Schemm 2018, doi 10.1029/2018GL079109)
48210	43	5	43	6	I suggest to check if there is content in the publication by Polyakov et al. (2017) that supports this statement, or if that citation came in here by mistake. Polyakov et al. (2017, Science) as in the reference list, deals in the first place with Arctic processes. [Sebastian Gerland, Norway]	I suggest to check if there is content in the publication by Polyakov et al. (2017) that supports this statement, or if that citation came in here by mistake. Polyakov et al. (2017, Science) as in the reference list, deals in the first place with Arctic processes.
6299	43	9	43	9	For explaination it should be added that the wind trends are caused by statistically significant changes in the number of extratropical low and high pressure systems, or blocks, and that these trends in weather systems affect the sea-ice trend via changes in the near-surface winds not only during the same but also across different seasons (Schemm 2018). Schemm (2018) shows that the trends in cyclone and blocking frequencies provide a means for understanding the regional inhomogeneity of the Antarctic sea ice trends in all regions and that the trends in cyclone an blocking frequency are positive as well as negative and affect with an almost perfect correlation the sea-ice extent mainly in distant regions of the cyclone's or block's center, due to changes in the wind direction and speed (Schemm 2018; doi: 10.1029/2018GL079109). [Sebastian Schemm, Switzerland]	For explaination it should be added that the wind trends are caused by statistically significant changes in the number of extratropical low and high pressure systems, or blocks, and that these trends in weather systems affect the sea-ice trend via changes in the near-surface winds not only during the same but also across different seasons (Schemm 2018). Schemm (2018) shows that the trends in cyclone and blocking frequencies provide a means for understanding the regional inhomogeneity of the Antarctic sea ice trends in all regions and that the trends in cyclone an blocking frequency are positive as well as negative and affect with an almost perfect correlation the sea-ice extent mainly in distant regions of the cyclone's or block's center, due to changes in the wind direction and speed (Schemm 2018; doi: 10.1029/2018GL079109).

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
19718	43	10	43	11	Could be elaborated what 'weakening and reversing of sea ice drift' means and what the consquences are. The velocity of the drift is reduced and the directions reverse? [Gwenaelle GREMION, Canada]	Could be elaborated what 'weakening and reversing of sea ice drift' means and what the consquences are. The velocity of the drift is reduced and the directions reverse?
40048	43	10		11	This report is about climate, by definition long term (2-3 decades) change. The paragraph talks abouts large scale trends over a few years. [Michael Tsimplis, China]	This report is about climate, by definition long term (2-3 decades) change. The paragraph talks abouts large scale trends over a few years.
42768	43	14	43	19	PDF diagnostics are also used to evaluate model performance, e.g. (Cardoso et al., 2019; Soares et al. 2017) Cardoso RM, Soares PMM, Lima DCA, Miranda PMA (2019) Mean and extreme temperatures in a warming climate: EURO CORDEX and WRF regional climate high-resolution projections for Portugal. Climate Dynamics, 52, 1-2, 129-157. DOI: 10.1007/s00382-018-4124-4 https://link.springer.com/article/10.1007%2Fs00382-, 018-4124-4 Soares PMM, Cardoso RM, Lima DCA, Miranda PMA (2017): Future precipitation in Portugal: high-resolution projections using WRF model and EURO-CORDEX multi-model ensembles. Clim Dyn, 49, 2503-2530. DOI 10.1007/s00382-016-3455-2 [Rita M Cardoso, Portugal]	PDF diagnostics are also used to evaluate model performance, e.g. (Cardoso et al., 2019; Soares et al. 2017) Cardoso RM, Soares PMM, Lima DCA, Miranda PMA (2019) Mean and extreme temperatures in a warming climate: EURO CORDEX and WRF regional climate high-resolution projections for Portugal. Climate Dynamics, 52, 1-2, 129-157. DOI: 10.1007/s00382-018-4124-4 https://link.springer.com/article/10.1007%2Fs00382-, 018-4124-4 Soares PMM, Cardoso RM, Lima DCA, Miranda PMA (2017): Future precipitation in Portugal: high?resolution projections using WRF model and EURO?CORDEX multi?model ensembles. Clim Dyn, 49, 2503-2530. DOI 10.1007/s00382-016-3455-2
26174	43	26	66	26	The section of ice sheets are too long comparing with other section (e.g. sea ice). The content should be shortened. [Jun Inoue, Japan]	The section of ice sheets are too long comparing with other section (e.g. sea ice). The content should be shortened.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
14960	43	26	66	26	In the ice sheet section of Chapter 9 there should be a subsection dealing with paleo-glaciological evidence from other ice sheets than Antarctica and Greenland. While the boundary conditions (ice sheet configuration, climate forcing etc.) affecting the glacial stage ice sheets (covering North America, Eurasia, Patagonia, the Alps) were different from the modern ice sheets, the physical processes were the same. Crucial data on how ice sheets behave when confronted with air and ocean warming can therefore be obtained. The paleo ice sheets are the only places where detailed studies on how an ice sheet can completely melt away can be made, and where observational evidence for the mode and rate of ice sheet retreat can be found. Below I mention some examples of paleo-glaciological evidence from other ice sheets covering the last deglaciation that could be included, there are, however, many more: Marine-based ice sheet deglaciation: A new study (Brendryen et al., in review in Nature Geoscience) on the last deglaciation of the marine-based sectors of the Eurasian ice sheet complex suggest that these sectors abruptly collapsed at the Bølling transition featuring an ice mass loss of 4.5-7.9 m SLE (95% quantiles) over 500 years. The estimated rates of ice loss from the EIS during the early Bølling (~1.6 cm SLE yr−1 averaged over 300 yr, peaking at ~2.2 cm SLE yr−1) are comparable to high-end values (DeConto and Pollard, 2016) of mass loss projected for the West Antarctic ice sheet in the next centuries. The bulk of the mass loss reconstructed in (Brendryen et al,) occurred from the Svalbard-Barents Ice Sheet where morphological and stratigraphic evidence (Andreassen et al., 2016; Brendryen et al., in review) suggest that ice streams occupying glacial troughs rapidly calved back into the interior ice sheet. In the Bear Island trough, continuity between subglacial carved lineation's and iceberg plough marks suggests calving of deep-keeled icebergs directly at the ice front (Piasecka et al., 2018). These findings are consistent with the operation of the marine ice cliff instability mechanism (MICI)(Pollard et al., 2015; Wise et al., 2017) during the rapid ice sheet retreat. The current water depth in the SW Barents Sea	In the ice sheet section of Chapter 9 there should be a subsection dealing with paleo-glaciological evidence from other ice sheets than Antarctica and Greenland. While the boundary conditions (ice sheet configuration, climate forcing etc.) affecting the glacial stage ice sheets (covering North America, Eurasia, Patagonia, the Alps) were different from the modern ice sheets, the physical processes were the same. Crucial data on how ice sheets behave when confronted with air and ocean warming can therefore be obtained. The paleo ice sheets are the only places where detailed studies on how an ice sheet can completely melt away can be made, and where observational evidence for the mode and rate of ice sheet retreat can be found. Below I mention some examples of paleo-glaciological evidence from other ice sheets covering the last deglaciation that could be included, there are, however, many more: Marine-based ice sheet deglaciation: A new study (Brendryen et al., in review in Nature Geoscience) on the last deglaciation of the marine-based sectors of the Eurasian ice sheet complex suggest that these sectors abruptly collapsed at the Bølling transition featuring an ice mass loss of 4.5-7.9 m SLE (95% quantiles) over 500 years. The estimated rates of ice loss from the EIS during the early Bølling (~1.6 cm SLE yr?1 averaged over 300 yr, peaking at

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
14962	43	26	66	26	Continues from comment above : Fjord and fjord-landscape deglaciations: Briner et al. (2009) found in a study of Sam Ford Fjord in Arctica Canada that it was rapidly deglaciated about 9,500 years ago, with retreat rates ranging from 5 to 58 m yr−1. Mangerud et al., (2013) found for two of the world's longest and deepest fjords, Sognefjorden and Hardangerfjorden in western Norway, that the ice front retreated during the early Holocene at mean rates of 240 +/- 70 and 340 +/- 70 m per year, respectively. These fjords have a similar morphology to the troughs holding many outlet glaciers of the Greenland ice sheet. Mangerud et al. (2019) found that in a larger area of Western Norway the ice margin retreated at rate of about 160 m a−1 in deep (300–700 m) fjords, and 60–80 m a−1 in shallower (<80 m) fjords. The mean retreat rate across this dissected fjord landscape with clear similarities to large areas in western Greenland, was 120 m a−1 for the first 200 years of the Holocene. Land-based ice sheet deglaciation: Ullmann et al. (2016) found in a study of the retreat of the Labrador ice dome, the largest Holocene remnant of the Laurentide Ice Sheet that this land-based ice sheet at a size of the West Antarctic ice sheet lost ice at a rate of 1 cm SLE per year. References: Andreassen, K., Bjarnadóttir, L. R., Rüther, D. C., & Winsborrow, M. C. M. Retreat patterns and dynamics of the former Bear Island Trough Ice Stream. Geological Society, London, Memoirs 46, 445-452 (2016). Brendryen J., Haflidason H., Yokoyama Y., Haaga K. A., & Hannisdal B. Collapse of Eurasian ice sheets 14,600 years ago was a major source of global Meltwater Pulse 1a. In review in Nature Geoscience.	Continues from comment above : Fjord and fjord-landscape deglaciations: Briner et al. (2009) found in a study of Sam Ford Fjord in Arctica Canada that it was rapidly deglaciated about 9,500?years ago, with retreat rates ranging from 5 to 58?m?yr?1. Mangerud et al., (2013) found for two of the world's longest and deepest fjords, Sognefjorden and Hardangerfjorden in western Norway, that the ice front retreated during the early Holocene at mean rates of 240 +/- 70 and 340 +/- 70 m per year, respectively. These fjords have a similar morphology to the troughs holding many outlet glaciers of the Greenland ice sheet. Mangerud et al. (2019) found that in a larger area of Western Norway the ice margin retreated at rate of about 160?m a?1 in deep (300–700 m) fjords, and 60–80 m a?1 in shallower (<80?m) fjords. The mean retreat rate across this dissected fjord landscape with clear similarities to large areas in western Greenland, was 120?m a?1 for the first 200 years of the Holocene. Land-based ice sheet deglaciation: Ullmann et al. (2016) found in a study of the retreat of the Labrador ice dome, the largest Holocene remnant of the Laurentide Ice Sheet that this land-based ice sheet at a size of the West Antarctic ice sheet lost ice at a rate of 1 cm SLE per year.
8372	43	28			It seems a few topics are missing from 9.4.1 (Ice sheets: Introduction). Specifically: 1) summary of ongoing observed mass changes, and what is driving this mass change 2) summary of how ice dynamics interacts with mass balance terms through gravitational-driven deformation/sliding (e.g. glaciology 101). [Jeremy Fyke, Canada]	It seems a few topics are missing from 9.4.1 (Ice sheets: Introduction). Specifically: 1) summary of ongoing observed mass changes, and what is driving this mass change 2) summary of how ice dynamics interacts with mass balance terms through gravitational-driven deformation/sliding (e.g. glaciology 101).
25312	43	29			Section 9.4.1 - This all appears to be background - can this be reduced? (also, some information probably gets repeated later. [Sharon Smith, Canada]	Section 9.4.1 - This all appears to be background - can this be reduced? (also, some information probably gets repeated later.
8358	43	30	43	31	Suggest indicating most up-to-date total sea level equivalent (SLE) values for both ice sheets, to support 'largest components of the cryosphere' initial statement. I suggest doing this on line 42, after the definition of SLE occurs. [Jeremy Fyke, Canada]	Suggest indicating most up-to-date total sea level equivalent (SLE) values for both ice sheets, to support 'largest components of the cryosphere' initial statement. I suggest doing this on line 42, after the definition of SLE occurs.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
9816	43	33	43	33	It is not true that temperature above 0 generally prevent accumulation because of runoff. Over Antarctica, temperature rises above 0 in many coastal regions in summer but melwater refreezes in the snowpack and does not runoff. Melt followed by refreeze does not affect surface mass balance. [Christophe Genthon, France]	It is not true that temperature above 0 generally prevent accumulation because of runoff. Over Antarctica, temperature rises above 0 in many coastal regions in summer but melwater refreezes in the snowpack and does not runoff. Melt followed by refreeze does not affect surface mass balance.
41454	43	33	43	33	I would specify as "surface accumulation". [Charalampos Charalampidis, Germany]	I would specify as "surface accumulation".
9818	43	34	43	34	Much of the snow evaporation in antarctica is not surface evaporation, The contribution of the evaporation of airborne snow eroded by wind is probably larger, as blown snow is very efficiently evaporated, much more than surface snow (eg https://www.the-cryosphere.net/8/1905/2014/, https://doi.org/10.5194/tc-8-1905-2014) [Christophe Genthon, France]	Much of the snow evaporation in antarctica is not surface evaporation, The contribution of the evaporation of airborne snow eroded by wind is probably larger, as blown snow is very efficiently evaporated, much more than surface snow (eg https://www.the-cryosphere.net/8/1905/2014/, https://doi.org/10.5194/tc-8-1905-2014)
26592	43	35	43	35	after 'ice flow' at reference - say : MacGregor, J. A., et al. (2016), A synthesis of the basal thermal state of the Greenland Ice Sheet, J. Geophys. Res.Earth Surf.,121, 1328–1350, doi:10.1002/2015JF003803 [Jeff Ridley, United Kingdom (of Great Britain and Northern Ireland)]	after 'ice flow' at reference - say : MacGregor, J. A., et al. (2016), A synthesis of the basal thermal state of the Greenland Ice Sheet, J. Geophys. Res.Earth Surf.,121, 1328–1350, doi:10.1002/2015JF003803
40418	43	35	43	36	A probably more targetted reference for this statement is: Pattyn, F. (2010). Antarctic subglacial conditions inferred from a hybrid ice sheet/ice stream model. Earth and Planetary Science Letters, 295(3-4), 451-461. [Nicolas Jourdain, France]	A probably more targetted reference for this statement is: Pattyn, F. (2010). Antarctic subglacial conditions inferred from a hybrid ice sheet/ice stream model. Earth and Planetary Science Letters, 295(3-4), 451-461.
26594	43	36	43	36	Is Bamber et al 2018b really the best reference here. It says very little about basal melt and does not quantify it [Jeff Ridley, United Kingdom (of Great Britain and Northern Ireland)]	Is Bamber et al 2018b really the best reference here. It says very little about basal melt and does not quantify it
9878	43	36	43	37	I would define the SMB as the net accumulation minus ablation rather than the sum of accumulation and ablation. I find personnaly the former definition clearer. [Kevin Bulthuis, Belgium]	I would define the SMB as the net accumulation minus ablation rather than the sum of accumulation and ablation. I find personnaly the former definition clearer.
41456	43	36	43	37	Again, surface mass balance components should be "surface accumulation and ablation". [Charalampos Charalampidis, Germany]	Again, surface mass balance components should be "surface accumulation and ablation".
26596	43	36	43	42	This section is a messy description of ocean interaction with iceshelves and tide-water glaciers the 'above floation' phrase should be replaced with 'grounded'. [Jeff Ridley, United Kingdom (of Great Britain and Northern Ireland)]	This section is a messy description of ocean interaction with iceshelves and tide-water glaciers the 'above floation' phrase should be replaced with 'grounded'.
8360	43	37	43	38	"Floating ice-shelves flanking Antarctica and Greenland are the interface between the ocean and the ice sheets": in most Greenland outlet glacier cases, there aren't significant ice shelves. Rather,there are more vertical ice fronts. Suggest pinging Twila Moon, Bea Csatho, or others for a best characterization of Greenland ice/ocean interface. [Jeremy Fyke, Canada]	"Floating ice-shelves flanking Antarctica and Greenland are the interface between the ocean and the ice sheets": in most Greenland outlet glacier cases, there aren't significant ice shelves. Rather,there are more vertical ice fronts. Suggest pinging Twila Moon, Bea Csatho, or others for a best characterization of Greenland ice/ocean interface.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
45302	43	37	43	39	floating ice shelves are nearly absent in Greenland. I would rephrase the sentence including the concept of “marine terminating glaciers” that can go afloat (Antarctica) or not (Greenland). The vertical wall in Greenland is the interface between ice and ocean. [Alessandro Silvano, Australia]	floating ice shelves are nearly absent in Greenland. I would rephrase the sentence including the concept of “marine terminating glaciers” that can go afloat (Antarctica) or not (Greenland). The vertical wall in Greenland is the interface between ice and ocean.
9812	43	38	43	38	Depending on coast configuration, many glaciers flow into the ocean without an ice shelf interface. An ice shelf is not the (only) interface between the ocean and the ice sheet. [Christophe Genthon, France]	Depending on coast configuration, many glaciers flow into the ocean without an ice shelf interface. An ice shelf is not the (only) interface between the ocean and the ice sheet.
19720	43	41	43	41	“originally above flotation” contains a lot of info in itself, which is hard to deconvolve as a non expert. I would make it more explicit and replace it with: “...if the ice was grounded on rock that sits above sea level” [Gwenaelle GREMION, Canada]	“originally above flotation” contains a lot of info in itself, which is hard to deconvolve as a non expert. I would make it more explicit and replace it with: “...if the ice was grounded on rock that sits above sea level”
31240	43	42	43	42	add Fretwell et al. 2012 and Rignot et al. 2019 as reference for "sea level if the ice was originally above flotation". REF: Fretwell, P et al. (2013). Bedmap2: improved ice bed, surface and thickness datasets for Antarctica. Cryosph. 7, 375–393. doi:10.5194/tc-7-375-2013. Rignot et al.; Four decades of Antarctic Ice Sheet mass balance from 1979–2017. Proceedings of the National Academy of Sciences Jan 2019, 116 (4) 1095-1103; DOI: 10.1073/pnas.1812883116 [Jeremie Mouginot, France]	add Fretwell et al. 2012 and Rignot et al. 2019 as reference for "sea level if the ice was originally above flotation". REF: Fretwell, P et al. (2013). Bedmap2: improved ice bed, surface and thickness datasets for Antarctica. Cryosph. 7, 375–393. doi:10.5194/tc-7-375-2013. Rignot et al.; Four decades of Antarctic Ice Sheet mass balance from 1979–2017. Proceedings of the National Academy of Sciences Jan 2019, 116 (4) 1095-1103; DOI: 10.1073/pnas.1812883116
8362	43	44	43	45	Polar amplification is also seen in future simulations. Refer to the CMIP6-endorsed PAMIP project/publications here (https://www.geosci-model-dev.net/12/1139/2019/) [Jeremy Fyke, Canada]	Polar amplification is also seen in future simulations. Refer to the CMIP6-endorsed PAMIP project/publications here (https://www.geosci-model-dev.net/12/1139/2019/)
41458	43	44	43	47	It would be nice to show confidence levels in these statements. [Charalampos Charalampidis, Germany]	It would be nice to show confidence levels in these statements.
19722	43	44	43	53	The polar amplification is a well-known phenomena. As mentioned here, climate models do not simulate the full impact of the polar amplification. Which consequences on the model output can be possible due to the lower simulated increase in temperature in the polar regions on the future predictions on the contribution to sea level rise and future temperature estimates? Do models account for this? [Gwenaelle GREMION, Canada]	The polar amplification is a well-known phenomena. As mentioned here, climate models do not simulate the full impact of the polar amplification. Which consequences on the model output can be possible due to the lower simulated increase in temperature in the polar regions on the future predictions on the contribution to sea level rise and future temperature estimates? Do models account for this?

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
26598	43	44	43	53	Is nthis discussion about past climates really necessary given differences in insolation/continents and uncertainties in reconstructions? I suggest cutting this as detrimental to the flow of the introducton. The first paragraph of page 44 is sufficient here. Indeed, this is a repetitiion of 2.3.4.1 [Jeff Ridley, United Kingdom (of Great Britain and Northern Ireland)]	Is nthis discussion about past climates really necessary given differences in insolation/continents and uncertainties in reconstructions? I suggest cutting this as detrimental to the flow of the introducton. The first paragraph of page 44 is sufficient here. Indeed, this is a repetitiion of 2.3.4.1
40050	43	46			how much more? [Michael Tsimplis, China]	how much more?
9880	43	47	43	47	Maybe the word "polar amplification" should be defined more explicitly in the paragraph. [Kevin Bulthuis, Belgium]	Maybe the word "polar amplification" should be defined more explicitly in the paragraph.
8364	43	47	43	49	"The higher value for polar amplification reflects multi-millennial atmospheric warming in the Arctic and the lower value for polar amplification is more representative of the Antarctic response. " Not sure what the former phrase means (for example, polar amplification of anthropogenic-forced change is not a 'multi-millennial' process). Regarding latter phrase, it should be noted that Southern Ocean heat uptake appears to be currently limiting SH polar amplification (link to Ch. 4, or other relevant polar amplification discussion. [Jeremy Fyke, Canada]	"The higher value for polar amplification reflects multi-millennial atmospheric warming in the Arctic and the lower value for polar amplification is more representative of the Antarctic response. " Not sure what the former phrase means (for example, polar amplification of anthropogenic-forced change is not a 'multi-millennial' process). Regarding latter phrase, it should be noted that Southern Ocean heat uptake appears to be currently limiting SH polar amplification (link to Ch. 4, or other relevant polar amplification discussion.
8366	43	47	43	49	Suggest addition of sentence: "Given the sensitivity of ice sheet mass balance to climate change at polar latitudes, the impact of polar amplification on future sea level trends is likely to be large (Fyke et al., 2014)." https://link.springer.com/article/10.1007/s00382-014-2050-7. Note, I would be entirely happy if a more recent paper that quantified polar amplification -> ice-sheet-driven sea level trends was cited instead, to emphasize this (important) point. [Jeremy Fyke, Canada]	Suggest addition of sentence: "Given the sensitivity of ice sheet mass balance to climate change at polar latitudes, the impact of polar amplification on future sea level trends is likely to be large (Fyke et al., 2014)." https://link.springer.com/article/10.1007/s00382-014-2050-7. Note, I would be entirely happy if a more recent paper that quantified polar amplification -> ice-sheet-driven sea level trends was cited instead, to emphasize this (important) point.
19748	44	1	44	1	Please define waxing and waning? [Gwenaelle GREMION, Canada]	Please define waxing and waning?
42658	44	1	44	43	Statement is made that the waxing and waning of ice sheets is ‘a phasing dictated by orbital cycles and the rise and fall of atmospheric C02’. The last phrase of this statement is false. The ice sheet cores e.g. Vostok, Dome C -clearly show C02 concentrations lagging temperature by an ever-increasing amount (a lag of 400 -1200 years) in the period from the present to 800,000 BP. There is no justification to ascribe any of these variations as due to the rise and fall of C02 in the last 800,000 years as the rise of C02 is related to the priot rise in temperature (not vice-versa). Unfortunately, there is no ice core data older than 800,000 BP. [Howard Brady, Australia]	Statement is made that the waxing and waning of ice sheets is ‘a phasing dictated by orbital cycles and the rise and fall of atmospheric C02’. The last phrase of this statement is false. The ice sheet cores e.g. Vostok, Dome C -clearly show C02 concentrations lagging temperature by an ever-increasing amount (a lag of 400 -1200 years) in the period from the present to 800,000 BP. There is no justification to ascribe any of these variations as due to the rise and fall of C02 in the last 800,000 years as the rise of C02 is related to the priot rise in temperature (not vice-versa). Unfortunately, there is no ice core data older than 800,000 BP.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
8368	44	4	44	5	Another problem with using past ice sheet change as analog for future change is the difference in major forcing. In past, primary external forcer was orbitals, and CO2 change was an internal positive climate system feedback. Currently, CO2 is now an external forcing mechanism, and orbital changes are not important as drivers of change. Some suggested text: "In addition, fundamental differences in external climate forcing mechanisms exist between paleoclimate cases (orbital change, enhanced by carbon cycle feedbacks) and the present day (anthropogenic CO2 emissions). It can therefore be challenging to relate CO2/ice sheet volume relationships from the recent past, to expected future changes." [Jeremy Fyke, Canada]	Another problem with using past ice sheet change as analog for future change is the difference in major forcing. In past, primary external forcer was orbitals, and CO2 change was an internal positive climate system feedback. Currently, CO2 is now an external forcing mechanism, and orbital changes are not important as drivers of change. Some suggested text: "In addition, fundamental differences in external climate forcing mechanisms exist between paleoclimate cases (orbital change, enhanced by carbon cycle feedbacks) and the present day (anthropogenic CO2 emissions). It can therefore be challenging to relate CO2/ice sheet volume relationships from the recent past, to expected future changes."
9490	44	4	44	7	something to consider.... this comes across as a bit negative and down on the contribution from paleoclimate efforts. Is there a way to talk about the limitations spun more positively? What the paleoglaciology perspective can do is shed light on whether ice sheet changes detected in the relatively brief satellite era are dynamic noise or climatic signal, and several studies have been successful at this. Also the paleo-perspective contributes to knowledge of ice sheet processes, examples: rates of ice streaming during ice sheet demise (Stokes et al. 2016), and rates of ice loss in marine versus land-based ice sheet sectors. [Jason Briner, United States of America]	something to consider.... this comes across as a bit negative and down on the contribution from paleoclimate efforts. Is there a way to talk about the limitations spun more positively? What the paleoglaciology perspective can do is shed light on whether ice sheet changes detected in the relatively brief satellite era are dynamic noise or climatic signal, and several studies have been successful at this. Also the paleo-perspective contributes to knowledge of ice sheet processes, examples: rates of ice streaming during ice sheet demise (Stokes et al. 2016), and rates of ice loss in marine versus land-based ice sheet sectors.
40052	44	4			rarely means sometimes they are. Perhaps use only these? If you want to say that they never do then the pargraph does not add anything as fas as I can see. [Michael Tsimplis, China]	rarely means sometimes they are. Perhaps use only these? If you want to say that they never do then the pargraph does not add anything as fas as I can see.
19728	44	9	44	9	I would insist on the fact that solid earth rebound is on much longer timescales than ice, by changing the sentence to “On century and generally much longer timescales (up to xxxx kyrs)”. [Gwenaelle GREMION, Canada]	I would insist on the fact that solid earth rebound is on much longer timescales than ice, by changing the sentence to “On century and generally much longer timescales (up to xxxx kyrs)”.
48716	44	9	44	10	The description is incorrect and inconsistent. As it states, the stabilization is due to combined deformation (= solid earth rebound) AND gravitational effects not just solid earth rebound. [Lev Tarasov, Canada]	The description is incorrect and inconsistent. As it states, the stabilization is due to combined deformation (= solid earth rebound) AND gravitational effects not just solid earth rebound.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
8370	44	9	44	10	"solid earth rebound can stabilize ice sheets" -> "solid earth mechanisms can dampen ice sheet change". In general, I think deformational/gravitational effects mostly enable negative ice sheet/solid earth feedback loops (which by definition dampen forced change, in either direction of change). [Jeremy Fyke, Canada]	"solid earth rebound can stabilize ice sheets" -> "solid earth mechanisms can dampen ice sheet change". In general, I think deformational/gravitational effects mostly enable negative ice sheet/solid earth feedback loops (which by definition dampen forced change, in either direction of change).
19750	44	9	44	16	I find that the comments on Earth rheology (viscoelastic, viscous) are highly technical and I wonder if some further explanation would not be needed for the non-expert reader (e.g., explain it in terms of "rebound" or "uplift", as in section 9.4.3.1 for Antarctica) [Gwenaelle GREMION, Canada]	I find that the comments on Earth rheology (viscoelastic, viscous) are highly technical and I wonder if some further explanation would not be needed for the non-expert reader (e.g., explain it in terms of "rebound" or "uplift", as in section 9.4.3.1 for Antarctica)
26600	44	9	44	16	The objective of this paragraph is confused is it about resistribution of water mass or about the impact of rebound on ice sheet behaviour. If the latter then the references need to be summerised - does it limit tidewater glaciers or reduce surface melt...? [Jeff Ridley, United Kingdom (of Great Britain and Northern Ireland)]	The objective of this paragraph is confused is it about resistribution of water mass or about the impact of rebound on ice sheet behaviour. If the latter then the references need to be summerised - does it limit tidewater glaciers or reduce surface melt...?
40054	44	9		11	All previous studies saying this have been wrong I assume? Selective referencing is a big problem. [Michael Tsimplis, China]	All previous studies saying this have been wrong I assume? Selective referencing is a big problem.
19730	44	11	44	15	The sentence starting with “Ice-sheet evolution” and ending with “Khan et al., 2016”: I think that the added information given in the brackets should be a separate sentence, as it relevant and important information that shouldn’t be just side info. I would try to expand perhaps just a little on the effects of solid earth rebound for the readers as a lot is contained in this paragraph. My suggestion would be: “Viscoelastic earth deformation influences ice-sheet evolution through two mechanisms that feedback into each other. The magnitude and the geometry of the ice sheet as it grows or wanes influences the amount and geometry of solid earth rebound. The viscosity of the mantle beneath the landmass influences the amount and pace of solid earth rebound that can occur (for example, Global Positioning System data show that southeast Greenland is underlain by a less viscous upper mantle than the rest of the landmass, Khan et al. ,2016)” [Gwenaelle GREMION, Canada]	The sentence starting with “Ice-sheet evolution” and ending with “Khan et al., 2016”: I think that the added information given in the brackets should be a separate sentence, as it relevant and important information that shouldn’t be just side info. I would try to expand perhaps just a little on the effects of solid earth rebound for the readers as a lot is contained in this paragraph. My suggestion would be: “Viscoelastic earth deformation influences ice-sheet evolution through two mechanisms that feedback into each other. The magnitude and the geometry of the ice sheet as it grows or wanes influences the amount and geometry of solid earth rebound. The viscosity of the mantle beneath the landmass influences the amount and pace of solid earth rebound that can occur (for example, Global Positioning System data show that southeast Greenland is underlain by a less viscous upper mantle than the rest of the landmass, Khan et al. ,2016)”
57936	44	13	44	15	Could add reference to Barlette et al. (Science, 2018) for Antarctica as an example. [Bas de Boer, Netherlands]	Could add reference to Barlette et al. (Science, 2018) for Antarctica as an example.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
9882	44	13	44	15	Maybe add something about the Antarctic Ice sheet between parentheses as well. For instance, the Earth's mantle has a lower viscosity underneath West Antarctica than East Antarctica. Some references: Van der Wal, W., Whitehouse, P. L., and Schrama, E. J. O.: Effect of GIA models with 3D composite mantle viscosity on GRACE mass balance estimates for Antarctica, Earth Planet. Sc. Lett., 414, 134-143, https://doi.org/10.1016/j.epsl.2015.01.001, 2015. Chen, B., Haeger, C. , Kaban, M. K., and Petrunin, A.G.: Variations of the effective elastic thickness reveal tectonic fragmentation of the Antarctic lithsophere, Tectonophysics, 746, 412-424, https://doi.org/10.1016/j.tecto.2017.06.012, 2018. [Kevin Bulthuis, Belgium]	Maybe add something about the Antarctic Ice sheet between parentheses as well. For instance, the Earth's mantle has a lower viscosity underneath West Antarctica than East Antarctica. Some references: Van der Wal, W., Whitehouse, P. L., and Schrama, E. J. O.: Effect of GIA models with 3D composite mantle viscosity on GRACE mass balance estimates for Antarctica, Earth Planet. Sc. Lett., 414, 134-143, https://doi.org/10.1016/j.epsl.2015.01.001, 2015. Chen, B., Haeger, C. , Kaban, M. K., and Petrunin, A.G.: Variations of the effective elastic thickness reveal tectonic fragmentation of the Antarctic lithsophere, Tectonophysics, 746, 412-424, https://doi.org/10.1016/j.tecto.2017.06.012, 2018.
19732	44	15	44	16	I would suggest adding a reference for the last sentence. My suggestion is: Mitrovica, J.X., Gomez, N. and Clark, P.U., 2009. The sea-level fingerprint of West Antarctic collapse. Science, 323(5915), pp.753-753. [Gwenaelle GREMION, Canada]	I would suggest adding a reference for the last sentence. My suggestion is: Mitrovica, J.X., Gomez, N. and Clark, P.U., 2009. The sea-level fingerprint of West Antarctic collapse. Science, 323(5915), pp.753-753.
40056	44	16			I would put the second sentence first, the third second and the first third. [Michael Tsimplis, China]	I would put the second sentence first, the third second and the first third.
40420	44	18	44	29	Reading this paragraph, it seems that there is a high confidence on these results, which is not completely accurate. Most studies cited in this paragraph use relatively simple prescription of freshwater fluxes. Accounting for the iceberg trajectories and latent heat of melting makes an important difference for projections (Schloesser et al. 2019), and the partition of ice-shelf vs iceberg melting can also be important in some sectors like Amundsen where strong melting at depth can affect the vertical entrainment of circumpolar deep water (Merino et al. 2018), although this is probably still a matter of debate (Pauling et al. 2016). References already included in ch.9, except: Schloesser, F., Friedrich, T., Timmermann, A., DeConto, R. M. and Pollard, D. (2019). Antarctic Iceberg impacts on future Southern Hemisphere Climate. Nature Climate Change (accepted). [Nicolas Jourdain, France]	Reading this paragraph, it seems that there is a high confidence on these results, which is not completely accurate. Most studies cited in this paragraph use relatively simple prescription of freshwater fluxes. Accounting for the iceberg trajectories and latent heat of melting makes an important difference for projections (Schloesser et al. 2019), and the partition of ice-shelf vs iceberg melting can also be important in some sectors like Amundsen where strong melting at depth can affect the vertical entrainment of circumpolar deep water (Merino et al. 2018), although this is probably still a matter of debate (Pauling et al. 2016). References already included in ch.9, except: Schloesser, F., Friedrich, T., Timmermann, A., DeConto, R. M. and Pollard, D. (2019). Antarctic Iceberg impacts on future Southern Hemisphere Climate. Nature Climate Change (accepted).

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
40058	44	18		29	Certainty/uncertainty assignments? The whole section needs reconsideration - what are these statements: descriptions of known/speculated mechanisms with unknown effects, or with known. Are they part of knowledge we have or published expert opionion? How much is observational or model based. [Michael Tsimplis, China]	Certainty/uncertainty assignments? The whole section needs reconsideration - what are these statements: descriptions of known/speculated mechanisms with unknown effects, or with known. Are they part of knowledge we have or published expert opionion? How much is observational or model based.
6319	44	19	44	20	It is said here that GrIS melt has long been predicted to weaken the AMOC. However, I'm not aware of studies on past or future climate change that make a strong case for a large role of GrIS melt and a substantial AMOC strength reduction. The suggested connection between GrIS and AMOC changes over the last centuries (Caesar et al., 2018) is debated in the community. As detailed in section 9.2.4.1, there is little evidence that GrIS melting will have a large impact on the future AMOC strength (order 5-15%). Moreover, the high-end estimate of 15% that is provided could well be an overestimation because it stemms from climate model simulations that only includes GrIS melt, not the combined effect of GHG increase and GrIS melt. The combined effect might well be much smaller than the sum of the individual parts. [Pepijn Bakker, Netherlands]	It is said here that GrIS melt has long been predicted to weaken the AMOC. However, I'm not aware of studies on past or future climate change that make a strong case for a large role of GrIS melt and a substantial AMOC strength reduction. The suggested connection between GrIS and AMOC changes over the last centuries (Caesar et al., 2018) is debated in the community. As detailed in section 9.2.4.1, there is little evidence that GrIS melting will have a large impact on the future AMOC strength (order 5-15%). Moreover, the high-end estimate of 15% that is provided could well be an overestimation because it stemms from climate model simulations that only includes GrIS melt, not the combined effect of GHG increase and GrIS melt. The combined effect might well be much smaller than the sum of the individual parts.
19734	44	19	44	22	To make the reading smoother, I would cut this sentence in two. End after “Golledge et al., 2019)” And start a new sentence with “Melwater and icebert calving...”. I would also add “post” to “glacial and deglacial” for an easier reading. [Gwenaelle GREMION, Canada]	To make the reading smoother, I would cut this sentence in two. End after “Golledge et al., 2019)” And start a new sentence with “Melwater and icebert calving...”. I would also add “post” to “glacial and deglacial” for an easier reading.
26602	44	20	44	22	There is no need to mention AMOC shut down from Lauentide ice sheet. It is not a relevant scenario to the impacts from Greenland. [Jeff Ridley, United Kingdom (of Great Britain and Northern Ireland)]	There is no need to mention AMOC shut down from Lauentide ice sheet. It is not a relevant scenario to the impacts from Greenland.
19736	44	22	44	22	I would add the following reference to the two references: Gregoire, L.J., Payne, A.J. and Valdes, P.J., 2012. Deglacial rapid sea level rises caused by ice-sheet saddle collapses. Nature, 487(7406), p.219. [Gwenaelle GREMION, Canada]	I would add the following reference to the two references: Gregoire, L.J., Payne, A.J. and Valdes, P.J., 2012. Deglacial rapid sea level rises caused by ice-sheet saddle collapses. Nature, 487(7406), p.219.
41462	44	22	44	22	"may have caused a collapse" should be accompanied by a confidence level. [Charalampos Charalampidis, Germany]	"may have caused a collapse" should be accompanied by a confidence level.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
19738	44	22	44	28	This is a very long sentence. I would restructure it like so for clarity: “For Antarctica, meltwater at the coast and further afield from transported icebergs is predicted to decrease the rate of Antarctic bottom water production by increasing Southern Ocean stratification. This decrease in bottom water production will then weaken the global overturning circulation and increase sea ice extent and submarine melt...” [Gwenaelle GREMION, Canada]	This is a very long sentence. I would restructure it like so for clarity: “For Antarctica, meltwater at the coast and further afield from transported icebergs is predicted to decrease the rate of Antarctic bottom water production by increasing Southern Ocean stratification. This decrease in bottom water production will then weaken the global overturning circulation and increase sea ice extent and submarine melt...”
42660	44	23	44	43	The main source of Antarctic bottom water is the annual surface ocean freezing that results in the formation of up to 14 million sq. kms of pack ice. As the surface water freezes the resultant pack-ice is slightly less salty resulting a heavier salty water formation and the sinking of this water now known as Deep Bottom Water. This Deep Bottom Water is a major component of Earth’s ocean even past the equator. There is currently no significant annual production of bottom water associated with ice bergs. Being colder than the ocean, ice bergs initially freeze sea water to their base to form salt-water keels. This may produce some bottom water but is a one-off process and not an annual event. Furthermore, the areal extent of ice bergs is insignificant compared to the annual sq. km extent of pack ice. And the melting of ice bergs largely by ablation takes hundred of years and such melting cannot have a significant effect on sea level rise at the present time. The mention of the melting of ice bergs diluting the Southern Ocean and decreasing the amount of bottom water is fairy-tale science. [Howard Brady, Australia]	The main source of Antarctic bottom water is the annual surface ocean freezing that results in the formation of up to 14 million sq. kms of pack ice. As the surface water freezes the resultant pack-ice is slightly less salty resulting a heavier salty water formation and the sinking of this water now known as Deep Bottom Water. This Deep Bottom Water is a major component of Earth’s ocean even past the equator. There is currently no significant annual production of bottom water associated with ice bergs. Being colder than the ocean, ice bergs initially freeze sea water to their base to form salt-water keels. This may produce some bottom water but is a one-off process and not an annual event. Furthermore, the areal extent of ice bergs is insignificant compared to the annual sq. km extent of pack ice. And the melting of ice bergs largely by ablation takes hundred of years and such melting cannot have a significant effect on sea level rise at the present time. The mention of the melting of ice bergs diluting the Southern Ocean and decreasing the amount of bottom water is fairy-tale science.
14588	44	25	44	26	This is indeed a positive feedback for mass loss but a negative feedback for surface temperature (and sea ice) changes, as stated in the first part of the sentence. [Hugues Goosse, Belgium]	This is indeed a positive feedback for mass loss but a negative feedback for surface temperature (and sea ice) changes, as stated in the first part of the sentence.
26604	44	26	44	26	submarine melting' need to ensure the same terminology is used throughout for ice shelf basal melt and tidewater glaciers cf page 43. [Jeff Ridley, United Kingdom (of Great Britain and Northern Ireland)]	submarine melting' need to ensure the same terminology is used throughout for ice shelf basal melt and tidewater glaciers cf page 43.
40422	44	27	44	27	Another recent reference for this is Bronselaer et al. (2018), reference already included in ch. 9. [Nicolas Jourdain, France]	Another recent reference for this is Bronselaer et al. (2018), reference already included in ch. 9.
19740	44	28	44	29	I find this sentence very vague. It’s not clear what the authors want the reader to conclude from it. I would develop it or remove it altogether. [Gwenaelle GREMION, Canada]	I find this sentence very vague. It’s not clear what the authors want the reader to conclude from it. I would develop it or remove it altogether.
19724	44	31	44	32	Name the key processes that Ice sheet models fail to represent. [Gwenaelle GREMION, Canada]	Name the key processes that Ice sheet models fail to represent.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
30248	44	31	44	33	Ice sheet models have also improved since AR5, but still fail to fully represent some of the key processes. Please add also reference to Pattyn et al. (2017) DOI 10.1007/s40641-017-0069 [Frank Pattyn, Belgium]	Ice sheet models have also improved since AR5, but still fail to fully represent some of the key processes. Please add also reference to Pattyn et al. (2017) DOI 10.1007/s40641-017-0069
8374	44	31	44	43	"These model weaknesses present difficulties, in terms of of physics, numerical schemes, or spatial resolution, for both detection and attribution of the ice sheets " -> in fact, I think these weaknesses pertain to the ATTRIBUTION of ice sheet change to a particular external forcing (e.g. anthropogenic emissions). Detection is a purely an observation-based exercise, and as noted in this section, change HAS been detected. [Jeremy Fyke, Canada]	"These model weaknesses present difficulties, in terms of of physics, numerical schemes, or spatial resolution, for both detection and attribution of the ice sheets " -> in fact, I think these weaknesses pertain to the ATTRIBUTION of ice sheet change to a particular external forcing (e.g. anthropogenic emissions). Detection is a purely an observation-based exercise, and as noted in this section, change HAS been detected.
26606	44	31	44	43	This section is far too dismissive of ice sheet models in which great progress has been made - particularly in understanding uncertainty and sensitivity analysis. Who decides what are 'key' processes and whether they are missing or notThese is also power in multimodel ensembles. This paragraph seems a blatent attempt to leaverage SEJ - which is nothing more than voodoo - into the discussion. [Jeff Ridley, United Kingdom (of Great Britain and Northern Ireland)]	This section is far too dismissive of ice sheet models in which great progress has been made - particularly in understanding uncertainty and sensitivity analysis. Who decides what are 'key' processes and whether they are missing or notThese is also power in multimodel ensembles. This paragraph seems a blatent attempt to leaverage SEJ - which is nothing more than voodoo - into the discussion.
9884	44	32	44	32	Maybe it would be relevant to add here some examples of key processes that fail to be reproduced in ice-sheet models (e.g. sub-shelf melting, calving, grounding-line migration). [Kevin Bulthuis, Belgium]	Maybe it would be relevant to add here some examples of key processes that fail to be reproduced in ice-sheet models (e.g. sub-shelf melting, calving, grounding-line migration).
9492	44	32			use of the word "fail" could change to "struggle" . Models will never fully represent a process, does that mean they always fail? [Jason Briner, United States of America]	use of the word "fail" could change to "struggle" . Models will never fully represent a process, does that mean they always fail?
50778	44	33	44	33	"of" is repeated. [Hernan Edgardo Sala, Argentina]	"of" is repeated.
9886	44	33	44	33	in terms of of physics (dubble of, remove one). [Kevin Bulthuis, Belgium]	in terms of of physics (dubble of, remove one).
19742	44	33	44	35	This sentence “These model weaknesses...for future projections” remains very vague, especially the part “for both detection and attribution of the ice sheet”. I would reword it to something such as: These model present weaknesses in both quantifying ice sheet future sea level contributions and attributing these to the right ice sheet, due to their difficulties in representing the correct physics, or in issues in their numerical schemes or spatial resolution.” [Gwenaelle GREMION, Canada]	This sentence “These model weaknesses...for future projections” remains very vague, especially the part “for both detection and attribution of the ice sheet”. I would reword it to something such as: These model present weaknesses in both quantifying ice sheet future sea level contributions and attributing these to the right ice sheet, due to their difficulties in representing the correct physics, or in issues in their numerical schemes or spatial resolution.”
40424	44	34	44	34	bracket missing, and "attribution of the ice sheets" should probably be "attribution of the ice sheet changes". [Nicolas Jourdain, France]	bracket missing, and "attribution of the ice sheets" should probably be "attribution of the ice sheet changes".

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
31242	44	35	44	43	Structured expert judgement has most probably less scientific value than "classical" scientific studies based on observations and models. The added knowledge from such studies is small and would rather remove this part from the report. [Jeremie Mouginot, France]	Structured expert judgement has most probably less scientific value than "classical" scientific studies based on observations and models. The added knowledge from such studies is small and would rather remove this part from the report.
40060	44	36			So where the models fail we just ask the experts what they think. Lots of difficulties in how an expert is defined and what certainty one can assign in a group of opinions based on contradictory evidence. Moreover this method is not used in other parts. Perhaps just saying we do not know would be fairer. [Michael Tsimplis, China]	So where the models fail we just ask the experts what they think. Lots of difficulties in how an expert is defined and what certainty one can assign in a group of opinions based on contradictory evidence. Moreover this method is not used in other parts. Perhaps just saying we do not know would be fairer.
40062	44	37		38	may have been used but has it been validated? [Michael Tsimplis, China]	may have been used but has it been validated?
9888	44	38	44	39	The recent SEJ excercise. Of which exercise are you talking about? Maybe give the name or a reference here for this exercise. [Kevin Bulthuis, Belgium]	The recent SEJ excercise. Of which exercise are you talking about? Maybe give the name or a reference here for this exercise.
33264	44	38	44	40	This sentence seems to indicate that MICI contributed most to the increase in the uncertainty of expert judgments. Yet I do not find this argument in the Bamber et al. 2019 paper. This is therefore speculative, many other reasons play a role as well. This is problematic since this argument seems to be the main reason to use process models for the sea level projections. [Dewi Le Bars, Netherlands]	This sentence seems to indicate that MICI contributed most to the increase in the uncertainty of expert judgments. Yet I do not find this argument in the Bamber et al. 2019 paper. This is therefore speculative, many other reasons play a role as well. This is problematic since this argument seems to be the main reason to use process models for the sea level projections.
19726	44	38	44	41	Give the spatial distribution of the contribution to sea-level rise rate due to Ice sheet melting at present and projections in the future. [Gwenaelle GREMION, Canada]	Give the spatial distribution of the contribution to sea-level rise rate due to Ice sheet melting at present and projections in the future.
52210	44	39	44	40	What "projections…. have grown"? Are these median numbers, across the full distribution, or some other number? [Daniel Gilford, United States of America]	What "projections…. have grown"? Are these median numbers, across the full distribution, or some other number?
8376	44	40	44	43	While MICI is indeed an important uncertainty-inducing theory that has received recent attention, I am not sure it should be highlighted specifically in this 'timeless' Introduction section. It risks overshadowing other uncertainty-inducers which are likely to be objectively important, and also need focus in the post-AR6 period. These include poor projection skill of coastal ocean change (9.2.4.6), uncertainty in polar amplification/climate sensitivity (9.4.1), uncertainty in ice sheet-Earth system feedback loop strengths, uncertainty in ice sheet bed conditions and geometry, and others. Suggest avoiding naming particular uncertainty sources, or alternatively being more comprehensive in listing these uncertainties. [Jeremy Fyke, Canada]	While MICI is indeed an important uncertainty-inducing theory that has received recent attention, I am not sure it should be highlighted specifically in this 'timeless' Introduction section. It risks overshadowing other uncertainty-inducers which are likely to be objectively important, and also need focus in the post-AR6 period. These include poor projection skill of coastal ocean change (9.2.4.6), uncertainty in polar amplification/climate sensitivity (9.4.1), uncertainty in ice sheet-Earth system feedback loop strengths, uncertainty in ice sheet bed conditions and geometry, and others. Suggest avoiding naming particular uncertainty sources, or alternatively being more comprehensive in listing these uncertainties.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
40064	44	43			Perhaps it should be said that the method is non-scientific. What your statement says is that there is increasing consensus that the uncertainty is larger, i.e. that the "experts" agree less with each other OR that thy agree that they disagree more. The question of course is whether the process-based models are better validated and reliable which is not self evident as a complete reasoning is avoided. [Michael Tsimplis, China]	Perhaps it should be said that the method is non-scientific. What your statement says is that there is increasing consensus that the uncertainty is larger, i.e. that the "experts" agree less with each other OR that thy agree that they disagree more. The question of course is whether the process-based models are better validated and reliable which is not self evident as a complete reasoning is avoided.
52174	44	46			It would be nice to make this a bit more explicitly integrated like was the case for the marine sections whereby observations, theory, attribution and projections are considered in an integrated fashion rather than element-by-element. [Peter Thorne, Ireland]	It would be nice to make this a bit more explicitly integrated like was the case for the marine sections whereby observations, theory, attribution and projections are considered in an integrated fashion rather than element-by-element.
8378	44	48			The introduction of Section 'reconstructed past evolution' is very heavily front-weighted towards model studies. Suggest weighting instead towards extensive observational-based literature which forms basis for current understanding of past GrIS states. See Antarctic equivalent section weighting (9.4.3.1) for reference. [Jeremy Fyke, Canada]	The introduction of Section 'reconstructed past evolution' is very heavily front-weighted towards model studies. Suggest weighting instead towards extensive observational-based literature which forms basis for current understanding of past GrIS states. See Antarctic equivalent section weighting (9.4.3.1) for reference.
8380	44	48			Section 'reconstructed past evolution' is very heavily weighted towards reconstructions of GrIS state during warmer (versus colder) climate states. This is appropriate and justified given future climate trends. However, a justificiation for this weighting should be provided up front for reader context. E.g. "In the following section, particular focus is given to warm-climate GrIS reconstructions, given the relevance to present and future climate and GrIS trends." [Jeremy Fyke, Canada]	Section 'reconstructed past evolution' is very heavily weighted towards reconstructions of GrIS state during warmer (versus colder) climate states. This is appropriate and justified given future climate trends. However, a justificiation for this weighting should be provided up front for reader context. E.g. "In the following section, particular focus is given to warm-climate GrIS reconstructions, given the relevance to present and future climate and GrIS trends."
8386	44	48			Litte discussion exists on post-Pliocene-Pleisocene but pre-LIG interglacials (MIS*). Suggest adding discussion around current body of knowledge of this period, specifically around impact of interglacial length-versus-magnitude, and similarity to Holocene interglacial [Jeremy Fyke, Canada]	Litte discussion exists on post-Pliocene-Pleisocene but pre-LIG interglacials (MIS*). Suggest adding discussion around current body of knowledge of this period, specifically around impact of interglacial length-versus-magnitude, and similarity to Holocene interglacial
44970	44	49	44	51	While I agree the statement about the size of the GrIS, it deserves much more attention by describing the evidence and referring to the most recent key studies. Box 1.3 doesn't help to back this statement. [Darrell Kaufman, United States of America]	While I agree the statement about the size of the GrIS, it deserves much more attention by describing the evidence and referring to the most recent key studies. Box 1.3 doesn't help to back this statement.
19744	44	52	44	52	I would add the word "studied" at the end of "the era" for clarity. [Gwenaelle GREMION, Canada]	I would add the word "studied" at the end of "the era" for clarity.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
40066	44	52			strange sentence: what does "the agreement of quantitative constraints depends on the era mean"? Is it that we are virtually certain that it was smaller BUT there is disagreement on how smaller (which perhaps could be expressed by a range) or that the disagreement in the constraints permits doubts on whether it was smaller consistently in both these eras? [Michael Tsimplis, China]	strange sentence: what does "the agreement of quantitative constraints depends on the era mean"? Is it that we are virtually certain that it was smaller BUT there is disagreement on how smaller (which perhaps could be expressed by a range) or that the disagreement in the constraints permits doubts on whether it was smaller consistently in both these eras?
9890	44	53	44	53	maybe add BP after 33-3.0 Ma. [Kevin Bulthuis, Belgium]	maybe add BP after 33-3.0 Ma.
25314	44	53	44	54	Pre AR5 refs - are there improvements since AR5? [Sharon Smith, Canada]	Pre AR5 refs - are there improvements since AR5?
44972	44	53			Thank you for thinking of CH2 for information on the mPWP, but CH2 does not include anything about “climate model inter-comparisons and evaluation”. I believe that CH7 does as part of its discussion of equilibrium climate sensitivity. [Darrell Kaufman, United States of America]	Thank you for thinking of CH2 for information on the mPWP, but CH2 does not include anything about “climate model inter-comparisons and evaluation”. I believe that CH7 does as part of its discussion of equilibrium climate sensitivity.
19746	44	55	44	55	For clarity, I would add “model” before “simulations” and add “during the mPWP after “Greenland” to be as explicit as possible. [Gwenaelle GREMION, Canada]	For clarity, I would add “model” before “simulations” and add “during the mPWP after “Greenland” to be as explicit as possible.
26608	45	1	45	6	Need to mention that the pliocene is only weakly constrainted by sea level estimates. Why is it relevant that models overestimate PI ice sheet mass? Surely it is the Delta change with respect to control that matters.. [Jeff Ridley, United Kingdom (of Great Britain and Northern Ireland)]	Need to mention that the pliocene is only weakly constrainted by sea level estimates. Why is it relevant that models overestimate PI ice sheet mass? Surely it is the Delta change with respect to control that matters..
44974	45	2	7	6	Please specify whether these estimates are all for the mPWP. It’s not clear because the first sentence of the paragraph includes Holocene changes. [Darrell Kaufman, United States of America]	Please specify whether these estimates are all for the mPWP. It’s not clear because the first sentence of the paragraph includes Holocene changes.
40068	45	2			predictions? of the past - as the section title would indicate? or the future? [Michael Tsimplis, China]	predictions? of the past - as the section title would indicate? or the future?
9892	45	3	45	3	"from growth from the present volume by 0.6 m SLE". Can we observe this ice growth on Figure 9.19. Which model predicts this? Maybe add a reference. [Kevin Bulthuis, Belgium]	"from growth from the present volume by 0.6 m SLE". Can we observe this ice growth on Figure 9.19. Which model predicts this? Maybe add a reference.
9894	45	3	45	4	Some of these references do not appear in Figure 9.19. Is it intended? [Kevin Bulthuis, Belgium]	Some of these references do not appear in Figure 9.19. Is it intended?
19752	45	5	45	5	Minor correction: add the word “ice” before “volume” for clarity. [Gwenaelle GREMION, Canada]	Minor correction: add the word “ice” before “volume” for clarity.
9896	45	8	45	9	The sentence is not totally clear for me. For which period are these volume losses. Are you talking about the Pliocene. Maybe add some informations about this. [Kevin Bulthuis, Belgium]	The sentence is not totally clear for me. For which period are these volume losses. Are you talking about the Pliocene. Maybe add some informations about this.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
15010	45	8	45	19	There is some geological data indicating Greenland ice presence (with tidewater margins) during the Pliocene, before the onset of northern hemisphere glaciation, although these data are marine records (e.g. of ice-rafted debris) so not detailed on exactly where the ice may have been located. The data also span more than just interglacials which seems to be the focus of your text here. For info: Bachem et al. (2015) Earth and Planetary Science Letters, https://doi.org/10.1016/j.epsl.2016.04.024; and Blake-Mizen, K et al. (2018) Quaternary Science Reviews, https://doi.org/10.1016/j.quascirev.2019.01.015 [Erin McClymont, United Kingdom (of Great Britain and Northern Ireland)]	There is some geological data indicating Greenland ice presence (with tidewater margins) during the Pliocene, before the onset of northern hemisphere glaciation, although these data are marine records (e.g. of ice-rafted debris) so not detailed on exactly where the ice may have been located. The data also span more than just interglacials which seems to be the focus of your text here. For info: Bachem et al. (2015) Earth and Planetary Science Letters, https://doi.org/10.1016/j.epsl.2016.04.024; and Blake-Mizen, K et al. (2018) Quaternary Science Reviews, https://doi.org/10.1016/j.quascirev.2019.01.015
40070	45	8			still about the past? [Michael Tsimplis, China]	still about the past?
19754	45	12	45	12	Add the word “between” after “even”. [Gwenaelle GREMION, Canada]	Add the word “between” after “even”.
9494	45	12			extra parenthesis [Jason Briner, United States of America]	extra parenthesis
19756	45	13	45	13	Typo: change “equilibriate” to “equilibrate” . [Gwenaelle GREMION, Canada]	Typo: change “equilibriate” to “equilibrate” .
40468	45	17	45	17	I would re-word to advise caution on this estimate, as it is indeed reported in the referenced section. [Alessio Rovere, Germany]	I would re-word to advise caution on this estimate, as it is indeed reported in the referenced section.
26610	45	17	45	19	What whas the global mean sea level rise (with uncertainties)? Can you really have 'high confidence' when the constraints are so weak and simulated clinate so uncertain? What is tall of this really telling us? [Jeff Ridley, United Kingdom (of Great Britain and Northern Ireland)]	What whas the global mean sea level rise (with uncertainties)? Can you really have 'high confidence' when the constraints are so weak and simulated clinate so uncertain? What is tall of this really telling us?
19758	45	19	45	19	I would add “a quantified” in front of amount, to be explicit. [Gwenaelle GREMION, Canada]	I would add “a quantified” in front of amount, to be explicit.
8382	45	19	45	19	Suggest authors see if there is formal language for stating HIGH confidence in 'trend direction' (e.g. positive GrIS contribution to mPWP sea level) but LOW confidence in 'trend magnitude' (e.g. quantitative GrIS-sourced SLR #) [Jeremy Fyke, Canada]	Suggest authors see if there is formal language for stating HIGH confidence in 'trend direction' (e.g. positive GrIS contribution to mPWP sea level) but LOW confidence in 'trend magnitude' (e.g. quantitative GrIS-sourced SLR #)
40072	45	19			Very confused about the positioning of this whole section. Start from virtually certain and go to high confidence. Fine for the past but if the models have so much spread is there any confidence for the future and indeed for the very immediate future of this century. [Michael Tsimplis, China]	Very confused about the positioning of this whole section. Start from virtually certain and go to high confidence. Fine for the past but if the models have so much spread is there any confidence for the future and indeed for the very immediate future of this century.
9496	45	28			I don’t' see the "grey shading shows extent of grounded ice" in the figure. [Jason Briner, United States of America]	I don’t' see the "grey shading shows extent of grounded ice" in the figure.
50780	45	29	45	29	Consider adding ", respectively" at the end of this line. [Hernan Edgardo Sala, Argentina]	Consider adding ", respectively" at the end of this line.
19760	45	34	45	36	In my opinion, an uncertainty statement is missing here. [Gwenaelle GREMION, Canada]	In my opinion, an uncertainty statement is missing here.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
19766	45	34	45	44	If CO2 is more important than insolation and the current CO2 levels of >400ppm are potentially high enough to cause volume and mass changes of the GrIS, does this mean that the GrIS is already close to a collapse? How similar is the Pliocene-Pleistocene transition to current conditions? Can we compare the current climatic trends without adaptions to the evolution of the GrIs during this time period 3-2.5Ma BP?\ [Gwenaelle GREMION, Canada]	If CO2 is more important than insolation and the current CO2 levels of >400ppm are potentially high enough to cause volume and mass changes of the GrIS, does this mean that the GrIS is already close to a collapse? How similar is the Pliocene-Pleistocene transition to current conditions? Can we compare the current climatic trends without adaptions to the evolution of the GrIs during this time period 3-2.5Ma BP?\
41464	45	36	45	40	I advice the use of past tense when outlining previously published results. [Charalampos Charalampidis, Germany]	I advice the use of past tense when outlining previously published results.
19762	45	40	45	40	The wording is a bit awkward. I would suggest: "… and land-sea configuration) so using the Pliocene-Pleistocene transition as an analog is limited." [Gwenaelle GREMION, Canada]	The wording is a bit awkward. I would suggest: "… and land-sea configuration) so using the Pliocene-Pleistocene transition as an analog is limited."
9898	45	40	45	40	so it is limited as analogue. Suggestion: so it provides a limited analogue for future warming. [Kevin Bulthuis, Belgium]	so it is limited as analogue. Suggestion: so it provides a limited analogue for future warming.
9498	45	42			it was analysis of sub-ice bedrock, not sediments. [Jason Briner, United States of America]	it was analysis of sub-ice bedrock, not sediments.
50572	45	48	45	48	Please remove the 'small' in small ice caps (as they could have been very large). [Frank Paul, Switzerland]	Please remove the 'small' in small ice caps (as they could have been very large).
9900	45	49	45	49	The GrISs and AISs: maybe the s at the end of GrIS and AIS are not necessary. [Kevin Bulthuis, Belgium]	The GrISs and AISs: maybe the s at the end of GrIS and AIS are not necessary.
40074	45	49		50	hardly scientific knowledge. Does this express anything but uncertainty? [Michael Tsimplis, China]	hardly scientific knowledge. Does this express anything but uncertainty?
57938	45	51	45	55	Please seperate this part to 2-3 sentences.. Not clear what is ment with "and, by inference .... for the latter" [Bas de Boer, Netherlands]	Please seperate this part to 2-3 sentences.. Not clear what is ment with "and, by inference .... for the latter"
19764	45	53	45	53	add an "s" to "constraint". [Gwenaelle GREMION, Canada]	add an "s" to "constraint".

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
13722	45	53			This is a structural comment, given that much of this material is bound to change based on CMIP6 + PMIP4. The section generally looks strong, what's missing with the current structure is the relationship between the IPO/PDO and ENSO. ENSO and Pacific decadal variability are discussed here in different paragraphs implicitly as independent phenomena, yet Pacific decadal variability influences ENSO strength and flavour, notably with canonical ENSO events more common during positive IPO/PDO phases and enhanced frequency of La Nina and Central Pacific El Ninos events during negative IPO/PDO (e.g. alluded to in Kosaka and Xie 2013 Nature, on decadal mean state of the Pacific, discussed in Banholzer and Donner 2014 GRL, though there are certainly more recent papers directly on this subject). This is something to look at in CMIP6 output, as model bias in representing ENSO and PDO/IPO frequencies may be related. [Simon Donner, Canada]	This is a structural comment, given that much of this material is bound to change based on CMIP6 + PMIP4. The section generally looks strong, what's missing with the current structure is the relationship between the IPO/PDO and ENSO. ENSO and Pacific decadal variability are discussed here in different paragraphs implicitly as independent phenomena, yet Pacific decadal variability influences ENSO strength and flavour, notably with canonical ENSO events more common during positive IPO/PDO phases and enhanced frequency of La Nina and Central Pacific El Ninos events during negative IPO/PDO (e.g. alluded to in Kosaka and Xie 2013 Nature, on decadal mean state of the Pacific, discussed in Banholzer and Donner 2014 GRL, though there are certainly more recent papers directly on this subject). This is something to look at in CMIP6 output, as model bias in representing ENSO and PDO/IPO frequencies may be related.
26612	45		46		The discussions of paleo-climates does not touch on precip changes nor seasonality of the insolation changes some discussion to tie in with the mass balance section of the Intro. Ice sheet shrink whebn summer hot and winter cold and grow when summer cold and winter hot (increased precip). Where the jets go (sst gradients and orography) can explain model differences (affecting east coast snowfall). The presence of the Lauentide has a big influence on jets and Greenland climaology so rate of deglaciation is dependent on its presence or not. [Jeff Ridley, United Kingdom (of Great Britain and Northern Ireland)]	The discussions of paleo-climates does not touch on precip changes nor seasonality of the insolation changes some discussion to tie in with the mass balance section of the Intro. Ice sheet shrink whebn summer hot and winter cold and grow when summer cold and winter hot (increased precip). Where the jets go (sst gradients and orography) can explain model differences (affecting east coast snowfall). The presence of the Lauentide has a big influence on jets and Greenland climaology so rate of deglaciation is dependent on its presence or not.
25316	46	2	46	7	If Robinson et al. (2011) and Stone et al. (2013) are the basis for AR5 conclusions, you don't need to cite them here but rather summarize the AR5 assessment and then focus on what is new since then. [Sharon Smith, Canada]	If Robinson et al. (2011) and Stone et al. (2013) are the basis for AR5 conclusions, you don't need to cite them here but rather summarize the AR5 assessment and then focus on what is new since then.
19798	46	2	46	19	The contribution from Greenland to the LIG sea level can either be modeled by rather capturing the temperature or the elevation constraint. A more detailed comment on the individual contributions, i.e. What would be caused by temperature changes and how much sea level contribution would be caused by elevation changes, would help to understand the mentioned difficulties of using coupled climate-ice models. [Gwenaelle GREMION, Canada]	The contribution from Greenland to the LIG sea level can either be modeled by rather capturing the temperature or the elevation constraint. A more detailed comment on the individual contributions, i.e. What would be caused by temperature changes and how much sea level contribution would be caused by elevation changes, would help to understand the mentioned difficulties of using coupled climate-ice models.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
9902	46	4	46	4	the highest estimate was from an equilibrium simulation. Maybe it lacks a reference here. [Kevin Bulthuis, Belgium]	the highest estimate was from an equilibrium simulation. Maybe it lacks a reference here.
8384	46	4	46	4	Describe why an equilibrium LIG simulation is not an appropriate tool for estimating LIG SLR (e.g. "glacial response timescale is likely longer than LIG length, precluding full relaxation to equilibrium") [Jeremy Fyke, Canada]	Describe why an equilibrium LIG simulation is not an appropriate tool for estimating LIG SLR (e.g. "glacial response timescale is likely longer than LIG length, precluding full relaxation to equilibrium")
9904	46	5	46	5	the transient simulations were clustered at the low end (1.4-1.9 m). Maybe it lacks a reference here. [Kevin Bulthuis, Belgium]	the transient simulations were clustered at the low end (1.4-1.9 m). Maybe it lacks a reference here.
40076	46	7			These studies were available at AR5. Is this a matter of consensus in a change or a matter that there is no consensus and therefore changing of the experts would make a different assessment - a fatal for the process of IPCC situation. [Michael Tsimplis, China]	These studies were available at AR5. Is this a matter of consensus in a change or a matter that there is no consensus and therefore changing of the experts would make a different assessment - a fatal for the process of IPCC situation.
19768	46	8	46	8	It would be good to have a likelihood assessment for the SROCC values given. [Gwenaelle GREMION, Canada]	It would be good to have a likelihood assessment for the SROCC values given.
19794	46	11	46	22	I haven't found the complete definition of the accronym NEEM in the chapter. [Gwenaelle GREMION, Canada]	I haven't found the complete definition of the accronym NEEM in the chapter.
19770	46	12	46	12	Shouldn't it be "higher" temperatures line 12? if not, the wording of this sentence is confusing. [Gwenaelle GREMION, Canada]	Shouldn't it be "higher" temperatures line 12? if not, the wording of this sentence is confusing.
19772	46	17	46	18	Instead of "Exacerbate", it might be good to be more explicit by using "tended to increase Greenland's sea level rise contribution beyond observations by increasing the ice sheet sensitivity..." [Gwenaelle GREMION, Canada]	Instead of "Exacerbate", it might be good to be more explicit by using "tended to increase Greenland's sea level rise contribution beyond observations by increasing the ice sheet sensitivity..."
41466	46	21	46	21	Possible explenations for what? Please, clarify. [Charalampos Charalampidis, Germany]	Possible explenations for what? Please, clarify.
19774	46	21	46	22	This sentence with a triple "or" is difficult to understand. I was trying to reword it but I'm not sure what the authors mean here. [Gwenaelle GREMION, Canada]	This sentence with a triple "or" is difficult to understand. I was trying to reword it but I'm not sure what the authors mean here.
40078	46	21		31	The assumption that the LIG period estimates can be useful to some extent for future projections is at the heart of this. To the extent that clearly there is no consensus due to the uncertainty and the doubtful contribution to our understanding this whole discussion may become an appendix and a statement of insufficient knowledge or as likely as .... A very difficult point but needs to be dealt with objectively. [Michael Tsimplis, China]	The assumption that the LIG period estimates can be useful to some extent for future projections is at the heart of this. To the extent that clearly there is no consensus due to the uncertainty and the doubtful contribution to our understanding this whole discussion may become an appendix and a statement of insufficient knowledge or as likely as .... A very difficult point but needs to be dealt with objectively.
19776	46	24	46	26	A few typos (changes in bold here): It could also be due to the interpretation of temperature reconstructions I.e. differences between summer and annual temperatures, or between the margin and the interior." [Gwenaelle GREMION, Canada]	A few typos (changes in bold here): It could also be due to the interpretation of temperature reconstructions I.e. differences between summer and annual temperatures, or between the margin and the interior."

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
48726	46	26	46	29	The continuous presence of Dye3 ice through the Eemian (Willerslev et al, Science 2007, https://dx.doi.org/10.1126%2Fscience.1141758) means that the upper bound of GRIS contribution to the LIG high-stand is well below the stated 6.2 m. I'm in the process of a full Bayesian calibration for the last glacial cycle of the GRIS (using a full SSA/SIA hybrid glaciological model), and the maximum LIG sealevel contribution I get to date (after >10,000 full model runs, and > 2 million emulated model runs) is < 4.8 m eustatic when requiring continuous Dye3 ice through the Eemian (this work will be submitted this fall). With the addition of the requirement of continuous Camp Century ice (which Dorthe Dahl-Jensen has assured me of personally), the maximum contribution drops to < 2.8 m eustatic sea level equivalent. Note these are absolute ensemble bounds. [Lev Tarasov, Canada]	The continuous presence of Dye3 ice through the Eemian (Willerslev et al, Science 2007, https://dx.doi.org/10.1126%2Fscience.1141758) means that the upper bound of GRIS contribution to the LIG high-stand is well below the stated 6.2 m. I'm in the process of a full Bayesian calibration for the last glacial cycle of the GRIS (using a full SSA/SIA hybrid glaciological model), and the maximum LIG sealevel contribution I get to date (after >10,000 full model runs, and > 2 million emulated model runs) is < 4.8 m eustatic when requiring continuous Dye3 ice through the Eemian (this work will be submitted this fall). With the addition of the requirement of continuous Camp Century ice (which Dorthe Dahl-Jensen has assured me of personally), the maximum contribution drops to < 2.8 m eustatic sea level equivalent. Note these are absolute ensemble bounds.
25318	46	30	46	31	Remove last sentence in paragraph - this section is on Greenland Ice sheet so no need to add statement regarding Antarctica [Sharon Smith, Canada]	Remove last sentence in paragraph - this section is on Greenland Ice sheet so no need to add statement regarding Antarctica
19800	46	33	46	36	It was earlier mentioned, that the LIG is not comparable to the current climate conditions, thus, projections for the rise in sea level cannot be concluded from this period. The MIS-11, however, is mentioned here as relevant for long-term future projections. Is MIS-11 more simillar to the current climate (e.g. forcing, greenhouse gas contents, etc) and would a warming nowadays effect the ice sheet similar as it did during MIS-11? [Gwenaelle GREMION, Canada]	It was earlier mentioned, that the LIG is not comparable to the current climate conditions, thus, projections for the rise in sea level cannot be concluded from this period. The MIS-11, however, is mentioned here as relevant for long-term future projections. Is MIS-11 more simillar to the current climate (e.g. forcing, greenhouse gas contents, etc) and would a warming nowadays effect the ice sheet similar as it did during MIS-11?
19778	46	34	46	34	Likelihood vocabulary was always used until here. Perhaps best to keep using “very likely”, “likely”, etc instead of % intervals here? [Gwenaelle GREMION, Canada]	Likelihood vocabulary was always used until here. Perhaps best to keep using “very likely”, “likely”, etc instead of % intervals here?
19780	46	34	46	34	Suggestion to add “of the interglacial conditions” after “due to the longer duration”. [Gwenaelle GREMION, Canada]	Suggestion to add “of the interglacial conditions” after “due to the longer duration”.
19796	46	34	46	34	"due to the longer duration". Of what? Please precise or rephrase. [Gwenaelle GREMION, Canada]	"due to the longer duration". Of what? Please precise or rephrase.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
19802	46	38	46	43	How would a better understanding of the early Holocene improve the understanding and the estimates of the rates of ice loss during the deglaciation? What kind of data or simulations are missing? [Gwenaelle GREMION, Canada]	How would a better understanding of the early Holocene improve the understanding and the estimates of the rates of ice loss during the deglaciation? What kind of data or simulations are missing?
8388	46	38	46	43	Can the community comment on the role of what was possibly a physical connection between GrIS and Laurentide (e.g. across Nares Strait), and how that potentially impacted reconstruction estimates of GrIS LGM volume? [Jeremy Fyke, Canada]	Can the community comment on the role of what was possibly a physical connection between GrIS and Laurentide (e.g. across Nares Strait), and how that potentially impacted reconstruction estimates of GrIS LGM volume?
19782	46	41	46	43	I would suggest rewording this entire sentence as: “This may imply a large ice sheet at the LGM than previously thoughts (...), and thus large rates of ice during the deglaciation to reach early Holocene (~11 ka BP) conditions.” [Gwenaelle GREMION, Canada]	I would suggest rewording this entire sentence as: “This may imply a large ice sheet at the LGM than previously thoughts (...), and thus large rates of ice during the deglaciation to reach early Holocene (~11 ka BP) conditions.”
45306	46	45	46	45	“Maximum”. [Alessandro Silvano, Australia]	“Maximum”.
41468	46	45	46	45	"Maximum" [Charalampos Charalampidis, Germany]	"Maximum"
44976	46	45	46	48	The HTM is defined as the time of peak Holocene warmth regionally (e.g., doi: 10.1016/j.quascirev.2003.09.007). Rather than referencing the temperatures to the HTM, which is not a specific time, just state when it was warm around Greenland (6-4 ka). Then, discuss what the models show for the timing of peak warmth in the region. [Darrell Kaufman, United States of America]	The HTM is defined as the time of peak Holocene warmth regionally (e.g., doi: 10.1016/j.quascirev.2003.09.007). Rather than referencing the temperatures to the HTM, which is not a specific time, just state when it was warm around Greenland (6-4 ka). Then, discuss what the models show for the timing of peak warmth in the region.
33234	46	45	47	7	When reading this, it sort of comes across as the authors looking for one specific period to bracket the HTM (mostly on page 46), though spatial differences in timing and extent is briefly mention/acknowlegde. I think it is only reasonable to expect spatial differences and thus I would encourage restructuring so that this comes before the uncertainty-issue. In the 2004 Kaufmann et al, QSR-paper (Quaternary Science Reviews 23 (2004) 529–560) there is a nice overview of HTM Initiation and termination, and although more data since has been published and refined this, it still highlights the spatial differences across the western Arctic. The presence of the North American Ice Complex is bound to have an effect on the atmospheric circulation and temperature during coming out of the glacial period and into the Holocene. [Kristian Kjelden, Denmark]	When reading this, it sort of comes across as the authors looking for one specific period to bracket the HTM (mostly on page 46), though spatial differences in timing and extent is briefly mentioNot applicablecknowlegde. I think it is only reasonable to expect spatial differences and thus I would encourage restructuring so that this comes before the uncertainty-issue. In the 2004 Kaufmann et al, QSR-paper (Quaternary Science Reviews 23 (2004) 529–560) there is a nice overview of HTM Initiation and termination, and although more data since has been published and refined this, it still highlights the spatial differences across the western Arctic. The presence of the North American Ice Complex is bound to have an effect on the atmospheric circulation and temperature during coming out of the glacial period and into the Holocene.
19784	46	47	46	47	Change “that was earliest” to “which occurred first”. [Gwenaelle GREMION, Canada]	Change “that was earliest” to “which occurred first”.
41470	46	47	46	47	Replace "earliest" by "earlier". [Charalampos Charalampidis, Germany]	Replace "earliest" by "earlier".

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
19786	46	48	46	48	In my opinion, the level of detail in the types of proxies is beyond interest for this chapter summary. I would suggest changing “threshold lake sediments” to just “lake sediments”, and “radiocarbon-dated reworked organic material in moraines” to “radiocarbon-dated moraines”. [Gwenaelle GREMION, Canada]	In my opinion, the level of detail in the types of proxies is beyond interest for this chapter summary. I would suggest changing “threshold lake sediments” to just “lake sediments”, and “radiocarbon-dated reworked organic material in moraines” to “radiocarbon-dated moraines”.
19788	46	49	46	49	It would be helpful to mention it’s the “Greenland ice sheet’s margins” to be specific. [Gwenaelle GREMION, Canada]	It would be helpful to mention it’s the “Greenland ice sheet’s margins” to be specific.
19790	46	53	46	53	I suggest to be more specific when stating “with local discrepancies”. Discrepancies in what? Ice volume? [Gwenaelle GREMION, Canada]	I suggest to be more specific when stating “with local discrepancies”. Discrepancies in what? Ice volume?
19792	46	55	46	55	Same remark as previously: keep it to “lake records” and remove “threshold”. [Gwenaelle GREMION, Canada]	Same remark as previously: keep it to “lake records” and remove “threshold”.
19806	47	2	47	2	It might be useful to explicitly state that they are uncertainties in “both climate and margin reconstructions from proxy data”. [Gwenaelle GREMION, Canada]	It might be useful to explicitly state that they are uncertainties in “both climate and margin reconstructions from proxy data”.
19808	47	3	47	3	Why the use of italics for “likely” here? Also add a “the” before “timing”. [Gwenaelle GREMION, Canada]	Why the use of italics for “likely” here? Also add a “the” before “timing”.
28010	47	5	47	7	On page 47 line 5-7 it says that it is likely that the period of retreat of the Greenland Ice Sheet during the Holocene Thermal Maximum in all sectors persisted for 2000 to 3000 years. However, the previous sentence states that it is likely that a minimum ice sheet extent was reached during the period 8-3 ka BP. This is a period of 5000 years and thus about twice the length of time the entire retreat persisted. Does this mean lake sediment layer thicknesses are much more accurate than radio-carbon dating? Maybe include this here. [roderik van de wal, Netherlands]	On page 47 line 5-7 it says that it is likely that the period of retreat of the Greenland Ice Sheet during the Holocene Thermal Maximum in all sectors persisted for 2000 to 3000 years. However, the previous sentence states that it is likely that a minimum ice sheet extent was reached during the period 8-3 ka BP. This is a period of 5000 years and thus about twice the length of time the entire retreat persisted. Does this mean lake sediment layer thicknesses are much more accurate than radio-carbon dating? Maybe include this here.
19810	47	6	47	6	Would it be more accurate to state all sectors persisted for “at least” 2000-3000 years ? [Gwenaelle GREMION, Canada]	Would it be more accurate to state all sectors persisted for “at least” 2000-3000 years ?
9500	47	6			period of retreat? Or period of minimum ice extent? The later seems more on point than the former to me. [Jason Briner, United States of America]	period of retreat? Or period of minimum ice extent? The later seems more on point than the former to me.
25320	47	10			Section 9.4.2.2 - There should probably be a reference to Ch 2 (2.3.2.4.1) in this section, particularly in the 1st paragraph since conclusions made there are essentially same as Ch 2 (might also be able to make the text a bit shorter) [Sharon Smith, Canada]	Section 9.4.2.2 - There should probably be a reference to Ch 2 (2.3.2.4.1) in this section, particularly in the 1st paragraph since conclusions made there are essentially same as Ch 2 (might also be able to make the text a bit shorter)

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
19828	47	12	47	16	For an easier comparison, it would be helpful to have the increase of the global mean sea level for both periods, 2002-2011 and 1991-2011 in the same order. It is mentioned, that the sea level rise during the latter period was 8mm. However, it is not clear how much contributed the first period (1991-2002) compared to 2002-2011, even if it is mentioned that this second period was 6 fold compared to the preceding decade. [Gwenaelle GREMION, Canada]	For an easier comparison, it would be helpful to have the increase of the global mean sea level for both periods, 2002-2011 and 1991-2011 in the same order. It is mentioned, that the sea level rise during the latter period was 8mm. However, it is not clear how much contributed the first period (1991-2002) compared to 2002-2011, even if it is mentioned that this second period was 6 fold compared to the preceding decade.
8390	47	12	47	29	Use of differences between pentad means can introduce a spurious signal to calculated trends (e.g. trends in ice loss in Gt/yr) due to climate-induced internal variability (e.g. aliasing of NAO). Instead, recommend quoting change in terms of fitted trend over time, or difference between 30-year periods (if possible?). Also, for inter-chapter consistency, suggest assessing how metrics of change are presented elsewhere in AR6 and using these methods here, for GrIS trends. [Jeremy Fyke, Canada]	Use of differences between pentad means can introduce a spurious signal to calculated trends (e.g. trends in ice loss in Gt/yr) due to climate-induced internal variability (e.g. aliasing of NAO). Instead, recommend quoting change in terms of fitted trend over time, or difference between 30-year periods (if possible?). Also, for inter-chapter consistency, suggest assessing how metrics of change are presented elsewhere in AR6 and using these methods here, for GrIS trends.
19804	47	13	47	16	"the contribution amounted to 8 mm of global mean sea level rise" Does the contribution uniform throughout the globe, which contradict the following sentence (page 43, line 15-16) "Ice sheet melt leads to non-uniform changes in relative sea level around the world as a result of gravitational, rotational and deformational (GRD) effects (Box 9.2)." [Gwenaelle GREMION, Canada]	"the contribution amounted to 8 mm of global mean sea level rise" Does the contribution uniform throughout the globe, which contradict the following sentence (page 43, line 15-16) "Ice sheet melt leads to non-uniform changes in relative sea level around the world as a result of gravitational, rotational and deformational (GRD) effects (Box 9.2)."
25322	47	16	47	16	van den Broek et al. (2017) is after AR5 so unclear why it is in this sentence and should be in the next part of paragraph where results since AR5 are discussed. (note don't need to give information regarding sources on which AR5 may have been based) [Sharon Smith, Canada]	van den Broek et al. (2017) is after AR5 so unclear why it is in this sentence and should be in the next part of paragraph where results since AR5 are discussed. (note don't need to give information regarding sources on which AR5 may have been based)
19812	47	16	47	22	This is a very long sentence. I would restructure it like so for clarity: "… use of historical aerial photographs, modelling as well as improvements in data processing, estimating error corrections, and in synthesizing data from different measurement methods (…) have all provided an increasingly clear picture of accelerated ice mass loss through time. These combined techniques have extended the mass balance record...". [Gwenaelle GREMION, Canada]	This is a very long sentence. I would restructure it like so for clarity: "… use of historical aerial photographs, modelling as well as improvements in data processing, estimating error corrections, and in synthesizing data from different measurement methods (…) have all provided an increasingly clear picture of accelerated ice mass loss through time. These combined techniques have extended the mass balance record...".

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
19830	47	16	47	22	Also use of old maps and documentary records supplemented by viewshed analyses (e.g. Lea et al., 2014a; 2014b combined give the longest observational record of tidewater glacier behaviour in Greenland spanning 1761-present). References: Lea, J.M., Mair, D.W., Nick, F.M., Rea, B.R., Weidick, A., Kjaer, K.H., Morlighem, M., Van As, D. and Schofield, J.E., 2014. Terminus-driven retreat of a major southwest Greenland tidewater glacier during the early 19th century: insights from glacier reconstructions and numerical modelling. Lea, J.M., Mair, D.W.F., Nick, F.M., Rea, B.R., Van As, D., Morlighem, M., Nienow, P.W. and Weidick, A., 2014. Fluctuations of a Greenlandic tidewater glacier driven by changes in atmospheric forcing: observations and modelling of Kangiata Nunaata Sermia, 1859–present. The Cryosphere. 8, 2031-2045 [Gwenaelle GREMION, Canada]	Also use of old maps and documentary records supplemented by viewshed analyses (e.g. Lea et al., 2014a; 2014b combined give the longest observational record of tidewater glacier behaviour in Greenland spanning 1761-present). References: Lea, J.M., Mair, D.W., Nick, F.M., Rea, B.R., Weidick, A., Kjaer, K.H., Morlighem, M., Van As, D. and Schofield, J.E., 2014. Terminus-driven retreat of a major southwest Greenland tidewater glacier during the early 19th century: insights from glacier reconstructions and numerical modelling. Lea, J.M., Mair, D.W.F., Nick, F.M., Rea, B.R., Van As, D., Morlighem, M., Nienow, P.W. and Weidick, A., 2014. Fluctuations of a Greenlandic tidewater glacier driven by changes in atmospheric forcing: observations and modelling of Kangiata Nunaata Sermia, 1859–present. The Cryosphere. 8, 2031-2045
31244	47	19	47	19	Include McMillan et al. 2017, Mouginot et al. 2019 (McMillan, M., et al. (2016), A high-resolution record of Greenland mass balance, Geophys. Res. Lett., 43, 7002– 7010, doi:10.1002/2016GL069666. Mouginot J, et al.; Forty-six years of Greenland Ice Sheet mass balance from 1972 to 2018. Proceedings of the National Academy of Sciences May 2019, 116 (19) 9239-9244; DOI: 10.1073/pnas.1904242116.) [Jeremie Mouginot, France]	Include McMillan et al. 2017, Mouginot et al. 2019 (McMillan, M., et al. (2016), A high?resolution record of Greenland mass balance, Geophys. Res. Lett., 43, 7002– 7010, doi:10.1002/2016GL069666. Mouginot J, et al.; Forty-six years of Greenland Ice Sheet mass balance from 1972 to 2018. Proceedings of the National Academy of Sciences May 2019, 116 (19) 9239-9244; DOI: 10.1073/pnas.1904242116.)
50782	47	21	47	21	With regard to "the satellite era (early 1990s)", take into account that in the meteorological and climatic scientific literature it is often assumed that the beginning of the satellite era was in 1979 (e.g. Rienecker et al. (2011). MERRA: NASA's Modern-Era Retrospective Analysis for Research and Applications. J. Climate, 24, 3624–3648, https://doi.org/10.1175/JCLI-D-11-00015.1). [Hernan Edgardo Sala, Argentina]	With regard to "the satellite era (early 1990s)", take into account that in the meteorological and climatic scientific literature it is often assumed that the beginning of the satellite era was in 1979 (e.g. Rienecker et al. (2011). MERRA: NASA's Modern-Era Retrospective Analysis for Research and Applications. J. Climate, 24, 3624–3648, https://doi.org/10.1175/JCLI-D-11-00015.1).
15658	47	22			Pay attention to potential double-counting of mass loss from Greenland's peripheral glaciers (GRACE cannot resolve glaciers from ice sheet mass change). See also comments above. [Michael Zemp, Switzerland]	Pay attention to potential double-counting of mass loss from Greenland's peripheral glaciers (GRACE cannot resolve glaciers from ice sheet mass change). See also comments above.
19814	47	23	47	23	It is unclear what "pentad mean" refers to. [Gwenaelle GREMION, Canada]	It is unclear what "pentad mean" refers to.
52176	47	23			Pentad could mean 5-day (used in SST), 5-month or 5-year. I assume its five year here and to avoid potential ambiguous interpretation it may be worth replacing with 5-year averages? [Peter Thorne, Ireland]	Pentad could mean 5-day (used in SST), 5-month or 5-year. I assume its five year here and to avoid potential ambiguous interpretation it may be worth replacing with 5-year averages?

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
52212	47	24	47	25	Is there an oppurtunity here is discuss why the uncertainties are so much smaller in the recent decade than in the first decade (i.e. +/-13 vs. 82). It would help with interpretation of just ho much this trend has grown. [Daniel Gilford, United States of America]	Is there an oppurtunity here is discuss why the uncertainties are so much smaller in the recent decade than in the first decade (i.e. +/-13 vs. 82). It would help with interpretation of just ho much this trend has grown.
40080	47	24			Does still mean: in agreement with AR5 [Michael Tsimplis, China]	Does still mean: in agreement with AR5
25324	47	25	47	25	"greater" a better word than "faster" when referring to rate of ice loss? [Sharon Smith, Canada]	"greater" a better word than "faster" when referring to rate of ice loss?
31246	47	26	47	29	The numbers for ice loss give here are based on only one studied (Bamber et al. 2018b). I think it would make sense to include a range based on several recent "long-term" studies (such as IMBIE2, Mouginot et al. 2019). Typically, Mouginot et al. 2019 estimated -55+/-17 Gt/yr and -298+/-18 Gt/yr for the same period 1992-2002 and 2007-2016, respectively. Mouginot et al. 2019 also come to to conclusion that the GrIS was near balance but with a different timing that reported here: GrIS started to significantly loss mass at the end of the 90's rather than the mid 2000's. [Jeremie Mouginot, France]	The numbers for ice loss give here are based on only one studied (Bamber et al. 2018b). I think it would make sense to include a range based on several recent "long-term" studies (such as IMBIE2, Mouginot et al. 2019). Typically, Mouginot et al. 2019 estimated -55+/-17 Gt/yr and -298+/-18 Gt/yr for the same period 1992-2002 and 2007-2016, respectively. Mouginot et al. 2019 also come to to conclusion that the GrIS was near balance but with a different timing that reported here: GrIS started to significantly loss mass at the end of the 90's rather than the mid 2000's.
41472	47	27	47	27	Replace "was" with "is" or "has been". [Charalampos Charalampidis, Germany]	Replace "was" with "is" or "has been".
19816	47	27	47	27	Change “was” to “has been”. [Gwenaelle GREMION, Canada]	Change “was” to “has been”.
26614	47	27	47	28	What does this mean? Is this a spot measurement in 2016 or does this refer to the decade ending in 2016? What are the uncertainties? [Jeff Ridley, United Kingdom (of Great Britain and Northern Ireland)]	What does this mean? Is this a spot measurement in 2016 or does this refer to the decade ending in 2016? What are the uncertainties?
19818	47	28	47	28	I suggest adding “at a rate of” in front of “0.69mm yr-1”. [Gwenaelle GREMION, Canada]	I suggest adding “at a rate of” in front of “0.69mm yr-1”.
8392	47	28	47	28	Is there an error estimate around GrIS SLR contribution (0.69 mm/yr)? [Jeremy Fyke, Canada]	Is there an error estimate around GrIS SLR contribution (0.69 mm/yr)?
33236	47	34	47	37	Kjeldsen et al, 2015, (doi:10.1038/nature16183) also provides total mass balance for the entire ice sheet based on a similar approach to Box and Colgan 2013, but using an updated version of the Box SMB model and more discharge data, effectively producing an updated data set. [Kristian Kjelden, Denmark]	Kjeldsen et al, 2015, (doi:10.1038/nature16183) also provides total mass balance for the entire ice sheet based on a similar approach to Box and Colgan 2013, but using an updated version of the Box SMB model and more discharge data, effectively producing an updated data set.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
8394	47	42	47	43	Main [observational] progress since AR5 ... is ... compilation of Greenland bed topography...' - this is too limiting description of post-AR5 progress in my opinion. For example, what about firn aquifer mapping, proximal climate measurements (ocean and atmospheric), subglacial hydrology process understanding..? Suggest broadening the description of primary advances since AR5 to include all relevant advances (of which there are many, across multiple disciplines, not just glaciology), and revising to 'Primary observational improvements since AR5 include...' or similar. [Jeremy Fyke, Canada]	Main [observational] progress since AR5 ... is ... compilation of Greenland bed topography...' - this is too limiting description of post-AR5 progress in my opinion. For example, what about firn aquifer mapping, proximal climate measurements (ocean and atmospheric), subglacial hydrology process understanding..? Suggest broadening the description of primary advances since AR5 to include all relevant advances (of which there are many, across multiple disciplines, not just glaciology), and revising to 'Primary observational improvements since AR5 include...' or similar.
31252	47	42	47	52	Other progresses since AR5 could be mentionned: the processing of historical datasets such as Landsat or ERS to derive ice discharge, the digital elevation model from the beginning of the 80's made from aerial images and the increasing availability of satellite observations in recent (CryoSat-2, Landsat-8, Sentinel1-3) that are continuously acquiring data (Mouginot et al. 2017, Gourmelen et al. 2018). REF: Mouginot, J.; Rignot, E.; Scheuchl, B.; Millan, R. Comprehensive Annual Ice Sheet Velocity Mapping Using Landsat-8, Sentinel-1, and RADARSAT-2 Data. Remote Sens. 2017, 9, 364. doi: 10.3390/rs9040364 ; Gourmelen, N., Escorihuela, M. J., Shepherd, A., Foresta, L., Muir, A., Garcia-Monde'jar, A., et al. (2018). CryoSat-2 swath interferometric altimetry for mapping ice elevation and elevation change. Adv. Space Res. 62, 1226–1242. doi: 10.1016/j.asr.2017.11.014 [Jeremie Mouginot, France]	Other progresses since AR5 could be mentionned: the processing of historical datasets such as Landsat or ERS to derive ice discharge, the digital elevation model from the beginning of the 80's made from aerial images and the increasing availability of satellite observations in recent (CryoSat-2, Landsat-8, Sentinel1-3) that are continuously acquiring data (Mouginot et al. 2017, Gourmelen et al. 2018). REF: Mouginot, J.; Rignot, E.; Scheuchl, B.; Millan, R. Comprehensive Annual Ice Sheet Velocity Mapping Using Landsat-8, Sentinel-1, and RADARSAT-2 Data. Remote Sens. 2017, 9, 364. doi: 10.3390/rs9040364 ; Gourmelen, N., Escorihuela, M. J., Shepherd, A., Foresta, L., Muir, A., Garcia-Monde'jar, A., et al. (2018). CryoSat-2 swath interferometric altimetry for mapping ice elevation and elevation change. Adv. Space Res. 62, 1226–1242. doi: 10.1016/j.asr.2017.11.014
9502	47	44			Replace "This" with "These" [Jason Briner, United States of America]	Replace "This" with "These"
19820	47	47	47	47	Typo: change “is” to “are” ? [Gwenaelle GREMION, Canada]	Typo: change “is” to “are” ?
26616	47	47	47	47	Consitent terminology -definitions - needed 'submarine melt' but not 'peripheral thinning' previously mentioned [Jeff Ridley, United Kingdom (of Great Britain and Northern Ireland)]	Consitent terminology -definitions - needed 'submarine melt' but not 'peripheral thinning' previously mentioned
19822	47	48	47	48	“observations” is quite vague. I would suggest “poor coverage of ice thickness and bedrock observations.” [Gwenaelle GREMION, Canada]	“observations” is quite vague. I would suggest “poor coverage of ice thickness and bedrock observations.”
19824	47	50	47	50	Typos: change to “with models covering all or a large part of the 20th century [...]and have a spatial resolution of up to 1km”. [Gwenaelle GREMION, Canada]	Typos: change to “with models covering all or a large part of the 20th century [...]and have a spatial resolution of up to 1km”.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
19826	47	50	47	50	Suggested references to be added: Noël, B., van de Berg, W. J., van Wessem, J. M., van Meijgaard, E., van As, D., Lenaerts, J. T. M., Lhermitte, S., Kuipers Munneke, P., Smeets, C. J. P. P., van Ulft, L. H., van de Wal, R. S. W., and van den Broeke, M. R.: Modelling the climate and surface mass balance of polar ice sheets using RACMO2 – Part 1: Greenland (1958–2016), The Cryosphere, 12, 811-831, https://doi.org/10.5194/tc-12-811-2018, 2018. [Gwenaelle GREMION, Canada]	Suggested references to be added: Noël, B., van de Berg, W. J., van Wessem, J. M., van Meijgaard, E., van As, D., Lenaerts, J. T. M., Lhermitte, S., Kuipers Munneke, P., Smeets, C. J. P. P., van Ulft, L. H., van de Wal, R. S. W., and van den Broeke, M. R.: Modelling the climate and surface mass balance of polar ice sheets using RACMO2 – Part 1: Greenland (1958–2016), The Cryosphere, 12, 811-831, https://doi.org/10.5194/tc-12-811-2018, 2018.
41474	47	51	47	51	I suppose, here is meant lower resolution of 1 km, compared to the previous bed-topogralhy, 150-m unprescedented resolution?.. [Charalampos Charalampidis, Germany]	I suppose, here is meant lower resolution of 1 km, compared to the previous bed-topogralhy, 150-m unprescedented resolution?..
9906	47	55	47	55	maybe add surface melt rates to avoid any confusion with possible sub-shelf melt rates. [Kevin Bulthuis, Belgium]	maybe add surface melt rates to avoid any confusion with possible sub-shelf melt rates.
39252	47	55	48	2	It should be made more clear in this section that the use of the term "high melt rates" and "indicated melt" in this section should be clarified so that they reference to melt occuring at the surface of the ice sheet - and subsquently that this mass is lost as runoff [Stephen Chuter, United Kingdom (of Great Britain and Northern Ireland)]	It should be made more clear in this section that the use of the term "high melt rates" and "indicated melt" in this section should be clarified so that they reference to melt occuring at the surface of the ice sheet - and subsquently that this mass is lost as runoff
19832	48	1	48	2	Wording change to “in 2010 and exceptional melt rates in 2012 when 97% of the total surface area...” [Gwenaelle GREMION, Canada]	Wording change to “in 2010 and exceptional melt rates in 2012 when 97% of the total surface area...”
31248	48	1	48	10	Again the estimated mass loss are based solely on Bamber et al. 2018b. I would strenghen the text if estimates for other studies where included. Typically, Mouginot et al. 2019 estimated that 398 +/- 57 Gt of ice was lost in 2012 by the GIS. [Jeremie Mouginot, France]	Again the estimated mass loss are based solely on Bamber et al. 2018b. I would strenghen the text if estimates for other studies where included. Typically, Mouginot et al. 2019 estimated that 398 +/- 57 Gt of ice was lost in 2012 by the GIS.
9506	48	1			insert "event" between "melt" and "in" [Jason Briner, United States of America]	insert "event" between "melt" and "in"
19834	48	2	48	2	Add “a total” in front of “mass loss”. [Gwenaelle GREMION, Canada]	Add “a total” in front of “mass loss”.
37912	48	2			As noted in comment 73 on Chapter 2, the total mass loss from the Greenland Ice Sheet is stated in line 52 of page 2-8 to be 627+-89Gt during summer 2012. Here, the 2012 mass loss Is stated to be 444 +52Gt. These different numbers are probably reconciliable - summer 2012 vs 2012 as a whole.? Loss through glaciers included or not? It would help the reader if there was more uniformity of presentation however. [Adrian Simmons, United Kingdom (of Great Britain and Northern Ireland)]	As noted in comment 73 on Chapter 2, the total mass loss from the Greenland Ice Sheet is stated in line 52 of page 2-8 to be 627+-89Gt during summer 2012. Here, the 2012 mass loss Is stated to be 444 +52Gt. These different numbers are probably reconciliable - summer 2012 vs 2012 as a whole.? Loss through glaciers included or not? It would help the reader if there was more uniformity of presentation however.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
9504	48	2			It says this in Chapter 2: "The total annual mass loss from Greenland reached a historical record value during summer 2012 (-627±89 Gt), which was the greatest one-season loss since the end of the LIA (Box and Colgan, 2013; Kjeldsen et al., 2015; Tedesco et al., 2013)." Is it that -627 is annual value and -444 is a shorter priod of the year, like certain summer months? Or is there a mistake, could be worth tracking down. [Jason Briner, United States of America]	It says this in Chapter 2: "The total annual mass loss from Greenland reached a historical record value during summer 2012 (-627±89 Gt), which was the greatest one-season loss since the end of the LIA (Box and Colgan, 2013; Kjeldsen et al., 2015; Tedesco et al., 2013)." Is it that -627 is annual value and -444 is a shorter priod of the year, like certain summer months? Or is there a mistake, could be worth tracking down.
19836	48	4	48	4	Change wording to “2013), which was followed” . [Gwenaelle GREMION, Canada]	Change wording to “2013), which was followed” .
19838	48	4	48	4	Perhaps “loss” instead of “imbalance” is clearer here. [Gwenaelle GREMION, Canada]	Perhaps “loss” instead of “imbalance” is clearer here.
19840	48	7	48	7	Typo: “have” instead of “has”. [Gwenaelle GREMION, Canada]	Typo: “have” instead of “has”.
31250	48	12	48	16	If SMB has dominated ice discharge on their contribution to mass loss during recent period. On a longer time period (1972-2018), the mass loss is controlled at 66 ± 8% by glacier dynamics and 34 ± 8% by SMB (Mouginot et al. 2019). (Mouginot et al. 2019 found same partitionning between) Perhaps a point could be made that SMB can vary on shorter time scale than discharge, therefore can largely dominated mass loss over some "short" time period (~10 years), but that the picture is less clear for longer time period. [Jeremie Mouginot, France]	If SMB has dominated ice discharge on their contribution to mass loss during recent period. On a longer time period (1972-2018), the mass loss is controlled at 66 ± 8% by glacier dynamics and 34 ± 8% by SMB (Mouginot et al. 2019). (Mouginot et al. 2019 found same partitionning between) Perhaps a point could be made that SMB can vary on shorter time scale than discharge, therefore can largely dominated mass loss over some "short" time period (~10 years), but that the picture is less clear for longer time period.
19842	48	13	48	13	Add “ an” in front of “increase in solid...”. [Gwenaelle GREMION, Canada]	Add “ an” in front of “increase in solid...”.
8396	48	14	48	14	increase in solid ice discharge' - partition this into submarine melting versus calving, to extent possible, or at least note these two terms. My impression is that the latter is much more important? For context, the Antarctic discussion (9.4.3.2) explicity partitions into these two categories. [Jeremy Fyke, Canada]	increase in solid ice discharge' - partition this into submarine melting versus calving, to extent possible, or at least note these two terms. My impression is that the latter is much more important? For context, the Antarctic discussion (9.4.3.2) explicity partitions into these two categories.
33238	48	14	48	16	A new study using 276 flux gates assigned to 176 ice-sheet sectors report approximately steady solid ice discharge from 1986 to 2000, and then a sharp increase during 2000-2005, followed by approximately steady ice discharge through 2017, though recognizing regional and glacier variability. (Mankoff et al, ESSD2019, https://doi.org/10.5194/essd-11-769-2019) [Kristian Kjelden, Denmark]	A new study using 276 flux gates assigned to 176 ice-sheet sectors report approximately steady solid ice discharge from 1986 to 2000, and then a sharp increase during 2000-2005, followed by approximately steady ice discharge through 2017, though recognizing regional and glacier variability. (Mankoff et al, ESSD2019, https://doi.org/10.5194/essd-11-769-2019)

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
8398	48	17	48	29	Suggest noting the potential for complex feedbacks at the ocean interface that could control submarine melting/calving. E.g. increased surface melt -> increased subglacial discharge -> increased plume-driven ice face melting -> increased calving. plume circulation? This is very much 'current research' but not worth neglecting here, since it could be really important in determining sea-level-relevant ice-ocean interface dynamics. Suggest contacting Twila Moon/Timothy Bartholamaus/David Sutherland/? for more insight [Jeremy Fyke, Canada]	Suggest noting the potential for complex feedbacks at the ocean interface that could control submarine melting/calving. E.g. increased surface melt -> increased subglacial discharge -> increased plume-driven ice face melting -> increased calving. plume circulation? This is very much 'current research' but not worth neglecting here, since it could be really important in determining sea-level-relevant ice-ocean interface dynamics. Suggest contacting Twila Moon/Timothy Bartholamaus/David Sutherland/? for more insight
19844	48	20	48	24	For ease of reading, I would suggest "… that reveals darker bare ice beneath which lowers the albedo and leads to future melting, and from dark particulate...". [Gwenaelle GREMION, Canada]	For ease of reading, I would suggest "… that reveals darker bare ice beneath which lowers the albedo and leads to future melting, and from dark particulate...".
48906	48	20	48	26	The text focuses on surface albedo and factors affecting it, ending with a statement on a very high confidence that that surface darkeningas well as a reduction in cloud cover have been instrumental in enhancing the recent negative trend in GrIS SMB. There are, however, papers with different results. A positive cloud radiative effect on the ablation zone of West Greenland was found by Van den Broeke et al. (2008) and by Van Tricht et al. (2016) on average over the GrIS . Välisuo et al. (2018) found out that the vertically integrated column water (water vapour + cloud water + cloud ice) was positively correlated with the number of melt days, cumulative melt extent, and modeled melt amount in GrIS (squared correlations of 0.82 to 0.84). When the surface albedo exceeds about 0.6 and clouds radiate as nearly ideal blackbodies (cloud liquid water path exceeding 30 gm2) the cloud longwave forcing dominates over the cloud shortwave forcing with a net warming effect on the surface. References: Van den Broeke, M., Smeets, P., Ettema, J., & Kuipers-Munneke, P. (2008). Surface radiation balance in the ablation zone of the west Greenland ice sheet. Journal of Geophysical Research, 113, D13105. https://doi.org/10.1029/2007JD009283. Van Tricht, K., Lhermitte, S., Lenaerts, J. T. M., Gorodetskaya, I. V., L'Ecuyer, T. S., Noël, B., et al. (2016). Clouds enhance Greenland ice sheet meltwater runoff. Nature Communications, 7, 10266. https://doi.org/10.1038/ncomms10266. Välisuo, I., Vihma, T., Pirazzini, R., & Schäfer, M. (2018). Interannual variability of atmospheric conditions and surface melt in Greenland in 2000–2014. Journal of Geophysical Research: Atmospheres, 123, 10,443–10,463. https://doi.org/10.1029/2018JD028445. [Timo Vihma, Finland]	The text focuses on surface albedo and factors affecting it, ending with a statement on a very high confidence that that surface darkeningas well as a reduction in cloud cover have been instrumental in enhancing the recent negative trend in GrIS SMB. There are, however, papers with different results. A positive cloud radiative effect on the ablation zone of West Greenland was found by Van den Broeke et al. (2008) and by Van Tricht et al. (2016) on average over the GrIS . Välisuo et al. (2018) found out that the vertically integrated column water (water vapour + cloud water + cloud ice) was positively correlated with the number of melt days, cumulative melt extent, and modeled melt amount in GrIS (squared correlations of 0.82 to 0.84). When the surface albedo exceeds about 0.6 and clouds radiate as nearly ideal blackbodies (cloud liquid water path exceeding 30 gm2) the cloud longwave forcing dominates over the cloud shortwave forcing with a net warming effect on the surface. References: Van den Broeke, M., Smeets, P., Ettema, J., & Kuipers-Munneke, P. (2008). Surface radiation balance in the ablation zone of the west Greenland ice sheet. Journal of Geophysical Research, 113, D13105. https://doi.org/10.1029/2007JD009283. Van Tricht, K., Lhermitte, S., Lenaerts, J. T. M., Gorodetskaya, I. V., L'Ecuyer, T. S., Noël, B., et al. (2016). Clouds enhance Greenland ice sheet

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
41476	48	24	48	24	The inclusion of Charalampidis et al. (2015) who reported darkening of the ice sheet's lower accumulaton area in 2012 due to hampered percolation and meltwater saturation of the ice sheet surface is warranted here. Reference: Charalampidis et al. (2015) Changing surface–atmosphere energy exchange and refreezing capacity of the lower accumulation area, West Greenland, The Cryosphere 9 (6), 2163-2181. [Charalampos Charalampidis, Germany]	The inclusion of Charalampidis et al. (2015) who reported darkening of the ice sheet's lower accumulaton area in 2012 due to hampered percolation and meltwater saturation of the ice sheet surface is warranted here. Reference: Charalampidis et al. (2015) Changing surface–atmosphere energy exchange and refreezing capacity of the lower accumulation area, West Greenland, The Cryosphere 9 (6), 2163-2181.
41478	48	27	48	27	Steger et al. (2017b) is a model comparison, and hence not the most appropriate reference in this instance. In situ, process analyses worth including instead: De la Peña et al. (2015) Changes in the firn structure of the western Greenland Ice Sheet caused by recent warming, The Cryosphere, 9, 1203-1211; Charalampidis et al. (2016) Thermal tracing of retained meltwater in the lower accumulation area of the Southwestern Greenland ice sheet, Annals of Glaciology 57 (72), 1-10; Heilig et al (2018) Seasonal monitoring of melt and accumulation within the deep percolation zone of the Greenland Ice Sheet and comparison with simulations of regional climate modeling, The Cryosphere, 12 (6), 1851-1866. [Charalampos Charalampidis, Germany]	Steger et al. (2017b) is a model comparison, and hence not the most appropriate reference in this instance. In situ, process analyses worth including instead: De la Peña et al. (2015) Changes in the firn structure of the western Greenland Ice Sheet caused by recent warming, The Cryosphere, 9, 1203-1211; Charalampidis et al. (2016) Thermal tracing of retained meltwater in the lower accumulation area of the Southwestern Greenland ice sheet, Annals of Glaciology 57 (72), 1-10; Heilig et al (2018) Seasonal monitoring of melt and accumulation within the deep percolation zone of the Greenland Ice Sheet and comparison with simulations of regional climate modeling, The Cryosphere, 12 (6), 1851-1866.
41480	48	28	48	28	Include also: Forster et al. (2014) Extensive liquid melt water storage in firn within the Greenland ice sheet, Nature Geoscience 7(2), 95–98. [Charalampos Charalampidis, Germany]	Include also: Forster et al. (2014) Extensive liquid melt water storage in firn within the Greenland ice sheet, Nature Geoscience 7(2), 95–98.
45308	48	29	48	29	Missing dot at the end of the sentence [Alessandro Silvano, Australia]	Missing dot at the end of the sentence
8400	48	31	48	31	In previous paragraph the % contribution to GrIS mass loss from SMB decreases is stated. Can authors provide the same statement for ice discharge (e.g. increased calving?). [Jeremy Fyke, Canada]	In previous paragraph the % contribution to GrIS mass loss from SMB decreases is stated. Can authors provide the same statement for ice discharge (e.g. increased calving?).
8402	48	31	48	31	For naïve readers, I suggest clearly identifying the mechanisms by which anomalous ice can be lost to ocean (e.g., a balance of ice front retreat and/or increased ice velocity, if I'm not mistaken), and how these both balance out in contributing to recent observed trends. As it stands, these two mechanisms are not well dis-aggregated in the text. [Jeremy Fyke, Canada]	For naïve readers, I suggest clearly identifying the mechanisms by which anomalous ice can be lost to ocean (e.g., a balance of ice front retreat and/or increased ice velocity, if I'm not mistaken), and how these both balance out in contributing to recent observed trends. As it stands, these two mechanisms are not well dis-aggregated in the text.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
39256	48	31	48	35	Recent research in King et al (2018) explicitly makes the link between between changes in glacier frontal position with that of increases in ice sheet discharge over the 2000-2016 period (Figure 5 of the paper). Therefore it woulf be appropriate to include this citation in this part of the text. The full citation for this literature is as follows: King, M. D., Howat, I. M., Jeong, S., Noh, M. J., Wouters, B., Noël, B., and van den Broeke, M. R.: Seasonal to decadal variability in ice discharge from the Greenland Ice Sheet, The Cryosphere, 12, 3813-3825, https://doi.org/10.5194/tc-12-3813-2018, 2018. [Stephen Chuter, United Kingdom (of Great Britain and Northern Ireland)]	Recent research in King et al (2018) explicitly makes the link between between changes in glacier frontal position with that of increases in ice sheet discharge over the 2000-2016 period (Figure 5 of the paper). Therefore it woulf be appropriate to include this citation in this part of the text. The full citation for this literature is as follows: King, M. D., Howat, I. M., Jeong, S., Noh, M. J., Wouters, B., Noël, B., and van den Broeke, M. R.: Seasonal to decadal variability in ice discharge from the Greenland Ice Sheet, The Cryosphere, 12, 3813-3825, https://doi.org/10.5194/tc-12-3813-2018, 2018.
33240	48	31	48	35	Khan et al, 2014, Nature Climate Change (DOI: 10.1038/NCLIMATE2161), reported a speed-up and dynamic mass loss of the NorthEast Greenland Ice stream (NEGIS) initiated between 2003 and 2006 caused by regional warming, following almost three decades of dormancy. [Kristian Kjelden, Denmark]	Khan et al, 2014, Nature Climate Change (DOI: 10.1038/NCLIMATE2161), reported a speed-up and dynamic mass loss of the NorthEast Greenland Ice stream (NEGIS) initiated between 2003 and 2006 caused by regional warming, following almost three decades of dormancy.
45310	48	31	48	43	Is it possible to say that ocean-driven melting was the primary forcing during 2000-2010 period? More than SMB? This might be important to highlight, considering the Van Den Broake et al. works that seem to suggest this [Alessandro Silvano, Australia]	Is it possible to say that ocean-driven melting was the primary forcing during 2000-2010 period? More than SMB? This might be important to highlight, considering the Van Den Broake et al. works that seem to suggest this

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
31254	48	31	48	44	It could be added that the GrIS ice discharge has increased by 18% between 1972-2018 and that even if large glaciers are slowing down in recent years (e.g. Jakobshavn), overall the ice discharge has continued to increase. This is especially true along the northwest coast of Greenland, where discharge has steadily increased since 1999. In addition, a comment could be made about the dynamic in northern sectors of Greenland. Indeed, if this sector (with a large SLE potential) has yet seen limited changes in ice discharge, there are signs showing the "weakening" or disapearance of the butressing ice shelves. Thus, glacier speed has increased about 10% for Petermann, Humbold and Nioghalfjerfjorden and 55% for Zachariae Isstrom during the last decades (Khan et al., 2014; Mouginot et al., 2015). REF: Khan et al., Sustained mass loss of the northeast Greenland ice sheet triggered by regional warming. Nature Climate Change volume 4, pages 292–299 (2014); Mouginot et al., Fast retreat of Zachariæ Isstrøm, northeast Greenland, Science. 2015 Dec 11;350(6266):1357-61. doi: 10.1126/science.aac7111) [Jeremie Mouginot, France]	It could be added that the GrIS ice discharge has increased by 18% between 1972-2018 and that even if large glaciers are slowing down in recent years (e.g. Jakobshavn), overall the ice discharge has continued to increase. This is especially true along the northwest coast of Greenland, where discharge has steadily increased since 1999. In addition, a comment could be made about the dynamic in northern sectors of Greenland. Indeed, if this sector (with a large SLE potential) has yet seen limited changes in ice discharge, there are signs showing the "weakening" or disapearance of the butressing ice shelves. Thus, glacier speed has increased about 10% for Petermann, Humbold and Nioghalfjerfjorden and 55% for Zachariae Isstrom during the last decades (Khan et al., 2014; Mouginot et al., 2015). REF: Khan et al., Sustained mass loss of the northeast Greenland ice sheet triggered by regional warming. Nature Climate Change volume 4, pages 292–299 (2014); Mouginot et al., Fast retreat of Zachariæ Isstrøm, northeast Greenland, Science. 2015 Dec 11;350(6266):1357-61. doi: 10.1126/science.aac7111)
26618	48	31	48	44	Poor structure. First sentence needs to define tidewater glaciers and what thinning and retreating means. Need also to define or remove reference to 'flux gates'. It is not just Jakobshavn Isbrae which shows slowing from previous surge in late 1990's to 2000's. Note that it is still likely that they will surge again as/when warm water returns. [Jeff Ridley, United Kingdom (of Great Britain and Northern Ireland)]	Poor structure. First sentence needs to define tidewater glaciers and what thinning and retreating means. Need also to define or remove reference to 'flux gates'. It is not just Jakobshavn Isbrae which shows slowing from previous surge in late 1990's to 2000's. Note that it is still likely that they will surge again as/when warm water returns.
19846	48	35	48	36	To be explicit in the variable, I would suggest adding “the fastest moving glacier...has shown flowing ice flow speeds...”. [Gwenaelle GREMION, Canada]	To be explicit in the variable, I would suggest adding “the fastest moving glacier...has shown flowing ice flow speeds...”.
19848	48	37	48	39	Adding a likelihood/confidence to this statement would be useful. [Gwenaelle GREMION, Canada]	Adding a likelihood/confidence to this statement would be useful.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
40426	48	37	48	39	It may be worth mentioning that surface melting can increase subglacial runoff and enhance ocean melt rates (e.g., Slater et al 2016; Xu et al 2013), even though ocean warming may have a stronger effect on future melt rates than increased runoff (Morlighem et al. 2019). Additional references: Slater, D. A., Goldberg, D. N., Nienow, P. W., and Cowton, T. R. (2016). Scalings for submarine melting at tidewater glaciers from buoyant plume theory. Journal of Physical Oceanography, 46(6), 1839-1855. Xu, Y., Rignot, E., Fenty, I., Menemenlis, D. and Flexas, M. M. (2013). Subaqueous melting of Store Glacier, west Greenland from three-dimensional, high-resolution numerical modeling and ocean observations. Geophysical Research Letters, 40(17), 4648-4653. Morlighem, M., Wood, M., Seroussi, H., Choi, Y., and Rignot, E. (2019). Modeling the response of northwest Greenland to enhanced ocean thermal forcing and subglacial discharge. The Cryosphere, 13(2), 723-734. [Nicolas Jourdain, France]	It may be worth mentioning that surface melting can increase subglacial runoff and enhance ocean melt rates (e.g., Slater et al 2016; Xu et al 2013), even though ocean warming may have a stronger effect on future melt rates than increased runoff (Morlighem et al. 2019). Additional references: Slater, D. A., Goldberg, D. N., Nienow, P. W., and Cowton, T. R. (2016). Scalings for submarine melting at tidewater glaciers from buoyant plume theory. Journal of Physical Oceanography, 46(6), 1839-1855. Xu, Y., Rignot, E., Fenty, I., Menemenlis, D. and Flexas, M. M. (2013). Subaqueous melting of Store Glacier, west Greenland from three?dimensional, high?resolution numerical modeling and ocean observations. Geophysical Research Letters, 40(17), 4648-4653. Morlighem, M., Wood, M., Seroussi, H., Choi, Y., and Rignot, E. (2019). Modeling the response of northwest Greenland to enhanced ocean thermal forcing and subglacial discharge. The Cryosphere, 13(2), 723-734.
19850	48	41	48	42	For clarity, I would suggest changing “path flux” to “path that the ice takes from the ice sheet to the ocean corresponds...”. Furthermore, adding a confidence statement would be useful here. [Gwenaelle GREMION, Canada]	For clarity, I would suggest changing “path flux” to “path that the ice takes from the ice sheet to the ocean corresponds...”. Furthermore, adding a confidence statement would be useful here.
19852	48	46	48	47	I would suggest rewording the sentence and cut it into two: “Further observations are needed to better understand the physical processes that influence the ice sheet’s behavior in general. They are all needed to provide more accurate model boundary conditions such as ...”. [Gwenaelle GREMION, Canada]	I would suggest rewording the sentence and cut it into two: “Further observations are needed to better understand the physical processes that influence the ice sheet’s behavior in general. They are all needed to provide more accurate model boundary conditions such as ...”.
26620	48	46	48	55	In the into basal melt was dismissed as insignificant, yet here it is suggested that the condition at the berock of hydrology is important. A section describing the importance of water getting to the bedrock for superglacial lake drainage, tidewater fresh water plumes, ice sheet dynamics , etc [Jeff Ridley, United Kingdom (of Great Britain and Northern Ireland)]	In the into basal melt was dismissed as insignificant, yet here it is suggested that the condition at the berock of hydrology is important. A section describing the importance of water getting to the bedrock for superglacial lake drainage, tidewater fresh water plumes, ice sheet dynamics , etc
19854	48	48	48	49	I would suggest rewording to “It is important to improve the understanding of what controls SMB changes, water pathways on, through…” [Gwenaelle GREMION, Canada]	I would suggest rewording to “It is important to improve the understanding of what controls SMB changes, water pathways on, through…”

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
41482	48	50	48	50	Next to Machguth et al. (2016), include also: MacFerrin et al. (in press) Rapid expansion of Greenland's low-permeability ice slabs, Nature. [Charalampos Charalampidis, Germany]	Next to Machguth et al. (2016), include also: MacFerrin et al. (in press) Rapid expansion of Greenland's low-permeability ice slabs, Nature.
19856	48	54	48	54	Add the words "ice sheet" after "affect". [Gwenaelle GREMION, Canada]	Add the words "ice sheet" after "affect".
19858	48	55	48	55	Typo: remove "the". [Gwenaelle GREMION, Canada]	Typo: remove "the".
49902	49	1	49	1	see also Hofer et al, Nature Clim Change, 2019 "Cloud microphysics and circulation anomalies control differences in future Greenland melt." This paper demonstrates that cloud schemes between different GCMs have a bigger impact on future melt than difference in RCP scenarios. [Jonathan Bamber, United Kingdom (of Great Britain and Northern Ireland)]	see also Hofer et al, Nature Clim Change, 2019 "Cloud microphysics and circulation anomalies control differences in future Greenland melt." This paper demonstrates that cloud schemes between different GCMs have a bigger impact on future melt than difference in RCP scenarios.
8442	49	4			Section title 'Model Evaluation and Attribution' is unclear. Model evaluation involves the assessment of model performance relative to observations, with the successful outcome being a 'trustworthy' model that can be used for various experiments. 'Model Attribution' is a misnomer - the model is not being attributed to anything. Rather, attribution exercises use evaluated models, to attribute the (combination of) forcings that are responsible for observed changes. Suggest separating into two section, or (less desireably) renaming to "Model evaluation and attribution of observed changes", and ensuring full consistency with Chapter 3, Section 3.1, where consistent AR6 language describing model evaluation and detection/attribution of change is present, and Chapter 3, Section 3.4.3.2 (Human Influence on the Cryosphere: Ice Sheets). [Jeremy Fyke, Canada]	Section title 'Model Evaluation and Attribution' is unclear. Model evaluation involves the assessment of model performance relative to observations, with the successful outcome being a 'trustworthy' model that can be used for various experiments. 'Model Attribution' is a misnomer - the model is not being attributed to anything. Rather, attribution exercises use evaluated models, to attribute the (combination of) forcings that are responsible for observed changes. Suggest separating into two section, or (less desireably) renaming to "Model evaluation and attribution of observed changes", and ensuring full consistency with Chapter 3, Section 3.1, where consistent AR6 language describing model evaluation and detectioNot applicablettribution of change is present, and Chapter 3, Section 3.4.3.2 (Human Influence on the Cryosphere: Ice Sheets).
8404	49	6	49	6	For naïve readers, suggest indicate that SMB modelling is NOT equivalent to full ice mass modelling (SMB is one term of several in the ice sheet mass budget closure equation). Perhaps, even preface this section (9.4.2.3) with a clear description of where modelling process improvements are focussed (e.g. SMB, dynamics, ocean interface, and coupling), before diving into SMB. [Jeremy Fyke, Canada]	For naïve readers, suggest indicate that SMB modelling is NOT equivalent to full ice mass modelling (SMB is one term of several in the ice sheet mass budget closure equation). Perhaps, even preface this section (9.4.2.3) with a clear description of where modelling process improvements are focussed (e.g. SMB, dynamics, ocean interface, and coupling), before diving into SMB.
41484	49	8	49	8	Relevant in situ citations: Fausto et al. (2018) A snow density dataset for improving surface boundary conditions in Greenland ice sheet firn modeling, Frontiers in Earth Science 6 (51); Vandecrux et al. (2019) Firn data compilation reveals widespread decrease of firn air content in western Greenland, The Cryosphere 13 (3), 845-859. [Charalampos Charalampidis, Germany]	Relevant in situ citations: Fausto et al. (2018) A snow density dataset for improving surface boundary conditions in Greenland ice sheet firn modeling, Frontiers in Earth Science 6 (51); Vandecrux et al. (2019) Firn data compilation reveals widespread decrease of firn air content in western Greenland, The Cryosphere 13 (3), 845-859.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
19860	49	9	49	9	Change end of the sentence to “have improved SMB projections” to state explicitly the variable discussed, It would be interesting to provide to the reader a quantitative value for the reduced uncertainty in the projections here. [Gwenaelle GREMION, Canada]	Change end of the sentence to “have improved SMB projections” to state explicitly the variable discussed, It would be interesting to provide to the reader a quantitative value for the reduced uncertainty in the projections here.
19862	49	9	49	10	Same remark as above: state “uncertainties in SMB projections remain due to...” explicitly. [Gwenaelle GREMION, Canada]	Same remark as above: state “uncertainties in SMB projections remain due to...” explicitly.
26622	49	12	49	12	Rererence to CMIP5 models is inappropriate. This review relates to CMIP6 models which are much improved in cloud micro-physics for mixed-phase cloud. A cross reference to section 7.1 (possibly FAQ7.1)is required here [Jeff Ridley, United Kingdom (of Great Britain and Northern Ireland)]	Rererence to CMIP5 models is inappropriate. This review relates to CMIP6 models which are much improved in cloud micro-physics for mixed-phase cloud. A cross reference to section 7.1 (possibly FAQ7.1)is required here
19864	49	12	49	16	Add “in the ice” after “meltwater “line 15. Also, I would suggest to add “the representation of blowing snow processes” in the poorly represented processes list. A good reference for this is perhaps: Lenaerts, J.T.M., den Broeke, M.R., Déry, S.J., Meijgaard, E., Berg, W.J., Palm, S.P. and Sanz Rodrigo, J., 2012. Modeling drifting snow in Antarctica with a regional climate model: 1. Methods and model evaluation. Journal of Geophysical Research: Atmospheres, 117(D5). [Gwenaelle GREMION, Canada]	Add “in the ice” after “meltwater “line 15. Also, I would suggest to add “the representation of blowing snow processes” in the poorly represented processes list. A good reference for this is perhaps: Lenaerts, J.T.M., den Broeke, M.R., Déry, S.J., Meijgaard, E., Berg, W.J., Palm, S.P. and Sanz Rodrigo, J., 2012. Modeling drifting snow in Antarctica with a regional climate model: 1. Methods and model evaluation. Journal of Geophysical Research: Atmospheres, 117(D5).
26624	49	16	49	16	Atmospheric blocking has also improved in Ar^ models Cross reference to figure 10.7 [Jeff Ridley, United Kingdom (of Great Britain and Northern Ireland)]	Atmospheric blocking has also improved in Ar^ models Cross reference to figure 10.7
41486	49	16	49	16	Instead of Machguth et al. (2016), which is an in situ sudy and has been appropriately cited earlier in the paragraph, include the recent relevant future projections: MacFerrin et al. (in press) Rapid expansion of Greenland’s low-permeability ice slabs, Nature. [Charalampos Charalampidis, Germany]	Instead of Machguth et al. (2016), which is an in situ sudy and has been appropriately cited earlier in the paragraph, include the recent relevant future projections: MacFerrin et al. (in press) Rapid expansion of Greenland’s low-permeability ice slabs, Nature.
9508	49	19	49	20	this is sort of awkward unless evidence is presented to support that such events may become more frequent in the future. A skeptic could read this and think, well duh, but the those studies could also overestimate the projected sl contribution if such events become less frequent in the future. It just seems a little alarmist. [Jason Briner, United States of America]	this is sort of awkward unless evidence is presented to support that such events may become more frequent in the future. A skeptic could read this and think, well duh, but the those studies could also overestimate the projected sl contribution if such events become less frequent in the future. It just seems a little alarmist.
9510	49	20			in "the" future. Add "the" [Jason Briner, United States of America]	in "the" future. Add "the"
19866	49	22	49	22	Typo: add “in” before “this century”. [Gwenaelle GREMION, Canada]	Typo: add “in” before “this century”.
9512	49	22			maybe write "there is" medium confidence. So far this report is written in third person, not first. [Jason Briner, United States of America]	maybe write "there is" medium confidence. So far this report is written in third person, not first.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
19868	49	25	49	30	For ease of reading, I would suggest cutting the sentence into two after Schlegel et al., 2015). And start the sentence with “This improvement is closely linked...”. I would also add a few modifications to the end of the sentence: “and new techniques use to generate internally consistent..”. [Gwenaelle GREMION, Canada]	For ease of reading, I would suggest cutting the sentence into two after Schlegel et al., 2015). And start the sentence with “This improvement is closely linked...”. I would also add a few modifications to the end of the sentence: “and new techniques use to generate internally consistent..”.
19876	49	25	49	40	Is it possible to give a concrete number of the model resolution for the mentioned improved model projecting the future of the GrIS? [Gwenaelle GREMION, Canada]	Is it possible to give a concrete number of the model resolution for the mentioned improved model projecting the future of the GrIS?
19870	49	36	49	37	Re-order the sentence as: … can show large mismatches with present-day observed geometry and velocity of the ice sheet”. [Gwenaelle GREMION, Canada]	Re-order the sentence as: … can show large mismatches with present-day observed geometry and velocity of the ice sheet”.
19872	49	42	49	44	A confidence statement is missing from the first sentence of this paragraph. [Gwenaelle GREMION, Canada]	A confidence statement is missing from the first sentence of this paragraph.
9514	49	42			Replace "Greenland" with "GrIS" [Jason Briner, United States of America]	Replace "Greenland" with "GrIS"
8406	49	47	55	47	Attribution of ongoing change to anthropogenic (or other) external forcing is not limited (for GrIS) by lack of observations. Indeed, available observations indicate a clear negative trend in GrIS mass. Rather it is primarily limited by lack of fully coupled models, that can assess the link between external climate forcing through the coupled climate/ice sheet system, to a robustly-simulated ice sheet mass response. [Jeremy Fyke, Canada]	Attribution of ongoing change to anthropogenic (or other) external forcing is not limited (for GrIS) by lack of observations. Indeed, available observations indicate a clear negative trend in GrIS mass. Rather it is primarily limited by lack of fully coupled models, that can assess the link between external climate forcing through the coupled climate/ice sheet system, to a robustly-simulated ice sheet mass response.
19874	49	50	49	50	I would suggest to add “of the exact mechanism for each change” after “formal attribution” for clarity. [Gwenaelle GREMION, Canada]	I would suggest to add “of the exact mechanism for each change” after “formal attribution” for clarity.
9516	49	52			Replace "Greenland" with "GrIS" [Jason Briner, United States of America]	Replace "Greenland" with "GrIS"
41488	50	1	50	1	"Greenland" [Charalampos Charalampidis, Germany]	"Greenland"
8408	50	1	50	2	The 2040 year for anthropogenic signal emergence for Greenland Ice Sheet is based on a highly conservative signal-to-noise assessment (S/N ratio>1). The paper from where this value stems (I was lead author, paper at https://agupubs.onlinelibrary.wiley.com/doi/epdf/10.1002/2014GL060735) notes that for more sensitive signal-to-noise assessment techniques, the emergence year can strongly reduce, to 2021. And that point-specific emergence (e.g. at Summit Camp, or in ablation areas) can occur much sooner. Suggest noting these points, and more generally noting that 'emergence year' depends strongly on the tecnhique used to separate signal from noise (more sensitive techniques will detect emergence earlier). [Jeremy Fyke, Canada]	The 2040 year for anthropogenic signal emergence for Greenland Ice Sheet is based on a highly conservative signal-to-noise assessment (S/N ratio>1). The paper from where this value stems (I was lead author, paper at https://agupubs.onlinelibrary.wiley.com/doi/epdf/10.1002/2014GL060735) notes that for more sensitive signal-to-noise assessment techniques, the emergence year can strongly reduce, to 2021. And that point-specific emergence (e.g. at Summit Camp, or in ablation areas) can occur much sooner. Suggest noting these points, and more generally noting that 'emergence year' depends strongly on the tecnhique used to separate signal from noise (more sensitive techniques will detect emergence earlier).
25326	50	8	50	8	The acronym GMSL has not been defined [Sharon Smith, Canada]	The acronym GMSL has not been defined

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
25328	50	11	50	11	Has Aschwanden et al. (2019) been published or accepted? It isn't clear from reference list this is the case. [Sharon Smith, Canada]	Has Aschwanden et al. (2019) been published or accepted? It isn't clear from reference list this is the case.
8410	50	14	50	15	"The ranges reflect uncertainties…": I would agree that climate input provides largest uncertainty (also see Fyke et al. 2014 for a GrIS-specific assessment of this uncertainty, https://link.springer.com/article/10.1007/s00382-014-2050-7 Is there a formal community consensus statement around uncertainty 'ranking' that could be cited here, so that this statement has some formal justification? [Jeremy Fyke, Canada]	"The ranges reflect uncertainties…": I would agree that climate input provides largest uncertainty (also see Fyke et al. 2014 for a GrIS-specific assessment of this uncertainty, https://link.springer.com/article/10.1007/s00382-014-2050-7 Is there a formal community consensus statement around uncertainty 'ranking' that could be cited here, so that this statement has some formal justification?
8412	50	16	50	16	Why is the 84th quantile values used here? Would quoting mean quantiles reduce this to within previously-found ranges? [Jeremy Fyke, Canada]	Why is the 84th quantile values used here? Would quoting mean quantiles reduce this to within previously-found ranges?
8414	50	18	50	19	Clarify if these temperature change values (2C, 5C) are for global average, or Greenland region average. [Jeremy Fyke, Canada]	Clarify if these temperature change values (2C, 5C) are for global average, or Greenland region average.
50784	50	19	50	19	Consider adding ", respectively" at the end of "approximately equivalent to RCP2.6 and RCP8.5". [Hernan Edgardo Sala, Argentina]	Consider adding ", respectively" at the end of "approximately equivalent to RCP2.6 and RCP8.5".
52178	50	26	51	4	This table takes up a lot of space and I'm not sure adds terribly much. There are likely ways to compress this information or perhaps show it graphically which may make it both more accessible and take up less overall room. It feels largely redundant with the figure that follows and you likely do not need both? [Peter Thorne, Ireland]	This table takes up a lot of space and I'm not sure adds terribly much. There are likely ways to compress this information or perhaps show it graphically which may make it both more accessible and take up less overall room. It feels largely redundant with the figure that follows and you likely do not need both?
16052	50	28	51	2	For completeness, RCP6.0 should be included in Table 9.2. [SAI MING LEE, China]	For completeness, RCP6.0 should be included in Table 9.2.
8678	50	28	51	3	The lowest projections of the Greenland ice-sheet to future sea-level rise from Calov et al 2018 for RCP 4,5 and 2100 (1,9cm) is slighy lower than other estimates, including Fürst et al 2015 (2,8cm), although Calov et al (2018) is based on 3 GCMs only. For users of these projections, it would be useful to understand why there are these differences among studies and if such low projections are credible, to the extent it is possible. [Goneri Le Cozannet, France]	The lowest projections of the Greenland ice-sheet to future sea-level rise from Calov et al 2018 for RCP 4,5 and 2100 (1,9cm) is slighy lower than other estimates, including Fürst et al 2015 (2,8cm), although Calov et al (2018) is based on 3 GCMs only. For users of these projections, it would be useful to understand why there are these differences among studies and if such low projections are credible, to the extent it is possible.
9752	50	28	51	4	Change the heading "Notes" to something a bit more descriptive, such as "Range Definition" [Andra Garner, United States of America]	Change the heading "Notes" to something a bit more descriptive, such as "Range Definition"
19878	50	30	50	30	Table 9.2: it might be helpful to state that no “Notes” means it only used 1 RCM ? As it stands, the reader has to presume it is the case. [Gwenaelle GREMION, Canada]	Table 9.2: it might be helpful to state that no “Notes” means it only used 1 RCM ? As it stands, the reader has to presume it is the case.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
31256	51	15	51	17	Based on most accurate bed topography published, this is not completely true: Morlighem et al. 2017 has shown that they are troughs below sea level up to the center of the ice sheet (as stated in the abstract : "reveals new pathways by which AW can access glaciers with marine-based basins, thereby highlighting sectors of Greenland that are most vulnerable to future oceanic forcing.") REF: Morlighem, M., Williams, C. N., Rignot, E., An, L., Arndt, J. E., Bamber, J. L., … Zinglersen, K. B. (2017). BedMachine v3: Complete bed topography and ocean bathymetry mapping of Greenland from multibeam echo sounding combined with mass conservation, Geophysical Research Letters, 44, 11,051– 11,061. https://doi.org/10.1002/2017GL074954 [Jeremie Mouginot, France]	Based on most accurate bed topography published, this is not completely true: Morlighem et al. 2017 has shown that they are troughs below sea level up to the center of the ice sheet (as stated in the abstract : "reveals new pathways by which AW can access glaciers with marine?based basins, thereby highlighting sectors of Greenland that are most vulnerable to future oceanic forcing.") REF: Morlighem, M., Williams, C. N., Rignot, E., An, L., Arndt, J. E., Bamber, J. L., … Zinglersen, K. B. (2017). BedMachine v3: Complete bed topography and ocean bathymetry mapping of Greenland from multibeam echo sounding combined with mass conservation, Geophysical Research Letters, 44, 11,051– 11,061. https://doi.org/10.1002/2017GL074954
19880	51	15	51	21	A confidence statement is missing from the first sentence of this paragraph. [Gwenaelle GREMION, Canada]	A confidence statement is missing from the first sentence of this paragraph.
39254	51	16	51	18	A more up to date and higher temporal resolution assessment of ice sheet discharge is available (King et al 2018), which supports this statement in the report and should be included as cited literature. This literature contains both the ice sheet wide discharge and the breakdown per ice sheet sector for 2000 - 2016 (Figures 1 and 3 of King et al (2018), respectively). The full reference is as follows: King, M. D., Howat, I. M., Jeong, S., Noh, M. J., Wouters, B., Noël, B., and van den Broeke, M. R.: Seasonal to decadal variability in ice discharge from the Greenland Ice Sheet, The Cryosphere, 12, 3813-3825, https://doi.org/10.5194/tc-12-3813-2018, 2018. [Stephen Chuter, United Kingdom (of Great Britain and Northern Ireland)]	A more up to date and higher temporal resolution assessment of ice sheet discharge is available (King et al 2018), which supports this statement in the report and should be included as cited literature. This literature contains both the ice sheet wide discharge and the breakdown per ice sheet sector for 2000 - 2016 (Figures 1 and 3 of King et al (2018), respectively). The full reference is as follows: King, M. D., Howat, I. M., Jeong, S., Noh, M. J., Wouters, B., Noël, B., and van den Broeke, M. R.: Seasonal to decadal variability in ice discharge from the Greenland Ice Sheet, The Cryosphere, 12, 3813-3825, https://doi.org/10.5194/tc-12-3813-2018, 2018.
45312	51	16	51	20	· Why ice discharge will become less important? How is this consistent with deep valleys (Morlighem et al., 2017) that can be drive rapid retreat? [Alessandro Silvano, Australia]	· Why ice discharge will become less important? How is this consistent with deep valleys (Morlighem et al., 2017) that can be drive rapid retreat?

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
31258	51	24	51	24	The conclusion that the future contribution to ice loss from ice discharge is relatively small compared to SMB, is made from low-resolution model and/or old geometric input that do not resolve deep pathways for ocean water to reach the interior of the GrIS, resulting in a disconnection between the GrIS and the ocean as the GrIS retreats. I would change "For this reason there is high confidence" to "There is low confidence" and includes a sentence to say that further studies using high resolution mode and bed topography would be needed to answer properly the question. In addition the high confidence stated here is contradictory to next paragraph (p51, l31-43) stating that we have low confidence in projections for GrIS out glacier contribution to sea level because we do not understand ice-ocean interactions. [Jeremie Mouginot, France]	The conclusion that the future contribution to ice loss from ice discharge is relatively small compared to SMB, is made from low-resolution model and/or old geometric input that do not resolve deep pathways for ocean water to reach the interior of the GrIS, resulting in a disconnection between the GrIS and the ocean as the GrIS retreats. I would change "For this reason there is high confidence" to "There is low confidence" and includes a sentence to say that further studies using high resolution mode and bed topography would be needed to answer properly the question. In addition the high confidence stated here is contradictory to next paragraph (p51, l31-43) stating that we have low confidence in projections for GrIS out glacier contribution to sea level because we do not understand ice-ocean interactions.
19882	52	5	52	6	This first sentence is missing a reference. [Gwenaelle GREMION, Canada]	This first sentence is missing a reference.
19884	52	6	52	7	Perhaps stating it is dependent on “the magnitude of the sea level contribution” isn’t needed as it is quite obvious? [Gwenaelle GREMION, Canada]	Perhaps stating it is dependent on “the magnitude of the sea level contribution” isn’t needed as it is quite obvious?
19886	52	15	52	15	Suggestion to add “ocean-forced” in front of “dynamic thinning”. [Gwenaelle GREMION, Canada]	Suggestion to add “ocean-forced” in front of “dynamic thinning”.
8416	52	15	52	29	This paragraph (I think rightly) indicates that ocean will have decreasing influence on long term future GrIS changes. However, this contradicts Page 47, Line 46 (Section 9.4.2.2), which discusses implications of newly discovered ice-covered valleys on marine influence ("...implying that ... the ice sheet as a whole is more vulnerable to ocaen thermal forcing...than previous modelling efforts have indicated."). Authors need to ensure that message is consistent on estimated ocean/atmospheric contributions to SMB loss, and (more importantly) likely changes to these contributions over time. [Jeremy Fyke, Canada]	This paragraph (I think rightly) indicates that ocean will have decreasing influence on long term future GrIS changes. However, this contradicts Page 47, Line 46 (Section 9.4.2.2), which discusses implications of newly discovered ice-covered valleys on marine influence ("...implying that ... the ice sheet as a whole is more vulnerable to ocaen thermal forcing...than previous modelling efforts have indicated."). Authors need to ensure that message is consistent on estimated oceaNot applicabletmospheric contributions to SMB loss, and (more importantly) likely changes to these contributions over time.
9518	52	22			in "the" 22nd century [Jason Briner, United States of America]	in "the" 22nd century

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
40428	52	24	52	25	The "high confidence" claimed here seems in contradiction with the "low confidence" mentioned in the following paragraph. Indeed, new topography datasets have revealed "widespread presence of submarine ice-covered valleys that extend substantially deeper below sea level and farther inland than previously estimated" (2nd paragraph of section 9.4.2.2), and the coarse resolution used in ice-sheet projections so far does probably not allow a good represention of the ice dynamics and ocean melting in these deep troughs. This may lead to an underestimation of the importance of dynamical effects. [Nicolas Jourdain, France]	The "high confidence" claimed here seems in contradiction with the "low confidence" mentioned in the following paragraph. Indeed, new topography datasets have revealed "widespread presence of submarine ice-covered valleys that extend substantially deeper below sea level and farther inland than previously estimated" (2nd paragraph of section 9.4.2.2), and the coarse resolution used in ice-sheet projections so far does probably not allow a good represention of the ice dynamics and ocean melting in these deep troughs. This may lead to an underestimation of the importance of dynamical effects.
25330	52	45	52	46	The way this is written (with ref >15 years old) it sounds like this is an old conclusion - It is suggested that this sentence be removed and you clearly present the post AR5 assessment in the paragraph (need to rewrite paragraph) [Sharon Smith, Canada]	The way this is written (with ref >15 years old) it sounds like this is an old conclusion - It is suggested that this sentence be removed and you clearly present the post AR5 assessment in the paragraph (need to rewrite paragraph)
33242	52	46	52	48	A study by Kjeldsen et al, GRL 2017 (doi: 10.1002/2017GL074081) further highlights that spatial variability in the glacial response (speed-up vs. no speed-up) of a tidewater outlet glacier in response to a ice-dammed lakes drainge event. [Kristian Kjelden, Denmark]	A study by Kjeldsen et al, GRL 2017 (doi: 10.1002/2017GL074081) further highlights that spatial variability in the glacial response (speed-up vs. no speed-up) of a tidewater outlet glacier in response to a ice-dammed lakes drainge event.
8418	52	47	52	48	Suggest adding Hoffman et al. (2016) as an additional reference: https://www.nature.com/articles/ncomms13903 [Jeremy Fyke, Canada]	Suggest adding Hoffman et al. (2016) as an additional reference: https://www.nature.com/articles/ncomms13903
8420	52	55	53	22	Excellent to see discussion of long-term GrIS SLR commitment. [Jeremy Fyke, Canada]	Excellent to see discussion of long-term GrIS SLR commitment.
8422	52	55	53	22	Explicitly note the need for more studies similar to Robinson et al 2012, to start to quantify model uncertainty. [Jeremy Fyke, Canada]	Explicitly note the need for more studies similar to Robinson et al 2012, to start to quantify model uncertainty.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
8424	52	55	53	22	Suggest noting in text that a key unexplored factor, is the relation of timescales of GrIS loss (and more generally, ice sheet loss) relative to long-term timescales of carbon cycle-regulated atmospheric CO2 drawdown of cumulative emissions (and related temperature change). This actually provides a key link between this chapter, and the equivalent chapter discussing carbon cycle and climate response to cumulative emissions. This time-evolving relationship between GrIS (or more generally, ice sheet) response to cumulative emissions is not captured in exercises that fix temperature at a constant level and assess the GrIS response (e.g. Clark et al 2016). It also requires coupled model frameworks (because at these timescales, ice-sheet/climate feedbacks are key). Please let me (Jeremy Fyke, fykej@ae.ca) know if specific content needs to be developed here that I can help with. [Jeremy Fyke, Canada]	Suggest noting in text that a key unexplored factor, is the relation of timescales of GrIS loss (and more generally, ice sheet loss) relative to long-term timescales of carbon cycle-regulated atmospheric CO2 drawdown of cumulative emissions (and related temperature change). This actually provides a key link between this chapter, and the equivalent chapter discussing carbon cycle and climate response to cumulative emissions. This time-evolving relationship between GrIS (or more generally, ice sheet) response to cumulative emissions is not captured in exercises that fix temperature at a constant level and assess the GrIS response (e.g. Clark et al 2016). It also requires coupled model frameworks (because at these timescales, ice-sheet/climate feedbacks are key). Please let me (Jeremy Fyke, fykej@ae.ca) know if specific content needs to be developed here that I can help with.
25332	52	55	53	22	It is suggested that first part of paragraph be rewritten to focus on new results and post AR5 assessment and conclusions. Also, the paragraph could probably be much shorter if some detail was removed. [Sharon Smith, Canada]	It is suggested that first part of paragraph be rewritten to focus on new results and post AR5 assessment and conclusions. Also, the paragraph could probably be much shorter if some detail was removed.
19894	53	2	53	2	Typo: “with temperature”. [Gwenaelle GREMION, Canada]	Typo: “with temperature”.
19902	53	2	53	13	It is mentioned here, that the threshold for irreversible decline of the GrIS occurs between 1.1-2.3ºC of regional summer warming above pre-industrial levels, best estimate 1.8ºC. A comparison to observed data of the anthropogenic warming indicating whether this threshold is – at least regionally – already exceeded. The same applies to the rise in global mean temperature. The best estimate is 1.6ºC above pre-industrail levels. What is the current number of the global mean temperature rise? What consequences must be expected from exceeding the threshold? Does it only mean that the GrIS starts to melt or that the contribution to sea level rise (0.4-3m/ºC) will affect us already in the 21st century? It would be nice to have some clarification between the current temperature rise and the here mentioned predictions. [Gwenaelle GREMION, Canada]	It is mentioned here, that the threshold for irreversible decline of the GrIS occurs between 1.1-2.3ºC of regional summer warming above pre-industrial levels, best estimate 1.8ºC. A comparison to observed data of the anthropogenic warming indicating whether this threshold is – at least regionally – already exceeded. The same applies to the rise in global mean temperature. The best estimate is 1.6ºC above pre-industrail levels. What is the current number of the global mean temperature rise? What consequences must be expected from exceeding the threshold? Does it only mean that the GrIS starts to melt or that the contribution to sea level rise (0.4-3m/ºC) will affect us already in the 21st century? It would be nice to have some clarification between the current temperature rise and the here mentioned predictions.
9520	53	2			replace "behaviour in" with "response to" ?? [Jason Briner, United States of America]	replace "behaviour in" with "response to" ??

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
19888	53	9	53	11	Rather than solely based on Robinson et al., 2012, it is better to use mean of the several other predictions on the number of years for the irreversible decline of the GrIS after passing the threshold. [Gwenaelle GREMION, Canada]	Rather than solely based on Robinson et al., 2012, it is better to use mean of the several other predictions on the number of years for the irreversible decline of the GrIS after passing the threshold.
19896	53	9	53	11	A possible rewording: "...does not lead to an immediate collapse: if the threshold is just exceeded, the decline...". [Gwenaelle GREMION, Canada]	A possible rewording: "...does not lead to an immediate collapse: if the threshold is just exceeded, the decline...".
19890	53	11	53	13	A graph would be appropriate for explaining the dependence of commitment of GMSL equivalent with temperature. [Gwenaelle GREMION, Canada]	A graph would be appropriate for explaining the dependence of commitment of GMSL equivalent with temperature.
19892	53	13	53	20	There is not enough context for the multimillennial sea-level commitment associated with sustained warming of the GrIS. A rational explanation is appropriate for justifying the estimates peak temperature values and a corresponding number of years for the complete loss of GrIS. Explanation of scenarios would be required in this regard. [Gwenaelle GREMION, Canada]	There is not enough context for the multimillennial sea-level commitment associated with sustained warming of the GrIS. A rational explanation is appropriate for justifying the estimates peak temperature values and a corresponding number of years for the complete loss of GrIS. Explanation of scenarios would be required in this regard.
9522	53	15	53	17	this is an interesting discussion for sure. Didn't Golledge et al. suggest that when one couples an ice sheet model to ocean and atmosphere models, the GrIS shrinks faster. I wonder if it might make sense to point this out - that this above discussion is fairly simplistic and treats ice sheets as isolated systems, and that when coupling them to the broader climate system, there is potential for these estimates to be grossly underestimated? [Jason Briner, United States of America]	this is an interesting discussion for sure. Didn't Golledge et al. suggest that when one couples an ice sheet model to ocean and atmosphere models, the GrIS shrinks faster. I wonder if it might make sense to point this out - that this above discussion is fairly simplistic and treats ice sheets as isolated systems, and that when coupling them to the broader climate system, there is potential for these estimates to be grossly underestimated?
52214	53	15	53	22	Whether we expect the low complexity model to bias these numbers high or low depencs explicitly on which processes are considered; in both caes the uncertainty should be reduced. It would be helpful to comment on whether it is believed that the Robinson et al. (2012) irreversibility numbers are an estimate which we expect to be a lower or upper bound (or unknown), once more complex models can include these missing processes. Put another way, are these missing processes expected to dampen or amplify the low complexity model projections? [Daniel Gilford, United States of America]	Whether we expect the low complexity model to bias these numbers high or low depencs explicitly on which processes are considered; in both caes the uncertainty should be reduced. It would be helpful to comment on whether it is believed that the Robinson et al. (2012) irreversibility numbers are an estimate which we expect to be a lower or upper bound (or unknown), once more complex models can include these missing processes. Put another way, are these missing processes expected to dampen or amplify the low complexity model projections?
19898	53	22	53	22	Adding "GrIS" in front of SMB would make it more explicit. [Gwenaelle GREMION, Canada]	Adding "GrIS" in front of SMB would make it more explicit.
25338	53	24			Refer to Ch 2 (2.3.2.4.2) especially when discussing evolution of ice sheet over various time periods. [Sharon Smith, Canada]	Refer to Ch 2 (2.3.2.4.2) especially when discussing evolution of ice sheet over various time periods.
25334	53	29	53	29	past warm climates? - Is "past warm periods" a better term - also what time scale are you referring to. [Sharon Smith, Canada]	past warm climates? - Is "past warm periods" a better term - also what time scale are you referring to.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
31634	53	30	53	30	3 "()" adjacent one to the other. Maybe consider moving the citation list earlier in the sentence ? [Pierre Mathiot, United Kingdom (of Great Britain and Northern Ireland)]	3 "()" adjacent one to the other. Maybe consider moving the citation list earlier in the sentence ?
42776	53	31	53	31	Soares et al. (2104) showed that the influence of coastal capes is fundamental in the dynamics of coastal low level jets. A good representation of the coastline is needed in order to correctly represent the climate change signal, since the strongest signals are associated to the protruding capes (Soares et al. 2017). Soares PMM, Cardoso RM, Semedo A, Chinita MJ, Ranjha R (2014) Climatology of Iberia Coastal Low-Level Wind Jet: WRF High Resolution Results. Tellus A, 66, 22377 Soares PMM, Cardoso RM, Lima DCA, Semedo A (2017) High resolution projections for the Western Iberian Coastal Low level jet in a changing climate. Climate Dynamics, 49, 1547-1566. DOI:10.1007/s00382-016-3397-8 [Rita M Cardoso, Portugal]	Soares et al. (2104) showed that the influence of coastal capes is fundamental in the dynamics of coastal low level jets. A good representation of the coastline is needed in order to correctly represent the climate change signal, since the strongest signals are associated to the protruding capes (Soares et al. 2017). Soares PMM, Cardoso RM, Semedo A, Chinita MJ, Ranjha R (2014) Climatology of Iberia Coastal Low-Level Wind Jet: WRF High Resolution Results. Tellus A, 66, 22377 Soares PMM, Cardoso RM, Lima DCA, Semedo A (2017) High resolution projections for the Western Iberian Coastal Low level jet in a changing climate. Climate Dynamics, 49, 1547-1566. DOI:10.1007/s00382-016-3397-8
19900	53	31	53	34	A suggestion for a reference to add here is the one that describes the Binge-Purge hypothesis, even if it is for the Laurentide Ice Sheet: MacAyeal, D.R., 1993. Binge/purge oscillations of the Laurentide ice sheet as a cause of the North Atlantic's Heinrich events. Paleoceanography, 8(6), pp.775-784. [Gwenaelle GREMION, Canada]	A suggestion for a reference to add here is the one that describes the Binge-Purge hypothesis, even if it is for the Laurentide Ice Sheet: MacAyeal, D.R., 1993. Binge/purge oscillations of the Laurentide ice sheet as a cause of the North Atlantic's Heinrich events. Paleoceanography, 8(6), pp.775-784.
52216	53	37	53	37	I suggested adding, ", sectors which are more prelevant in the Western AIS" after "in the past." [Daniel Gilford, United States of America]	I suggested adding, ", sectors which are more prelevant in the Western AIS" after "in the past."
57940	54	5	54	5	To me it is quite confusing that Cross-chapter box 9.1 and 9.2 have the same numbering of (Chapter) box 9.1 and 9.2.. Cross-chapter boxes should be number either differently or following the order of appearance in the chapter (so Cross-chapter box 9.1, box 9.2 box 9.3, Cross-chapter box 9.4). [Bas de Boer, Netherlands]	To me it is quite confusing that Cross-chapter box 9.1 and 9.2 have the same numbering of (Chapter) box 9.1 and 9.2.. Cross-chapter boxes should be number either differently or following the order of appearance in the chapter (so Cross-chapter box 9.1, box 9.2 box 9.3, Cross-chapter box 9.4).
45314	54	5	54	44	· I do agree that ice sheet instabilities require a box. However, I'm not sure if this is the correct location, since these instabilities are supposed to occur in Greenland as well (e.g. Jakobshavn). So, why not putting the box at the beginning of the "Ice Sheets" section? [Alessandro Silvano, Australia]	· I do agree that ice sheet instabilities require a box. However, I'm not sure if this is the correct location, since these instabilities are supposed to occur in Greenland as well (e.g. Jakobshavn). So, why not putting the box at the beginning of the "Ice Sheets" section?
45316	54	5	54	44	The concept of tipping points seems not used in this chapter. I gues it would be useful, especially becuase MISI is one of them. [Alessandro Silvano, Australia]	The concept of tipping points seems not used in this chapter. I gues it would be useful, especially becuase MISI is one of them.
6369	54	5	54	45	Most of the data is before SR5. What is new? [Baruch Rinkevich, Israel]	Most of the data is before SR5. What is new?
9908	54	7	54	7	Suggestion: Maybe add a word about what a marine ice sheet is (an ice sheet whose bedrock lies below sea level). [Kevin Bulthuis, Belgium]	Suggestion: Maybe add a word about what a marine ice sheet is (an ice sheet whose bedrock lies below sea level).

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
19908	54	7	54	24	Box 9.1. I would suggest wording the MISI explanation a bit differently, for non experts. Starting line 10, I would suggest rewording as such: “It arises when the ice is sitting on bedrock that is sloping towards the interior of the ice sheet (retrograde slope). In such a scenario, as long as the ice flux going out to the ocean through the grounding line matches the total accumulation upstream, the situation is stable. However, when a perturbation occurs that causes enhanced ice thinning, such as a warm ocean water incursion, the ice shelf will start to thin from below, the glaciers behind will accelerate and so the grounding line will retreat inland. Because the bedrock slopes inland, the grounding line will retreat to a position where the ice is thicker. Because ice flux through the grounding ling is strongly dependent on ice thickness, this results in increased ice flux out towards the oceans, while the ice flux from upstream remains the same. This imbalance in ice fluxes implies that the grounding line will continue to retreat further into thicker ice as a positive feedback. The West Antarctic Ice Sheet is positioned on such retrograde bedrock. The process may halt…” [Gwenaelle GREMION, Canada]	Box 9.1. I would suggest wording the MISI explanation a bit differently, for non experts. Starting line 10, I would suggest rewording as such: “It arises when the ice is sitting on bedrock that is sloping towards the interior of the ice sheet (retrograde slope). In such a scenario, as long as the ice flux going out to the ocean through the grounding line matches the total accumulation upstream, the situation is stable. However, when a perturbation occurs that causes enhanced ice thinning, such as a warm ocean water incursion, the ice shelf will start to thin from below, the glaciers behind will accelerate and so the grounding line will retreat inland. Because the bedrock slopes inland, the grounding line will retreat to a position where the ice is thicker. Because ice flux through the grounding ling is strongly dependent on ice thickness, this results in increased ice flux out towards the oceans, while the ice flux from upstream remains the same. This imbalance in ice fluxes implies that the grounding line will continue to retreat further into thicker ice as a positive feedback. The West Antarctic Ice Sheet is positioned on such retrograde bedrock. The process may halt…”
9910	54	10	54	10	Maybe add also the following reference besides Pattyn et al., 2012 and Schoof 2007. Pattyn, F., Perichon, L., Durand, G., Favier, L., Gagliardini, O., Hindmarsh, R. C., Zwinger, T., Albrecht, T., Cornford, S., Docquier, D., Furst, J. J., Goldberg, D., Gudmundsson, G. H., Humbert, A., Hutten, M., Huybrechts, P., Jouvet, G., Kleiner, T., Larour, E., Martin, D., Morlighem, M., Payne, A. J., Pollard, D., Ruckamp, M., Rybak, O., Seroussi, H., Thoma, M., and Wilkens, N. Grounding-line migration in plan-view marine ice sheet models: results of the ice2sea MISMIP3d intercomparison, J. Glaciol., 59, 410-412, https:.//doi.org/10.3189/2013jog12j129, 2013. [Kevin Bulthuis, Belgium]	Maybe add also the following reference besides Pattyn et al., 2012 and Schoof 2007. Pattyn, F., Perichon, L., Durand, G., Favier, L., Gagliardini, O., Hindmarsh, R. C., Zwinger, T., Albrecht, T., Cornford, S., Docquier, D., Furst, J. J., Goldberg, D., Gudmundsson, G. H., Humbert, A., Hutten, M., Huybrechts, P., Jouvet, G., Kleiner, T., Larour, E., Martin, D., Morlighem, M., Payne, A. J., Pollard, D., Ruckamp, M., Rybak, O., Seroussi, H., Thoma, M., and Wilkens, N. Grounding-line migration in plan-view marine ice sheet models: results of the ice2sea MISMIP3d intercomparison, J. Glaciol., 59, 410-412, https:.//doi.org/10.3189/2013jog12j129, 2013.
8426	54	10	54	10	Suggest including in MISI references to key post-AR5 references (these are both pre-AR5). Perhaps there are MISI review paperrs available at this point? (if not there should be!) [Jeremy Fyke, Canada]	Suggest including in MISI references to key post-AR5 references (these are both pre-AR5). Perhaps there are MISI review paperrs available at this point? (if not there should be!)
52218	54	11	53	11	Replace "latter" with "grounding line" for specificity. [Daniel Gilford, United States of America]	Replace "latter" with "grounding line" for specificity.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
8428	54	12	54	12	"Thicker ice results in increased ice flux": important to describe in ~one sentence WHY this occurs, for naive readers. [Jeremy Fyke, Canada]	"Thicker ice results in increased ice flux": important to describe in ~one sentence WHY this occurs, for naive readers.
39258	54	13	54	13	The use of the phrase "This is especially true" seems to suggest that the MISI hypothesis is also applicable to areas of the ice sheet in which there is a prograde bedrock topography from the grounding line to the interior. This language should be clarified so that it is explicitly clear that MISI is only applicable in those regions of Antarctica that have a retrograde bed topography (e.g. WAIS), as described in Schoof (2007). [Stephen Chuter, United Kingdom (of Great Britain and Northern Ireland)]	The use of the phrase "This is especially true" seems to suggest that the MISI hypothesis is also applicable to areas of the ice sheet in which there is a prograde bedrock topography from the grounding line to the interior. This language should be clarified so that it is explicitly clear that MISI is only applicable in those regions of Antarctica that have a retrograde bed topography (e.g. WAIS), as described in Schoof (2007).
57942	54	15	54	17	What is probably good to include here is that bedrock uplift and self-gravitationel effects, when the ice-sheet retreats, will actually lower local relative sea-level and therefore might slow down the retreat of the ice sheet, although the retreat is still initiatied due to MISI. Could include same references in as in line 9-11 page 44. [Bas de Boer, Netherlands]	What is probably good to include here is that bedrock uplift and self-gravitationel effects, when the ice-sheet retreats, will actually lower local relative sea-level and therefore might slow down the retreat of the ice sheet, although the retreat is still initiatied due to MISI. Could include same references in as in line 9-11 page 44.
6385	54	15	54	17	MISI has also been shown to slow down and halt when lateral drag is sufficiently enhanced from reduced trough width (Jamieson et al., 2012, Nature Geoscience, DOI: 10.1038/NGEO1600). [Richard Selwyn Jones, United Kingdom (of Great Britain and Northern Ireland)]	MISI has also been shown to slow down and halt when lateral drag is sufficiently enhanced from reduced trough width (Jamieson et al., 2012, Nature Geoscience, DOI: 10.1038/NGEO1600).
19914	54	17	54	24	Can the statements for Pine Island Glacier and Thwaites Glacier also be substantiated with observations and not only with simulations? With what level of confidence are these results reliable? [Gwenaelle GREMION, Canada]	Can the statements for Pine Island Glacier and Thwaites Glacier also be substantiated with observations and not only with simulations? With what level of confidence are these results reliable?
26626	54	32	54	44	Box 9.1: MICI is not a new concept (see refs in DP15) and also arises from the 1970's There needs mention of some of the uncertainties, rather than implying that is is a validated process unlike MISI [Jeff Ridley, United Kingdom (of Great Britain and Northern Ireland)]	Box 9.1: MICI is not a new concept (see refs in DP15) and also arises from the 1970's There needs mention of some of the uncertainties, rather than implying that is is a validated process unlike MISI

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
52222	54	33	54	34	~90m is not an exact number, it was a suggested parameterized value proposed in DeConto and Pollard (2016). Rather than speculate on these parameter values in the modeling context, it would be much more useful to instead rewrite this sentence describing the physical phoenomon being discussed, e.g., "It postulates that ice cliffs become unstable and collapse under their own weight if they exceed a critical height threshold (Pollard et al. 2015, DeConto and Pollard 2016). Crumbiling ice cliffs could then in turn facilitate the collapse of ice sheets, and the Antarctic Ice Sheet in particular, in addition to MISI." New suggested citation: Pollard, D., DeConto, R. M. & Alley, R. B. Potential Antarctic Ice Sheet retreat driven by hydrofracturing and ice cliff failure. Earth Planet. Sci. Lett. 412, 112–121 (2015). [Daniel Gilford, United States of America]	~90m is not an exact number, it was a suggested parameterized value proposed in DeConto and Pollard (2016). Rather than speculate on these parameter values in the modeling context, it would be much more useful to instead rewrite this sentence describing the physical phoenomon being discussed, e.g., "It postulates that ice cliffs become unstable and collapse under their own weight if they exceed a critical height threshold (Pollard et al. 2015, DeConto and Pollard 2016). Crumbiling ice cliffs could then in turn facilitate the collapse of ice sheets, and the Antarctic Ice Sheet in particular, in addition to MISI." New suggested citation: Pollard, D., DeConto, R. M. & Alley, R. B. Potential Antarctic Ice Sheet retreat driven by hydrofracturing and ice cliff failure. Earth Planet. Sci. Lett. 412, 112–121 (2015).
19910	54	33	54	35	Box 9.1. I would suggest re-ordering the logic in this description of the MICI. Starting Line 33: “It postulates that ice cliffs forming in floating ice with reduced buttressing will become unstable and collapse if the cliffs are higher than ~ 90 m above sea level, thus facilitating the collapse of ice sheets through a reduction in the buttressing effect of the ice shelves and therefore an acceleration of the ice flow upstream of the cliffs. This was first postulated for the Antarctic Ice Sheet during past warm periods (...” [Gwenaelle GREMION, Canada]	Box 9.1. I would suggest re-ordering the logic in this description of the MICI. Starting Line 33: “It postulates that ice cliffs forming in floating ice with reduced buttressing will become unstable and collapse if the cliffs are higher than ~ 90 m above sea level, thus facilitating the collapse of ice sheets through a reduction in the buttressing effect of the ice shelves and therefore an acceleration of the ice flow upstream of the cliffs. This was first postulated for the Antarctic Ice Sheet during past warm periods (...”
52220	54	33	54	38	These two sentences seem out of order. It would be best to first describe the hydrofracturing, and then the cliff loss. [Daniel Gilford, United States of America]	These two sentences seem out of order. It would be best to first describe the hydrofracturing, and then the cliff loss.
39260	54	38	54	39	This section states that MISI cannot apply to prograde bed topography, which supports previous comment 4 asking for clarification in the wording of the MISI hypothesis [Stephen Chuter, United Kingdom (of Great Britain and Northern Ireland)]	This section states that MISI cannot apply to prograde bed topography, which supports previous comment 4 asking for clarification in the wording of the MISI hypothesis
19912	54	39	54	39	Box 9.1. I would suggest mentioning that the Larsen B ice shelf is situated in Antarctica, as opposed to Jakobshavn Isbrae in Greenland. [Gwenaelle GREMION, Canada]	Box 9.1. I would suggest mentioning that the Larsen B ice shelf is situated in Antarctica, as opposed to Jakobshavn Isbrae in Greenland.
52224	54	41	54	41	I suggest rewriting as, "It's current impact has been limited---only a few Antarctic ice shelves have been observed to collapse since [date when observations being referred to began]." [Daniel Gilford, United States of America]	I suggest rewriting as, "It's current impact has been limited---only a few Antarctic ice shelves have been observed to collapse since [date when observations being referred to began]."

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
31904	54	41	54	42	Replace the word 'few' with an exeption for the Antarctic Peninsula. At least 8 Antarctic Peninsula Ice shelves have collapsed or retreated in recent decades. See: https://discoveringantarctica.org.uk/science-and-exploration/geographic-information-systems-gis/ice-shelf-retreat-on-the-antarctic-peninsula/ [Dominic Hodgson, United Kingdom (of Great Britain and Northern Ireland)]	Replace the word 'few' with an exeption for the Antarctic Peninsula. At least 8 Antarctic Peninsula Ice shelves have collapsed or retreated in recent decades. See: https://discoveringantarctica.org.uk/science-and-exploration/geographic-information-systems-gis/ice-shelf-retreat-on-the-antarctic-peninsula/
19904	54	54	54	54	Possible reference to add for the ice volume changes worldwide: Zachos, J., Pagani, M., Sloan, L., Thomas, E. and Billups, K., 2001. Trends, rhythms, and aberrations in global climate 65 Ma to present. science, 292(5517), pp.686-693. [Gwenaelle GREMION, Canada]	Possible reference to add for the ice volume changes worldwide: Zachos, J., Pagani, M., Sloan, L., Thomas, E. and Billups, K., 2001. Trends, rhythms, and aberrations in global climate 65 Ma to present. science, 292(5517), pp.686-693.
19906	54	54	54	54	Add “rise” after “sea level”. [Gwenaelle GREMION, Canada]	Add “rise” after “sea level”.
45318	55	1	55	1	I remember estimates lower than 10 m. Since this might mean zero contribution from Antarctica, it would be good to include the lowest estimates found (5-7 m?). [Alessandro Silvano, Australia]	I remember estimates lower than 10 m. Since this might mean zero contribution from Antarctica, it would be good to include the lowest estimates found (5-7 m?).
19916	55	4	55	4	It would be good to have a short description of “near-field”, or perhaps use simple vocabulary such as “Geological archives retrieved near the AIS coastline...”. [Gwenaelle GREMION, Canada]	It would be good to have a short description of “near-field”, or perhaps use simple vocabulary such as “Geological archives retrieved near the AIS coastline...”.
37914	55	8	55	9	See comment 11 on the entire report. This is a paragraph where ka is used to mean a thousand years, not a BP date. [Adrian Simmons, United Kingdom (of Great Britain and Northern Ireland)]	See comment 11 on the entire report. This is a paragraph where ka is used to mean a thousand years, not a BP date.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
19928	55	9	55	17	On the topic of evidence for episodes of rapid Antarctic ice loss (21 to 8 ka), I think it might be beneficial to reference some terrestrial evidence for rapid ice loss in this time period. Although they do not show evidence for multiple periods of ice loss, they do show a growing dataset of terrestrial evidence indicative of rapid ice loss in a proxy other than the marine study by Weber et al. (2014). Examples from the Weddell Sea sector include Hein et al. (2016) (Mid-Holocene pulse of thinning in the Weddell Sea sector of the West Antarctic ice sheet, https://doi.org/10.1038/ncomms12511) and Johnson et al. (2019) (Abrupt mid-Holocene ice loss in the western Weddell Sea Embayment of Antarctica, https://doi.org/10.1016/j.epsl.2019.05.002). Other examples located in areas further away from the sediment cores of Weber et al. (2014) are Pine Island Bay (Johnson et al., 2014, Rapid Thinning of Pine Island Glacier in the Early Holocene, DOI: 10.1126/science.1247385) and the Ross Sea (Jones et al., 2015, Rapid Holocene thinning of an East Antarctic outlet glacier driven by marine ice sheet instability, doi: 10.1038/ncomms9910). Although restricted by the resolution of the dating method used (10Be and in situ 14C exposure dating), these studies do record evidence for rapid ice loss in Antarctica during 21 to 8 ka, much like Weber et al. (2014). I therefore think these studies add clout to the statement at the end of the paragraph "and therefore indirect support for unstable collapses during warm climates (medium confidence)." [Gwenaelle GREMION, Canada]	On the topic of evidence for episodes of rapid Antarctic ice loss (21 to 8 ka), I think it might be beneficial to reference some terrestrial evidence for rapid ice loss in this time period. Although they do not show evidence for multiple periods of ice loss, they do show a growing dataset of terrestrial evidence indicative of rapid ice loss in a proxy other than the marine study by Weber et al. (2014). Examples from the Weddell Sea sector include Hein et al. (2016) (Mid-Holocene pulse of thinning in the Weddell Sea sector of the West Antarctic ice sheet, https://doi.org/10.1038/ncomms12511) and Johnson et al. (2019) (Abrupt mid-Holocene ice loss in the western Weddell Sea Embayment of Antarctica, https://doi.org/10.1016/j.epsl.2019.05.002). Other examples located in areas further away from the sediment cores of Weber et al. (2014) are Pine Island Bay (Johnson et al., 2014, Rapid Thinning of Pine Island Glacier in the Early Holocene, DOI: 10.1126/science.1247385) and the Ross Sea (Jones et al., 2015, Rapid Holocene thinning of an East Antarctic outlet glacier driven by marine ice sheet instability, doi: 10.1038/ncomms9910). Although restricted by the resolution of the dating method used (10Be and in situ 14C exposure dating), these studies do record evidence for rapid ice loss in Antarctica during 21 to 8 ka, much like Weber et al. (2014). I therefore think these studies add clout to
6387	55	15	55	21	Geological evidence of ice sheet thinning shows that rates of ice loss similar to rapidly changing parts of the AIS today have previously occurred as a result of MISI and lasted for several hundred years (Jones et al., 2015, Nature Communications, DOI: 10.1038/ncomms9910; Small et al., 2019, Quaternary Science Reviews, DOI: 10.1016/j.quascirev.2018.12.024). [Richard Selwyn Jones, United Kingdom (of Great Britain and Northern Ireland)]	Geological evidence of ice sheet thinning shows that rates of ice loss similar to rapidly changing parts of the AIS today have previously occurred as a result of MISI and lasted for several hundred years (Jones et al., 2015, Nature Communications, DOI: 10.1038/ncomms9910; Small et al., 2019, Quaternary Science Reviews, DOI: 10.1016/j.quascirev.2018.12.024).

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
8430	55	19	55	41	This paragraph is (I think) intended to summarize reasons why understanding primary drivers of past AIS retreat is difficult. However, discussion seems over-concentrated on MICI. In fact, other possible regulators of AIS mass loss (such as poorly understood ocean-ice sheet feedbacks or greater-than-reconstructed ocean warming) are, strangely, only mentioned in relation to MICI. If this paragraph is intended to summarize uncertainty in mechanistic understanding of past AIS retreat, suggest balancing discussion across all possible uncertainty sources (including MICI). If this paragraph was intended just to target MICI, suggest adding other equivalent sections on other poorly constrained past mechanisms of change. [Jeremy Fyke, Canada]	This paragraph is (I think) intended to summarize reasons why understanding primary drivers of past AIS retreat is difficult. However, discussion seems over-concentrated on MICI. In fact, other possible regulators of AIS mass loss (such as poorly understood ocean-ice sheet feedbacks or greater-than-reconstructed ocean warming) are, strangely, only mentioned in relation to MICI. If this paragraph is intended to summarize uncertainty in mechanistic understanding of past AIS retreat, suggest balancing discussion across all possible uncertainty sources (including MICI). If this paragraph was intended just to target MICI, suggest adding other equivalent sections on other poorly constrained past mechanisms of change.
52226	55	19	56	3	MISI is mentioned here in line 19, but almost exclusively the discussion in the remainder of this section focuses on MICI. Is there a way to incoorporate potential implications for MISI into these paragraphs, or at least clarify that there is no way to know whether the potentially substantial losses in these warm periods were associated with primarily MISI, primarily MICI, or both nearly equally. [Daniel Gilford, United States of America]	MISI is mentioned here in line 19, but almost exclusively the discussion in the remainder of this section focuses on MICI. Is there a way to incoorporate potential implications for MISI into these paragraphs, or at least clarify that there is no way to know whether the potentially substantial losses in these warm periods were associated with primarily MISI, primarily MICI, or both nearly equally.
26630	55	20	55	20	remove 'istability' as this word is the last 'I' in the abriviations [Jeff Ridley, United Kingdom (of Great Britain and Northern Ireland)]	remove 'istability' as this word is the last 'I' in the abriviations
30254	55	21	55	25	To be added: For this reason some models (e.g. Pollard et al., 2012; Pattyn, 2017) use parametrizations of grounding-line fluxes concordant with theory (Schoof, 2007) to enable grounding-line migration across the continental shelf in large-scale ice sheet models. Others (e.g. Golledge et al., 2015; 2019) make use on grounding line interpolations to enable grounding lines to behave in line with theoretical considerations (Feldmann et al., 2014), although some simulations also consider subshelf melting to be spread under the grounded part, facilitating this grounding line movement, which may overestimate ice mass loss in future simulations (Seroussi and Morlighem, 2018; https://doi.org/10.5194/tc-12-3085-2018). [Frank Pattyn, Belgium]	To be added: For this reason some models (e.g. Pollard et al., 2012; Pattyn, 2017) use parametrizations of grounding-line fluxes concordant with theory (Schoof, 2007) to enable grounding-line migration across the continental shelf in large-scale ice sheet models. Others (e.g. Golledge et al., 2015; 2019) make use on grounding line interpolations to enable grounding lines to behave in line with theoretical considerations (Feldmann et al., 2014), although some simulations also consider subshelf melting to be spread under the grounded part, facilitating this grounding line movement, which may overestimate ice mass loss in future simulations (Seroussi and Morlighem, 2018; https://doi.org/10.5194/tc-12-3085-2018).
19918	55	24	55	24	change “back” to “ in length”. [Gwenaelle GREMION, Canada]	change “back” to “ in length”.
19920	55	31	55	32	To be explicit, I would suggest to change this sentence to “better agreement might also be achieved with models that do not include MICI...” [Gwenaelle GREMION, Canada]	To be explicit, I would suggest to change this sentence to “better agreement might also be achieved with models that do not include MICI...”

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
50786	55	31	55	33	Please, check the sentence: "However, it is not necessarily required (Edwards et al., 2019), and better agreement might also be achieved with other models, greater ocean warming (which is currently not well constrained), or incorporation of meltwater-ocean feedbacks that increase AIS ice loss (Golledge et al., 2019)." [Hernan Edgardo Sala, Argentina]	Please, check the sentence: "However, it is not necessarily required (Edwards et al., 2019), and better agreement might also be achieved with other models, greater ocean warming (which is currently not well constrained), or incorporation of meltwater-ocean feedbacks that increase AIS ice loss (Golledge et al., 2019)."
57944	55	35	55	35	Could the estimates of Dolan et al., (2018) refered to here also be included in Figure 9.23e? (in Dolan et al., 2018: the all-experiments range indicates 5.11 ± 4.65 m sea-level equivalent) [Bas de Boer, Netherlands]	Could the estimates of Dolan et al., (2018) refered to here also be included in Figure 9.23e? (in Dolan et al., 2018: the all-experiments range indicates 5.11 ± 4.65 m sea-level equivalent)
30270	55	43	55	46	See previous remarks: models do not include MISI; rephrase as models resolving grounding-line migration so that they potentially exhibit or can cope with MISI. [Frank Pattyn, Belgium]	See previous remarks: models do not include MISI; rephrase as models resolving grounding-line migration so that they potentially exhibit or can cope with MISI.
19922	55	44	55	44	For clarity, I would suggest the following rewording: "…), require a ~3 m contribution from AIS and have only been simulated in a few models...". [Gwenaelle GREMION, Canada]	For clarity, I would suggest the following rewording: "…), require a ~3 m contribution from AIS and have only been simulated in a few models...".
19924	55	46	55	46	For clarity, I would suggest the following rewording: "The largest possible contributions from AIS imply … ". [Gwenaelle GREMION, Canada]	For clarity, I would suggest the following rewording: "The largest possible contributions from AIS imply … ".
31636	55	48	55	48	LIG defined in line 48 but used in line 43 and 30 of the same page. [Pierre Mathiot, United Kingdom (of Great Britain and Northern Ireland)]	LIG defined in line 48 but used in line 43 and 30 of the same page.
19926	55	48	55	48	For clarity, adding "from the AIS" after "8-9 m" would be helpful as it is currently unclear if it represents AIS only or AIS+GrIS contributions combined. [Gwenaelle GREMION, Canada]	For clarity, adding "from the AIS" after "8-9 m" would be helpful as it is currently unclear if it represents AIS only or AIS+GrIS contributions combined.
45320	55	48	55	49	Are you talking about "LGM"? [Alessandro Silvano, Australia]	Are you talking about "LGM"?
57946	55	48	55	49	The term: 'the Last Interglacial Maximum' is to my knowledge rarely used.. LIG is already defined before, so just use LIG [Bas de Boer, Netherlands]	The term: 'the Last Interglacial Maximum' is to my knowledge rarely used.. LIG is already defined before, so just use LIG

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
48718	55	53	56	3	From detailed experience with data-constrained paleo modelling of both Greenland and Antarctic sheets, it is likely that the two ice sheets reached their minimum extent at different times during the LIG. The two are very different ice sheets with different effective time constants and different dominant controls for interglacial mass loss (surface mass balance versus subshelf ocean temperature and circulation). Furthermore, the continuous presence of Dye3 ice through the Eemian (Willerslev et al, Science 2007, https://dx.doi.org/10.1126%2Fscience.1141758) means that the upper bound of GRIS contribution to the LIG high-stand is well below the stated 6.2 m. I'm in the process of a full Bayesian calibration for the last glacial cycle of the GRIS (using a full SSA/SIA hybrid glaciological model), and the maximum LIG sealevel contribution I get to date (after >10,000 full model runs, and > 2 million emulated model runs) is < 4.8 m eustatic when requiring continuous Dye3 ice through the Eemian (this work will be submitted this fall). With the addition of the requirement of continuous Camp Century ice (which Dorthe Dahl-Jensen has assured me of personally), the maximum contribution drops to < 2.8 m eustatic sea level equivalent. All of the above along with current constraints on the Eemian high-stand (6-10 m) makes it highly unlikely that the Antarctic ice sheet did not contribute to this highstand. [Lev Tarasov, Canada]	From detailed experience with data-constrained paleo modelling of both Greenland and Antarctic sheets, it is likely that the two ice sheets reached their minimum extent at different times during the LIG. The two are very different ice sheets with different effective time constants and different dominant controls for interglacial mass loss (surface mass balance versus subshelf ocean temperature and circulation). Furthermore, the continuous presence of Dye3 ice through the Eemian (Willerslev et al, Science 2007, https://dx.doi.org/10.1126%2Fscience.1141758) means that the upper bound of GRIS contribution to the LIG high-stand is well below the stated 6.2 m. I'm in the process of a full Bayesian calibration for the last glacial cycle of the GRIS (using a full SSA/SIA hybrid glaciological model), and the maximum LIG sealevel contribution I get to date (after >10,000 full model runs, and > 2 million
25336	55	54	55	55	Repeating information on Greenland Ice Sheet - need this here as section focusses on Antarctica [Sharon Smith, Canada]	Repeating information on Greenland Ice Sheet - need this here as section focusses on Antarctica
31906	56	2	56	2	The 'very low confidence' statement here is true for models - which range from a 0-9 m AIS contribution. However the palaeo record reduces this uncertainty. There is no geological evidence to support complete loss of GRIS during the LIG, so the AIS contribution must be substantially more than zero. [Dominic Hodgson, United Kingdom (of Great Britain and Northern Ireland)]	The 'very low confidence' statement here is true for models - which range from a 0-9 m AIS contribution. However the palaeo record reduces this uncertainty. There is no geological evidence to support complete loss of GRIS during the LIG, so the AIS contribution must be substantially more than zero.
31260	56	5	56	5	references should includes Larour et al. (2019). REF: Larour et al. (2019), Slowdown in Antarctic mass loss from solid Earth and sea-level feedbacks, Science, 07 Jun 2019, Vol. 364, Issue 6444, eaav7908, DOI: 10.1126/science.aav7908 [Jeremie Mouginot, France]	references should includes Larour et al. (2019). REF: Larour et al. (2019), Slowdown in Antarctic mass loss from solid Earth and sea-level feedbacks, Science, 07 Jun 2019, Vol. 364, Issue 6444, eaav7908, DOI: 10.1126/science.aav7908
19932	56	5	56	15	See previous comment about p. 44, line 9 to 16: here the explanation of the effect of bed rheology comes out much more clearly. [Gwenaelle GREMION, Canada]	See previous comment about p. 44, line 9 to 16: here the explanation of the effect of bed rheology comes out much more clearly.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
31908	56	8	56	12	The 'medium confidence' statement of metres to tens of metres of viscoelastic uplift here is not supported by longer term palaeo records of relative sea level. For example in the northern Antarctic Peninsula rates of relative sea level fall are in the order of 0.29 - 3.91 mm/yr (see Roberts, S. J., et al. (2011). "Geological constraints on glacio-isostatic adjustment models of relative sea-level change during deglaciation of Prince Gustav Channel, Antarctic Peninsula." Quaternary Science Reviews 30: 3603-3617). In the southern Antarctic Peninsula rates are 2.7 - 12.5 mm/yr (see Hodgson , D. A., et al. (2013). "Late Quaternary environmental changes in Marguerite Bay, Antarctic Peninsula, inferred from lake sediments and raised beaches." Quaternary Science Reviews 68: 216-236). In east Antarctica highest rates are 12-48 mm yr (Vestfold) and 8.8 mm/yr (Larsemann) and 2.5-3.7 (Syowa) (See: Hodgson, D. A., et al. (2016). "Rapid early Holocene sea-level rise in Prydz Bay, East Antarctica." Global and Planetary Change 139: 128-140; Verleyen, E., et al. (2017). "Ice sheet retreat and glacio-isostatic adjustment in Lützow-Holm Bay, East Antarctica." Quaternary Science Reviews 169: 85-98. In Pine Island Bay (West Antarctic Ice Sheet) - raised beach altitudes are in the order of a few 10's of metres (unpublished observations) over the last few thousand years (unpublished ages). [Dominic Hodgson, United Kingdom (of Great Britain and Northern Ireland)]	The 'medium confidence' statement of metres to tens of metres of viscoelastic uplift here is not supported by longer term palaeo records of relative sea level. For example in the northern Antarctic Peninsula rates of relative sea level fall are in the order of 0.29 - 3.91 mm/yr (see Roberts, S. J., et al. (2011). "Geological constraints on glacio-isostatic adjustment models of relative sea-level change during deglaciation of Prince Gustav Channel, Antarctic Peninsula." Quaternary Science Reviews 30: 3603-3617). In the southern Antarctic Peninsula rates are 2.7 - 12.5 mm/yr (see Hodgson , D. A., et al. (2013). "Late Quaternary environmental changes in Marguerite Bay, Antarctic Peninsula, inferred from lake sediments and raised beaches." Quaternary Science Reviews 68: 216-236). In east Antarctica highest rates are 12-48 mm yr (Vestfold) and 8.8 mm/yr (Larsemann) and 2.5-3.7 (Syowa) (See: Hodgson, D. A., et al. (2016). "Rapid early Holocene sea-level rise in Prydz Bay, East Antarctica." Global and Planetary Change 139: 128-140; Verleyen, E., et al. (2017). "Ice sheet retreat and glacio-isostatic adjustment in Lützow-Holm Bay, East Antarctica." Quaternary Science Reviews 169: 85-98. In Pine Island Bay (West Antarctic Ice Sheet) - raised beach altitudes are in the order of a few 10's of metres (unpublished observations) over the last few thousand years (unpublished ages).
9912	56	9	56	9	Earth rheology in Antarctica is highly variable … I would add some references, for instance, Van der Wal, W., Whitehouse, P. L., and Schrama, E. J. O.: Effect of GIA models with 3D composite mantle viscosity on GRACE mass balance estimates for Antarctica, Earth Planet. Sc. Lett., 414, 134-143, https://doi.org/10.1016/j.epsl.2015.01.001, 2015. Chen, B., Haeger, C. , Kaban, M. K., and Petrunin, A.G.: Variations of the effective elastic thickness reveal tectonic fragmentation of the Antarctic lithsophere, Tectonophysics, 746, 412-424, https://doi.org/10.1016/j.tecto.2017.06.012, 2018. [Kevin Bulthuis, Belgium]	Earth rheology in Antarctica is highly variable … I would add some references, for instance, Van der Wal, W., Whitehouse, P. L., and Schrama, E. J. O.: Effect of GIA models with 3D composite mantle viscosity on GRACE mass balance estimates for Antarctica, Earth Planet. Sc. Lett., 414, 134-143, https://doi.org/10.1016/j.epsl.2015.01.001, 2015. Chen, B., Haeger, C. , Kaban, M. K., and Petrunin, A.G.: Variations of the effective elastic thickness reveal tectonic fragmentation of the Antarctic lithsophere, Tectonophysics, 746, 412-424, https://doi.org/10.1016/j.tecto.2017.06.012, 2018.
8432	56	29			Section 9.4.3.2: BEAUTIFUL REVIEW, as far as I can tell. Nice work to whoever authors were/are. [Jeremy Fyke, Canada]	Section 9.4.3.2: BEAUTIFUL REVIEW, as far as I can tell. Nice work to whoever authors were/are.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
19930	56	33	56	37	A comparison is appropriate on modelled and observed grounded AIS mass loss and its contribution to global mean sea level from 1992 to 2016. Does the multi-team intercomparison include both the observed and modelled? Can be used for model calibrations. [Gwenaelle GREMION, Canada]	A comparison is appropriate on modelled and observed grounded AIS mass loss and its contribution to global mean sea level from 1992 to 2016. Does the multi-team intercomparison include both the observed and modelled? Can be used for model calibrations.
26632	56	34			Confusing terminology 'agree well with..'. The studies (methodologies) of Shepherd et al. do not agree well with each other and merely confirm the observational uncertainty - they thus have not inproved our knowledge of the system. [Jeff Ridley, United Kingdom (of Great Britain and Northern Ireland)]	Confusing terminology 'agree well with..'. The studies (methodologies) of Shepherd et al. do not agree well with each other and merely confirm the observational uncertainty - they thus have not inproved our knowledge of the system.
9814	56	40	56	40	There has been major advance since the last AR concerning precipitation in Antarctica and its contribution to variability and change in the surface mass balance. Precipitation was not previously observed and much of the conclusions were drawn from models or model-based analyses. The CloudSat satellite, with its Cloud Profiling Radar, recently made it possible for the 1st time to assemble a continental scale climatology of antarctic precipitation (Palerme et al. 2014, https://www.the-cryosphere.net/8/1577/2014/tc-8-1577-2014.pdf), from this evaluate analysis products (palerme t al. 2017a, https://doi.org/10.1016/j.atmosres.2017.02.015) and cmip5 models ability to reproduce present and predict change (Palerme et al. 2017b, https://doi.org/10.1007/s00382-016-3071-1). Just like a highlight is made on recent progress in understanding ice dynamics contributions to the mass balance of the ice sheet, one may wonder whether a proportional (probably shorter) highlight would be appropriate about recent progress in observing and predicting the contribution of precipitation. [Christophe Genthon, France]	There has been major advance since the last AR concerning precipitation in Antarctica and its contribution to variability and change in the surface mass balance. Precipitation was not previously observed and much of the conclusions were drawn from models or model-based analyses. The CloudSat satellite, with its Cloud Profiling Radar, recently made it possible for the 1st time to assemble a continental scale climatology of antarctic precipitation (Palerme et al. 2014, https://www.the-cryosphere.net/8/1577/2014/tc-8-1577-2014.pdf), from this evaluate analysis products (palerme t al. 2017a, https://doi.org/10.1016/j.atmosres.2017.02.015) and cmip5 models ability to reproduce present and predict change (Palerme et al. 2017b, https://doi.org/10.1007/s00382-016-3071-1). Just like a highlight is made on recent progress in understanding ice dynamics contributions to the mass balance of the ice sheet, one may wonder whether a proportional (probably shorter) highlight would be appropriate about recent progress in observing and predicting the contribution of precipitation.
26634	56	40	56	41	Is Bamber et al 2018b really the best reference here? Palerme et al, 2017 https://doi.org/10.1016/j.atmosres.2017.02.015 seems better as it also describes the uncertainty in analyses. [Jeff Ridley, United Kingdom (of Great Britain and Northern Ireland)]	Is Bamber et al 2018b really the best reference here? Palerme et al, 2017 https://doi.org/10.1016/j.atmosres.2017.02.015 seems better as it also describes the uncertainty in analyses.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
31262	56	42	56	42	references for surface height changes should include Shepherd et al. (2019). REF: Shepherd et al. (2019), Trends in Antarctic Ice Sheet Elevation and Mass, Geophysical Research Letters, 46. https://doi.org/10.1029/2019GL082182), McMillan et al. 2014 (McMillan, M. et al. (2014), Increased ice losses from Antarctica detected by CryoSat-2, Geophys. Res. Lett., 41, 3899– 3905, doi:10.1002/2014GL060111.) [Jeremie Mouginot, France]	references for surface height changes should include Shepherd et al. (2019). REF: Shepherd et al. (2019), Trends in Antarctic Ice Sheet Elevation and Mass, Geophysical Research Letters, 46. https://doi.org/10.1029/2019GL082182), McMillan et al. 2014 (McMillan, M. et al. (2014), Increased ice losses from Antarctica detected by CryoSat?2, Geophys. Res. Lett., 41, 3899– 3905, doi:10.1002/2014GL060111.)
15660	56	42			Antarctic Peninsula hosts a larger number of peripheral glaciers. Huber et al. (2017, ESSD) suggest a separation at 70° S which is in line with the regions defined by Zwally (2012). These glaciers are currently not included in RGI 6.0 (and hence neither in most global studies using RGI as an input). Consequences: lower risk of double-counting (cf. GRACE estimates of Greenland) but inconsistency in definition/separation of Ice Sheet versus glaciers between Antarctica and Greenland (cf. connectivity levels in Rastner et al. 2012). Rastner, P., Bolch, T., Mölg, N., Machguth, H., Le Bris, R., andPaul, F.: The first complete inventory of the local glaciersand ice caps on Greenland, The Cryosphere, 6, 1483–1495,doi:10.5194/tc-6-1483-2012, 2012. Zwally, H. J., Giovinetto, M. B., Beckley, M. A., and Saba, J. L.:Antarctic and Greenland Drainage Systems, available at: http://icesat4.gsfc.nasa.gov/cryo_data/ant_grn_drainage_systems.php, [Michael Zemp, Switzerland]	Antarctic Peninsula hosts a larger number of peripheral glaciers. Huber et al. (2017, ESSD) suggest a separation at 70° S which is in line with the regions defined by Zwally (2012). These glaciers are currently not included in RGI 6.0 (and hence neither in most global studies using RGI as an input). Consequences: lower risk of double-counting (cf. GRACE estimates of Greenland) but inconsistency in definition/separation of Ice Sheet versus glaciers between Antarctica and Greenland (cf. connectivity levels in Rastner et al. 2012). Rastner, P., Bolch, T., Mölg, N., Machguth, H., Le Bris, R., andPaul, F.: The first complete inventory of the local glaciersand ice caps on Greenland, The Cryosphere, 6, 1483–1495,doi:10.5194/tc-6-1483-2012, 2012. Zwally, H. J., Giovinetto, M. B., Beckley, M. A., and Saba, J. L.:Antarctic and Greenland Drainage Systems, available at: http://icesat4.gsfc.nasa.gov/cryo_data/ant_grn_drainage_systems.php,
45322	56	43	56	43	include Sheperd et al. 2019 GRL (Trends in Antarctic Ice Sheet Elevation and Mass). [Alessandro Silvano, Australia]	include Sheperd et al. 2019 GRL (Trends in Antarctic Ice Sheet Elevation and Mass).
39262	56	44	56	48	I agree with this statement in that overall the individual approaches are consistent with each other based on Bamber et al (2018) and Shepherd et al (2018). However figure 9.23a indicates that the Rignot et al (2019) (orange line) assesment is far more negative than the other two studies and outside the uncertainty bounds for Bamber et al (2018). Therefore I believe more explanation or clarification is needed into why Rignot et al (2019) differs from the other studies - particularly as input-output method studies are included in Shepherd et al (2018) multi-team assessment. i.e. is the input-output method data used in Shepherd et al (2018) different from Rignot et al (2019)? and if so why. [Stephen Chuter, United Kingdom (of Great Britain and Northern Ireland)]	I agree with this statement in that overall the individual approaches are consistent with each other based on Bamber et al (2018) and Shepherd et al (2018). However figure 9.23a indicates that the Rignot et al (2019) (orange line) assesment is far more negative than the other two studies and outside the uncertainty bounds for Bamber et al (2018). Therefore I believe more explanation or clarification is needed into why Rignot et al (2019) differs from the other studies - particularly as input-output method studies are included in Shepherd et al (2018) multi-team assessment. i.e. is the input-output method data used in Shepherd et al (2018) different from Rignot et al (2019)? and if so why.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
31270	57	10	57	10	I think a sentence should be added about Totten glacier linked EAIS mass loss (at the end of the paragraph). The mention of recent changes in ice dynamics is not enough. There is a clear signal of mass loss from independent method (altimetry, gravimetry and input/output method) on this particular glacier of East Antarctica (Schroder et al. 2019, Shepherd et al. 2019, Li et al. 2016, Rignot et al. 2019, Mohajerani et al. 2018) REF: Shepherd et al. (2019), Trends in Antarctic Ice Sheet Elevation and Mass, Geophysical Research Letters, 46. https://doi.org/10.1029/2019GL082182; Schröder, L., Horwath, M., Dietrich, R., Helm, V., van den Broeke, M. R., and Ligtenberg, S. R. M. (2019). Four decades of Antarctic surface elevation changes from multi-mission satellite altimetry. Cryosph. 13, 427–449. doi:10.5194/tc-13-427-2019.; Mohajerani, Y., Velicogna, I., and Rignot, E. (2018). Mass Loss of Totten and Moscow University Glaciers, East Antarctica, Using Regionally Optimized GRACE Mascons. Geophys. Res. Lett. 45, 7010–7018. doi:10.1029/2018GL078173.; Rignot, E., Mouginot, J., Scheuchl, B., van den Broeke, M. R., van Wessem, M. J., and Morlighem, M. (2019). Four decades of Antarctic Ice Sheet mass balance from 1979-2017. Proc. Natl. Acad. Sci. 116, 1–9. doi:10.1073/pnas.1812883116. [Jeremie Mouginot, France]	I think a sentence should be added about Totten glacier linked EAIS mass loss (at the end of the paragraph). The mention of recent changes in ice dynamics is not enough. There is a clear signal of mass loss from independent method (altimetry, gravimetry and input/output method) on this particular glacier of East Antarctica (Schroder et al. 2019, Shepherd et al. 2019, Li et al. 2016, Rignot et al. 2019, Mohajerani et al. 2018) REF: Shepherd et al. (2019), Trends in Antarctic Ice Sheet Elevation and Mass, Geophysical Research Letters, 46. https://doi.org/10.1029/2019GL082182; Schro?der, L., Horwath, M., Dietrich, R., Helm, V., van den Broeke, M. R., and Ligtenberg, S. R. M. (2019). Four decades of Antarctic surface elevation changes from multi-mission satellite altimetry. Cryosph. 13, 427–449. doi:10.5194/tc-13-427-2019.; Mohajerani, Y., Velicogna, I., and Rignot, E. (2018). Mass Loss of Totten and Moscow University Glaciers, East Antarctica, Using Regionally Optimized GRACE Mascons. Geophys. Res. Lett. 45, 7010–7018. doi:10.1029/2018GL078173.; Rignot, E., Mouginot, J., Scheuchl, B., van den Broeke, M. R., van Wessem, M. J., and Morlighem, M. (2019). Four decades of Antarctic Ice Sheet mass balance from 1979-2017. Proc. Natl. Acad. Sci. 116, 1–9. doi:10.1073/pnas.1812883116.
19934	57	10	57	21	Give the estimated contribution to global mean sea level due to mass loss of the WAIS and Antarctic Peninsula. [Gwenaelle GREMION, Canada]	Give the estimated contribution to global mean sea level due to mass loss of the WAIS and Antarctic Peninsula.
19938	57	19	57	19	Perhaps locating ASE on one of the figures would be helpful as it comes up a lot in the text, but the readers do not know where to locate it as it is never shown on the figures. [Gwenaelle GREMION, Canada]	Perhaps locating ASE on one of the figures would be helpful as it comes up a lot in the text, but the readers do not know where to locate it as it is never shown on the figures.
19946	57	19	57	21	The mass loss from the EAIS seems to happen only in some places/ sectors. These sectors are characterized by change in ice dynamics in this sectors (as it is mentioned in the text). What are the ice dynamics driving the mass loss and which areas are most affected? Is it concentrated on the coasts or is the thinning of the interior also contributing to the mass loss of the EAIS? [Gwenaelle GREMION, Canada]	The mass loss from the EAIS seems to happen only in some places/ sectors. These sectors are characterized by change in ice dynamics in this sectors (as it is mentioned in the text). What are the ice dynamics driving the mass loss and which areas are most affected? Is it concentrated on the coasts or is the thinning of the interior also contributing to the mass loss of the EAIS?
9914	57	20	57	20	recent changes in ice dynamics in sectors of the EAIS. Maybe it would be relevant to give examples of such sectors. [Kevin Bulthuis, Belgium]	recent changes in ice dynamics in sectors of the EAIS. Maybe it would be relevant to give examples of such sectors.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
31264	57	24	57	24	references for reduction of ice shelf thickness should include Paolo et al. (2015) (Paolo et al. (2015), Volume loss from Antarctic ice shelves is accelerating, Science 17 Apr 2015: Vol. 348, Issue 6232, pp. 327-331 DOI: 10.1126/science.aaa0940) and probably not shepherd et al. 2018 [Jeremie Mouginot, France]	references for reduction of ice shelf thickness should include Paolo et al. (2015) (Paolo et al. (2015), Volume loss from Antarctic ice shelves is accelerating, Science 17 Apr 2015: Vol. 348, Issue 6232, pp. 327-331 DOI: 10.1126/science.aaa0940) and probably not shepherd et al. 2018
30250	57	27	57	27	Please add reference to Reese et al. (2017) doi:10.1038/s41558-017-0020-x DO [Frank Pattyn, Belgium]	Please add reference to Reese et al. (2017) doi:10.1038/s41558-017-0020-x DO
19936	57	30	57	33	Give the estimated contribution to global mean sea level due to mass loss from Antarctic ice shelves as well? [Gwenaelle GREMION, Canada]	Give the estimated contribution to global mean sea level due to mass loss from Antarctic ice shelves as well?
19948	57	30	57	33	Just a clarification: is volume loss the same as mass loss? If not, please clarify the differences. [Gwenaelle GREMION, Canada]	Just a clarification: is volume loss the same as mass loss? If not, please clarify the differences.
19942	57	30	57	46	I would suggest to conclude this paragraph with a one-line statement summarizing the certainty in all the processes described in this paragraph. [Gwenaelle GREMION, Canada]	I would suggest to conclude this paragraph with a one-line statement summarizing the certainty in all the processes described in this paragraph.
31266	57	32	57	32	references for ice shelve basal melting and iceberg calving should include Rignot et al. (2013). REF: Rignot, E., Jacobs, S., Mouginot, J., and Scheuchl, B. (2013). Ice-shelf melting around Antarctica. Science (80-.). 341, 266–270. doi:10.1126/science.1235798. [Jeremie Mouginot, France]	references for ice shelve basal melting and iceberg calving should include Rignot et al. (2013). REF: Rignot, E., Jacobs, S., Mouginot, J., and Scheuchl, B. (2013). Ice-shelf melting around Antarctica. Science (80-.). 341, 266–270. doi:10.1126/science.1235798.
31910	57	36	57	41	This statement is strengthened by the strong evidence in the palaeo record of CDW inflow to the Amundsen Sea sector, the most vulnerable part of the West Antarctic Ice Sheet, during the Holocene. The chemical compositions of foraminifer shells and benthic foraminifer assemblages in marine sediments indicate that enhanced CDW upwelling, controlled by the latitudinal position of the Southern Hemisphere westerly winds, forced deglaciation of this sector from at least 10,400 years ago until 7,500 years ago—when an ice-shelf collapse may have caused rapid ice-sheet thinning further upstream (see: Hillenbrand, C.-D., et al. (2017). "West Antarctic Ice Sheet retreat driven by Holocene warm water incursions." Nature 547(7661): 43-48). [Dominic Hodgson, United Kingdom (of Great Britain and Northern Ireland)]	This statement is strengthened by the strong evidence in the palaeo record of CDW inflow to the Amundsen Sea sector, the most vulnerable part of the West Antarctic Ice Sheet, during the Holocene. The chemical compositions of foraminifer shells and benthic foraminifer assemblages in marine sediments indicate that enhanced CDW upwelling, controlled by the latitudinal position of the Southern Hemisphere westerly winds, forced deglaciation of this sector from at least 10,400 years ago until 7,500 years ago—when an ice-shelf collapse may have caused rapid ice-sheet thinning further upstream (see: Hillenbrand, C.-D., et al. (2017). "West Antarctic Ice Sheet retreat driven by Holocene warm water incursions." Nature 547(7661): 43-48).

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
19950	57	36	57	46	Are the processes thermal forcing and upwelling of the Circumpolar Deep Water, which are influencing the acceleration of ice-shelf mass loss, driven or influenced by the anthropogenic global warming or is it part of natural variability? Are there studies (either on observations or simulations) that investigate the distinction between natural variability and anthropogenic trends in these processes? [Gwenaelle GREMION, Canada]	Are the processes thermal forcing and upwelling of the Circumpolar Deep Water, which are influencing the acceleration of ice-shelf mass loss, driven or influenced by the anthropogenic global warming or is it part of natural variability? Are there studies (either on observations or simulations) that investigate the distinction between natural variability and anthropogenic trends in these processes?
9916	57	40	57	40	Not sure if the reference for the figure is correct. Figure 9.20b is about the Greenland ice sheet not Antarctica. [Kevin Bulthuis, Belgium]	Not sure if the reference for the figure is correct. Figure 9.20b is about the Greenland ice sheet not Antarctica.
19940	57	40	57	40	It seems that Figure 9.20 isn't the right figure to reference? [Gwenaelle GREMION, Canada]	It seems that Figure 9.20 isn't the right figure to reference?
31268	57	45	57	45	references for "thickness changes" should also include Gourmelen et al. (2017). REF: Gourmelen, N. et al. (2017). channelized melting drives thinning under a rapidly melting Antarctic ice shelf. Geophysical Research Letters, 44, 9796– 9804. https://doi.org/10.1002/2017GL074929; Paolo et al. (2015) (Paolo et al. (2015), Volume loss from Antarctic ice shelves is accelerating, Science 17 Apr 2015: Vol. 348, Issue 6232, pp. 327-331 DOI: 10.1126/science.aaa0940 [Jeremie Mouginot, France]	references for "thickness changes" should also include Gourmelen et al. (2017). REF: Gourmelen, N. et al. (2017). channelized melting drives thinning under a rapidly melting Antarctic ice shelf. Geophysical Research Letters, 44, 9796– 9804. https://doi.org/10.1002/2017GL074929; Paolo et al. (2015) (Paolo et al. (2015), Volume loss from Antarctic ice shelves is accelerating, Science 17 Apr 2015: Vol. 348, Issue 6232, pp. 327-331 DOI: 10.1126/science.aaa0940
19944	57	48	57	51	This first sentence uses a lot of lingo for non-expert readers. I would suggest rewording to something like: "Although a physical link between sea ice presence and ice sheet stability has not yet been proven, it is likely that wind-driven reductions in sea ice formation rate also to reduce vertical mixing in the ocean column and increase stratification, allowing warming of the ice subsurface due to the penetration of warm CDW onto the continental shelf." [Gwenaelle GREMION, Canada]	This first sentence uses a lot of lingo for non-expert readers. I would suggest rewording to something like: "Although a physical link between sea ice presence and ice sheet stability has not yet been proven, it is likely that wind-driven reductions in sea ice formation rate also to reduce vertical mixing in the ocean column and increase stratification, allowing warming of the ice subsurface due to the penetration of warm CDW onto the continental shelf."

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
45324	57	48	57	54	· In general, it is not very clear from the text (here and before, e.g. line 51-52 from page 9.54) the role of sea ice on ice shelf melting and buttressing. I think you need to explain that there are three main mechanisms; a) changing in sea ice formation can change vertical mixing and heat delivery to ice shelves; b) sea ice can provide buttressing to the ice shelf flow; c) less sea ice can cause heat accumulation in the summer that can the affect ice-shelf front melting (e.g. Stewart et al., 2019 Nature Geoscience, Basal melting of Ross Ice Shelf from solar heat absorption in an ice-front polynya). I would try to re-structure this paragraph. [Alessandro Silvano, Australia]	· In general, it is not very clear from the text (here and before, e.g. line 51-52 from page 9.54) the role of sea ice on ice shelf melting and buttressing. I think you need to explain that there are three main mechanisms; a) changing in sea ice formation can change vertical mixing and heat delivery to ice shelves; b) sea ice can provide buttressing to the ice shelf flow; c) less sea ice can cause heat accumulation in the summer that can the affect ice-shelf front melting (e.g. Stewart et al., 2019 Nature Geoscience, Basal melting of Ross Ice Shelf from solar heat absorption in an ice-front polynya). I would try to re-structure this paragraph.
19960	58	5	58	8	What is the effect of a calving flux decrease on a glacier and would this lead to a stabilization of glaciers? [Gwenaelle GREMION, Canada]	What is the effect of a calving flux decrease on a glacier and would this lead to a stabilization of glaciers?
50788	58	6	58	6	Replace "decades" by "years" in: "...about 20 decades ago". [Hernan Edgardo Sala, Argentina]	Replace "decades" by "years" in: "...about 20 decades ago".
37916	58	6			Should "20 decades" be "two decades"? [Adrian Simmons, United Kingdom (of Great Britain and Northern Ireland)]	Should "20 decades" be "two decades"?
19952	58	11	58	11	Typo for area? [Gwenaelle GREMION, Canada]	Typo for area?
39264	58	11	58	13	This sentence could be reworded to just refer to the instability as MISI (this acronym has been used earlier in the chapter and is expalined in full in Box 9.1). This would shorten the text without any loss of relevant information [Stephen Chuter, United Kingdom (of Great Britain and Northern Ireland)]	This sentence could be reworded to just refer to the instability as MISI (this acronym has been used earlier in the chapter and is expalined in full in Box 9.1). This would shorten the text without any loss of relevant information
19954	58	12	58	12	Replace “elements” with “bedrock”. [Gwenaelle GREMION, Canada]	Replace “elements” with “bedrock”.
39266	58	15	58	20	The Marie Byrd Land (Getz region) has also seen grounding line retreat, with 33% of the grounding line undergoing retreat from 2003 - 2015 (Christie et al, 2018). Therefore it may be relevant to add this region and citation to this section of the text. This literature also makes a link between the rates of grounding line retreat in this region and its connection with variations in wind-driven upwelling of Circumpolar Deep Water on the continental shelf. The full citation is as follows: Christie, F. D. W., Bingham, R. G., Gourmelen, N., Steig, E. J., Bisset, R. R., Pritchard, H. D., Snow, K., and Tett, S. F. B.: Glacier change along West Antarctica's Marie Byrd Land Sector and links to inter-decadal atmosphere–ocean variability, The Cryosphere, 12, 2461-2479, https://doi.org/10.5194/tc-12-2461-2018, 2018. [Stephen Chuter, United Kingdom (of Great Britain and Northern Ireland)]	The Marie Byrd Land (Getz region) has also seen grounding line retreat, with 33% of the grounding line undergoing retreat from 2003 - 2015 (Christie et al, 2018). Therefore it may be relevant to add this region and citation to this section of the text. This literature also makes a link between the rates of grounding line retreat in this region and its connection with variations in wind-driven upwelling of Circumpolar Deep Water on the continental shelf. The full citation is as follows: Christie, F. D. W., Bingham, R. G., Gourmelen, N., Steig, E. J., Bisset, R. R., Pritchard, H. D., Snow, K., and Tett, S. F. B.: Glacier change along West Antarctica's Marie Byrd Land Sector and links to inter-decadal atmosphere–ocean variability, The Cryosphere, 12, 2461-2479, https://doi.org/10.5194/tc-12-2461-2018, 2018.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
19956	58	18	58	18	The following reference should be added regarding the cavity below the Totten ice shelf: Greenbaum, J.S., Blankenship, D.D., Young, D.A., Richter, T.G., Roberts, J.L., Aitken, A.R.A., Legresy, B., Schroeder, D.M., Warner, R.C., Van Ommen, T.D. and Siegert, M.J., 2015. Ocean access to a cavity beneath Totten Glacier in East Antarctica. Nature Geoscience, 8(4), p.294. [Gwenaelle GREMION, Canada]	The following reference should be added regarding the cavity below the Totten ice shelf: Greenbaum, J.S., Blankenship, D.D., Young, D.A., Richter, T.G., Roberts, J.L., Aitken, A.R.A., Legresy, B., Schroeder, D.M., Warner, R.C., Van Ommen, T.D. and Siegert, M.J., 2015. Ocean access to a cavity beneath Totten Glacier in East Antarctica. Nature Geoscience, 8(4), p.294.
50790	58	19	58	19	I suggest adding "adjacent to the glacier" at the end of "...allowing warm water to enter the cavity below the ice shelf". [Hernan Edgardo Sala, Argentina]	I suggest adding "adjacent to the glacier" at the end of "...allowing warm water to enter the cavity below the ice shelf".
19962	58	22	58	26	Grounding line retreats do not happen at all glacier of the WAIS at the same time. As it is mentioned, different mechanism can cause a grounding line retreat and the relationship between ocean temperature changes and grounding line retreat rates are nonlinear in West Antarctica. Is a collapse of a glacier correlating to its retreat of the grounding line? If so, can tipping points be simulated at which a collapse might happen and how would these simulations contribute to changes in mass or volume of the ice sheet? [Gwenaelle GREMION, Canada]	Grounding line retreats do not happen at all glacier of the WAIS at the same time. As it is mentioned, different mechanism can cause a grounding line retreat and the relationship between ocean temperature changes and grounding line retreat rates are nonlinear in West Antarctica. Is a collapse of a glacier correlating to its retreat of the grounding line? If so, can tipping points be simulated at which a collapse might happen and how would these simulations contribute to changes in mass or volume of the ice sheet?
8434	58	28	58	29	Konrad et al., 2018, apparently highlight that some fraction of current GL retreat rate may be residual remaining post-LGM deglacial response. This seems a key point, that is not highlighted elsewhere. Beyond Konrad et al. (2018) can Section authors review available literature of (for example) LGM-present AIS model simulations, to assess to a greater degree if there is any consensus on amount of overall present-day AIS response that is due to natural (post-glacial) response? Note: this verges on an aspect of detection/attribution (which for ice sheets is complicated by residual LGM responses) [Jeremy Fyke, Canada]	Konrad et al., 2018, apparently highlight that some fraction of current GL retreat rate may be residual remaining post-LGM deglacial response. This seems a key point, that is not highlighted elsewhere. Beyond Konrad et al. (2018) can Section authors review available literature of (for example) LGM-present AIS model simulations, to assess to a greater degree if there is any consensus on amount of overall present-day AIS response that is due to natural (post-glacial) response? Note: this verges on an aspect of detectioNot applicablettribution (which for ice sheets is complicated by residual LGM responses)
31912	58	33	58	34	This is not 'unclear'. A paper by Smith et al. shows that this grounding line retreat commenced from the 1940s (see: Smith, J. A., et al. (2016). "Sub-ice-shelf sediments record history of twentieth-century retreat of Pine Island Glacier." Nature 541: 77.) [Dominic Hodgson, United Kingdom (of Great Britain and Northern Ireland)]	This is not 'unclear'. A paper by Smith et al. shows that this grounding line retreat commenced from the 1940s (see: Smith, J. A., et al. (2016). "Sub-ice-shelf sediments record history of twentieth-century retreat of Pine Island Glacier." Nature 541: 77.)
19958	58	48	58	49	This sentence is quite confusing, could it be clarified? [Gwenaelle GREMION, Canada]	This sentence is quite confusing, could it be clarified?
8436	58	53	58	53	Regarding possible ozone forcing of AIS change: suggest removing subjective word 'remarkable' and replacing with 'notable' or similar. [Jeremy Fyke, Canada]	Regarding possible ozone forcing of AIS change: suggest removing subjective word 'remarkable' and replacing with 'notable' or similar.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
8438	58	53	58	53	Regarding possible ozone forcing of AIS change: since ozone depletion has been long demonstrated to produce a SAM-like response, it may be that the pattern of AIS snowfall change is ozone-forced, and manifests as a response that looks SAM-like. In general, i recommend being careful to describe a system response to an external climate forcing (ozone depletion) in terms of a response to a pattern of variability (SAM). It can conflate the two, to naive readers. [Jeremy Fyke, Canada]	Regarding possible ozone forcing of AIS change: since ozone depletion has been long demonstrated to produce a SAM-like response, it may be that the pattern of AIS snowfall change is ozone-forced, and manifests as a response that looks SAM-like. In general, i recommend being careful to describe a system response to an external climate forcing (ozone depletion) in terms of a response to a pattern of variability (SAM). It can conflate the two, to naive readers.
19968	59	1	59	9	Worth mentioning in this paragraph is that a lot of spatial variability in SMB is observed in ice cores. Relevant reference: Philippe, M., Tison, J.L., Fjøsne, K., Hubbard, B., Kjær, H.A., Lenaerts, J., Drews, R., Sheldon, S.G., Bondt, K.D., Claeys, P. and Pattyn, F., 2016. Ice core evidence for a 20th century increase in surface mass balance in coastal Dronning Maud Land, East Antarctica. The Cryosphere, 10(5), pp.2501-2516. [Gwenaelle GREMION, Canada]	Worth mentioning in this paragraph is that a lot of spatial variability in SMB is observed in ice cores. Relevant reference: Philippe, M., Tison, J.L., Fjøsne, K., Hubbard, B., Kjær, H.A., Lenaerts, J., Drews, R., Sheldon, S.G., Bondt, K.D., Claeys, P. and Pattyn, F., 2016. Ice core evidence for a 20th century increase in surface mass balance in coastal Dronning Maud Land, East Antarctica. The Cryosphere, 10(5), pp.2501-2516.
8440	59	2	59	4	To be clear: disaggregating ozone depletion vs. warming forcings on AIS SMB is the EXACT task of a detection/attribution study. Perhaps note this here, particularly as next section is 'model evaluation and attribution' [Jeremy Fyke, Canada]	To be clear: disaggregating ozone depletion vs. warming forcings on AIS SMB is the EXACT task of a detectioNot applicablettribution study. Perhaps note this here, particularly as next section is 'model evaluation and attribution'
19966	59	2	59	4	The process of atmospheric blocking could be added to the causes' list here, in which case the following reference could be used: Scarchilli, C., Frezzotti, M. and Ruti, P.M., 2011. Snow precipitation at four ice core sites in East Antarctica: provenance, seasonality and blocking factors. Climate Dynamics, 37(9-10), pp.2107-2125. [Gwenaelle GREMION, Canada]	The process of atmospheric blocking could be added to the causes' list here, in which case the following reference could be used: Scarchilli, C., Frezzotti, M. and Ruti, P.M., 2011. Snow precipitation at four ice core sites in East Antarctica: provenance, seasonality and blocking factors. Climate Dynamics, 37(9-10), pp.2107-2125.
8446	59	12			Suggest adding an additional known limitation: "The high model resolution needed to adequately capture local-scale bathymetry and ocean processes relevant to ice-ocean interactions, is difficult to reconcile with the timescales inherent in Antarctic ice dynamics and coupling to global processes. Capturing both requires high resolution, long-duration simulations that exceed the capacity of current supercomputers." [Jeremy Fyke, Canada]	Suggest adding an additional known limitation: "The high model resolution needed to adequately capture local-scale bathymetry and ocean processes relevant to ice-ocean interactions, is difficult to reconcile with the timescales inherent in Antarctic ice dynamics and coupling to global processes. Capturing both requires high resolution, long-duration simulations that exceed the capacity of current supercomputers."

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
8444	59	14	59	15	Unclear to reader why short satellite record of OBSERVED AIS changes is responsible for the less mature state of ice sheet MODELLING. In addition, is it the state of ice sheet modelling that is primarily immature, or the state of coupling between ice sheet models and Earth system models (which is the framework that attribution exercises generally require)? I think both. Suggest removing satellite record reference, and altering text to 'Antarctic ice sheet modelling, and coupling between Antarctic ice mass balance and dynamics, and the broader climate system, is significantly less mature than most other numerical model-based representations of global climate system components'. [Jeremy Fyke, Canada]	Unclear to reader why short satellite record of OBSERVED AIS changes is responsible for the less mature state of ice sheet MODELLING. In addition, is it the state of ice sheet modelling that is primarily immature, or the state of coupling between ice sheet models and Earth system models (which is the framework that attribution exercises generally require)? I think both. Suggest removing satellite record reference, and altering text to 'Antarctic ice sheet modelling, and coupling between Antarctic ice mass balance and dynamics, and the broader climate system, is significantly less mature than most other numerical model-based representations of global climate system components'.
26636	59	14	59	29	Discusion is requirwed of uncertainty in slideing laws and till properties see Bulthuls et al., 2019 https://www.the-cryosphere.net/13/1349/2019/. [Jeff Ridley, United Kingdom (of Great Britain and Northern Ireland)]	Discusion is requirwed of uncertainty in slideing laws and till properties see Bulthuls et al., 2019 https://www.the-cryosphere.net/13/1349/2019/.
40430	59	20	59	29	A few key references are missing and I think that the clarity of a few things can be improved.Here is an alternative suggestion: Three approaches exist: standalone ice sheet models driven by (i) basal melting from ocean models with static ice shelves, or (ii) thermal forcing from ocean models, via a temperature-melt parameterisation, or (iii) coupled ocean-ice-sheet models (Asay-Davis et al., 2017). The two first approaches do not fully represent the feedbacks between the ocean state beneath ice shelves and the ice-shelf basal topography (Donat-Magnin et al. 2017, Timmermann and Goeller 2017). Coupled ocean-ice-sheet models are under development in several centers and have been used in regional studies (Seroussi et al. 2017; Thoma et al. 2015; Timmermann and Goeller 2017), but so far not in studies simulating the entire Antarctic ice sheet. Ocean models have also known limitations due to poor knowledge of the bathymetry and fine-scale complexities such as seawater intrusion along preferential channels at tidal frequencies, which causes local high melt rates (Milillo et al., 2019). Other aspects of ice sheet models lead to significant uncertainty of ice sheet simulations, such as the basal friction law (Brondex et al. 2019), and the grounding-line flux formula used in models of relatively coarse resolution (Reese et al. 2018b). Additional references: Brondex, J., Gillet-Chaulet, F., and Gagliardini, O.: Sensitivity of centennial mass loss projections of the Amundsen basin to the friction law, The Cryosphere, 13, 177-195, https://doi.org/10.5194/tc-13-177-2019, 2019. Reese, R., Winkelmann, R. and Gudmundsson, H. (2018b). Grounding-line flux formula applied as a flux condition in numerical simulations fails for buttressed Antarctic ice streams. The Cryosphere, 12(10), 3229-3242.	A few key references are missing and I think that the clarity of a few things can be improved.Here is an alternative suggestion: Three approaches exist: standalone ice sheet models driven by (i) basal melting from ocean models with static ice shelves, or (ii) thermal forcing from ocean models, via a temperature-melt parameterisation, or (iii) coupled ocean-ice-sheet models (Asay-Davis et al., 2017). The two first approaches do not fully represent the feedbacks between the ocean state beneath ice shelves and the ice-shelf basal topography (Donat-Magnin et al. 2017, Timmermann and Goeller 2017). Coupled ocean-ice-sheet models are under development in several centers and have been used in regional studies (Seroussi et al. 2017; Thoma et al. 2015; Timmermann and Goeller 2017), but so far not in studies simulating the entire Antarctic ice sheet. Ocean models have also known limitations due to poor knowledge of the bathymetry and fine-scale complexities such as seawater intrusion along preferential channels at tidal frequencies, which causes local high melt rates (Milillo et al., 2019). Other aspects of ice sheet models lead to significant uncertainty of ice sheet simulations, such as the basal friction law (Brondex et al. 2019), and the grounding-line flux formula used in models of relatively coarse resolution (Reese et al.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
30252	59	21	59	22	Add reference to Favier et al. (2019) https://doi.org/10.5194/gmd-12-2255-2019 [Frank Pattyn, Belgium]	Add reference to Favier et al. (2019) https://doi.org/10.5194/gmd-12-2255-2019
19970	59	33	59	33	Add " due to ocean thermal forcing" after "ice mass". [Gwenaelle GREMION, Canada]	Add " due to ocean thermal forcing" after "ice mass".
19964	59	33	59	33	Cite references for rationalising the conclusion. [Gwenaelle GREMION, Canada]	Cite references for rationalising the conclusion.
8448	59	33	59	52	This section indicates that it is unclear whether recent Antarctic ice mass observed changes are due to human influence or are rather part of ongoing, natural oscillations (internal variability). This is an important point that a true model-based attribution exercise would specifically address. To that end, I suggest clearly linking, via references or internal language calibration, to Chapter 3 theme and statements, "The evaluation of human influence on the climate system requires an estimate of the expected responses to forcings and the contribution from internal climate variability, which are obtained primarily from climate and Earth system models." "To be fit for detecting and attributing human influence [...], climate models need to represent, from physically-based understanding, both the response of surface temperature to external forcings and the internal variability in surface temperature over various time scales." Then, explaining why these exercises have not yet been carried out for Antarctica. [Jeremy Fyke, Canada]	This section indicates that it is unclear whether recent Antarctic ice mass observed changes are due to human influence or are rather part of ongoing, natural oscillations (internal variability). This is an important point that a true model-based attribution exercise would specifically address. To that end, I suggest clearly linking, via references or internal language calibration, to Chapter 3 theme and statements, "The evaluation of human influence on the climate system requires an estimate of the expected responses to forcings and the contribution from internal climate variability, which are obtained primarily from climate and Earth system models." "To be fit for detecting and attributing human influence [...], climate models need to represent, from physically-based understanding, both the response of surface temperature to external forcings and the internal variability in surface temperature over various time scales." Then, explaining why these exercises have not yet been carried out for Antarctica.
8450	59	33	59	52	Work is available that formally attributes regional changes in Southern Ocean conditions to anthropogenic forcing (Swart et al., 2018, https://www.nature.com/articles/s41561-018-0226-1). Suggest noting this work, which 'closes in' on attribution of Antarctic changes from the far-field ocean side of ice-ocean interactions. [Jeremy Fyke, Canada]	Work is available that formally attributes regional changes in Southern Ocean conditions to anthropogenic forcing (Swart et al., 2018, https://www.nature.com/articles/s41561-018-0226-1). Suggest noting this work, which 'closes in' on attribution of Antarctic changes from the far-field ocean side of ice-ocean interactions.
8452	59	33	59	52	Suggest referencing Swart et al., 2018, https://www.nature.com/articles/s41561-018-0226-1, attribution study, in the context of broader SO ocean changes that may affect coastal Antarctic oceanographic conditions. This may change the 'very low confidence' ranking [Jeremy Fyke, Canada]	Suggest referencing Swart et al., 2018, https://www.nature.com/articles/s41561-018-0226-1, attribution study, in the context of broader SO ocean changes that may affect coastal Antarctic oceanographic conditions. This may change the 'very low confidence' ranking

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
45326	59	38	59	38	there are no observations at the Totten to support any temporal signal in the ocean, in contrast to the Amundsen Sea where there are more than two decades of observations. Changes at the Totten can be inferred only from the satellites (e.g. Greene et al., 2017; Science Advances) or from models (Gwyther et al., 2018; Khazendar et al., 2013) [Alessandro Silvano, Australia]	there are no observations at the Totten to support any temporal signal in the ocean, in contrast to the Amundsen Sea where there are more than two decades of observations. Changes at the Totten can be inferred only from the satellites (e.g. Greene et al., 2017; Science Advances) or from models (Gwyther et al., 2018; Khazendar et al., 2013)
40432	59	38	59	40	The thermal forcing does not directly depend on the velocity of water at the ice/ocean interface. The sentence should be replaced with something like "Melt rates are affected by both thermal forcing and ocean velocity at the ice/ocean interface, so changes on tidal and seasonal...". [Nicolas Jourdain, France]	The thermal forcing does not directly depend on the velocity of water at the ice/ocean interface. The sentence should be replaced with something like "Melt rates are affected by both thermal forcing and ocean velocity at the ice/ocean interface, so changes on tidal and seasonal...".
40434	59	42	59	50	It may be worth mentioning the possible role of ENSO as part of the natural variability that makes it more difficult to identify anthropogenic trends: Marine intrusions of Circumpolar Deep Water in the Amundsen Sea are favored by El Niño events (Steig et al., 2012), and increase ice-shelf melting (Paolo et al. 2018). Additional references: Paolo, F. S., Padman, L., Fricker, H. A., Adusumilli, S., Howard, S. and Siegfried, M. R. (2018). Response of Pacific-sector Antarctic ice shelves to the El Niño/Southern Oscillation. Nature geoscience, 11(2), 121. // Steig, E. J., Ding, Q., Battisti, D. S. and Jenkins, A. (2012). Tropical forcing of Circumpolar Deep Water inflow and outlet glacier thinning in the Amundsen Sea Embayment, West Antarctica. Annals of Glaciology, 53(60), 19-28. [Nicolas Jourdain, France]	It may be worth mentioning the possible role of ENSO as part of the natural variability that makes it more difficult to identify anthropogenic trends: Marine intrusions of Circumpolar Deep Water in the Amundsen Sea are favored by El Nin?o events (Steig et al., 2012), and increase ice-shelf melting (Paolo et al. 2018). Additional references: Paolo, F. S., Padman, L., Fricker, H. A., Adusumilli, S., Howard, S. and Siegfried, M. R. (2018). Response of Pacific-sector Antarctic ice shelves to the El Niño/Southern Oscillation. Nature geoscience, 11(2), 121. // Steig, E. J., Ding, Q., Battisti, D. S. and Jenkins, A. (2012). Tropical forcing of Circumpolar Deep Water inflow and outlet glacier thinning in the Amundsen Sea Embayment, West Antarctica. Annals of Glaciology, 53(60), 19-28.
39268	59	45	59	46	The link between variations in wind-driven upwelling of Circumpolar Deep Water on the continental shelf and the rate of grounding line retreat for the Marie Byrd Land sector has also been noted in Christie et al (2018) and would be a suitable literature citation here. See comment 8 for full explanation. The full citation of this paper is as follows: Christie, F. D. W., Bingham, R. G., Gourmelen, N., Steig, E. J., Bisset, R. R., Pritchard, H. D., Snow, K., and Tett, S. F. B.: Glacier change along West Antarctica's Marie Byrd Land Sector and links to inter-decadal atmosphere–ocean variability, The Cryosphere, 12, 2461-2479, https://doi.org/10.5194/tc-12-2461-2018, 2018. [Stephen Chuter, United Kingdom (of Great Britain and Northern Ireland)]	The link between variations in wind-driven upwelling of Circumpolar Deep Water on the continental shelf and the rate of grounding line retreat for the Marie Byrd Land sector has also been noted in Christie et al (2018) and would be a suitable literature citation here. See comment 8 for full explanation. The full citation of this paper is as follows: Christie, F. D. W., Bingham, R. G., Gourmelen, N., Steig, E. J., Bisset, R. R., Pritchard, H. D., Snow, K., and Tett, S. F. B.: Glacier change along West Antarctica's Marie Byrd Land Sector and links to inter-decadal atmosphere–ocean variability, The Cryosphere, 12, 2461-2479, https://doi.org/10.5194/tc-12-2461-2018, 2018.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
45328	59	48	59	48	(Khazendar et al., 2013; Gwyther et al., 2014 Ocean Science, Simulated melt rates for the Totten and Dalton ice shelves). [Alessandro Silvano, Australia]	(Khazendar et al., 2013; Gwyther et al., 2014 Ocean Science, Simulated melt rates for the Totten and Dalton ice shelves).
45330	59	54	59	55	It would be to include the river network that forms on the ice shelf surface that can mitigate increased surface melting (Bell et al., 2017; Nature; Antarctic ice shelf potentially stabilized by export of meltwater in surface river) [Alessandro Silvano, Australia]	It would be to include the river network that forms on the ice shelf surface that can mitigate increased surface melting (Bell et al., 2017; Nature; Antarctic ice shelf potentially stabilized by export of meltwater in surface river)
26638	59	54	60	7	Turner 2016 actually suggests a cooling and consequently the original warming was associated with multidecadal variability. There is thus no reason to suspect human influence.Need reference to marine sediment cores that suggest Larsen-b has been thinning throughout the Holocene https://www.ncbi.nlm.nih.gov/pubmed/16079842 and consequently passed a tipping point with the 1960-2000 warming. Other ice shelves on the Norther Peninsula are known to be at the limit of viability and have previously collapsed during the Holocene [Jeff Ridley, United Kingdom (of Great Britain and Northern Ireland)]	Turner 2016 actually suggests a cooling and consequently the original warming was associated with multidecadal variability. There is thus no reason to suspect human influence.Need reference to marine sediment cores that suggest Larsen-b has been thinning throughout the Holocene https://www.ncbi.nlm.nih.gov/pubmed/16079842 and consequently passed a tipping point with the 1960-2000 warming. Other ice shelves on the Norther Peninsula are known to be at the limit of viability and have previously collapsed during the Holocene
8454	59	55	59	55	regional warming' -> 'regional atmospheric warming' [Jeremy Fyke, Canada]	regional warming' -> 'regional atmospheric warming'
19982	60	4	60	4	"quantifying the relative influence of human influence": please rephrase to improve the reading, e.g., "relative contribution of human influence". [Gwenaelle GREMION, Canada]	"quantifying the relative influence of human influence": please rephrase to improve the reading, e.g., "relative contribution of human influence".
8456	60	5	60	7	Measures of emergence are very coarse measures of signal-to-noise (e.g. when signal is of ~same magnitude as noise). As with Greenland emergence discussion, note that the actual detection of a signal, will certainly occur well before full emergence occurs (and possibly even earlier in particularly low-noise or high-signal AIS spatial locations). [Jeremy Fyke, Canada]	Measures of emergence are very coarse measures of signal-to-noise (e.g. when signal is of ~same magnitude as noise). As with Greenland emergence discussion, note that the actual detection of a signal, will certainly occur well before full emergence occurs (and possibly even earlier in particularly low-noise or high-signal AIS spatial locations).
19972	60	16	60	22	Why the range (-6 -12 cm) of the projection of the ice-dynamical contribution to GMSL under RCP8.5 is less than that (-3 - 14 cm) of the RCP2.6 scenario? Explain to avoid confusion. [Gwenaelle GREMION, Canada]	Why the range (-6 -12 cm) of the projection of the ice-dynamical contribution to GMSL under RCP8.5 is less than that (-3 - 14 cm) of the RCP2.6 scenario? Explain to avoid confusion.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
8458	60	19	60	19	It is perhaps more likely that increased AIS sub-shelf melting will arise more due to dynamical shifts in ocean circulation (e.g. shoaling of CDW) than from ambient ocean temperature changes. As noted later in chapter. Suggest changing to: "Ocean temperature predictions around Antarctica can be assessed as an indicator of the basal melt": suggest changing to "one potential indicator of melt changes". [Jeremy Fyke, Canada]	It is perhaps more likely that increased AIS sub-shelf melting will arise more due to dynamical shifts in ocean circulation (e.g. shoaling of CDW) than from ambient ocean temperature changes. As noted later in chapter. Suggest changing to: "Ocean temperature predictions around Antarctica can be assessed as an indicator of the basal melt": suggest changing to "one potential indicator of melt changes".
30256	60	19	60	20	Technically speaking, MISI is not something that you 'include' in ice sheet models. It is a theoretical concept as explained in Box 9.1. Whether models are capable or not to reproduce its behaviour all boils down to spatial resolution which needs to be high enough to make grounding lines migrate, otherwise their migration is heavily influenced by numerics and not due to physics. It boils down to whether models resolve grounding line migration or not, which translates into a floatation criterion AS WELL AS solving membrane stresses at both sides of the grounding line. Initially, models only took into account flotation. [Frank Pattyn, Belgium]	Technically speaking, MISI is not something that you 'include' in ice sheet models. It is a theoretical concept as explained in Box 9.1. Whether models are capable or not to reproduce its behaviour all boils down to spatial resolution which needs to be high enough to make grounding lines migrate, otherwise their migration is heavily influenced by numerics and not due to physics. It boils down to whether models resolve grounding line migration or not, which translates into a floatation criterion AS WELL AS solving membrane stresses at both sides of the grounding line. Initially, models only took into account flotation.
9918	60	21	60	21	Maybe also add the following reference: Bulthuis, K., Arnst, M., Sun, S., and Pattyn, F.: Uncertainty qunatification of the multi-centennial response of the Antarctic ice sheet to climate change, The Cryosphere, 13, 1349-1380, https://doi.org/10.5194/tc-13-1349-2019, 2019. [Kevin Bulthuis, Belgium]	Maybe also add the following reference: Bulthuis, K., Arnst, M., Sun, S., and Pattyn, F.: Uncertainty qunatification of the multi-centennial response of the Antarctic ice sheet to climate change, The Cryosphere, 13, 1349-1380, https://doi.org/10.5194/tc-13-1349-2019, 2019.
8460	60	22	60	22	Suggest clearly segregating the ambient temperature change (e.g. Yin, 2012, and probably more recent references), from dynamical circulation changes (e.g. Hellmer et al. 2012 and probably more recent references), as potential drivers. [Jeremy Fyke, Canada]	Suggest clearly segregating the ambient temperature change (e.g. Yin, 2012, and probably more recent references), from dynamical circulation changes (e.g. Hellmer et al. 2012 and probably more recent references), as potential drivers.
57948	60	22	60	22	Shouldn't this be Table 9.3 and Figure 9.24? [Bas de Boer, Netherlands]	Shouldn't this be Table 9.3 and Figure 9.24?
19974	60	24	60	25	I would suggest specifying it is 43 cm in GMSL. But also, it would be good to clarify this is for a AIS-only source. And finally, is the Figure number supposed to be Figure 9.24? [Gwenaelle GREMION, Canada]	I would suggest specifying it is 43 cm in GMSL. But also, it would be good to clarify this is for a AIS-only source. And finally, is the Figure number supposed to be Figure 9.24?
9920	60	25	60	25	I assume this is Table 9.3 instead of Table 9.2. [Kevin Bulthuis, Belgium]	I assume this is Table 9.3 instead of Table 9.2.
9922	60	25	60	25	I do not think this the correct number for the figure (maybe Figure 9.24 instead). [Kevin Bulthuis, Belgium]	I do not think this the correct number for the figure (maybe Figure 9.24 instead).

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
26640	60	25	60	29	Too much is being made of the MICI (of unproven importance given the uncertainty in parameterisation). The implication here is that models that do not include it are somehow deficient! [Jeff Ridley, United Kingdom (of Great Britain and Northern Ireland)]	Too much is being made of the MICI (of unproven importance given the uncertainty in parameterisation). The implication here is that models that do not include it are somehow deficient!
33266	60	30	60	30	The likely probability that the Antarctic ice sheet will loose mass this century seems weak. Negative contribution is reached only for one model under the RCP2.6 scenario and negative values are outside the range of expert judgment. It seems that very likely would be more appropriate. [Dewi Le Bars, Netherlands]	The likely probability that the Antarctic ice sheet will loose mass this century seems weak. Negative contribution is reached only for one model under the RCP2.6 scenario and negative values are outside the range of expert judgment. It seems that very likely would be more appropriate.
19976	60	39	60	40	Correction: add “the” in front of “ASE” and “consistency”. [Gwenaelle GREMION, Canada]	Correction: add “the” in front of “ASE” and “consistency”.
31914	60	39	60	43	Sattellite evidence of changing rates of ice mass loss should be included in this statement. [Dominic Hodgson, United Kingdom (of Great Britain and Northern Ireland)]	Sattellite evidence of changing rates of ice mass loss should be included in this statement.
19978	60	43	60	43	I would suggest to be more specific for “longer-term”: 100 yr, 1000 yr, 10 kyr? [Gwenaelle GREMION, Canada]	I would suggest to be more specific for “longer-term”: 100 yr, 1000 yr, 10 kyr?
9764	60	46	61	3	I suggest the following changes to the columns and headings in the table, for simplicity and clarification: In the column for projections, remove the secondary column including information such as "With time delay" or "No time delay". Instead, place this information in the current "Notes" column. I also suggest changing the "Notes" heading to "Range and Projection Description". Then, make separate rows for each projection, even those that come from the same study. So, for example, the first row in the RCP 2.6 section would be: Column 1--7(0, 23); Column 2--Median(5-95%) for models with ice shelves, with a time delay; Column 3--Levermann et al., 2014. The second row would then be: Column 1--9(2, 25); Column 2--Median(5-95%) for models with ice shelves, with no time delay; Column 3--Levermann et al., 2014. [Andra Garner, United States of America]	I suggest the following changes to the columns and headings in the table, for simplicity and clarification: In the column for projections, remove the secondary column including information such as "With time delay" or "No time delay". Instead, place this information in the current "Notes" column. I also suggest changing the "Notes" heading to "Range and Projection Description". Then, make separate rows for each projection, even those that come from the same study. So, for example, the first row in the RCP 2.6 section would be: Column 1--7(0, 23); Column 2--Median(5-95%) for models with ice shelves, with a time delay; Column 3--Levermann et al., 2014. The second row would then be: Column 1--9(2, 25); Column 2--Median(5-95%) for models with ice shelves, with no time delay; Column 3--Levermann et al., 2014.
9766	60	46	61	3	For consistency, SRES should be a separate section of the table, as the individual RCP scenarios are. [Andra Garner, United States of America]	For consistency, SRES should be a separate section of the table, as the individual RCP scenarios are.
52180	60	46	61	3	Similar to my comment on the same table in the GiS section I don't get much from this table and it is largely redundant with the figure that follows. See that earlier comment for further thoughts on the matter. [Peter Thorne, Ireland]	Similar to my comment on the same table in the GiS section I don't get much from this table and it is largely redundant with the figure that follows. See that earlier comment for further thoughts on the matter.
19980	60	48	60	48	Table 9.3. It would helpful to state what the “with time delay” and “without” are explicitly. [Gwenaelle GREMION, Canada]	Table 9.3. It would helpful to state what the “with time delay” and “without” are explicitly.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
30258	60	48	60	48	Reference and SLR contributions from Bulthuis et al (2019) to be added. https://doi.org/10.5194/tc-13-1349-2019 [Frank Pattyn, Belgium]	Reference and SLR contributions from Bulthuis et al (2019) to be added. https://doi.org/10.5194/tc-13-1349-2019
8680	60	48	60	48	Another study published during the 1st order draft review is Bulthuis et al. (2019). Bulthuis, K., Arnst, M., Sun, S. and Pattyn, F., 2019. Uncertainty quantification of the multi-centennial response of the Antarctic ice sheet to climate change. The Cryosphere, 13, pp.1349-1380 [Goneri Le Cozannet, France]	Another study published during the 1st order draft review is Bulthuis et al. (2019). Bulthuis, K., Arnst, M., Sun, S. and Pattyn, F., 2019. Uncertainty quantification of the multi-centennial response of the Antarctic ice sheet to climate change. The Cryosphere, 13, pp.1349-1380
16054	60	48	61	2	For completeness, RCP4.5 and RCP6.0 should be included in Table 9.3. [SAI MING LEE, China]	For completeness, RCP4.5 and RCP6.0 should be included in Table 9.3.
52228	61	14	61	25	Is there any confidence in how the snowfall changes will relate to dynamic losses (i.e. what are their relative contributions to net ice-sheet mass changes), compared between the EAIS and WAIS? Reporting so will give the reader an idea of which processes could dominate the mass changes and uncertainties in which region. [Daniel Gilford, United States of America]	Is there any confidence in how the snowfall changes will relate to dynamic losses (i.e. what are their relative contributions to net ice-sheet mass changes), compared between the EAIS and WAIS? Reporting so will give the reader an idea of which processes could dominate the mass changes and uncertainties in which region.
42664	61	14	62	40	There is a statement that Antarctic snowfall is expected to increase and result in a negative contribution to sea level rise page 9-61 line 14ff. This statement is at odds with an [Howard Brady, Australia]	There is a statement that Antarctic snowfall is expected to increase and result in a negative contribution to sea level rise page 9-61 line 14ff. This statement is at odds with an
33268	61	15	61	16	The "likely" qualifier is strangely used here. Does it mean that if precipitations increase in Antarctica the probability that it makes sea level drop is 66% or more? I think what the authors mean is that it is likely that precipitations will increase. Which if it happened would result in sea level drop (100% sure). [Dewi Le Bars, Netherlands]	The "likely" qualifier is strangely used here. Does it mean that if precipitations increase in Antarctica the probability that it makes sea level drop is 66% or more? I think what the authors mean is that it is likely that precipitations will increase. Which if it happened would result in sea level drop (100% sure).
26642	62	2	62	4	Over what period is snowfall expected to exceed melt? Is this up to 2100 or for any amount of warming? [Jeff Ridley, United Kingdom (of Great Britain and Northern Ireland)]	Over what period is snowfall expected to exceed melt? Is this up to 2100 or for any amount of warming?
19984	62	5	62	5	When stating that the changes are expected to be “small”, it would be more informative to give a quantitative estimate, even if it’s a range. [Gwenaelle GREMION, Canada]	When stating that the changes are expected to be “small”, it would be more informative to give a quantitative estimate, even if it’s a range.
25340	62	5	62	7	Unclear [Sharon Smith, Canada]	Unclear
31650	62	12	62	12	A full sentence is in bracket (). I suggest to remove the bracket or reformulate. [Pierre Mathiot, United Kingdom (of Great Britain and Northern Ireland)]	A full sentence is in bracket (). I suggest to remove the bracket or reformulate.
52230	62	13	62	14	For context it would helpful to clarify that that this is "even with no additional forcing" on top of current forcing (Arthern and Williams). This isn't very clear from what is currently written. [Daniel Gilford, United States of America]	For context it would helpful to clarify that that this is "even with no additional forcing" on top of current forcing (Arthern and Williams). This isn't very clear from what is currently written.
31652	62	13	62	14	(e.g. (Arthern and Williams, 2017; Nias et al., 2016))': I suggest to remove the inner bracket. [Pierre Mathiot, United Kingdom (of Great Britain and Northern Ireland)]	(e.g. (Arthern and Williams, 2017; Nias et al., 2016))': I suggest to remove the inner bracket.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
31638	62	21	62	21	o I found the reference to 'an average warming of ~0.5C° at depths of 200–500 m in 2091–2100 compared to 1991–2000' in Yin et al. (2012). o I will have found welcome the put the trend of 0.5C in depth in perspective with the variability of the trend across model (if available) or the variability of the temperature itself across models as show in Figure 1 of Heuze et al. (2013) for the bottom water. [Pierre Mathiot, United Kingdom (of Great Britain and Northern Ireland)]	o I found the reference to 'an average warming of ~0.5C° at depths of 200–500 m in 2091–2100 compared to 1991–2000' in Yin et al. (2012). o I will have found welcome the put the trend of 0.5C in depth in perspective with the variability of the trend across model (if available) or the variability of the temperature itself across models as show in Figure 1 of Heuze et al. (2013) for the bottom water.
9924	62	31	62	31	BellinGshausen instead of Bellinshausen. [Kevin Bulthuis, Belgium]	BellinGshausen instead of Bellinshausen.
31640	62	32	62	35	o The present day condition over the Amundsen/Bellingshausen shelf in Naughten et al. (2018) are not realistic, the main reason is the absence of MCDW on the Amundsen/Bellingshausen shelf for various reasons discussed in the paper. As the model results presented in this paper are in the wrong regime (cold shelf instead of warm), I am very dubious about the reliability of the trend and so are the authors: "These present-day biases may affect the simulated future changes, and our projections should therefore be interpreted with caution.". I suggest to remove this example. o The sentence focuses on Amudsen and Bellingshausen sea, but in the figure 9.25 in Antarctic wide, so it is very difficult to see value over these small ice shelves. Should it be a zoom over AMundsen/Bellingshausen sea of reformulate the example to talk also about the giant ice shelves and EAIS. [Pierre Mathiot, United Kingdom (of Great Britain and Northern Ireland)]	o The present day condition over the Amundsen/Bellingshausen shelf in Naughten et al. (2018) are not realistic, the main reason is the absence of MCDW on the Amundsen/Bellingshausen shelf for various reasons discussed in the paper. As the model results presented in this paper are in the wrong regime (cold shelf instead of warm), I am very dubious about the reliability of the trend and so are the authors: "These present-day biases may affect the simulated future changes, and our projections should therefore be interpreted with caution.". I suggest to remove this example. o The sentence focuses on Amudsen and Bellingshausen sea, but in the figure 9.25 in Antarctic wide, so it is very difficult to see value over these small ice shelves. Should it be a zoom over AMundsen/Bellingshausen sea of reformulate the example to talk also about the giant ice shelves and EAIS.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
40436	62	32	62	40	Naughten et al. (2018) is a great study, but their biases are very strong in the Amundsen Sea: their "FESOM configuration exhibits a cold bias in the Amundsen Sea, with bottom water temperatures around -1°C on the continental shelf (Fig. 7a). By comparison, observations in this region suggest temperatures around 1°C" (quoted from their section 4d). So basically, their present-day Amundsen sector has cold cavities that become warm cavities under rcp85. This is very likely the reason why their relative increase is so large for the Amundsen Sea. For this reason, I would not claim that we have more confidence in melting projections in the Amundsen Sea than in the Weddell Sea. Overall, I think that it would be fair to say that there is low confidence on the range of projected melt rates because of the present-day model biases and because these projections do not really explore the range of possible climate forcing (e.g. 2 CMIP3 models used in Timmermann et al. 2013, 1 individual CMIP5 model and the CMIP5 multi-model-mean in Naughten et al. 2018). [Nicolas Jourdain, France]	Naughten et al. (2018) is a great study, but their biases are very strong in the Amundsen Sea: their "FESOM configuration exhibits a cold bias in the Amundsen Sea, with bottom water temperatures around -1°C on the continental shelf (Fig. 7a). By comparison, observations in this region suggest temperatures around 1°C" (quoted from their section 4d). So basically, their present-day Amundsen sector has cold cavities that become warm cavities under rcp85. This is very likely the reason why their relative increase is so large for the Amundsen Sea. For this reason, I would not claim that we have more confidence in melting projections in the Amundsen Sea than in the Weddell Sea. Overall, I think that it would be fair to say that there is low confidence on the range of projected melt rates because of the present-day model biases and because these projections do not really explore the range of possible climate forcing (e.g. 2 CMIP3 models used in Timmermann et al. 2013, 1 individual CMIP5 model and the CMIP5 multi-model-mean in Naughten et al. 2018).
31642	62	52	62	53	As Naughten et al. (2018) is not able to represent intrusion of CDW for present day, I suggest to remove this reference to the list mention in l53. [Pierre Mathiot, United Kingdom (of Great Britain and Northern Ireland)]	As Naughten et al. (2018) is not able to represent intrusion of CDW for present day, I suggest to remove this reference to the list mention in l53.
31280	62	53	62	53	I think Mohajerani et al. 2018 is not appropriatie for supporting intrusion of warm water onto Antarctic Shelves, although I would like the paper to be cited for supporting changes on Totten Glacier, East Antarctica on page 57 line 10. [Jeremie Mouginot, France]	I think Mohajerani et al. 2018 is not appropriatie for supporting intrusion of warm water onto Antarctic Shelves, although I would like the paper to be cited for supporting changes on Totten Glacier, East Antarctica on page 57 line 10.
31916	62	54	62	55	Future projections should be well informed by the palaeo evidence for CDW intrusions (see: Hillenbrand, C.-D., et al. (2017). "West Antarctic Ice Sheet retreat driven by Holocene warm water incursions." Nature 547(7661): 43-48). [Dominic Hodgson, United Kingdom (of Great Britain and Northern Ireland)]	Future projections should be well informed by the palaeo evidence for CDW intrusions (see: Hillenbrand, C.-D., et al. (2017). "West Antarctic Ice Sheet retreat driven by Holocene warm water incursions." Nature 547(7661): 43-48).
19986	63	13	63	13	I would suggest adding the following references for the basal channels: Drews, R., 2015. Evolution of ice-shelf channels in Antarctic ice shelves. The Cryosphere, 9(3), pp.1169-1181. AND/OR Berger, S., Drews, R., Helm, V., Sun, S. and Pattyn, F., 2017. Detecting high spatial variability of ice shelf basal mass balance, Roi Baudouin Ice Shelf, Antarctica. The Cryosphere, 11(6), pp.2675-2690. [Gwenaelle GREMION, Canada]	I would suggest adding the following references for the basal channels: Drews, R., 2015. Evolution of ice-shelf channels in Antarctic ice shelves. The Cryosphere, 9(3), pp.1169-1181. AND/OR Berger, S., Drews, R., Helm, V., Sun, S. and Pattyn, F., 2017. Detecting high spatial variability of ice shelf basal mass balance, Roi Baudouin Ice Shelf, Antarctica. The Cryosphere, 11(6), pp.2675-2690.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
40440	63	18	63	40	This paragraph is a bit confusing. I would start with a list of the methods that have been used for the ocean forcing in the latest Antarctic ice-sheet projections: (i) Prescribed melt with ad-hoc perturbation (uniform or depth-dependent, e.g. Seroussi et al. 2019); (ii) Prescribed onset date for grounding line retreat (Ritz et al. 2015); (iii) Prescribed melt rate from ocean projections (with static ice shelf cavities) themselves forced by a CMIP simulation (Cornford et al. 2015); (iv) Parameterized melt rates, i.e. melt rates are calculated at the simulated ice draft depth, based on ocean temperatures (and possibly salinity) from a climate simulation (deConto and Pollard 2016, Golledge et al. 2019). The limitations are the following: (i) does not enable a connection between emission scenarios and melt rates, and depth-dependent formulations do not compare well to ice/ocean coupled models (DeRydt and Gudmundsson 2016; Seroussi et al. 2017), (ii) is empirical (expert judgement based on melting projections in Ritz et al. 2015) and hides a lot of poorly known processes behind an onset date, (iii) does not account for feedbacks between the ocean circulation and temperature and the geometry of the ice shelf base, (e.g. Donat-Magnin et al. 2017; Timmermann and Goeller 2017) and needs to be extrapolated where grounding lines retreat, (iv) includes a variety of parameterizations that respond differently to ocean warming (Favier et al. 2019) and that are usually calibrated to match present-day melt rates (using various methodologies). The parameterizations produce various melting patterns, which can make a large difference to ice sheet response (e.g., Arthern and Williams, 2017; Goldberg et al., 2018; Seroussi et al., 2017). [Nicolas Jourdain, France]	This paragraph is a bit confusing. I would start with a list of the methods that have been used for the ocean forcing in the latest Antarctic ice-sheet projections: (i) Prescribed melt with ad-hoc perturbation (uniform or depth-dependent, e.g. Seroussi et al. 2019); (ii) Prescribed onset date for grounding line retreat (Ritz et al. 2015); (iii) Prescribed melt rate from ocean projections (with static ice shelf cavities) themselves forced by a CMIP simulation (Cornford et al. 2015); (iv) Parameterized melt rates, i.e. melt rates are calculated at the simulated ice draft depth, based on ocean temperatures (and possibly salinity) from a climate simulation (deConto and Pollard 2016, Golledge et al. 2019). The limitations are the following: (i) does not enable a connection between emission scenarios and melt rates, and depth-dependent formulations do not compare well to ice/ocean coupled models (DeRydt and Gudmundsson 2016; Seroussi et al. 2017), (ii) is empirical (expert judgement based on melting projections in Ritz et al. 2015) and hides a lot of poorly known processes behind an onset date, (iii) does not account for feedbacks between the ocean circulation and temperature and the geometry of the ice shelf base, (e.g. Donat-Magnin et al. 2017; Timmermann and Goeller 2017) and needs to be extrapolated where grounding lines retreat, (iv) includes a variety of parameterizations that respond
9926	63	19	63	20	"but also due to the lack of feedback between basal melting and cavity geometry as the ice sheet evolves". I do not find this sentence very clear (but I understand it wrong). It suggests there is no feedback between basal melting and cavity geometry. I thought there was such a feedback. [Kevin Bulthuis, Belgium]	"but also due to the lack of feedback between basal melting and cavity geometry as the ice sheet evolves". I do not find this sentence very clear (but I understand it wrong). It suggests there is no feedback between basal melting and cavity geometry. I thought there was such a feedback.
19988	63	20	63	20	I would suggest adding “in the models” at the end of the sentence to be explicit. [Gwenaelle GREMION, Canada]	I would suggest adding “in the models” at the end of the sentence to be explicit.
45332	63	20	63	20	Include a citiation: e.g. Jacobs et al., 2011 Nat Geoscience (Stronger ocean circulation and increased melting under Pine Island Glacier ice shelf). [Alessandro Silvano, Australia]	Include a citiation: e.g. Jacobs et al., 2011 Nat Geoscience (Stronger ocean circulation and increased melting under Pine Island Glacier ice shelf).
31644	63	21	63	22	I suggest to also add Asay-Davis et al. (2016), Goldberg et al. (2012), Favier et al. (2019) to the list of references. [Pierre Mathiot, United Kingdom (of Great Britain and Northern Ireland)]	I suggest to also add Asay-Davis et al. (2016), Goldberg et al. (2012), Favier et al. (2019) to the list of references.
45334	63	22	63	22	include Jordan et al 2018 JGRO (Ocean-Forced Ice-Shelf Thinning in a Synchronously Coupled Ice-Ocean Model). [Alessandro Silvano, Australia]	include Jordan et al 2018 JGRO (Ocean?Forced Ice?Shelf Thinning in a Synchronously Coupled Ice?Ocean Model).

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
40438	63	22	63	24	I am not sure it is worth mentionning the velocity-dependent melt formulation here, I guess that the important message is that there are feedbacks whereby stronger melt rates induce stronger circulation, which induces stronger turbulent exchange and therefore stronger melt rates. These feedbacks can meke important differences when grounding lines retreat. [Nicolas Jourdain, France]	I am not sure it is worth mentionning the velocity-dependent melt formulation here, I guess that the important message is that there are feedbacks whereby stronger melt rates induce stronger circulation, which induces stronger turbulent exchange and therefore stronger melt rates. These feedbacks can meke important differences when grounding lines retreat.
30260	63	24	63	27	A discussion should be given on sub-shelf parametrizations derived from ocean circulation beneath ice shelves (Reese et al., 2018 (https://doi.org/10.5194/tc-12-1969-2018), Lazeromes et al., 2018 (https://doi.org/10.5194/tc-12-49-2018), Pelle et al., 2019 (https://doi.org/10.5194/tc-13-1043-2019)) [Frank Pattyn, Belgium]	A discussion should be given on sub-shelf parametrizations derived from ocean circulation beneath ice shelves (Reese et al., 2018 (https://doi.org/10.5194/tc-12-1969-2018), Lazeromes et al., 2018 (https://doi.org/10.5194/tc-12-49-2018), Pelle et al., 2019 (https://doi.org/10.5194/tc-13-1043-2019))
40442	63	35	63	35	Jourdain et al. 2017 is not an apropriate reference for this sentence (Favier et al. 2019 is sufficient). [Nicolas Jourdain, France]	Jourdain et al. 2017 is not an apropriate reference for this sentence (Favier et al. 2019 is sufficient).
8682	63	38	63	40	"There is medium confidence that ice shelf basal melt will increase around Antarctica (high confidence for west Antarctica)": suggest: "There is high confidence that ice shelf basal melt will increase around West-Antarctica (medium (or low?) confidence for East Antarctica)": [Goneri Le Cozannet, France]	"There is medium confidence that ice shelf basal melt will increase around Antarctica (high confidence for west Antarctica)": suggest: "There is high confidence that ice shelf basal melt will increase around West-Antarctica (medium (or low?) confidence for East Antarctica)":
19990	63	39	63	40	Would it be possible to still mention a range for the magnitude of the changes, even if it is low confidence? Thoughout the paragraph (L18-40), there is never any mention of magnitudes of basal melt. [Gwenaelle GREMION, Canada]	Would it be possible to still mention a range for the magnitude of the changes, even if it is low confidence? Thoughout the paragraph (L18-40), there is never any mention of magnitudes of basal melt.
45336	63	39	63	40	I'm not really sure that basal melt can increase much in West Antarctica where CDW is already flushing the continental shelf. You can have more access of CDW to the continental shelf, but so far there has not been any observations of increased access during the past couple of decades (Jenkins et al., 2018, Nat Geoscience). Decadal variability is possibly masking the signal. Models show an increase in 2100 but most of them are too "cold" in present day (Naugthen et al., 2017), and therefore the increase might be true in the model but not in the reality. What might be more relevant for West Antarctica is future atmospheric warming [Alessandro Silvano, Australia]	I'm not really sure that basal melt can increase much in West Antarctica where CDW is already flushing the continental shelf. You can have more access of CDW to the continental shelf, but so far there has not been any observations of increased access during the past couple of decades (Jenkins et al., 2018, Nat Geoscience). Decadal variability is possibly masking the signal. Models show an increase in 2100 but most of them are too "cold" in present day (Naugthen et al., 2017), and therefore the increase might be true in the model but not in the reality. What might be more relevant for West Antarctica is future atmospheric warming

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
31646	63	39	63	40	The mention of 'There is medium confidence that ice shelf basal melt will increase around Antarctica (high confidence for West Antarctica)' seems not to be really discussed in the previous 2 paragraphs but mostly in page 62 line 19 to 40 with already a mention to almost exactly the same sentence. Suggest to remove to remove one of the mention to increase melt in the future. [Pierre Mathiot, United Kingdom (of Great Britain and Northern Ireland)]	The mention of 'There is medium confidence that ice shelf basal melt will increase around Antarctica (high confidence for West Antarctica)' seems not to be really discussed in the previous 2 paragraphs but mostly in page 62 line 19 to 40 with already a mention to almost exactly the same sentence. Suggest to remove to remove one of the mention to increase melt in the future.
30262	63	43	63	46	Add reference to Bulthuis et al. (2019) [Frank Pattyn, Belgium]	Add reference to Bulthuis et al. (2019)
9928	63	46	63	46	… Seroussi et al., 2019). Maybe add also the following reference: Bulthuis, K., Arnst, M., Sun, S., and Pattyn, F.: Uncertainty qunatification of the multi-centennial response of the Antarctic ice sheet to climate change, The Cryosphere, 13, 1349-1380, https://doi.org/10.5194/tc-13-1349-2019, 2019. [Kevin Bulthuis, Belgium]	… Seroussi et al., 2019). Maybe add also the following reference: Bulthuis, K., Arnst, M., Sun, S., and Pattyn, F.: Uncertainty qunatification of the multi-centennial response of the Antarctic ice sheet to climate change, The Cryosphere, 13, 1349-1380, https://doi.org/10.5194/tc-13-1349-2019, 2019.
48720	63	55	64	1	ONLY submarine basal melt is heavily parametrized, terrestrial basal melt is accurately computed. [Lev Tarasov, Canada]	ONLY submarine basal melt is heavily parametrized, terrestrial basal melt is accurately computed.
9930	64	1	46	1	"and grounding line evolution". Maybe some references here. Here are two suggestions: Pollard, D. And DeConto, R. M.: Description of a hybrid ice sheet-shelf model, and application to Antarctica, Geosci. Model. Dev., 5, 1273-1295, https://doi.org/10.5194/gmd-5-1273-2012, 2012. Pattyn, F.: Sea-level response to melting of Antarctic ice shelves on multi-centennial timescales with the fast Elementary Thermomechanical Ice Sheet model (f.ETISh v1.0), The Cryosphere, 11, 1851-1878, https://doi.org/10.5194/tc-11.1851-2017, 2017. [Kevin Bulthuis, Belgium]	"and grounding line evolution". Maybe some references here. Here are two suggestions: Pollard, D. And DeConto, R. M.: Description of a hybrid ice sheet-shelf model, and application to Antarctica, Geosci. Model. Dev., 5, 1273-1295, https://doi.org/10.5194/gmd-5-1273-2012, 2012. Pattyn, F.: Sea-level response to melting of Antarctic ice shelves on multi-centennial timescales with the fast Elementary Thermomechanical Ice Sheet model (f.ETISh v1.0), The Cryosphere, 11, 1851-1878, https://doi.org/10.5194/tc-11.1851-2017, 2017.
19992	64	2	64	2	Missing “the” in front of “sensitivity”. [Gwenaelle GREMION, Canada]	Missing “the” in front of “sensitivity”.
9932	64	3	64	3	"Tsai et al., 2015)". Maybe aadd also the following reference: Bulthuis, K., Arnst, M., Sun, S., and Pattyn, F.: Uncertainty qunatification of the multi-centennial response of the Antarctic ice sheet to climate change, The Cryosphere, 13, 1349-1380, https://doi.org/10.5194/tc-13-1349-2019, 2019. [Kevin Bulthuis, Belgium]	"Tsai et al., 2015)". Maybe aadd also the following reference: Bulthuis, K., Arnst, M., Sun, S., and Pattyn, F.: Uncertainty qunatification of the multi-centennial response of the Antarctic ice sheet to climate change, The Cryosphere, 13, 1349-1380, https://doi.org/10.5194/tc-13-1349-2019, 2019.
19994	64	9	64	9	Missing “to” in front of “a collapse”. [Gwenaelle GREMION, Canada]	Missing “to” in front of “a collapse”.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
9934	64	11	64	11	"(Mercer, 1978; Weertman, 1974)". Mabe add also the following reference: Schoof, C.: Ice sheet grounding line dynamics: Steady states, stability and hysteresis, J. Geophys. Res., 112, F03S28, https://doi.org/10.1029/2006JF000664, 2007. [Kevin Bulthuis, Belgium]	"(Mercer, 1978; Weertman, 1974)". Mabe add also the following reference: Schoof, C.: Ice sheet grounding line dynamics: Steady states, stability and hysteresis, J. Geophys. Res., 112, F03S28, https://doi.org/10.1029/2006JF000664, 2007.
19996	64	18	64	20	It would be good to cite a paper that shows the MISI configuration of the Wilkes basin. Perhaps BEDMAP2: Fretwell, P., Pritchard, H.D., Vaughan, D.G., Bamber, J.L., Barrand, N.E., Bell, R., Bianchi, C., Bingham, R.G., Blankenship, D.D., Casassa, G. and Catania, G., 2012. Bedmap2: improved ice bed, surface and thickness datasets for Antarctica. The Cryosphere Discussions, 6, pp.4305-4361. [Gwenaelle GREMION, Canada]	It would be good to cite a paper that shows the MISI configuration of the Wilkes basin. Perhaps BEDMAP2: Fretwell, P., Pritchard, H.D., Vaughan, D.G., Bamber, J.L., Barrand, N.E., Bell, R., Bianchi, C., Bingham, R.G., Blankenship, D.D., Casassa, G. and Catania, G., 2012. Bedmap2: improved ice bed, surface and thickness datasets for Antarctica. The Cryosphere Discussions, 6, pp.4305-4361.
20004	64	29	64	31	Which parameters and/or processes would lead to a MISI of Thwaites and Pine Island glacier but not in other regions?Is it possible to characterize the stability of glaciers against MISI? [Gwenaelle GREMION, Canada]	Which parameters and/or processes would lead to a MISI of Thwaites and Pine Island glacier but not in other regions?Is it possible to characterize the stability of glaciers against MISI?
19998	64	31	64	31	Remove “a” in front of “relatively”. [Gwenaelle GREMION, Canada]	Remove “a” in front of “relatively”.
20000	64	33	64	33	“Interrupt” seems to better fit the notion of stopping a process while it is occurring, while “stop” seems redundant with “prevent”. [Gwenaelle GREMION, Canada]	“Interrupt” seems to better fit the notion of stopping a process while it is occurring, while “stop” seems redundant with “prevent”.
30266	64	35	64	35	Projections that in clude MISI': this has nothing to do with MISI but with the capability of resolving grounding line processes (see my earlier remarks). Whether MISI occurs or not is due to the amount of buttressing of ice shelves. [Frank Pattyn, Belgium]	Projections that in clude MISI': this has nothing to do with MISI but with the capability of resolving grounding line processes (see my earlier remarks). Whether MISI occurs or not is due to the amount of buttressing of ice shelves.
20002	64	36	64	37	I would suggest rewording the sentence as: ...grounding line processes(…) to those with a very simple and coarse spatial resolution”. [Gwenaelle GREMION, Canada]	I would suggest rewording the sentence as: ...grounding line processes(…) to those with a very simple and coarse spatial resolution”.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
52232	64	40	64	51	It is important to note in this paragraph that the decisions of which paleoclimate evidence and periods to use, and their interpretation in the callibration process, has a strong influence on both the efficiacy of instability processes and the net projected sea level contributions from the AIS (as evidenced in the differences between DeConto and Pollard, 2016, and Edwards et al. 2019, which used the same exact model esemble data but arrived at different conclusions based on paleoclimate interpretations). See also discussion in Steig and Neff, 2018: The prescience of paleoclimatology and the future of the Antarctic ice sheet, Nature Comm., 9:2730, DOI: 10.1038/s41467-018-05001-1. The further implication which should be stated is that our large uncertainties in paleoclimate data (section 9.4.3.1) project onto our uncertainties in future projections. [Daniel Gilford, United States of America]	It is important to note in this paragraph that the decisions of which paleoclimate evidence and periods to use, and their interpretation in the callibration process, has a strong influence on both the efficiacy of instability processes and the net projected sea level contributions from the AIS (as evidenced in the differences between DeConto and Pollard, 2016, and Edwards et al. 2019, which used the same exact model esemble data but arrived at different conclusions based on paleoclimate interpretations). See also discussion in Steig and Neff, 2018: The prescience of paleoclimatology and the future of the Antarctic ice sheet, Nature Comm., 9:2730, DOI: 10.1038/s41467-018-05001-1. The further implication which should be stated is that our large uncertainties in paleoclimate data (section 9.4.3.1) project onto our uncertainties in future projections.
8462	65	1	65	2	"low confidence in the possibility of" - this is a bit unclear to the reader. Suggest changing to "low confidence in simulating mechanisms that have the potential to cause widespread, sustained and very rapid ice loss..." [Jeremy Fyke, Canada]	"low confidence in the possibility of" - this is a bit unclear to the reader. Suggest changing to "low confidence in simulating mechanisms that have the potential to cause widespread, sustained and very rapid ice loss..."
25342	65	6	65	12	Background information - some of this material already presented (in chapter box etc?) . [Sharon Smith, Canada]	Background information - some of this material already presented (in chapter box etc?) .
20012	65	8	65	8	Missing “the” in front of “Larsen A”. [Gwenaelle GREMION, Canada]	Missing “the” in front of “Larsen A”.
20014	65	9	65	9	Typo: change “by” to “of”. [Gwenaelle GREMION, Canada]	Typo: change “by” to “of”.
20016	65	13	65	13	I would suggest adding “forcing” after “atmospheric warming” to be clear that the latter is the forcing and the ice shelf surface response is the result. It would make it easier to read. [Gwenaelle GREMION, Canada]	I would suggest adding “forcing” after “atmospheric warming” to be clear that the latter is the forcing and the ice shelf surface response is the result. It would make it easier to read.
20018	65	19	65	19	I would suggest inserting “ice shelf” after “subsequent” to be explicit. [Gwenaelle GREMION, Canada]	I would suggest inserting “ice shelf” after “subsequent” to be explicit.
20020	65	20	65	20	I suggest adding the following reference after Trusel et al., 2015: Van Wessem, J.M., Reijmer, C.H., Morlighem, M., Mouginot, J., Rignot, E., Medley, B., Joughin, I., Wouters, B., Depoorter, M.A., Bamber, J.L. and Lenaerts, J.T.M., 2014. Improved representation of East Antarctic surface mass balance in a regional atmospheric climate model. [Gwenaelle GREMION, Canada]	I suggest adding the following reference after Trusel et al., 2015: Van Wessem, J.M., Reijmer, C.H., Morlighem, M., Mouginot, J., Rignot, E., Medley, B., Joughin, I., Wouters, B., Depoorter, M.A., Bamber, J.L. and Lenaerts, J.T.M., 2014. Improved representation of East Antarctic surface mass balance in a regional atmospheric climate model.
30268	65	27	35	31	Add reference and numbers from Bulthuis et al. (2019) [Frank Pattyn, Belgium]	Add reference and numbers from Bulthuis et al. (2019)
20006	65	27	65	28	Better to name the scenarios rather than saying vaguely "medium to high emissions scenarios". [Gwenaelle GREMION, Canada]	Better to name the scenarios rather than saying vaguely "medium to high emissions scenarios".

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
20022	65	27	65	28	I would reword to be explicit: “Projections at 2200 include a GSLR contribution from Antarctica of 4-71 cm..”. Also, it is unclear here for me if these numbers are with respect to present day sea-level or if they are with respect to 2100 sea level? Could it be clarified? [Gwenaelle GREMION, Canada]	I would reword to be explicit: “Projections at 2200 include a GSLR contribution from Antarctica of 4-71 cm..”. Also, it is unclear here for me if these numbers are with respect to present day sea-level or if they are with respect to 2100 sea level? Could it be clarified?
8464	65	35	65	37	"Due to the dominant role of surface mass balance" -> "Due to the dominant role of surface mass balance and lack of realistic ocean coupling" [Jeremy Fyke, Canada]	"Due to the dominant role of surface mass balance" -> "Due to the dominant role of surface mass balance and lack of realistic ocean coupling"
8466	65	38	65	38	"But newer ice sheet models" -> "But newer ice sheet models and more realistic representations of ocean-ice coupling" [Jeremy Fyke, Canada]	"But newer ice sheet models" -> "But newer ice sheet models and more realistic representations of ocean-ice coupling"
20008	65	38	65	38	around 1.6 m°C? Should be around 1.6 m/°C [Gwenaelle GREMION, Canada]	around 1.6 m°C? Should be around 1.6 m/°C
30264	65	40	65	44	Add reference and numbers from Bulthuis et al. (2019) [Frank Pattyn, Belgium]	Add reference and numbers from Bulthuis et al. (2019)
20010	65	40	65	48	Give these projected values in a table or graph for more clarity. [Gwenaelle GREMION, Canada]	Give these projected values in a table or graph for more clarity.
20024	65	46	65	49	I wonder if non experts will find this sentence confusing. Perhaps adding a figure would help showing that in RCP scenarios, sea level peaks and then decreases but with a commitment. Readers used to IPCC graphs will understand but new readers might be puzzled. [Gwenaelle GREMION, Canada]	I wonder if non experts will find this sentence confusing. Perhaps adding a figure would help showing that in RCP scenarios, sea level peaks and then decreases but with a commitment. Readers used to IPCC graphs will understand but new readers might be puzzled.
8468	66	1	66	26	Discussion on the low confidence in ability to predict far-future AIS change is excellent, and true. Suggest placing in context of projections of other more well constrained mechanisms so readers have a sense of the gap between AIS projections, and projects of other climate change metrics (e..g global average near surface air temperature). Note that even more well constrained measures still have some significant futuire uncertainty (e.g. due to ECS, climate sensivitity, ice/climate feedback strengths) despite having a good handle on inter-model uncertainty and emission scenario uncertainty. These will need to be addressed in the case of AIS projections as well (as with GrIS projections), even once model/scenario uncertainty are potentially addressed. Perhaps this would be a suitable place to present a summary of outstanding issues in AIS-sourced sea level projections. [Jeremy Fyke, Canada]	Discussion on the low confidence in ability to predict far-future AIS change is excellent, and true. Suggest placing in context of projections of other more well constrained mechanisms so readers have a sense of the gap between AIS projections, and projects of other climate change metrics (e..g global average near surface air temperature). Note that even more well constrained measures still have some significant futuire uncertainty (e.g. due to ECS, climate sensivitity, ice/climate feedback strengths) despite having a good handle on inter-model uncertainty and emission scenario uncertainty. These will need to be addressed in the case of AIS projections as well (as with GrIS projections), even once model/scenario uncertainty are potentially addressed. Perhaps this would be a suitable place to present a summary of outstanding issues in AIS-sourced sea level projections.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
20026	66	5	66	7	The scenario of all available fossil fuels are burned may not be rational because extracting all available fossil fuel may not be technically and economically practical. Therefore, there will be a limit for extracting the fossil fuel and model simulations would be appropriate for a rational limit of fossil fuel extraction. There should be a discussion on the rationality of the scenario of Winkelmann et al., (2015). [Gwenaelle GREMION, Canada]	The scenario of all available fossil fuels are burned may not be rational because extracting all available fossil fuel may not be technically and economically practical. Therefore, there will be a limit for extracting the fossil fuel and model simulations would be appropriate for a rational limit of fossil fuel extraction. There should be a discussion on the rationality of the scenario of Winkelmann et al., (2015).
49910	66	13	66	13	See previous comment. It is not "total" collapse of the WAIS but "collapse of the marine sector of WAIS that is susceptible to the MISI". Other sectors (~ 2 m SLE) are not "unstable" and do not have a threshold behaviour in the same way. [Jonathan Bamber, United Kingdom (of Great Britain and Northern Ireland)]	See previous comment. It is not "total" collapse of the WAIS but "collapse of the marine sector of WAIS that is susceptible to the MISI". Other sectors (~ 2 m SLE) are not "unstable" and do not have a threshold behaviour in the same way.
49908	66	16	66	16	Incorrect sentence. Should read "The volume of the WAIS that is susceptible to the MISI is equivalent to 3.3 m SLE" [Jonathan Bamber, United Kingdom (of Great Britain and Northern Ireland)]	Incorrect sentence. Should read "The volume of the WAIS that is susceptible to the MISI is equivalent to 3.3 m SLE"
39270	66	19	66	20	The impacts of including elastic uplift in future ice sheet model projections have also been presented in the recently published literature of Larour et al (2019). The main finding of a reduction of sea level contribution of 26.8% for Thwaites glacier would be worth including in this section. The full citation for this literature is as follows: E. Larouret al.,Science364,eaav7908(2019). DOI: 10.1126/science.aav7908 [Stephen Chuter, United Kingdom (of Great Britain and Northern Ireland)]	The impacts of including elastic uplift in future ice sheet model projections have also been presented in the recently published literature of Larour et al (2019). The main finding of a reduction of sea level contribution of 26.8% for Thwaites glacier would be worth including in this section. The full citation for this literature is as follows: E. Larouret al.,Science364,eaav7908(2019). DOI: 10.1126/science.aav7908
52234	66	26	66	26	Note here that this long time-scale to regrow the WAIS wold imply an irreversible contribution to SLR on those timescales. [Daniel Gilford, United States of America]	Note here that this long time-scale to regrow the WAIS wold imply an irreversible contribution to SLR on those timescales.
15734	66	29	66	35	I am a bit puzzled by the term 'freshwater ice'. This refers to lake and river ice. But are glaciers not also bodies of ice that consist of fresh water? Is an appropriate term not rather 'seasonal ice' for lake and river ice? I guess the used terminology here is the standard one, but I can't help finding it a bit confusing [Harry Zekollari, Belgium]	I am a bit puzzled by the term 'freshwater ice'. This refers to lake and river ice. But are glaciers not also bodies of ice that consist of fresh water? Is an appropriate term not rather 'seasonal ice' for lake and river ice? I guess the used terminology here is the standard one, but I can't help finding it a bit confusing
37918	66	29			The glaciers that are covered in section 9.5 include glaciers in Greenland and Antarctica that are discussed in section 9.4. Consideration could be given to presenting the general material on glaciers first, and following it by the discussions of the Greenland and Antarctic ice sheets and particular aspects of their peripheral glaciers. [Adrian Simmons, United Kingdom (of Great Britain and Northern Ireland)]	The glaciers that are covered in section 9.5 include glaciers in Greenland and Antarctica that are discussed in section 9.4. Consideration could be given to presenting the general material on glaciers first, and following it by the discussions of the Greenland and Antarctic ice sheets and particular aspects of their peripheral glaciers.
15662	66	29			"freshwater ice" used to be "lake & river ice" in previous IPCC reports. In this report, both terms appear. I propose to be consistent. [Michael Zemp, Switzerland]	"freshwater ice" used to be "lake & river ice" in previous IPCC reports. In this report, both terms appear. I propose to be consistent.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
20030	66	33	66	35	The cited reference seems only to deal with snow while it is used for a general statement on the entire crysosphere (also glaciers, permafrost and reshwater ice). In my opinion it would be more appropriate to cite the SWIPA report as a whole than citing a specific chapter. [Gwenaelle GREMION, Canada]	The cited reference seems only to deal with snow while it is used for a general statement on the entire crysosphere (also glaciers, permafrost and reshwater ice). In my opinion it would be more appropriate to cite the SWIPA report as a whole than citing a specific chapter.
25346	66	33	66	43	Paragraph not well balanced as there is much focus on glacier and ice caps - also probably repeats information presented earlier. [Sharon Smith, Canada]	Paragraph not well balanced as there is much focus on glacier and ice caps - also probably repeats information presented earlier.
20038	66	33	66	52	This whole section, to line 52, discusses elements of the cryosphere. The first paragraph, to line 46, discusses the time scale on which different elements of the cryosphere react to change, and this is an important element that sets the stage for the rest of section 9.5. It would be helpful to include a statement at the start of the first paragraph that specifically addresses time scales, and then also include some information about the time scale of snow and permafrost as well in the second paragraph to provide more context for the rest of the section. [Gwenaelle GREMION, Canada]	This whole section, to line 52, discusses elements of the cryosphere. The first paragraph, to line 46, discusses the time scale on which different elements of the cryosphere react to change, and this is an important element that sets the stage for the rest of section 9.5. It would be helpful to include a statement at the start of the first paragraph that specifically addresses time scales, and then also include some information about the time scale of snow and permafrost as well in the second paragraph to provide more context for the rest of the section.
26676	66	34			Should prefer "climate variables" instead of "climate parameters" [Antoine Rabatel, France]	Should prefer "climate variables" instead of "climate parameters"
25344	66	35	65	35	Brown et al. only refers to snow - suggest you make reference to other chapters for other cryosphere components (e.g. Romanovsky et al. 2017 for permafrost) [Sharon Smith, Canada]	Brown et al. only refers to snow - suggest you make reference to other chapters for other cryosphere components (e.g. Romanovsky et al. 2017 for permafrost)
52516	66	36	66	36	"Permafrost can be found at great depth…" - can you provide a depth range? [John Brian Robin Matthews, France]	"Permafrost can be found at great depth…" - can you provide a depth range?
20040	66	38	66	38	"Glaciers have a delayed response to climate change." Does this actually mean glaciers have a delayed (time lagged) response to climate change, or that glaciers have delayed the response to climate change? (i.e. the response of sea level rise has been delayed because of glaciers?) I found this sentence unclear. [Gwenaelle GREMION, Canada]	"Glaciers have a delayed response to climate change." Does this actually mean glaciers have a delayed (time lagged) response to climate change, or that glaciers have delayed the response to climate change? (i.e. the response of sea level rise has been delayed because of glaciers?) I found this sentence unclear.
15736	66	38	66	38	Depending primarly on their geometry and slope': in fact the 'slope' is also part of the glacier characteristic that determine the 'geometry' [Harry Zekollari, Belgium]	Depending primarly on their geometry and slope': in fact the 'slope' is also part of the glacier characteristic that determine the 'geometry'

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
26678	66	38	66	39	It is said "glaciers have delayed response to climate", this is not correct in terms of surface mass balance, accumulation, ablation, equilibrium line altitude etc. Changes in glacier geometry, yes, has a delayed response. I suggest the following reformulation: "Glacier changes in geometry are a delayed response to climate change. Depending primarily on their ice thickness distribution and slope, glaciers can have response times ranging from a few years to hundreds of years". [Antoine Rabatel, France]	It is said "glaciers have delayed response to climate", this is not correct in terms of surface mass balance, accumulation, ablation, equilibrium line altitude etc. Changes in glacier geometry, yes, has a delayed response. I suggest the following reformulation: "Glacier changes in geometry are a delayed response to climate change. Depending primarily on their ice thickness distribution and slope, glaciers can have response times ranging from a few years to hundreds of years".
20032	66	38	66	39	Reference needed for response time (e.g. Raper & Braithwaite, 2009), or Marzeion reference needs to be up front - Raper, S.C. and Braithwaite, R.J., 2009. Glacier volume response time and its links to climate and topography based on a conceptual model of glacier hypsometry. The Cryosphere, 3(2), pp.183-194. [Gwenaelle GREMION, Canada]	Reference needed for response time (e.g. Raper & Braithwaite, 2009), or Marzeion reference needs to be up front - Raper, S.C. and Braithwaite, R.J., 2009. Glacier volume response time and its links to climate and topography based on a conceptual model of glacier hypsometry. The Cryosphere, 3(2), pp.183-194.
15738	66	39	66	39	response times ranging from decades to few hundreds of years': for a glaciologist it may be clear what a 'response time' is, but for others not necessarily (and even within the community there is some discussion about the definition of the 'response time'). Could this not be reformulated without referring to a specific term? E.g. 'react on timescales ranging from X to Y''. Related comment: 'from decades' --> depending on the definition used for the response time (first part of this comment), can also be in the order of a few years (i.e. less than 'decades'): see e.g. Oerlemans (2007, Journal of Glaciology, doi: 10.3189/002214307783258387) [Harry Zekollari, Belgium]	response times ranging from decades to few hundreds of years': for a glaciologist it may be clear what a 'response time' is, but for others not necessarily (and even within the community there is some discussion about the definition of the 'response time'). Could this not be reformulated without referring to a specific term? E.g. 'react on timescales ranging from X to Y''. Related comment: 'from decades' --> depending on the definition used for the response time (first part of this comment), can also be in the order of a few years (i.e. less than 'decades'): see e.g. Oerlemans (2007, Journal of Glaciology, doi: ?10.3189/002214307783258387)
20028	66	39	66	41	The sentence is not clear. [Gwenaelle GREMION, Canada]	The sentence is not clear.
20034	66	39	66	41	The meaning of the sentence is not clear. I think the use of the word volume is confusing as it could refer to the size of individual glaciers (i.e. their volume) or the number of glaciers that respond with a 100-150 year delay to climate change. I think what you are trying to say is that the majority of glaciers worldwide have a decadal response time, but the bigger glaciers (in terms of volume) respond with a 100 - 150 year delay? Please reword to make this clear. [Gwenaelle GREMION, Canada]	The meaning of the sentence is not clear. I think the use of the word volume is confusing as it could refer to the size of individual glaciers (i.e. their volume) or the number of glaciers that respond with a 100-150 year delay to climate change. I think what you are trying to say is that the majority of glaciers worldwide have a decadal response time, but the bigger glaciers (in terms of volume) respond with a 100 - 150 year delay? Please reword to make this clear.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
15740	66	40	66	41	responds with a delay between 100 and 150 years': well, glaciers respond immediately, while here it reads like if it takes these 100-150 years before they start reacting. They can still react on these timescales, but would be good to slightly reformulate this [Harry Zekollari, Belgium]	responds with a delay between 100 and 150 years': well, glaciers respond immediately, while here it reads like if it takes these 100-150 years before they start reacting. They can still react on these timescales, but would be good to slightly reformulate this
15742	66	41	66	41	Due to this…': is this true? With this formulation you imply that if the glaciers' response would have been faster, they would not be / have been major contributors to sea level rise. Not sure you can state this, and may in fact have been the other way round: they would have contributed even more if they would respond immediately (although maybe not in absolute terms, if accounting for an - hypothetical - immediate response of the ice sheets also..) [Harry Zekollari, Belgium]	Due to this…': is this true? With this formulation you imply that if the glaciers' response would have been faster, they would not be / have been major contributors to sea level rise. Not sure you can state this, and may in fact have been the other way round: they would have contributed even more if they would respond immediately (although maybe not in absolute terms, if accounting for an - hypothetical - immediate response of the ice sheets also..)
26680	66	41	66	42	As it stands, the link between the decadal to centennial-scale response and the fact that glacier melt has been the largest contributor to sea level rise after thermal expansion is not clear at all. Reformulation is needed or simply removing the first part of the sentence. [Antoine Rabatel, France]	As it stands, the link between the decadal to centennial-scale response and the fact that glacier melt has been the largest contributor to sea level rise after thermal expansion is not clear at all. Reformulation is needed or simply removing the first part of the sentence.
26004	66	43	66	43	New sentence after “decades”: … decades. For the period ... [Marius Schaefer, Chile]	New sentence after “decades”: … decades. For the period ...
15744	66	44	66	44	The reference given is correct, but here some references to the most recent works on glacier contribution to SLR would fit well. I am mainly thinking of Zemp et al. (2019, Nature, doi: 10.1038/s41586-019-1071-0) and Wouters et al. (2019, Frontiers in Earth Science, doi: 10.3389/feart.2019.00096) [Harry Zekollari, Belgium]	The reference given is correct, but here some references to the most recent works on glacier contribution to SLR would fit well. I am mainly thinking of Zemp et al. (2019, Nature, doi: ?10.1038/s41586-019-1071-0) and Wouters et al. (2019, Frontiers in Earth Science, doi: ?10.3389/feart.2019.00096)
15746	66	44	66	44	However': in contrast with what? [Harry Zekollari, Belgium]	However': in contrast with what?
15748	66	45	66	45	up to a few hundred years' vs. the '100-150 years' mentioned a few lines before (line 41). Not entirely consistent. Maybe reformulate the previous range a bit broader? [Harry Zekollari, Belgium]	up to a few hundred years' vs. the '100-150 years' mentioned a few lines before (line 41). Not entirely consistent. Maybe reformulate the previous range a bit broader?
15664	66	45			With regard to "committed volume loss", you might consider including observational estimates as available from: + Mernild, S.H., Lipscomb, W.H., Bahr, D.B., Radic, V. and Zemp, M. (2013): Global glacier changes: a revised assessment of committed mass losses and samling uncertainties. The Cryosphere, 7, 1565-1577, doi:10.5194/tc-7-1565-2013 + Zemp et al. (2015, J. Glaciol.), for ref see above. [Michael Zemp, Switzerland]	With regard to "committed volume loss", you might consider including observational estimates as available from: + Mernild, S.H., Lipscomb, W.H., Bahr, D.B., Radic, V. and Zemp, M. (2013): Global glacier changes: a revised assessment of committed mass losses and samling uncertainties. The Cryosphere, 7, 1565-1577, doi:10.5194/tc-7-1565-2013 + Zemp et al. (2015, J. Glaciol.), for ref see above.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
26682	66	45			Suggest changing "there is a long-term committed volume loss even…" by "a long-term committed volume loss will occur even…" [Antoine Rabatel, France]	Suggest changing "there is a long-term committed volume loss even…" by "a long-term committed volume loss will occur even…"
29310	66	46			Might be worth to mention that there are processes that can lead to faster responses than the slow adjustment between steady states, e.g. thermokarst processes/downwasting, flow instabilities, retreat of calving fronts... [Andreas Kääb, Norway]	Might be worth to mention that there are processes that can lead to faster responses than the slow adjustment between steady states, e.g. thermokarst processes/downwasting, flow instabilities, retreat of calving fronts...
52182	66	49	66	51	Should this not cross-reference to chapter 5? Also, there is a need to ensure that this feedback desn't fall between the cracks between chapters 5 and 9 [Peter Thorne, Ireland]	Should this not cross-reference to chapter 5? Also, there is a need to ensure that this feedback desn't fall between the cracks between chapters 5 and 9
15666	66	52			Maybe add a note on the (local) hazard potential (e.g. Haeberli and Whiteman 2015, and references therein): Haeberli, W., & Whiteman, C. (2015). Snow and ice-related hazards, risks, and disasters: a general framework. In Snow and Ice-Related Hazards, Risks and Disasters (pp. 1-34). Academic Press. [Michael Zemp, Switzerland]	Maybe add a note on the (local) hazard potential (e.g. Haeberli and Whiteman 2015, and references therein): Haeberli, W., & Whiteman, C. (2015). Snow and ice-related hazards, risks, and disasters: a general framework. In Snow and Ice-Related Hazards, Risks and Disasters (pp. 1-34). Academic Press.
25348	66	54	66	54	"strong evidence of an increase in…" - better wording? [Sharon Smith, Canada]	"strong evidence of an increase in…" - better wording?
20036	66	54	66	54	If I am not mistaken, the concept of the 'active layer' (i.e. seasonally unfrozen) is mentioned here for a first time. I suggest to include a short definition (as in p. 9-75 line 25). [Gwenaelle GREMION, Canada]	If I am not mistaken, the concept of the 'active layer' (i.e. seasonally unfrozen) is mentioned here for a first time. I suggest to include a short definition (as in p. 9-75 line 25).
15752	66	54	66	54	active layer thickening'. Also here, not clear to what this is referring for non-specialist. I guess this refers to permafrost? [Harry Zekollari, Belgium]	active layer thickening'. Also here, not clear to what this is referring for non-specialist. I guess this refers to permafrost?
15750	66	54	66	55	changes are described: but for which reference periods is this (i.e. from when to when)? Cannot be grasped from here, could be on timescale ranging from a few years to a multi-decadal observation [Harry Zekollari, Belgium]	changes are described: but for which reference periods is this (i.e. from when to when)? Cannot be grasped from here, could be on timescale ranging from a few years to a multi-decadal observation
26176	67	1	67	2	Snow depth is also depending on the storm tracks. [Jun Inoue, Japan]	Snow depth is also depending on the storm tracks.
25350	67	4	67	4	Just say "permafrost extent" here as this will cover deepening thaw (reduction in vertical extent) and also overall areal extent. [Sharon Smith, Canada]	Just say "permafrost extent" here as this will cover deepening thaw (reduction in vertical extent) and also overall areal extent.
29312	67	6	67	10	This is partially repetition from two paragraphs earlier. [Andreas Kääb, Norway]	This is partially repetition from two paragraphs earlier.
20060	67	7	67	9	This sentence ends "…water availability, transport or structures." Using the term infrastructure instead of structure might be more appropriate. [Gwenaelle GREMION, Canada]	This sentence ends "…water availability, transport or structures." Using the term infrastructure instead of structure might be more appropriate.
25352	67	8	67	9	Impacts are covered by WG2 so not sure why mentioned here. [Sharon Smith, Canada]	Impacts are covered by WG2 so not sure why mentioned here.
20046	67	13	67	13	[FIGURE 9.26] how to display 'relevance' ? … Informative figure but its focus is latitudinal/altitudinal distribution of glaciers/permafrost. [Gwenaelle GREMION, Canada]	[FIGURE 9.26] how to display 'relevance' ? … Informative figure but its focus is latitudinal/altitudinal distribution of glaciers/permafrost.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
20048	67	15	67	18	Figure 9.26: Snow and freshwater ice have to be added. I do not understand how to read the violet circles depicting permafrost area. Why the light and dark violet parts?, why is the circle in some cases split in half (light/dark violet) and in other cases there is an outer circle of light violet and an inner circle of dark violet? [Gwenaelle GREMION, Canada]	Figure 9.26: Snow and freshwater ice have to be added. I do not understand how to read the violet circles depicting permafrost area. Why the light and dark violet parts?, why is the circle in some cases split in half (light/dark violet) and in other cases there is an outer circle of light violet and an inner circle of dark violet?
25446	67	15			Figure 9.26 - Unclear - how do you get permafrost area at various elevation (need some explanation) [Sharon Smith, Canada]	Figure 9.26 - Unclear - how do you get permafrost area at various elevation (need some explanation)
15754	67	17	67	17	RGI 6.0': OK. Although likely that a new version will appear between now and finalization of this report [Harry Zekollari, Belgium]	RGI 6.0': OK. Although likely that a new version will appear between now and finalization of this report
38578	67	17			You may consider the new zonation map published here https://doi.pangaea.de/10.1594/PANGAEA.888600?format=html#download - southern hemishpere data are also done, contact the author. Relevant citation is https://doi.org/10.1016/j.earscirev.2019.04.023 [Annett Bartsch, Austria]	You may consider the new zonation map published here https://doi.pangaea.de/10.1594/PANGAEA.888600?format=html#download - southern hemishpere data are also done, contact the author. Relevant citation is https://doi.org/10.1016/j.earscirev.2019.04.023
8470	67	23	67	23	Add simple sentence differentiating glaciers from ice sheets, for naive readers. [Jeremy Fyke, Canada]	Add simple sentence differentiating glaciers from ice sheets, for naive readers.
42528	67	23	67	23	This section and section 9.5.2.4 have substantial overlap and should be better integrated. Here for example there is some mention of response time of a glaciers but that should be stated earlier. [Brian Menounos, Canada]	This section and section 9.5.2.4 have substantial overlap and should be better integrated. Here for example there is some mention of response time of a glaciers but that should be stated earlier.
20050	67	25	67	25	perennial usually means it spans beyond one melting season, hence unnecessary to explain that [Gwenaelle GREMION, Canada]	perennial usually means it spans beyond one melting season, hence unnecessary to explain that
15756	67	25	67	25	Description is relatively specific here for a glacier with a distinct melt and accumulation season ('surviving the melt season'). This is however not always the case (think for instance of glaciers that gain and lose most of their mass during monsoon season). May be worth reformulating to be more generally defined [Harry Zekollari, Belgium]	Description is relatively specific here for a glacier with a distinct melt and accumulation season ('surviving the melt season'). This is however not always the case (think for instance of glaciers that gain and lose most of their mass during monsoon season). May be worth reformulating to be more generally defined
26684	67	26	67	27	why not simply writting "as a result of gravity". [Antoine Rabatel, France]	why not simply writting "as a result of gravity".
20042	67	26	67	27	I'm not sure why the word 'possibly' is used. Is this in reference to a terminology issue that Cuffey and Paterson (2010) describe on page 223? [Gwenaelle GREMION, Canada]	I'm not sure why the word 'possibly' is used. Is this in reference to a terminology issue that Cuffey and Paterson (2010) describe on page 223?
20052	67	26	67	28	These facts have been known for a long time. In my opinion, much older references should be given here. [Gwenaelle GREMION, Canada]	These facts have been known for a long time. In my opinion, much older references should be given here.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
39204	67	27	67	28	Three references are used to support this very trivial statement. Why are three references needed? Why are exactly these three papers referred here, when 100s of other papers could have been chosen instead? Why not referring to a standard textbook such as Cuffey and Paterson (2010)? [Jacob Yde, Norway]	Three references are used to support this very trivial statement. Why are three references needed? Why are exactly these three papers referred here, when 100s of other papers could have been chosen instead? Why not referring to a standard textbook such as Cuffey and Paterson (2010)?
15758	67	28	67	28	References here are definitely OK, but are just some of the many potential references that could be used here. i.e. they are not the ones in which this is defined, but should rather be seen as examples. Would therefore expect an 'e.g.' before them [Harry Zekollari, Belgium]	References here are definitely OK, but are just some of the many potential references that could be used here. i.e. they are not the ones in which this is defined, but should rather be seen as examples. Would therefore expect an 'e.g.' before them
52416	67	28	67	30	These sentences make use of personal pronouns, i.e. "they" instead of glaciers, hence please, try to merge them appropriately to avoid ambuiguity as to what "they" refers to. [Charalampos Charalampidis, Germany]	These sentences make use of personal pronouns, i.e. "they" instead of glaciers, hence please, try to merge them appropriately to avoid ambuiguity as to what "they" refers to.
39206	67	28	67	33	There is a lack of references to support these statements. This is inconsistent with the general use of references in Chapter 9. A good reference to support the statement about calving (line 30) would be Post et al. (2011. A complex relationship between calving glaciers and climate. EOS transactions, vol. 92, issue 37, 305-306) [Jacob Yde, Norway]	There is a lack of references to support these statements. This is inconsistent with the general use of references in Chapter 9. A good reference to support the statement about calving (line 30) would be Post et al. (2011. A complex relationship between calving glaciers and climate. EOS transactions, vol. 92, issue 37, 305-306)
26686	67	28			Why quoting these peculiar references? This sentence is very general and it meaning is known since decades. Thousands of papers could be quoted instead! If you want to quote something here, the Cuffey and Paterson reference is enough. [Antoine Rabatel, France]	Why quoting these peculiar references? This sentence is very general and it meaning is known since decades. Thousands of papers could be quoted instead! If you want to quote something here, the Cuffey and Paterson reference is enough.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
46284	67	29	67	29	propose to add "for example, the most part of the Alamkouh glacier in Iran has experienced lowering which the overall 1955–2010 geodetic volume change is estimated to be -0.29 ± 0.03 km3 which the highest retreat (equal to 42% of total volumetric change) occurred during 1997–2002 (Karimi et al., 2012b). Also in another studied The satellite-based analysis revealed that the clean ice areas of Khersan and Merjikesh glaciers (located in Takht e Solaiman region) shrank since 2010 with an overall area decrease of about 45% and 60% respectively. During 1987-1991 the maximum decrease in the glacier area was observed. The elevation change results over the Takht e Solaiman region revealed that, the glacier surface lowering has occurred during 1955-2010 continuously without any thickening with the mean annual thinning of about 0.4 ± 0.04 m per year. The maximum thinning rate has been observed during 1997-2002 (about 1.1 ± 0.09 per year and 0.96 ± 0.01 m/year), which was compatible partially with area change analysis. (Karimi et al., 2015, 2012a; Karimi and Eftekhari, 2014). " Ref: Karimi, N., Eftekhari, M., Farajzadeh, M., Namdari, S., Moridnejad, A., Karimi, D., 2015. Use of multitemporal satellite images to find some evidence for glacier changes in the Haft-Khan glacier, Iran. Arab. J. Geosci. 8. https://doi.org/10.1007/s12517-014-1578-5 Karimi, N., Farajzadeh, M., Moridnejad, A., Namdari, S., 2014. Evidence for Mountain Glacier Changes in Semi-arid Environments based on Remote Sensing Data. J. Indian Soc. Remote Sens. 42, 801–815. https://doi.org/10.1007/s12524-013-0343-7 Karimi, N., Farokhnia, A., Karimi, L., Eftekhari, M., Ghalkhani, H., 2012a. Combining optical and thermal remote sensing data for mapping debris-covered glaciers (Alamkouh Glaciers, Iran). Cold Reg. Sci. Technol. 71, 73–83. https://doi.org/10.1016/j.coldregions.2011.10.004 [sadegh zeyaeyan, Iran]	propose to add "for example, the most part of the Alamkouh glacier in Iran has experienced lowering which the overall 1955–2010 geodetic volume change is estimated to be -0.29 ± 0.03 km3 which the highest retreat (equal to 42% of total volumetric change) occurred during 1997–2002 (Karimi et al., 2012b). Also in another studied The satellite-based analysis revealed that the clean ice areas of Khersan and Merjikesh glaciers (located in Takht e Solaiman region) shrank since 2010 with an overall area decrease of about 45% and 60% respectively. During 1987-1991 the maximum decrease in the glacier area was observed. The elevation change results over the Takht e Solaiman region revealed that, the glacier surface lowering has occurred during 1955-2010 continuously without any thickening with the mean annual thinning of about 0.4 ± 0.04 m per year. The maximum thinning rate has been observed during 1997-2002 (about 1.1 ± 0.09 per year and 0.96 ± 0.01 m/year), which was compatible partially with area change analysis. (Karimi et al., 2015, 2012a; Karimi and Eftekhari, 2014). " Ref: Karimi, N., Eftekhari, M., Farajzadeh, M., Namdari, S., Moridnejad, A., Karimi, D., 2015. Use of multitemporal satellite images to find some evidence for glacier changes in the Haft-Khan glacier, Iran. Arab. J. Geosci. 8. https://doi.org/10.1007/s12517-

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
57560	67	29	67	29	propose to add "for example, the most part of the Alamkouh glacier in Iran has experienced lowering which the overall 1955–2010 geodetic volume change is estimated to be -0.29 ± 0.03 km3 which the highest retreat (equal to 42% of total volumetric change) occurred during 1997–2002 (Karimi et al., 2012b). Also in another studied The satellite-based analysis revealed that the clean ice areas of Khersan and Merjikesh glaciers (located in Takht e Solaiman region) shrank since 2010 with an overall area decrease of about 45% and 60% respectively. During 1987-1991 the maximum decrease in the glacier area was observed. The elevation change results over the Takht e Solaiman region revealed that, the glacier surface lowering has occurred during 1955-2010 continuously without any thickening with the mean annual thinning of about 0.4 ± 0.04 m per year. The maximum thinning rate has been observed during 1997-2002 (about 1.1 ± 0.09 per year and 0.96 ± 0.01 m/year), which was compatible partially with area change analysis. (Karimi et al., 2015, 2012a; Karimi and Eftekhari, 2014). " Ref: Karimi, N., Eftekhari, M., Farajzadeh, M., Namdari, S., Moridnejad, A., Karimi, D., 2015. Use of multitemporal satellite images to find some evidence for glacier changes in the Haft-Khan glacier, Iran. Arab. J. Geosci. 8. https://doi.org/10.1007/s12517-014-1578-5 Karimi, N., Farajzadeh, M., Moridnejad, A., Namdari, S., 2014. Evidence for Mountain Glacier Changes in Semi-arid Environments based on Remote Sensing Data. J. Indian Soc. Remote Sens. 42, 801–815. https://doi.org/10.1007/s12524-013-0343-7 Karimi, N., Farokhnia, A., Karimi, L., Eftekhari, M., Ghalkhani, H., 2012a. Combining optical and thermal remote sensing data for mapping debris-covered glaciers (Alamkouh Glaciers, Iran). Cold Reg. Sci. Technol. 71, 73–83. https://doi.org/10.1016/j.coldregions.2011.10.004 [Sahar Tajbakhsh Mosalman, Iran]	propose to add "for example, the most part of the Alamkouh glacier in Iran has experienced lowering which the overall 1955–2010 geodetic volume change is estimated to be -0.29 ± 0.03 km3 which the highest retreat (equal to 42% of total volumetric change) occurred during 1997–2002 (Karimi et al., 2012b). Also in another studied The satellite-based analysis revealed that the clean ice areas of Khersan and Merjikesh glaciers (located in Takht e Solaiman region) shrank since 2010 with an overall area decrease of about 45% and 60% respectively. During 1987-1991 the maximum decrease in the glacier area was observed. The elevation change results over the Takht e Solaiman region revealed that, the glacier surface lowering has occurred during 1955-2010 continuously without any thickening with the mean annual thinning of about 0.4 ± 0.04 m per year. The maximum thinning rate has been observed during 1997-2002 (about 1.1 ± 0.09 per year and 0.96 ± 0.01 m/year), which was compatible partially with area change analysis. (Karimi et al., 2015, 2012a; Karimi and Eftekhari, 2014). " Ref: Karimi, N., Eftekhari, M., Farajzadeh, M., Namdari, S., Moridnejad, A., Karimi, D., 2015. Use of multitemporal satellite images to find some evidence for glacier changes in the Haft-Khan glacier, Iran. Arab. J. Geosci. 8. https://doi.org/10.1007/s12517-
15668	67	29			With regard to the use of glaciers as climate indicators, you may consider adding a reference to: Bojinski, S., Verstraete, M., Peterson, T.C., Richter, C., Simmons, A. and Zemp, M. (2014): The concept of Essential Climate Variables in support of climate research, applications, and policy. Bulletin of the American Meteorological Society, 95, 9: p. 1431-1443. e-View: doi: http://dx.doi.org/10.1175/BAMS-D-13-00047.1 [Michael Zemp, Switzerland]	With regard to the use of glaciers as climate indicators, you may consider adding a reference to: Bojinski, S., Verstraete, M., Peterson, T.C., Richter, C., Simmons, A. and Zemp, M. (2014): The concept of Essential Climate Variables in support of climate research, applications, and policy. Bulletin of the American Meteorological Society, 95, 9: p. 1431-1443. e-View: doi: http://dx.doi.org/10.1175/BAMS-D-13-00047.1

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
20044	67	30	67	32	This sentence needs rewording. The word 'seasonal' is repeated. The last part of the sentence from 'as they stor' onwards is not clear. The word 'amounts' doesn't really fit into the sentence. I don't know whether it means the equivalent of many years precipitation from multiple locations are stored in glaciers or that glaciers store the equivalent of many years precipitation in multiple locations i.e. in many glaciers. [Gwenaelle GREMION, Canada]	This sentence needs rewording. The word 'seasonal' is repeated. The last part of the sentence from 'as they stor' onwards is not clear. The word 'amounts' doesn't really fit into the sentence. I don't know whether it means the equivalent of many years precipitation from multiple locations are stored in glaciers or that glaciers store the equivalent of many years precipitation in multiple locations i.e. in many glaciers.
20062	67	30	67	32	the end of this sentence is unclear ("as they store the equivalent of many years' precipitation amounts in many locations"). In particular, the part about "in many locations" is unclear. [Gwenaelle GREMION, Canada]	the end of this sentence is unclear ("as they store the equivalent of many years' precipitation amounts in many locations"). In particular, the part about "in many locations" is unclear.
25354	67	30	67	33	Background and also more WG2 material - need this? [Sharon Smith, Canada]	Background and also more WG2 material - need this?
26688	67	31			Glaciers not only regulate river runoff at seasonnal time scale, but also at daily, yearly, long-term… [Antoine Rabatel, France]	Glaciers not only regulate river runoff at seasonnal time scale, but also at daily, yearly, long-term…
15760	67	32	67	32	Here I would expect (a) reference(s) at the end of the sentence '…in many location' [Harry Zekollari, Belgium]	Here I would expect (a) reference(s) at the end of the sentence '…in many location'
20054	67	34	67	35	"…are committed to losing considerabl mass in the future, even without further change in temperature". This is a repetition of page 66 lines 44-46. The Introduction 9.5.1 seems to be a bit unbalanced in terms of how much information is given on glaciers, permafrost, seasonal snow cover and fresh water ice. Thus, this information could possibly be omitted in the Introduction 9.5.1 and only given at this point. [Gwenaelle GREMION, Canada]	"…are committed to losing considerabl mass in the future, even without further change in temperature". This is a repetition of page 66 lines 44-46. The Introduction 9.5.1 seems to be a bit unbalanced in terms of how much information is given on glaciers, permafrost, seasonal snow cover and fresh water ice. Thus, this information could possibly be omitted in the Introduction 9.5.1 and only given at this point.
52184	67	40			Globally aggregated glacier behaviour is also assessed in chapter 2 and possibly 3. If making references to other assessment locations this should be holistic. I suspect they may also be subject to consideration by one or more of chapters 10 through 12 which I am not going to get time to review. [Peter Thorne, Ireland]	Globally aggregated glacier behaviour is also assessed in chapter 2 and possibly 3. If making references to other assessment locations this should be holistic. I suspect they may also be subject to consideration by one or more of chapters 10 through 12 which I am not going to get time to review.
15762	67	42	67	42	The title of this section refers to 'observational techniques', but this section only treats remote sensing observations and not in-situ observations (nor does it consider studies combining both: e.g. Zemp et al., 2019, Nature, doi: 10.1038/s41586-019-1071-0). Consider renaming to be more consistent [Harry Zekollari, Belgium]	The title of this section refers to 'observational techniques', but this section only treats remote sensing observations and not in-situ observations (nor does it consider studies combining both: e.g. Zemp et al., 2019, Nature, doi: 10.1038/s41586-019-1071-0). Consider renaming to be more consistent
29314	67	44	71	46	The focus is on glacier extent and volume change. Should also other parametres be covered a bit? Such as glacier flow, ELA, etc.? [Andreas Kääb, Norway]	The focus is on glacier extent and volume change. Should also other parametres be covered a bit? Such as glacier flow, ELA, etc.?

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
20056	67	46	67	46	Something seems to be missing in the citation of the work by Seperd et al. 2012 in the reference list --> (80-.) [Gwenaelle GREMION, Canada]	Something seems to be missing in the citation of the work by Seperd et al. 2012 in the reference list --> (80-.)
15764	67	46	67	46	Would be logical to also include the recent study by Wouters et al. (2019, Frontiers in Earth Science, doi:10.3389/feart.2019.00096) here [Harry Zekollari, Belgium]	Would be logical to also include the recent study by Wouters et al. (2019, Frontiers in Earth Science, doi:10.3389/feart.2019.00096) here
26690	67	46			References by Shepher et al. are focused on ice sheets (Greenland and Antarctica). Likely not adapted in the "glaciers" chapter. Talking about the paper by Zemp et al. in Nature (2019) would be most appropriated [Antoine Rabatel, France]	References by Shepher et al. are focused on ice sheets (Greenland and Antarctica). Likely not adapted in the "glaciers" chapter. Talking about the paper by Zemp et al. in Nature (2019) would be most appropriated
15670	67	47			there are a few new global estimates: - Zemp, M., Huss, M., Thibert, E., Eckert, N., McNabb, R., Huber, J., Barandun, M., Machguth, H., Nussbaumer, S.U., Gärtner-Roer, I., Thomson, L., Paul, F., Maussion, F., Kutuzov, S., and Cogley, J.G. (2019): Global glacier mass changes and their contributions to sea-level rise from 1961 to 2016. Nature, https://doi.org/10.1038/s41586-019-1071-0 - Wouters et al. 2019: Front. Earth Sci., https://doi.org/10.3389/feart.2019.00096 And many new regional studies: - SROCC and references therein - Frontiers Research Topic (with paper submission deadline 31 Dec 2019): https://www.frontiersin.org/research-topics/9957/observational-assessments-of-glacier-mass-changes-at-regional-and-global-level [Michael Zemp, Switzerland]	there are a few new global estimates: - Zemp, M., Huss, M., Thibert, E., Eckert, N., McNabb, R., Huber, J., Barandun, M., Machguth, H., Nussbaumer, S.U., Gärtner-Roer, I., Thomson, L., Paul, F., Maussion, F., Kutuzov, S., and Cogley, J.G. (2019): Global glacier mass changes and their contributions to sea-level rise from 1961 to 2016. Nature, https://doi.org/10.1038/s41586-019-1071-0 - Wouters et al. 2019: Front. Earth Sci., https://doi.org/10.3389/feart.2019.00096 And many new regional studies: - SROCC and references therein - Frontiers Research Topic (with paper submission deadline 31 Dec 2019): https://www.frontiersin.org/research-topics/9957/observational-assessments-of-glacier-mass-changes-at-regional-and-global-level
50574	67	50	67	50	The Glaciers_cci project has mostly used Landsat and Sentinel-2 data for the glacier inventory work. Please note that the link might change in the future. [Frank Paul, Switzerland]	The Glaciers_cci project has mostly used Landsat and Sentinel-2 data for the glacier inventory work. Please note that the link might change in the future.
15712	67	51			Add reference to GLIMS database: GLIMS and NSIDC (2005, updated 2013): Global Land Ice Measurements from Space glacier database. Compiled and made available by the international GLIMS community and the National Snow and Ice Data Center, Boulder CO, U.S.A. DOI:10.7265/N5V98602 [Michael Zemp, Switzerland]	Add reference to GLIMS database: GLIMS and NSIDC (2005, updated 2013): Global Land Ice Measurements from Space glacier database. Compiled and made available by the international GLIMS community and the National Snow and Ice Data Center, Boulder CO, U.S.A. DOI:10.7265/N5V98602
26692	67	53			Should read "continues efforts to…" [Antoine Rabatel, France]	Should read "continues efforts to…"

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
20058	67	54	68	7	Most of the references you provide here present examples of the application of the addressed observational techniques. Few references (e.g. Krieger et al. 2007, Shean et al. 2016) seem to rather present the technical aspects of the named missions. If you provide such technical papers, I would provide them for each mentioned observation technique in this section 9.5.2.1 or then omit them in all cases in order to be more consisent. [Gwenaelle GREMION, Canada]	Most of the references you provide here present examples of the application of the addressed observational techniques. Few references (e.g. Krieger et al. 2007, Shean et al. 2016) seem to rather present the technical aspects of the named missions. If you provide such technical papers, I would provide them for each mentioned observation technique in this section 9.5.2.1 or then omit them in all cases in order to be more consisent.
27018	67		75		One general comment on this chapter. It mentions debris cover and increased temperatures destabilizing rock glaciers but I didn't see any mention of debris cover slowing down glacial melt especially when debris cover is thick or it is transitioning to a rock glacier. While it is acknowledged that models struggle with glacial processes, it should also be acknowledged that models also cannot predict which glaciers will transition to rock glaciers or how quickly. This could be important if transitioning to a rock glacier slows down the rate of glaciers melting. These are examples of publications that might be useful: Jones D, Harrison S, Anderson K, Selley H, Wood J, Betts R (2017). The distribution and hydrological significance of rock glaciers in the Nepalese Himalaya. Global and Planetary Change. Rangecroft S, Harrison S, Anderson K, Magrath J, Castel AP, Pacheco P (2013). Climate change and water resources in arid mountains: an example from the Bolivian Andes. Ambio, 42(7), 852-863. Abstract. [Camilla Mathison, United Kingdom (of Great Britain and Northern Ireland)]	One general comment on this chapter. It mentions debris cover and increased temperatures destabilizing rock glaciers but I didn't see any mention of debris cover slowing down glacial melt especially when debris cover is thick or it is transitioning to a rock glacier. While it is acknowledged that models struggle with glacial processes, it should also be acknowledged that models also cannot predict which glaciers will transition to rock glaciers or how quickly. This could be important if transitioning to a rock glacier slows down the rate of glaciers melting. These are examples of publications that might be useful: Jones D, Harrison S, Anderson K, Selley H, Wood J, Betts R (2017). The distribution and hydrological significance of rock glaciers in the Nepalese Himalaya. Global and Planetary Change. Rangecroft S, Harrison S, Anderson K, Magrath J, Castel AP, Pacheco P (2013). Climate change and water resources in arid mountains: an example from the Bolivian Andes. Ambio, 42(7), 852-863. Abstract.
14568	68	1	68	8	I suggest to add CryoSat-2 and the paper by Foresta et al 2018 https://doi.org/10.1016/j.rse.2018.03.041 [Rivera Andres, Chile]	I suggest to add CryoSat-2 and the paper by Foresta et al 2018 https://doi.org/10.1016/j.rse.2018.03.041
25356	68	1	68	9	Need all this - Can you summarize key advancements since AR5 [Sharon Smith, Canada]	Need all this - Can you summarize key advancements since AR5
20064	68	2	68	2	There is a mistake in the citation of Surazakov… --> it should be Surazakov and Aizen 2010. Also, check the citation in the reference list, it does not seem to be complete (nr. 5, page 603-608); where does the 76 come from? [Gwenaelle GREMION, Canada]	There is a mistake in the citation of Surazakov… --> it should be Surazakov and Aizen 2010. Also, check the citation in the reference list, it does not seem to be complete (nr. 5, page 603-608); where does the 76 come from?
50576	68	2	68	2	The date range does not match with the sensor. KH-9 missions operated from 1973 to 1980. [Frank Paul, Switzerland]	The date range does not match with the sensor. KH-9 missions operated from 1973 to 1980.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
20066	68	3	68	3	Something seems to be missing in the citation of the work by Bindschadler 1998 in the reference list --> (80-.) [Gwenaelle GREMION, Canada]	Something seems to be missing in the citation of the work by Bindschadler 1998 in the reference list --> (80-.)
26694	68	3			Refering to ASTER data, you might include the paper by Menounos et al. (Menounos, B., Hugonnet, R., Shean, D., Gardner, A., Howat, I., Berthier, E., ... & Brun, F. (2019). Heterogeneous Changes in Western North American Glaciers Linked to Decadal Variability in Zonal Wind Strength. Geophysical Research Letters, 46(1), 200-209.) [Antoine Rabatel, France]	Refering to ASTER data, you might include the paper by Menounos et al. (Menounos, B., Hugonnet, R., Shean, D., Gardner, A., Howat, I., Berthier, E., ... & Brun, F. (2019). Heterogeneous Changes in Western North American Glaciers Linked to Decadal Variability in Zonal Wind Strength. Geophysical Research Letters, 46(1), 200-209.)
20068	68	4	68	5	The citation of the work by Braun et al. 2019 in the reference list does not seem to be complete (page 130-136); where does the 1 come from? [Gwenaelle GREMION, Canada]	The citation of the work by Braun et al. 2019 in the reference list does not seem to be complete (page 130-136); where does the 1 come from?
42532	68	9	68	9	A biased comment as I led the paper but Menounos et al., 2019 (doi.org/10.1029/2018GL080942) describe this sort of method for a large region (20 degrees of latitude). That paper further illustrates that although long-term records will be dominated by mass loss, regional variability in melt rates are governed by factors that affect moisture flux (in that paper zonal wind strength). [Brian Menounos, Canada]	A biased comment as I led the paper but Menounos et al., 2019 (doi.org/10.1029/2018GL080942) describe this sort of method for a large region (20 degrees of latitude). That paper further illustrates that although long-term records will be dominated by mass loss, regional variability in melt rates are governed by factors that affect moisture flux (in that paper zonal wind strength).
15672	68	9			You may consider mentionning the major efforst within ESA's Climate Change Initiative (http://cci.esa.int/) and Copernicus Climat Change Service (https://climate.copernicus.eu/) which allowed to compile these geodetic observations and making it available through the World Glacier Monitoring Service (http://www.wgms.ch) for regional and global assessments. [Michael Zemp, Switzerland]	You may consider mentionning the major efforst within ESA's Climate Change Initiative (http://cci.esa.int/) and Copernicus Climat Change Service (https://climate.copernicus.eu/) which allowed to compile these geodetic observations and making it available through the World Glacier Monitoring Service (http://www.wgms.ch) for regional and global assessments.
26696	68	9			Braun et al. 2019 did not used ASP, you should prefer here again the reference by Menounos et al. 2019. [Antoine Rabatel, France]	Braun et al. 2019 did not used ASP, you should prefer here again the reference by Menounos et al. 2019.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
15766	68	12	68	12	I found this section very hard to follow, because of the various periods of time considered and the order in which they are treated. It could potentially become easier to follow if this would be organised in a more consistent way, possibly also incorporating the previous section (9.5.2.1). To further clarify my point, I would describe the present structure as follows:(i) remote sensing recent past and present-day (section 9.5.2.1), (ii) remote sensing after 1992 (p.68, l.14-22), (iii) uncharted glaciers 20th century (p.68, l.24-26), (iv) regional anomalies present-day (p.68, l.28-32), (v) direct observations present-day + remote sensing (p.68, l. 34-47), (vi) thickness present-day (p.70, l.5-22), (vii) MB past decades and length past century (p.70, l.24-35), (viii) 20th century global MB-SLR (p.70,l.49 - p.71, l.4), (ix) Holocene (p.71, l.6-31), (x) processes present-day (p.71, l.33-46). A re-organisation of this (e.g. evolving in time) would really help the reader I guess [Harry Zekollari, Belgium]	I found this section very hard to follow, because of the various periods of time considered and the order in which they are treated. It could potentially become easier to follow if this would be organised in a more consistent way, possibly also incorporating the previous section (9.5.2.1). To further clarify my point, I would describe the present structure as follows:(i) remote sensing recent past and present-day (section 9.5.2.1), (ii) remote sensing after 1992 (p.68, l.14-22), (iii) uncharted glaciers 20th century (p.68, l.24-26), (iv) regional anomalies present-day (p.68, l.28-32), (v) direct observations present-day + remote sensing (p.68, l. 34-47), (vi) thickness present-day (p.70, l.5-22), (vii) MB past decades and length past century (p.70, l.24-35), (viii) 20th century global MB-SLR (p.70,l.49 - p.71, l.4), (ix) Holocene (p.71, l.6-31), (x) processes present-day (p.71, l.33-46). A re-organisation of this (e.g. evolving in time) would really help the reader I guess
48214	68	12	71	46	A new update on Svalbard glacier mass balance is available (van Pelt et al. (2019): A long-term dataset of climatic mass balance, snow conditions and runoff in Svalbard (1957-2018). The Cryosphere Discuss., https://doi.org/10.5194/tc-2019-53). I suggest to consider if this could be relevant in the context of the text in subsection 9.5.2.2. [Sebastian Gerland, Norway]	A new update on Svalbard glacier mass balance is available (van Pelt et al. (2019): A long-term dataset of climatic mass balance, snow conditions and runoff in Svalbard (1957-2018). The Cryosphere Discuss., https://doi.org/10.5194/tc-2019-53). I suggest to consider if this could be relevant in the context of the text in subsection 9.5.2.2.
25358	68	12			Section 9.5.2.2 - There should probably be additional reference to chapter 2 (2.3.2.3) which covers changes in glaciers over various time scales. [Sharon Smith, Canada]	Section 9.5.2.2 - There should probably be additional reference to chapter 2 (2.3.2.3) which covers changes in glaciers over various time scales.
29316	68	14	71	46	Unknowns, or less well known processes in glacier response could be summarized, e.g. debris cover, dynamics, ... [Andreas Kääb, Norway]	Unknowns, or less well known processes in glacier response could be summarized, e.g. debris cover, dynamics, ...
20070	68	16	68	16	The citation "Cazenave et al. 2018" is actually the same paper as " WCRP Global Sea Level Budget Group, 2018" (e.g. page 9-68 line 19) and I believe the later citation is the correct one. [Gwenaelle GREMION, Canada]	The citation "Cazenave et al. 2018" is actually the same paper as " WCRP Global Sea Level Budget Group, 2018" (e.g. page 9-68 line 19) and I believe the later citation is the correct one.
20072	68	17	68	17	I guess the correct word here should be SPANNING (instead of 'apanning')? [Gwenaelle GREMION, Canada]	I guess the correct word here should be SPANNING (instead of 'apanning')?
50578	68	17	68	17	period 1992-2016': I suggest adding the study by Zemp et al. (2019) covering the period 1961-2016 (doi.org/10.1038/s41586-019-1071-0) [Frank Paul, Switzerland]	period 1992-2016': I suggest adding the study by Zemp et al. (2019) covering the period 1961-2016 (doi.org/10.1038/s41586-019-1071-0)
30140	68	17	68	17	apanning --> spanning [patrick Wagnon, France]	apanning --> spanning
52418	68	17	68	17	"spanning" [Charalampos Charalampidis, Germany]	"spanning"
20090	68	18	68	18	Provide a definition of SLE in the text. [Gwenaelle GREMION, Canada]	Provide a definition of SLE in the text.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
20074	68	18	68	20	Actually, the WCRP Global Sea Level Budet Group 2018 cites Box and Colgan 2017 (in the SWIPA-AMAP report). While I see that the work by Box et al. 2018 is probably even more extensive, the way the sentence is written, I would rather cite Box and Colgan. Or then rephrase to include Box et al. 2018. And in any case, the citation Box et al. 2018 in the reference list should be updated (Environmental Research Letters, Vol 13, Nr. 12) [Gwenaelle GREMION, Canada]	Actually, the WCRP Global Sea Level Budet Group 2018 cites Box and Colgan 2017 (in the SWIPA-AMAP report). While I see that the work by Box et al. 2018 is probably even more extensive, the way the sentence is written, I would rather cite Box and Colgan. Or then rephrase to include Box et al. 2018. And in any case, the citation Box et al. 2018 in the reference list should be updated (Environmental Research Letters, Vol 13, Nr. 12)
20092	68	18	68	20	The end of this sentence states "…which, for some areas, was based on scaling." It's unclear what effect scaling has on the estimates, and whether scaling produces more or less accurate estimates. Also, it seems to me that this part of the sentence may not be necessary, and could safely be deleted. [Gwenaelle GREMION, Canada]	The end of this sentence states "…which, for some areas, was based on scaling." It's unclear what effect scaling has on the estimates, and whether scaling produces more or less accurate estimates. Also, it seems to me that this part of the sentence may not be necessary, and could safely be deleted.
15768	68	23	68	23	uncharted': term is used here, but is not introduced/explained. Would it be clear what 'uncharted' means for someone that did not read the paper? [Harry Zekollari, Belgium]	uncharted': term is used here, but is not introduced/explained. Would it be clear what 'uncharted' means for someone that did not read the paper?
39208	68	24	68	24	The format of the unit (mm of SLE per year) is inconsistent with the unit format in line 18 (SLE mm yr-1). [Jacob Yde, Norway]	The format of the unit (mm of SLE per year) is inconsistent with the unit format in line 18 (SLE mm yr-1).
20094	68	24	68	26	I think the implication of this sentence is that that the contributions are decreasing and expected to become minimal because they are disappearing. If this is correct, it should be stated to clarify the process. [Gwenaelle GREMION, Canada]	I think the implication of this sentence is that that the contributions are decreasing and expected to become minimal because they are disappearing. If this is correct, it should be stated to clarify the process.
42534	68	28	68	28	See comment above (that paper provides insight into atmospheric phenomena that can explain regional variability. [Brian Menounos, Canada]	See comment above (that paper provides insight into atmospheric phenomena that can explain regional variability.
15770	68	28	68	32	Short 'anomaly' section. Here the work by de Kok and colleagues (2018, Geophysical Research Letters, doi: 10.1002/2017GL076158) would be suited to mention. Another related publication from the same group is the recent paper by Bonekamp et al. (2019, Frontiers in Earth Science, doi: 10.3389/feart.2019.00107/full). Other paper to consider here is the recent paper by Berhier and Brun (2019, Journal of Glaciology, doi: 10.1017/jog.2019.32) [Harry Zekollari, Belgium]	Short 'anomaly' section. Here the work by de Kok and colleagues (2018, Geophysical Research Letters, doi: ?10.1002/2017GL076158) would be suited to mention. Another related publication from the same group is the recent paper by Bonekamp et al. (2019, Frontiers in Earth Science, doi: 10.3389/feart.2019.00107/full). Other paper to consider here is the recent paper by Berhier and Brun (2019, Journal of Glaciology, doi: ?10.1017/jog.2019.32)

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
14570	68	28	68	32	I suggest adding a phrase discussing the role of volcanoes as a possible source of anomalies. Normally, it has been assumed that volcanic activity enhance glacier losses, but they can also generate the contrary (advancing ice, see Rivera et al., 2012 doi:10.1088/1748-9326/7/014036). Also is interesting to mention that in regions with strong volcanic activity on ice covered volcanoes the glacier recession is similar in magnitude to the impact of climate change on glaciers (Reinthaler et al., 2019 doi:10.1017/jog.2019.30.) [Rivera Andres, Chile]	I suggest adding a phrase discussing the role of volcanoes as a possible source of anomalies. Normally, it has been assumed that volcanic activity enhance glacier losses, but they can also generate the contrary (advancing ice, see Rivera et al., 2012 doi:10.1088/1748-9326/7/014036). Also is interesting to mention that in regions with strong volcanic activity on ice covered volcanoes the glacier recession is similar in magnitude to the impact of climate change on glaciers (Reinthaler et al., 2019 doi:10.1017/jog.2019.30.)
14572	68	28	68	32	Another anomaly that I suggest to add is related to calving glaciers. In Patagonia we have some cases of advancing glaciers due to positive mass balance in a regional context of strong ice wastage. The best example is Pio XI, the biggest glacier of the Southern Patagonia Icefield that is at present advancing, thickening and pushing moraines (Wilson et al., 2016 doi: 10.1017/aog.2016.32). [Rivera Andres, Chile]	Another anomaly that I suggest to add is related to calving glaciers. In Patagonia we have some cases of advancing glaciers due to positive mass balance in a regional context of strong ice wastage. The best example is Pio XI, the biggest glacier of the Southern Patagonia Icefield that is at present advancing, thickening and pushing moraines (Wilson et al., 2016 doi: 10.1017/aog.2016.32).
15674	68	28			Regional anomalies from these global trends exist at regional and decadal scale. It is "normal" that there are deviation from the global trend. Hence, I would mention that such anomalies have also occurred in the past: European Alps, Coastal Norway, New Zealand. [Michael Zemp, Switzerland]	Regional anomalies from these global trends exist at regional and decadal scale. It is "normal" that there are deviation from the global trend. Hence, I would mention that such anomalies have also occurred in the past: European Alps, Coastal Norway, New Zealand.
15772	68	30	68	31	over at last two decades': not very specific. Especially given that the report is likely to come out on 2021, while this study refers to the period 2000-2016. Assume that the findings remain consistent over period 2016-2021? Maybe better to be a more specific in formulation here? [Harry Zekollari, Belgium]	over at last two decades': not very specific. Especially given that the report is likely to come out on 2021, while this study refers to the period 2000-2016. Assume that the findings remain consistent over period 2016-2021? Maybe better to be a more specific in formulation here?
30142	68	30	68	31	the karakoram anomaly goes back to the 70s, as shown by Bolch et al 2017 and Zhou et al, 2017, so better to cite this ref, and to say that it exists for at least 4 decades; Bolch T, Pieczonka T, Mukherjee K and Shea J (2017) Brief communication:glaciers in the Hunza catchment (Karakoram) have been nearly in balance since the 1970s. Cryosphere, 11(1), 531 Zhou Y, Li Z and Li J (2017) Slight glacier mass loss in the Karakoram region during the 1970s to 2000 revealed by KH-9 images and SRTM DEM. J. Glaciol., 63(238), 331–342 [patrick Wagnon, France]	the karakoram anomaly goes back to the 70s, as shown by Bolch et al 2017 and Zhou et al, 2017, so better to cite this ref, and to say that it exists for at least 4 decades; Bolch T, Pieczonka T, Mukherjee K and Shea J (2017) Brief communication:glaciers in the Hunza catchment (Karakoram) have been nearly in balance since the 1970s. Cryosphere, 11(1), 531 Zhou Y, Li Z and Li J (2017) Slight glacier mass loss in the Karakoram region during the 1970s to 2000 revealed by KH-9 images and SRTM DEM. J. Glaciol., 63(238), 331–342

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50580	68	31	68	32	the last two decades': Further studies by Zhou et al. (2017) - doi.org/10.1017/jog.2016.142 - and Bolch et al. (2017) - doi.org/10.5194/tc-11-531-2017 - confirm this trend for the Karakoram back to 1970s (5 decades). [Frank Paul, Switzerland]	the last two decades': Further studies by Zhou et al. (2017) - doi.org/10.1017/jog.2016.142 - and Bolch et al. (2017) - doi.org/10.5194/tc-11-531-2017 - confirm this trend for the Karakoram back to 1970s (5 decades).
51528	68	34	68	34	"Direct observations" - The methods used for observation can be discussed or listed here [Sathiyaseelan Rengaraju, India]	"Direct observations" - The methods used for observation can be discussed or listed here
26006	68	34	68	34	mass balance or length ??? [Marius Schaefer, Chile]	mass balance or length ???
15676	68	34	68	36	this is still true for in-situ measurement of glacier changes in front variations and mass. However, thanks to ESA CCI and C3S, the WGMS and the glacier monitoring community have been able to boost the geodetic dataset from air and space borne surveys. WGMS 2018 include 85,000 geodetic thickness and volume change estimates from 19,000 glaciers, cover about 25% of the global glacier area (Zemp et al. 2019). [Michael Zemp, Switzerland]	this is still true for in-situ measurement of glacier changes in front variations and mass. However, thanks to ESA CCI and C3S, the WGMS and the glacier monitoring community have been able to boost the geodetic dataset from air and space borne surveys. WGMS 2018 include 85,000 geodetic thickness and volume change estimates from 19,000 glaciers, cover about 25% of the global glacier area (Zemp et al. 2019).
52420	68	35	68	35	"while sporadic" [Charalampos Charalampidis, Germany]	"while sporadic"
52422	68	36	68	37	The Randolph Glacier Inventory has been already introduced in the previous paragraph. [Charalampos Charalampidis, Germany]	The Randolph Glacier Inventory has been already introduced in the previous paragraph.
20076	68	38	68	38	Is "M4 Citavi" in the citation of the work by Pfeffer t al. 2014 in the reference list needed? [Gwenaelle GREMION, Canada]	Is "M4 Citavi" in the citation of the work by Pfeffer t al. 2014 in the reference list needed?
20078	68	38	68	38	Possibly add the reference for the RGI inventory version 6: RGI Consortium (2017). Randolph Glacier Inventory - a Dataset of Global Glacier Outlines: Version 6.0: Technical Report, Gobal Land Ice Measurements from Space, Colorado, USA. Digital Media. Doi:https://doi.org/10.7265/N5-RGI-60. [Gwenaelle GREMION, Canada]	Possibly add the reference for the RGI inventory version 6: RGI Consortium (2017). Randolph Glacier Inventory - a Dataset of Global Glacier Outlines: Version 6.0: Technical Report, Gobal Land Ice Measurements from Space, Colorado, USA. Digital Media. Doi:https://doi.org/10.7265/N5-RGI-60.
20080	68	39	68	39	where's the explanation of RGI error? [Gwenaelle GREMION, Canada]	where's the explanation of RGI error?
20082	68	40	68	41	Currently this is not shown in the figure but I assume since the current figure is a placeholder this will be updated correctly [Gwenaelle GREMION, Canada]	Currently this is not shown in the figure but I assume since the current figure is a placeholder this will be updated correctly
20096	68	41	68	41	Clarify which figure is being referred to. [Gwenaelle GREMION, Canada]	Clarify which figure is being referred to.
26008	68	41	68	41	Figure 9.26 and listed in Table 9.4: the over 90 second-order … [Marius Schaefer, Chile]	Figure 9.26 and listed in Table 9.4: the over 90 second-order …
26698	68	43			"improved" instead of "improving" [Antoine Rabatel, France]	"improved" instead of "improving"

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
15774	68	45	68	47	Sounds like the main limiting factor in determining the number of glaciers is our ability to detect them. This is in part true, but moreover the number of glaciers simply results from the fact we put a limit (area threshold) above which glaciers are included in the inventory (and smaller glaciers are neglected). With a lower threshold, the number of glaciers would be higher. Could refer to the fact that this number is thus dependent on the threshold used (and not only on our (in)ability to detect small ones) [Harry Zekollari, Belgium]	Sounds like the main limiting factor in determining the number of glaciers is our ability to detect them. This is in part true, but moreover the number of glaciers simply results from the fact we put a limit (area threshold) above which glaciers are included in the inventory (and smaller glaciers are neglected). With a lower threshold, the number of glaciers would be higher. Could refer to the fact that this number is thus dependent on the threshold used (and not only on our (in)ability to detect small ones)
20084	68	46	68	46	what's the area of a VERY SMALL GLACIER? There are plenty of discussions regarding this issue already. [Gwenaelle GREMION, Canada]	what's the area of a VERY SMALL GLACIER? There are plenty of discussions regarding this issue already.
26010	68	46	68	46	"very small glacier": what is a very small glacier for you ?< 0.1km² or < 0.01km² ? What is your limiting size to call an icebody a glacier? [Marius Schaefer, Chile]	"very small glacier": what is a very small glacier for you ?< 0.1km² or < 0.01km² ? What is your limiting size to call an icebody a glacier?
39210	68	47	68	47	I miss information about whether "local" ice caps in contact with the Greenland Ice Sheet are included or excluded in this total area estimate. It has significant influence on the area of "Greenland Periphery" glaciers whether Blosseville Ice Cap (east Greenland), Ammassalik Ice Cap (southeast Greenland) and Julianehåb Ice Cap (south Greenland) are included or excluded. [Jacob Yde, Norway]	I miss information about whether "local" ice caps in contact with the Greenland Ice Sheet are included or excluded in this total area estimate. It has significant influence on the area of "Greenland Periphery" glaciers whether Blosseville Ice Cap (east Greenland), Ammassalik Ice Cap (southeast Greenland) and Julianehåb Ice Cap (south Greenland) are included or excluded.
20086	68	47	68	47	Possibly add a reference here, e.g. Bahr and Radic, Cryosphere 6, 763-770, 2012 and/or Pfeffer et al. 2014 [Gwenaelle GREMION, Canada]	Possibly add a reference here, e.g. Bahr and Radic, Cryosphere 6, 763-770, 2012 and/or Pfeffer et al. 2014
8472	68	52	68	52	It is not clear what 'error' in Table 9.4 refers to - is this perhaps 'uncertainty' instead? [Jeremy Fyke, Canada]	It is not clear what 'error' in Table 9.4 refers to - is this perhaps 'uncertainty' instead?
42536	68	52	68	52	I find Table 9.4 is not a great use of space in this document. I would recommend that the authors think about a presenting most of these data in terms of graph (or graph superimposed with a map of the RGI regions). [Brian Menounos, Canada]	I find Table 9.4 is not a great use of space in this document. I would recommend that the authors think about a presenting most of these data in terms of graph (or graph superimposed with a map of the RGI regions).
52412	68	52	68	52	A regional table showing percentage of ice mass loss over time and a different RCPs or GMTs would be extremely useful here for policy makers. On a regional/local level, this is more communicative than contribution to GMSL, for example. [Pam Pearson, Sweden]	A regional table showing percentage of ice mass loss over time and a different RCPs or GMTs would be extremely useful here for policy makers. On a regional/local level, this is more communicative than contribution to GMSL, for example.
20088	68	52	70	2	Great table, but it would be good to have a sentence in the table caption explaining the error columns [Gwenaelle GREMION, Canada]	Great table, but it would be good to have a sentence in the table caption explaining the error columns

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
25360	68	52			Table 9.4 - Should it be clear what the time periods are for AR5 and AR6 values when giving #glaciers and their area so time period over which changes occurred is clear. [Sharon Smith, Canada]	Table 9.4 - Should it be clear what the time periods are for AR5 and AR6 values when giving #glaciers and their area so time period over which changes occurred is clear.
26012	69	1	69	3	Values for “effective Sea Level rise 2010-2100” will be replaced by results of the glacier MIP project? [Marius Schaefer, Chile]	Values for “effective Sea Level rise 2010-2100” will be replaced by results of the glacier MIP project?
15678	69	1			With regard to glacier volume below sea level: To be correct, it would be good to make the difference between floating glacier tongues (no SLE) and the grounded ice below sea level PLUS its freeboard (no SLE). (grounded ice below sea level contributes negative to sea-level rise.). [Michael Zemp, Switzerland]	With regard to glacier volume below sea level: To be correct, it would be good to make the difference between floating glacier tongues (no SLE) and the grounded ice below sea level PLUS its freeboard (no SLE). (grounded ice below sea level contributes negative to sea-level rise.).
26700	69	2	69	3	In the Table, the effective sea level rise values derived from Huss and Hock (2015) should be changed by the values given by GLACIERMIP multimodels mean. [Antoine Rabatel, France]	In the Table, the effective sea level rise values derived from Huss and Hock (2015) should be changed by the values given by GLACIERMIP multimodels mean.
20098	69	2	69	3	Table 9.4 caption: Possibly add reference for RGI 4.0 (Arendt et al. 2014) --> For the RGI 6.0 it is also provided… [Gwenaelle GREMION, Canada]	Table 9.4 caption: Possibly add reference for RGI 4.0 (Arendt et al. 2014) --> For the RGI 6.0 it is also provided…
20100	69	2	69	3	Table 9.4 caption: Possibly detail in caption that the simulated effective sea level rise is provided for 2 different emission scenarios (representative concentration pathways) [Gwenaelle GREMION, Canada]	Table 9.4 caption: Possibly detail in caption that the simulated effective sea level rise is provided for 2 different emission scenarios (representative concentration pathways)
42538	69	4	69	4	What is meant by 'error' in this table? We have no perfect means to establish this. Do authors mean 'uncertainty' [Brian Menounos, Canada]	What is meant by 'error' in this table? We have no perfect means to establish this. Do authors mean 'uncertainty'
52186	69	4			Error should be replaced with uncertainty in this table. Tautologically an error pre-supposes the truth is known which cannot be the case. The metrologically correct terminology, per the guide to uncertainty in measurementsis uncertainty. Error should also not be used in the associated text and instead uncertainty shoul be used. [Peter Thorne, Ireland]	Error should be replaced with uncertainty in this table. Tautologically an error pre-supposes the truth is known which cannot be the case. The metrologically correct terminology, per the guide to uncertainty in measurementsis uncertainty. Error should also not be used in the associated text and instead uncertainty shoul be used.
15776	69	5	69	5	Table 9.4: last column: would not refer to this as 'effective Sea level rise' --> it is rather an estimate (based on model calculations) --> 'Estimated SLR'? [Harry Zekollari, Belgium]	Table 9.4: last column: would not refer to this as 'effective Sea level rise' --> it is rather an estimate (based on model calculations) --> 'Estimated SLR'?
15778	69	5	69	5	Table 9.4: why only base yourself on Huss and Hock (2015) for the future SLR contribution? The new results from GlacierMIP (Hock et al., 2019, Journal of Glaciology, doi: 10.1017/jog.2019.22), encompass several studies and with this get an insight in the spread. Furthermore, the results from the second phase of GlacierMIP, in which various glacier models are driven with the same climate models, should become available in the near future - hopefully in time to be included... [Harry Zekollari, Belgium]	Table 9.4: why only base yourself on Huss and Hock (2015) for the future SLR contribution? The new results from GlacierMIP (Hock et al., 2019, Journal of Glaciology, doi: ?10.1017/jog.2019.22), encompass several studies and with this get an insight in the spread. Furthermore, the results from the second phase of GlacierMIP, in which various glacier models are driven with the same climate models, should become available in the near future - hopefully in time to be included...

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15780	69	5	69	5	Table 9.4: columns 'difference between AR6 and AR5': because of what? Better observations / new version of RGI / different model for sea level equivalent estimate? (on what was it based on AR5?) [Harry Zekollari, Belgium]	Table 9.4: columns 'difference between AR6 and AR5': because of what? Better observations / new version of RGI / different model for sea level equivalent estimate? (on what was it based on AR5?)
15680	69	11			Greenland periphery: Note that these numbers include peripheral glaciers with connectivity levels 0 and 1 (with CL2 assigned to the Ice Sheet, cf. Rastner et al. 2012, for ref see above) [Michael Zemp, Switzerland]	Greenland periphery: Note that these numbers include peripheral glaciers with connectivity levels 0 and 1 (with CL2 assigned to the Ice Sheet, cf. Rastner et al. 2012, for ref see above)
20102	69		69		Two of the final four columns refer to RCP (2.6 and 8.5). I think it would be helpful to define what these are, and where they come from, in the table header. [Gwenaelle GREMION, Canada]	Two of the final four columns refer to RCP (2.6 and 8.5). I think it would be helpful to define what these are, and where they come from, in the table header.
15682	70	1			Antarctic and Subantarctic: Note that these numbers include only peripheral glaciers with connectivity levels 0 (located on Sub/Antarctic islands). Peripheral glaciers on the Antarctic mainland (e.g. CL0 in Dry Valleys, or CL1 and CL2 on Ant. Peninsula) are not included in RGI 6.0 and, hence, implicitly considered to be part of the Antarctic Ice Sheet). According to Huber et al. (2017, ESSD, for ref see above), the Antarctic Peninsula hosts 1,589 glacier (CL1) with an area of 95,273 km2; the total estimated ice volume is 34,590 km3, of which one-third is below sea level [Michael Zemp, Switzerland]	Antarctic and Subantarctic: Note that these numbers include only peripheral glaciers with connectivity levels 0 (located on Sub/Antarctic islands). Peripheral glaciers on the Antarctic mainland (e.g. CL0 in Dry Valleys, or CL1 and CL2 on Ant. Peninsula) are not included in RGI 6.0 and, hence, implicitly considered to be part of the Antarctic Ice Sheet). According to Huber et al. (2017, ESSD, for ref see above), the Antarctic Peninsula hosts 1,589 glacier (CL1) with an area of 95,273 km2; the total estimated ice volume is 34,590 km3, of which one-third is below sea level
26704	70	5	70	22	This paragraph about ice thickness should end with the mention of a need for more direct measurements of mountain glaciers thickness, either from in situ or remote sensing observations. Regarding remote sensing, micro gravimetry can be seen as a promising tool (e.g. Millan, R., Rignot, E., Rivera, A., Martineau, V., Mouginot, J., Zamora, R., ... & Gim, Y. 2019. Ice thickness and bed elevation of the Northern and Southern Patagonian Icefields. Geophysical Research Letters, doi: 10.1029/2019GL082485) [Antoine Rabatel, France]	This paragraph about ice thickness should end with the mention of a need for more direct measurements of mountain glaciers thickness, either from in situ or remote sensing observations. Regarding remote sensing, micro gravimetry can be seen as a promising tool (e.g. Millan, R., Rignot, E., Rivera, A., Martineau, V., Mouginot, J., Zamora, R., ... & Gim, Y. 2019. Ice thickness and bed elevation of the Northern and Southern Patagonian Icefields. Geophysical Research Letters, doi: 10.1029/2019GL082485)

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
14564	70	5	70	22	The global consensus model presented by Farinotti et al 2019 is a better quote in this paragraph. In spite of this big modeling effort, I suggest to add a phrase indicating the high uncertainties in this model. For example in Patagonia, the first comprehensive ice thickness compilation of radar and gravity measurements (Millan et al 2019, http://dx.doi.org/10.1029/2019GL082485) allowed the estimation of the total volume of ice in the Northern and Southern Patagonian ice fields, the most important glacier area of region 17 of the RGI6.0 Interestingly, the total volume of Farinotti for these icefields are within the errors of measurements, but Millan indicated that "this was more a coincidence than a validation of the model results", since Farinotti failed dramatically in detecting deep ice in many places having differences of more than 1000 m ice thickness in several places. [Rivera Andres, Chile]	The global consensus model presented by Farinotti et al 2019 is a better quote in this paragraph. In spite of this big modeling effort, I suggest to add a phrase indicating the high uncertainties in this model. For example in Patagonia, the first comprehensive ice thickness compilation of radar and gravity measurements (Millan et al 2019, http://dx.doi.org/10.1029/2019GL082485) allowed the estimation of the total volume of ice in the Northern and Southern Patagonian ice fields, the most important glacier area of region 17 of the RGI6.0 Interestingly, the total volume of Farinotti for these icefields are within the errors of measurements, but Millan indicated that "this was more a coincidence than a validation of the model results", since Farinotti failed dramatically in detecting deep ice in many places having differences of more than 1000 m ice thickness in several places.
20120	70	6	70	13	This section of text might fit better in the section on observation techniques (section 9.5.2.1). [Gwenaelle GREMION, Canada]	This section of text might fit better in the section on observation techniques (section 9.5.2.1).
26702	70	8	70	10	The number of glaciers with thickness obversations available in Glathida needs to be adjusted according to the v3.0 of the database released in 2019. In agreement, the reference must be up-dated. [Antoine Rabatel, France]	The number of glaciers with thickness obversations available in Glathida needs to be adjusted according to the v3.0 of the database released in 2019. In agreement, the reference must be up-dated.
15684	70	10			The new version 3.0 of GlaThiDa extend includes more than 3.8 million point observations of glacier ice thickness from over 5,000 surveys of more than 3,000 glaciers worldwide: GlaThiDa Consortium (2019): Glacier Thickness Database 3.0.1. World Glacier Monitoring Service, Zurich, Switzerland. DOI: 10.5904/wgms-glathida-2019-03 [Michael Zemp, Switzerland]	The new version 3.0 of GlaThiDa extend includes more than 3.8 million point observations of glacier ice thickness from over 5,000 surveys of more than 3,000 glaciers worldwide: GlaThiDa Consortium (2019): Glacier Thickness Database 3.0.1. World Glacier Monitoring Service, Zurich, Switzerland. DOI: 10.5904/wgms-glathida-2019-03
26014	70	13	70	13	eliminate “consensus” In Farinotti2019 an average of five models is presented which is not necessary a consensus [Marius Schaefer, Chile]	eliminate “consensus” In Farinotti2019 an average of five models is presented which is not necessary a consensus
15782	70	13	70	13	world's glacier thickness' --> 'world's glacier volume'? There is not a single world glacier thickness [Harry Zekollari, Belgium]	world's glacier thickness' --> 'world's glacier volume'? There is not a single world glacier thickness
20104	70	14	70	14	Check the reference of Frey et al. 2014 - the title of the article is not taken correctly [Gwenaelle GREMION, Canada]	Check the reference of Frey et al. 2014 - the title of the article is not taken correctly

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
20106	70	14	70	14	Update reference of Maussion et al. 2018, which is a discussion paper. The finally published article seems to be: Maussion et al. 2019, The open glacier model (OGGM) v.1.1, Geoscientific Model Development, 12, 909-931. [Gwenaelle GREMION, Canada]	Update reference of Maussion et al. 2018, which is a discussion paper. The finally published article seems to be: Maussion et al. 2019, The open glacier model (OGGM) v.1.1, Geoscientific Model Development, 12, 909-931.
26016	70	16	70	17	replace: “the total volume estimate of all the glaciers in the world of 158 ... ” by “the mean value of the five models for the total volume estimate of all glacier in the world is 158 ...” [Marius Schaefer, Chile]	replace: “the total volume estimate of all the glaciers in the world of 158 ... ” by “the mean value of the five models for the total volume estimate of all glacier in the world is 158 ...”
20122	70	17	70	17	Change the units of sea level equivalent to mm, to be consistent with how this information is presented in table 9.4. [Gwenaelle GREMION, Canada]	Change the units of sea level equivalent to mm, to be consistent with how this information is presented in table 9.4.
28012	70	18	70	22	Page 70, line 18-22: The reference here should probably be to Table 9.4, not Table 9.2. [roderik van de wal, Netherlands]	Page 70, line 18-22: The reference here should probably be to Table 9.4, not Table 9.2.
20108	70	18	70	22	It should be Table 9.4 not 9.2. However, glacier volume is not addressed in this table. Either add glacier volume to this table or refer to Farinotti et al. 2019. [Gwenaelle GREMION, Canada]	It should be Table 9.4 not 9.2. However, glacier volume is not addressed in this table. Either add glacier volume to this table or refer to Farinotti et al. 2019.
15686	70	19			Note that the RGI-based values for glaciers in the Antarctic periphery are missing peripheral glaciers on Antarctic mainland (see comments above). [Michael Zemp, Switzerland]	Note that the RGI-based values for glaciers in the Antarctic periphery are missing peripheral glaciers on Antarctic mainland (see comments above).
42540	70	20	70	20	Use 'new' and ensure you attribute what new refers to (Farinotti et al. 2019). If you use 'newer' you need to tell reader what you are comparing to. [Brian Menounos, Canada]	Use 'new' and ensure you attribute what new refers to (Farinotti et al. 2019). If you use 'newer' you need to tell reader what you are comparing to.
26018	70	20	70	20	replace “This newer estimate” by “This sea-level rise estimate” [Marius Schaefer, Chile]	replace “This newer estimate” by “This sea-level rise estimate”
15784	70	24	70	24	The WGMS does not exist more than a century. So probably better to reformulate to something like 'The World Glacier Monitoring Service (WGMS) and its predecessor organizations' (in line with https://wgms.ch/) [Harry Zekollari, Belgium]	The WGMS does not exist more than a century. So probably better to reformulate to something like 'The World Glacier Monitoring Service (WGMS) and its predecessor organizations' (in line with https://wgms.ch/)
20110	70	24	70	25	WGMS data is first introduced on page 9-67, lines 52-54, further detailed on page 9-68, lines 34-36 and now retaken here. If so, I would put "The WGMS…has coordinated glacier monitoring efforts for more than a century" where the first introduction of the WGMS is made (page 9-67). Otherwise maybe omit this information at this point as it is not necessary anymore. [Gwenaelle GREMION, Canada]	WGMS data is first introduced on page 9-67, lines 52-54, further detailed on page 9-68, lines 34-36 and now retaken here. If so, I would put "The WGMS…has coordinated glacier monitoring efforts for more than a century" where the first introduction of the WGMS is made (page 9-67). Otherwise maybe omit this information at this point as it is not necessary anymore.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
20112	70	24	70	25	The information on page 9-68, lines 34-36 could be integrated/merged with the information on the WGMS that you provide at this point. In my opinion this would increase the readibility of the text. Currently, I find it a bit confusing that you talk about WGMS on page 9-68 lines 34-36, as the rest of this section is then dedicated to the RGI. At this point, you dedicate a section to WGMS and I think all relevant information on this topic should be provided here (but keeping the first introduction to the WGMS on page 9-67, lines 52-54) [Gwenaelle GREMION, Canada]	The information on page 9-68, lines 34-36 could be integrated/merged with the information on the WGMS that you provide at this point. In my opinion this would increase the readibility of the text. Currently, I find it a bit confusing that you talk about WGMS on page 9-68 lines 34-36, as the rest of this section is then dedicated to the RGI. At this point, you dedicate a section to WGMS and I think all relevant information on this topic should be provided here (but keeping the first introduction to the WGMS on page 9-67, lines 52-54)
42542	70	24	70	35	This needs to updated with the Zemp et al. (Nature) paper. Also, Roe et al., DOI: 10.1038/NGEO2863 is pertinent in the section. [Brian Menounos, Canada]	This needs to updated with the Zemp et al. (Nature) paper. Also, Roe et al., DOI: 10.1038/NGEO2863 is pertinent in the section.
26706	70	24	70	35	The entire paragraph needs to be updated with Zemp et al. 2019 paper: Zemp, M., Huss, M., Thibert, E., Eckert, N., McNabb, R., Huber, J., ... & Thomson, L. (2019). Global glacier mass changes and their contributions to sea-level rise from 1961 to 2016. Nature, 568(7752), 382. [Antoine Rabatel, France]	The entire paragraph needs to be updated with Zemp et al. 2019 paper: Zemp, M., Huss, M., Thibert, E., Eckert, N., McNabb, R., Huber, J., ... & Thomson, L. (2019). Global glacier mass changes and their contributions to sea-level rise from 1961 to 2016. Nature, 568(7752), 382.
14566	70	24	70	35	I suggest to update the values with the results provided by paper of Zemp et al 2019 https://doi.org/10.1038/s41586-019-1071-0. These new results clearly show the strong wastage acceleration trend in recent decades that I recommend to highlight more emphatically in the text. [Rivera Andres, Chile]	I suggest to update the values with the results provided by paper of Zemp et al 2019 https://doi.org/10.1038/s41586-019-1071-0. These new results clearly show the strong wastage acceleration trend in recent decades that I recommend to highlight more emphatically in the text.
15688	70	25			Update: WGMS 2018 includes >100,000 observations of glacier changes in length, volume, and mass from about 20,000 glaciers worldwide. [Michael Zemp, Switzerland]	Update: WGMS 2018 includes >100,000 observations of glacier changes in length, volume, and mass from about 20,000 glaciers worldwide.
50582	70	33	70	33	There is an update from 2019 (doi.org/10.1038/s41586-019-1071-0) [Frank Paul, Switzerland]	There is an update from 2019 (doi.org/10.1038/s41586-019-1071-0)
20124	70	33	70	33	Rather than state -0.5 m w.e. a-1, clearly state that the average mass balance of all observed glaciers has decreased by 0.5 m w.e. a-1. [Gwenaelle GREMION, Canada]	Rather than state -0.5 m w.e. a-1, clearly state that the average mass balance of all observed glaciers has decreased by 0.5 m w.e. a-1.
44978	70	34	70	35	The first sentence says that observations go “as far back to 16th century”. This seems to contradict the statement, “the beginning of the observational record in the second half of the 19th century”. [Darrell Kaufman, United States of America]	The first sentence says that observations go “as far back to 16th century”. This seems to contradict the statement, “the beginning of the observational record in the second half of the 19th century”.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
14574	70	40	70	46	In the Southern Andes, tidewater glaciers have also shown similar strong dependency on oceanic warming (Moffat et al., 2018 https://doi.org/10.1002/2017JC013069) but water depth and near buoyancy conditions enhancing ice cliff calving and retreat (Rivera et al., 2012 doi:10.5194/cp-8-403-2012) is an important factor to be mentioned. [Rivera Andres, Chile]	In the Southern Andes, tidewater glaciers have also shown similar strong dependency on oceanic warming (Moffat et al., 2018 https://doi.org/10.1002/2017JC013069) but water depth and near buoyancy conditions enhancing ice cliff calving and retreat (Rivera et al., 2012 doi:10.5194/cp-8-403-2012) is an important factor to be mentioned.
15786	70	49	70	49	further back in time': vs. what? After this, there is a part on '20th century', which was also partly covered earlier in this section. In general, as mentioned in earlier comment (comment #17): quite difficult to keep track in this section because of jumps in time [Harry Zekollari, Belgium]	further back in time': vs. what? After this, there is a part on '20th century', which was also partly covered earlier in this section. In general, as mentioned in earlier comment (comment #17): quite difficult to keep track in this section because of jumps in time
20114	70	49	70	50	The works by Midgley and Tonkin 2017 and Solomina et al. 2016a do seem to directly address volume changes, possibly choose another wording on line 49? [Gwenaelle GREMION, Canada]	The works by Midgley and Tonkin 2017 and Solomina et al. 2016a do seem to directly address volume changes, possibly choose another wording on line 49?
44980	70	49	70	50	“Back in time” seem too vague. Specify that this paragraph relates to 20th century reconstructions. Also, how were the three references selected? There must be dozens of studies published since AR5 with reconstructed post LIA glacier changes. Are there no available review or summary papers? [Darrell Kaufman, United States of America]	“Back in time” seem too vague. Specify that this paragraph relates to 20th century reconstructions. Also, how were the three references selected? There must be dozens of studies published since AR5 with reconstructed post LIA glacier changes. Are there no available review or summary papers?
25362	70	49	71	4	Many pre AR5 refs - need all this? Focus on new knowledge since AR5 [Sharon Smith, Canada]	Many pre AR5 refs - need all this? Focus on new knowledge since AR5
26708	70	49	71	4	Nothing new in this paragraph since to AR5. Needed? [Antoine Rabatel, France]	Nothing new in this paragraph since to AR5. Needed?
20116	70	50	71	1	The Luethi papers are not cited in Marzeion et al. 2015 (only the Leclercq papers…). I had no time to fully check up on the consistency of the cited Luethi and Leclercq papers. But I assume this has been done, so that the mutual consistency between indirect methods and modelling proposed from Marzeion et al. 2015 is really true for the work by Luethi et al. as well... [Gwenaelle GREMION, Canada]	The Luethi papers are not cited in Marzeion et al. 2015 (only the Leclercq papers…). I had no time to fully check up on the consistency of the cited Luethi and Leclercq papers. But I assume this has been done, so that the mutual consistency between indirect methods and modelling proposed from Marzeion et al. 2015 is really true for the work by Luethi et al. as well...
20118	70	50	71	4	Could paragraph 9.5.2.2 Observed and reconstructed glacier extent and volume changes somehow be brought in chronological order, i.e. ,starting with reconstructions 1850 and earlier (page 9-70 line 49-page 9-71 line 4), followed by satellite era (page 9-68 lines 14-32), present and future? [Gwenaelle GREMION, Canada]	Could paragraph 9.5.2.2 Observed and reconstructed glacier extent and volume changes somehow be brought in chronological order, i.e. ,starting with reconstructions 1850 and earlier (page 9-70 line 49-page 9-71 line 4), followed by satellite era (page 9-68 lines 14-32), present and future?

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
42544	71	1	71	4	Poorly worded last sentence. I'm not entirely certain what authors are trying to state here. 'Contributed positively to global sea level ' = 'contributed to sea level rise'? [Brian Menounos, Canada]	Poorly worded last sentence. I'm not entirely certain what authors are trying to state here. 'Contributed positively to global sea level ' = 'contributed to sea level rise'?
15690	71	2			I would write: "Leclercq et al. 2014, and references therein" since the latter study is based on a large compilation of reconstructed front variations. With respect to the compilatios by Zemp et al. (2011, PAGES) and Leclercq et al. (2014), there is a number of recent publications on reconstructed glacier front variations, e.g.: Zumbühl, H. J. and S. U. Nussbaumer (2018): Little Ice Age glacier history of the Central and Western Alps from pictorial documents. Cuadernos de Investigación Geográfica, 44(1), 115–136. Nussbaumer, S. U. and H. J. Zumbühl (2012): The Little Ice Age history of the Glacier des Bossons (Mont Blanc area, France): a new high-resolution glacier length curve based on historical documents. Climatic Change, 111(2), 301–334. Zumbühl, H. J., S. U. Nussbaumer, H. Holzhauser, and R. Wolf (Eds.) (2016): Die Grindelwaldgletscher – Kunst und Wissenschaft. Haupt, Bern, 256 pp. Nussbaumer, S. U., P. Deline, C. Vincent, and H. J. Zumbühl (Eds.) (2012): Mer de Glace – art & science. Atelier ésope, Chamonix, 192 pp. Holzhauser, H. (2010): Zur Geschichte des Gornergletschers. Geographica Bernensia, Bern, 253 pp. [Michael Zemp, Switzerland]	I would write: "Leclercq et al. 2014, and references therein" since the latter study is based on a large compilation of reconstructed front variations. With respect to the compilatios by Zemp et al. (2011, PAGES) and Leclercq et al. (2014), there is a number of recent publications on reconstructed glacier front variations, e.g.: Zumbühl, H. J. and S. U. Nussbaumer (2018): Little Ice Age glacier history of the Central and Western Alps from pictorial documents. Cuadernos de Investigación Geográfica, 44(1), 115–136. Nussbaumer, S. U. and H. J. Zumbühl (2012): The Little Ice Age history of the Glacier des Bossons (Mont Blanc area, France): a new high-resolution glacier length curve based on historical documents. Climatic Change, 111(2), 301–334. Zumbühl, H. J., S. U. Nussbaumer, H. Holzhauser, and R. Wolf (Eds.) (2016): Die Grindelwaldgletscher – Kunst und Wissenschaft. Haupt, Bern, 256 pp. Nussbaumer, S. U., P. Deline, C. Vincent, and H. J. Zumbühl (Eds.) (2012): Mer de Glace – art & science. Atelier ésope, Chamonix, 192 pp. Holzhauser, H. (2010): Zur Geschichte des Gornergletschers. Geographica Bernensia, Bern, 253 pp.
42654	71	6	71	7	The rapid thinning on these glaciers in the HTM as described above means that the statement below is not correct as the current retreat is not dissimilar to the glacial retreat in the HTM. [Howard Brady, Australia]	The rapid thinning on these glaciers in the HTM as described above means that the statement below is not correct as the current retreat is not dissimilar to the glacial retreat in the HTM.
42656	71	6	71	7	“ The Current retreat of glaciers is very unusual during the Holocene..no single period of common glacial retreat of centennial duration, except for the past century, has been identified during the Holocene” page 9-71, line 6-7 [Howard Brady, Australia]	“ The Current retreat of glaciers is very unusual during the Holocene..no single period of common glacial retreat of centennial duration, except for the past century, has been identified during the Holocene” page 9-71, line 6-7

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
42546	71	6	71	8	This is problematic statement as the geologic evidence does not support what is written here. Alpine glaciers in many mountain underwent rapid retreat at Pleistocene-Holocene boundary and continued to remain small in the NH due to factors like high summer insolation. At face value this statement is not supported by the evidence. I needs to be qualified. What is unusual is that the rate and global pattern of retreat cannot be explained by external forcing (changes in insolation). [Brian Menounos, Canada]	This is problematic statement as the geologic evidence does not support what is written here. Alpine glaciers in many mountain underwent rapid retreat at Pleistocene-Holocene boundary and continued to remain small in the NH due to factors like high summer insolation. At face value this statement is not supported by the evidence. I needs to be qualified. What is unusual is that the rate and global pattern of retreat cannot be explained by external forcing (changes in insolation).
40622	71	6	71	8	"The current global retreat of glaciers is very unusual during the Holocene" - this statement is correct, but not only because "no single period of common global glacier retreat of centennial duration, except for the past century, has been identified during the Holocene". This can be easily explained by the lacunes in our paleorecords. So, I suggest to edit a little the beginning of this paragraph. Let's say: The current global retreat of glaciers is very unusual during the Holocene : it occurs worldwide with very few regional exceptions, very rapidly, and this trend disagrees with the orbital forcing, that should instead contribute to the increase of glaciers in the Northern Hemisphere. [Olga Solomina, Russian Federation]	"The current global retreat of glaciers is very unusual during the Holocene" - this statement is correct, but not only because "no single period of common global glacier retreat of centennial duration, except for the past century, has been identified during the Holocene". This can be easily explained by the lacunes in our paleorecords. So, I suggest to edit a little the beginning of this paragraph. Let's say: The current global retreat of glaciers is very unusual during the Holocene : it occurs worldwide with very few regional exceptions, very rapidly, and this trend disagrees with the orbital forcing, that should instead contribute to the increase of glaciers in the Northern Hemisphere.
39212	71	6	71	22	This section could be shortened significantly without losing valuable information. [Jacob Yde, Norway]	This section could be shortened significantly without losing valuable information.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
45088	71	6	71	31	It could be useful to add few words here about the high altitude warming amplification. For the last 50 years, this high elevation amplification is qualitatively well established from modern temperature data (see SORCC special report, page 9 to 10), but the regional variability of this mechanism is significant and some unertainties remain for future projection. Glacial interglacial timescales observations of the lapse rate (the temperature gradient) reconstructed for the last glacial maximum, between 21 and 18 kilo-years ago bring useful complementary insights, but this require more data. This could be acknwoledged here to stimulate and encourage research effort on LGM moutain glacier reconstruction. Looking at such timescale indeed provides important information: i) this gives an estimate of the sensitivity of the elevation dependence warming under large changes (>2°C) of global temperatures. Independent evidences suggest (with medium to high confidence) that the tropical lapse rate was steeper during the LGM (6.5°C/km) compared to today (5.5 °C/km) (e.g. Fig. S4 in Blard et al., Nature, 2007; Fig. 3 in Loomis et al., Science Advances, 2017). ii) Importantly, state-of-the-art global climate models correctly capture the sign of this change, but they underestimate its magnitude. Consequently, future warming in high tropical mountains may be larger than indicated by model projections. [Pierre-Henri BLARD, France]	It could be useful to add few words here about the high altitude warming amplification. For the last 50 years, this high elevation amplification is qualitatively well established from modern temperature data (see SORCC special report, page 9 to 10), but the regional variability of this mechanism is significant and some unertainties remain for future projection. Glacial interglacial timescales observations of the lapse rate (the temperature gradient) reconstructed for the last glacial maximum, between 21 and 18 kilo-years ago bring useful complementary insights, but this require more data. This could be acknwoledged here to stimulate and encourage research effort on LGM moutain glacier reconstruction. Looking at such timescale indeed provides important information: i) this gives an estimate of the sensitivity of the elevation dependence warming under large changes (>2°C) of global temperatures. Independent evidences suggest (with medium to high confidence) that the tropical lapse rate was steeper during the LGM (6.5°C/km) compared to today (5.5 °C/km) (e.g. Fig. S4 in Blard et al., Nature, 2007; Fig. 3 in Loomis et al., Science Advances, 2017). ii) Importantly, state-of-the-art global climate models correctly capture the sign of this change, but they underestimate its magnitude. Consequently, future warming in high tropical mountains may be larger than indicated by model projections.
20144	71	6	71	31	This paragraph discusses orbital forcing and the effect on glaciers. It would be helpful to include a very short definition of orbital forcing, since it is a term that some may not be familiar with. [Gwenaelle GREMION, Canada]	This paragraph discusses orbital forcing and the effect on glaciers. It would be helpful to include a very short definition of orbital forcing, since it is a term that some may not be familiar with.
26020	71	7	71	8	Replace: “single” by “other” Delete: “except for the past century” [Marius Schaefer, Chile]	Replace: “single” by “other” Delete: “except for the past century”
20126	71	8	71	10	This sentence can be clarified - use of "erosion" is ambiguous (i.e. bedrock erosion vs destruction of sedimentary landforms). Would suggest "However, this could be explained by previous Holocene glacier advances destroying geomorphological and sedimentological evidence of past glacier retreat." [Gwenaelle GREMION, Canada]	This sentence can be clarified - use of "erosion" is ambiguous (i.e. bedrock erosion vs destruction of sedimentary landforms). Would suggest "However, this could be explained by previous Holocene glacier advances destroying geomorphological and sedimentological evidence of past glacier retreat."
26710	71	10	71	11	This is for millenial time scales? Precision needed. [Antoine Rabatel, France]	This is for millenial time scales? Precision needed.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
40624	71	10	71	11	Please see my comment on the figure Figure 2.25 and chapter 2.3.2.3. I cannot find the description of the correlation of glacier variations with the orbital forcings in Ch. 2. I think you decribed the orbital forcing in the Ch. 9 and the reference to the Ch. 2 should be removed here. I believe that the figure 2.25 should be either modified somehow or deleted. In my opinion this attempt to quantify the qualitative information may be misleading. [Olga Solomina, Russian Federation]	Please see my comment on the figure Figure 2.25 and chapter 2.3.2.3. I cannot find the description of the correlation of glacier variations with the orbital forcings in Ch. 2. I think you decribed the orbital forcing in the Ch. 9 and the reference to the Ch. 2 should be removed here. I believe that the figure 2.25 should be either modified somehow or deleted. In my opinion this attempt to quantify the qualitative information may be misleading.
20128	71	10	71	15	No one besides Solomina et al. can sustain these statements? [Gwenaelle GREMION, Canada]	No one besides Solomina et al. can sustain these statements?
40626	71	11	71	12	The sentence"Glacier retreated after the LGM…" is almost the same as in 2-62 lines 42-43. I would recommend to deleate it here and to use instead a more careful "In both hemispheres, glacier advances in the mid Holocene were generally small in comparison to their LIA magnitudes" Solomina et al., 2015. [Olga Solomina, Russian Federation]	The sentence"Glacier retreated after the LGM…" is almost the same as in 2-62 lines 42-43. I would recommend to deleate it here and to use instead a more careful "In both hemispheres, glacier advances in the mid Holocene were generally small in comparison to their LIA magnitudes" Solomina et al., 2015.
20146	71	12	71	12	Does the upper tree line refer to the tree line in alpine areas (i.e. on mountains)? I was confused by this term. [Gwenaelle GREMION, Canada]	Does the upper tree line refer to the tree line in alpine areas (i.e. on mountains)? I was confused by this term.
15788	71	13	71	13	Warmer extra-tropical areas at Holocene Thermal Maximum vs. now: not only known from glacier sizes (e.g. a recent study that nicely shows this for various Greenland ice caps and could be considered including here: Larsen et al., 2019, Boreas, doi: 10.1111/bor.12384) + tree lines. Also appears from ice cores (e.g. for Arctic Canada + Greenland), which may be worth mentioning here: e.g. Lecavalier et al. (2017, Proceedings of the National Academy of Sciences, doi: 10.1073/pnas.1616287114) [Harry Zekollari, Belgium]	Warmer extra-tropical areas at Holocene Thermal Maximum vs. now: not only known from glacier sizes (e.g. a recent study that nicely shows this for various Greenland ice caps and could be considered including here: Larsen et al., 2019, Boreas, doi: 10.1111/bor.12384) + tree lines. Also appears from ice cores (e.g. for Arctic Canada + Greenland), which may be worth mentioning here: e.g. Lecavalier et al. (2017, Proceedings of the National Academy of Sciences, doi: ?10.1073/pnas.1616287114)
15790	71	14	71	15	Role insolation: indeed. Well illustrated by ice cap constraints from Greenland in recent study by Axford et al. (2019, Quaternary Science Reviews, doi: 10.1016/j.quascirev.2019.05.011) [Harry Zekollari, Belgium]	Role insolation: indeed. Well illustrated by ice cap constraints from Greenland in recent study by Axford et al. (2019, Quaternary Science Reviews, doi: 10.1016/j.quascirev.2019.05.011)
20130	71	15	71	15	The work by Kaplan et al. 2016 is mainly dealing with Patagonia with a link to other southern hemisphere records --> I would rephrase, the way it is written now one thinks the article deals primarily with glaciers in New Zealand [Gwenaelle GREMION, Canada]	The work by Kaplan et al. 2016 is mainly dealing with Patagonia with a link to other southern hemisphere records --> I would rephrase, the way it is written now one thinks the article deals primarily with glaciers in New Zealand

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
40628	71	15	71	15	Probably it would be better to replace Kaplan et al., 2016 by Schaefer, J.M., Denton, G.H., Kaplan, M., Putnam, A., Finkel, R.C., Barrell, D.J.A., Andersen, B.G., Schwartz, R., Mackintosh, A., Chinn, T., Schlüchter, C., 2009. High-frequency Holocene glacier fluctuations in New Zealand differ from the Northern signature. Science 324, 622-625. http://refhub.elsevier.com/S0277-3791(14)00478-8/sref307. Although Kaplan et al., 2016 consider the Holocene New Zealand glaciers in the Discussion section the paper is focused on Patagonia. [Olga Solomina, Russian Federation]	Probably it would be better to replace Kaplan et al., 2016 by Schaefer, J.M., Denton, G.H., Kaplan, M., Putnam, A., Finkel, R.C., Barrell, D.J.A., Andersen, B.G., Schwartz, R., Mackintosh, A., Chinn, T., Schlüchter, C., 2009. High-frequency Holocene glacier fluctuations in New Zealand differ from the Northern signature. Science 324, 622-625. http://refhub.elsevier.com/S0277-3791(14)00478-8/sref307. Although Kaplan et al., 2016 consider the Holocene New Zealand glaciers in the Discussion section the paper is focused on Patagonia.
20132	71	16	71	16	If I got it right, the work by Jomelli et al. 2014 is focusing on the transition of the pleistocene to the holocene and is not addressing the evolution during the holocene…? [Gwenaelle GREMION, Canada]	If I got it right, the work by Jomelli et al. 2014 is focusing on the transition of the pleistocene to the holocene and is not addressing the evolution during the holocene…?
40630	71	16	71	16	I would recommend to delete the reference for Carcaillet et al., 2013 here. The paper is focused on the LGM and Late Glacial Time and only briefly discusses the Holocene. [Olga Solomina, Russian Federation]	I would recommend to delete the reference for Carcaillet et al., 2013 here. The paper is focused on the LGM and Late Glacial Time and only briefly discusses the Holocene.
20134	71	17	71	17	Does it contradict lines 7-8 ? [Gwenaelle GREMION, Canada]	Does it contradict lines 7-8 ?
40632	71	19	71	19	Probably it makes sense to mention here the advances forced by precipitation. For instance Batbaar et al., 2018 report that the advance of glaciers in Gichginii range of central Gobi-Altai at ~8-7 ka was of similar magnitude to the local LGM glacier size due to additional snow accumulation despite of much warmer climate. [Olga Solomina, Russian Federation]	Probably it makes sense to mention here the advances forced by precipitation. For instance Batbaar et al., 2018 report that the advance of glaciers in Gichginii range of central Gobi-Altai at ~8-7 ka was of similar magnitude to the local LGM glacier size due to additional snow accumulation despite of much warmer climate.
20148	71	21	71	22	Move the statement "though no single mechanism of glacier fluctuations over the Holocene on a global scale is identified" to earlier in the paragraph (for e.g., modify the sentence on lines 6 to 8 of this page). It would help focus the reader on the main points of this paragraph. [Gwenaelle GREMION, Canada]	Move the statement "though no single mechanism of glacier fluctuations over the Holocene on a global scale is identified" to earlier in the paragraph (for e.g., modify the sentence on lines 6 to 8 of this page). It would help focus the reader on the main points of this paragraph.
20136	71	22	71	25	Do I understand this sentence correctly in that the given metrics "likely" and "medium confidence" were used in IPCC AR4 and AR5? If so, and if as stated recent studies support these previous conclusions, could then not updated metrics be provided at this point (increased likelihood and confidence)? [Gwenaelle GREMION, Canada]	Do I understand this sentence correctly in that the given metrics "likely" and "medium confidence" were used in IPCC AR4 and AR5? If so, and if as stated recent studies support these previous conclusions, could then not updated metrics be provided at this point (increased likelihood and confidence)?

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
39214	71	25	71	27	Why is this statement restricted to Svalbard and Canada, when there are similar reports from other glaciers worldwide? Why not include similar findings from Norway (Nesje et al. 2012. The climatic significance of artefacts related to prehistoric reindeer hunting exposed at melting ice patches in southern Norway. The Holocene, vol. 22, issue 4, 485-496) and Greenland (Knudsen et al. 2008. Recent marginal changes at Mittivakkat Glacier, Southeast Greenland and the discovery of remains of reindeer (Rangifer tarandus), polar bear (Ursus maritimus) and peaty material. Danish Journal of Geography, vol. 108, issue 1, 137-142) or probably other sites from around the world? [Jacob Yde, Norway]	Why is this statement restricted to Svalbard and Canada, when there are similar reports from other glaciers worldwide? Why not include similar findings from Norway (Nesje et al. 2012. The climatic significance of artefacts related to prehistoric reindeer hunting exposed at melting ice patches in southern Norway. The Holocene, vol. 22, issue 4, 485-496) and Greenland (Knudsen et al. 2008. Recent marginal changes at Mittivakkat Glacier, Southeast Greenland and the discovery of remains of reindeer (Rangifer tarandus), polar bear (Ursus maritimus) and peaty material. Danish Journal of Geography, vol. 108, issue 1, 137-142) or probably other sites from around the world?
26022	71	25	71	27	delete “in Svalbard and Canada” (line 25) and add: “...1300 years (in Svalbard) and 40000 years (in Canada).. “ delete: respectively [Marius Schaefer, Chile]	delete “in Svalbard and Canada” (line 25) and add: “...1300 years (in Svalbard) and 40000 years (in Canada).. “ delete: respectively
20150	71	27	71	31	Move these sentences to the start of the paragraph. As written, the main points of this paragraph are buried at the end. [Gwenaelle GREMION, Canada]	Move these sentences to the start of the paragraph. As written, the main points of this paragraph are buried at the end.
15692	71	27			I suggest adding a note about response time and, hence, limitations in climatic interpretation of current with earlier periods of limited glacier extents. See comments above. [Michael Zemp, Switzerland]	I suggest adding a note about response time and, hence, limitations in climatic interpretation of current with earlier periods of limited glacier extents. See comments above.
44982	71	28	71	29	Where (which hemisphere) is orbital forcing now favorable for glacier growth? [Darrell Kaufman, United States of America]	Where (which hemisphere) is orbital forcing now favorable for glacier growth?
45090	71	29	71	31	(Shakun et al., 2015) also state that other regional factors are overprinted over greenhouse gas rise, and are also major drivers of mountain glacier fluctuations during the deglaciation, between 20 and 11 ka. Snowfall increases may overbalance warming and maintain Equilibrium Line Altitudes in near constant positions. Such combined effect of precipitation and temperature may induce significant interregional variabilities, both during the last deglaication, during the Holocene and for future projections. In certain regions, such as the Tropical Andes (e.g. Martin et al., Science Advances, 2018), glaciers stayed closed to their maximum local position until the end of the Heinrich 1 event, about 15 ka, because the precipitation increase between 17 and 15 ka compensated the synchronous post-LGM warming. [Pierre-Henri BLARD, France]	(Shakun et al., 2015) also state that other regional factors are overprinted over greenhouse gas rise, and are also major drivers of mountain glacier fluctuations during the deglaciation, between 20 and 11 ka. Snowfall increases may overbalance warming and maintain Equilibrium Line Altitudes in near constant positions. Such combined effect of precipitation and temperature may induce significant interregional variabilities, both during the last deglaication, during the Holocene and for future projections. In certain regions, such as the Tropical Andes (e.g. Martin et al., Science Advances, 2018), glaciers stayed closed to their maximum local position until the end of the Heinrich 1 event, about 15 ka, because the precipitation increase between 17 and 15 ka compensated the synchronous post-LGM warming.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
15792	71	29	71	31	Confusing last sentence of this paragraph, as it refers to a period further back in time. Consider moving to beginning of paragraph to sketch the general picture immediately: i.e. LGM --> Holocene. And then only give the Holocene info [Harry Zekollari, Belgium]	Confusing last sentence of this paragraph, as it refers to a period further back in time. Consider moving to beginning of paragraph to sketch the general picture immediately: i.e. LGM --> Holocene. And then only give the Holocene info
26024	71	30	71	30	delete: “surface” [Marius Schaefer, Chile]	delete: “surface”
26712	71	33	71	34	This sentence is not clear and needs reformulation [Antoine Rabatel, France]	This sentence is not clear and needs reformulation
51530	71	33	71	38	More studies related to black carbon deposition on glaciers and snow can be included [Sathiyaseelan Rengaraju, India]	More studies related to black carbon deposition on glaciers and snow can be included
42552	71	33	71	46	I think this section could be linked to a special box about alpine glaciers (major processes affecting change and also a well-drafted illustration that outlines uncertainties in mass change - Albedo is never really quantified in this section of the report and is important. Changes in albedo remain a large uncertainty [Brian Menounos, Canada]	I think this section could be linked to a special box about alpine glaciers (major processes affecting change and also a well-drafted illustration that outlines uncertainties in mass change - Albedo is never really quantified in this section of the report and is important. Changes in albedo remain a large uncertainty
30144	71	33	71	46	Here is a list of some processes potentially responsible for glacier melt in general, although the subject is more the enhancement of glacier melt. I suggest to revise this paragraph 1. bringing a more exhaustive list of processes involved in glacier melt i.e sensible heat flux increase, enhanced long wave radiation input, superficial pond energy intake over debris covered glaciers, etc. and also 2. to separate which processes have potentially change over the last decades to lead to enhanced glacier melt (for instance, ice cliff backwasting has always been involved in debris covered glacier melt and there is no study yet assessing the area groth of cliffs over such glaciers; on the opposite, BC is responsible for an enhanced absorption of short wave radiation leading to glacier melt increase over the last decades) [patrick Wagnon, France]	Here is a list of some processes potentially responsible for glacier melt in general, although the subject is more the enhancement of glacier melt. I suggest to revise this paragraph 1. bringing a more exhaustive list of processes involved in glacier melt i.e sensible heat flux increase, enhanced long wave radiation input, superficial pond energy intake over debris covered glaciers, etc. and also 2. to separate which processes have potentially change over the last decades to lead to enhanced glacier melt (for instance, ice cliff backwasting has always been involved in debris covered glacier melt and there is no study yet assessing the area groth of cliffs over such glaciers; on the opposite, BC is responsible for an enhanced absorption of short wave radiation leading to glacier melt increase over the last decades)
39216	71	34	71	34	Change "disappearance" to "shrinkage". [Jacob Yde, Norway]	Change "disappearance" to "shrinkage".
26714	71	34	71	35	This study by Ménégoz et al is dedicaded to snow cover at "continental" scale, not precisely dedicated to glaciers and glacier surface melt. The paper by Ginot et al is more adapted : Ginot, P., Dumont, M., Lim, S., Patris, N., Taupin, J. D., Wagnon, P., ... & Laj, P. (2014). A 10 year record of black carbon and dust from a Mera Peak ice core (Nepal): variability and potential impact on melting of Himalayan glaciers. The Cryosphere, 8(4), 1479-1496. [Antoine Rabatel, France]	This study by Ménégoz et al is dedicaded to snow cover at "continental" scale, not precisely dedicated to glaciers and glacier surface melt. The paper by Ginot et al is more adapted : Ginot, P., Dumont, M., Lim, S., Patris, N., Taupin, J. D., Wagnon, P., ... & Laj, P. (2014). A 10 year record of black carbon and dust from a Mera Peak ice core (Nepal): variability and potential impact on melting of Himalayan glaciers. The Cryosphere, 8(4), 1479-1496.
20138	71	37	71	37	The sentence seems to be missing words between "reduces" and "resulting". [Gwenaelle GREMION, Canada]	The sentence seems to be missing words between "reduces" and "resulting".

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
26026	71	37	71	37	“The refreezing capacity of firn ...” New topic! New paragraph? [Marius Schaefer, Chile]	“The refreezing capacity of firn ...” New topic! New paragraph?
20140	71	38	71	40	link between air T and meltwater driven enhanced calving needs to be clearer. Would suggest "Tidewater glaciers lose mass through calving, the rate of which can be substantially amplified by warming ocean temperatures (Luckman et al., 2015), in addition to increased undermining of calving fronts driven by enhanced submarine meltwater runoff (O'Leary & Christoffersen, 2013; Lea et al., 2014; Fried et al., 2018) New references: Lea, J.M., Mair, D.W.F., Nick, F.M., Rea, B.R., Van As, D., Morlighem, M., Nienow, P.W. and Weidick, A., 2014. Fluctuations of a Greenlandic tidewater glacier driven by changes in atmospheric forcing: observations and modelling of Kangiata Nunaata Sermia, 1859–present. The Cryosphere. 8, 2031-2045 Fried, M.J., Catania, G.A., Stearns, L.A., Sutherland, D.A., Bartholomaus, T.C., Shroyer, E. and Nash, J., 2018. Reconciling drivers of seasonal terminus advance and retreat at 13 Central West Greenland tidewater glaciers. Journal of Geophysical Research: Earth Surface, 123(7), pp.1590-1607. [Gwenaelle GREMION, Canada]	link between air T and meltwater driven enhanced calving needs to be clearer. Would suggest "Tidewater glaciers lose mass through calving, the rate of which can be substantially amplified by warming ocean temperatures (Luckman et al., 2015), in addition to increased undermining of calving fronts driven by enhanced submarine meltwater runoff (O'Leary & Christoffersen, 2013; Lea et al., 2014; Fried et al., 2018) New references: Lea, J.M., Mair, D.W.F., Nick, F.M., Rea, B.R., Van As, D., Morlighem, M., Nienow, P.W. and Weidick, A., 2014. Fluctuations of a Greenlandic tidewater glacier driven by changes in atmospheric forcing: observations and modelling of Kangiata Nunaata Sermia, 1859–present. The Cryosphere. 8, 2031-2045 Fried, M.J., Catania, G.A., Stearns, L.A., Sutherland, D.A., Bartholomaus, T.C., Shroyer, E. and Nash, J., 2018. Reconciling drivers of seasonal terminus advance and retreat at 13 Central West Greenland tidewater glaciers. Journal of Geophysical Research: Earth Surface, 123(7), pp.1590-1607.
39218	71	42	71	43	This statement about tidewater glaciers in the Russian Arctic and Svalbard needs to be better supported by research on the coupling between ocean temperature changes and surge frequency. The reference by Dunse et al. (2015) proposes surface melting as the driving mechanism, not modulation by warming ocean temperature, so it should be removed. Also, the recent surge frequency of tidewater glaciers in Svalbard should be statistically compared to historic surge frequencies and ocean temperatures before this statement should be included in an IPCC report. This statement about tidewater glaciers should be deleted. [Jacob Yde, Norway]	This statement about tidewater glaciers in the Russian Arctic and Svalbard needs to be better supported by research on the coupling between ocean temperature changes and surge frequency. The reference by Dunse et al. (2015) proposes surface melting as the driving mechanism, not modulation by warming ocean temperature, so it should be removed. Also, the recent surge frequency of tidewater glaciers in Svalbard should be statistically compared to historic surge frequencies and ocean temperatures before this statement should be included in an IPCC report. This statement about tidewater glaciers should be deleted.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
20142	71	42	71	44	I do not see where Dunse et al. 2015 and Willis et al. 2018 address warming ocean temperatures (I could not check Sevestre et al. 2018 as I do not have acces to the article). Dunse et al. 2015 cite in their introduction 'accelera- tion of outlet glaciers of the Greenland Ice Sheet are generally attributed to hydraulic lubrication and marine terminus destabilization by oceanic warming and calving (Nick et al.,2009; Bartholomew et al., 2010; Moon et al., 2014)'. However, their article addresses a hydro-thermodynamic feedback mechanism to surface melt, subsequently mobilizing the ice within the reservoir area and weakening cold-based marginal ice that restricts inland ice from draining into the ocean. Thus, their paper is in my opinion not the most suited as reference to surge behaviour modulated by warming ocean temperatures. Willis et al. 2018 do not seem to address this subject directly either (unless I missunderstood). [Gwenaelle GREMION, Canada]	I do not see where Dunse et al. 2015 and Willis et al. 2018 address warming ocean temperatures (I could not check Sevestre et al. 2018 as I do not have acces to the article). Dunse et al. 2015 cite in their introduction 'accelera- tion of outlet glaciers of the Greenland Ice Sheet are generally attributed to hydraulic lubrication and marine terminus destabilization by oceanic warming and calving (Nick et al.,2009; Bartholomew et al., 2010; Moon et al., 2014)'. However, their article addresses a hydro-thermodynamic feedback mechanism to surface melt, subsequently mobilizing the ice within the reservoir area and weakening cold-based marginal ice that restricts inland ice from draining into the ocean. Thus, their paper is in my opinion not the most suited as reference to surge behaviour modulated by warming ocean temperatures. Willis et al. 2018 do not seem to address this subject directly either (unless I missunderstood).
50584	71	44	71	44	There is also an Arctic-wide study by Strozzi et al. (2017) that might be cited here: doi.org/:10.3390/rs9090947 [Frank Paul, Switzerland]	There is also an Arctic-wide study by Strozzi et al. (2017) that might be cited here: doi.org/:10.3390/rs9090947
26028	71	44	71	44	What is “Ice-cliff wasting”? Explain! Is calving a form of ice-cliff wasting? Does it only exist for debris covered glaciers? [Marius Schaefer, Chile]	What is “Ice-cliff wasting”? Explain! Is calving a form of ice-cliff wasting? Does it only exist for debris covered glaciers?
15794	71	45	71	46	not represented in glacier models': not entirely true. In detailed models, which are typically applied at a high spatial resolution', many of these processes are included. But they are indeed not included in more generalized approaches. So may be worth being a bit more specific here: e.g. 'not represented in regional and global glacier models' [Harry Zekollari, Belgium]	not represented in glacier models': not entirely true. In detailed models, which are typically applied at a high spatial resolution', many of these processes are included. But they are indeed not included in more generalized approaches. So may be worth being a bit more specific here: e.g. 'not represented in regional and global glacier models'
15796	71	49	71	49	In this section, two of the most recent models that can be globally be applied - and which are the two only ones that explicitly account for ice dynamics! - are not included; OGGM the Open Global Glacier Model; Maussion et al., 2019, Geoscientific Model Development, doi:10.5194/gmd-12-909-2019) and GloGEMflow (Global Glacier Evolution Model flow; Zekollari et al., 2019, The Cryosphere, doi: 10.5194/tc-13-1125-2019). [Harry Zekollari, Belgium]	In this section, two of the most recent models that can be globally be applied - and which are the two only ones that explicitly account for ice dynamics! - are not included; OGGM the Open Global Glacier Model; Maussion et al., 2019, Geoscientific Model Development, doi:?10.5194/gmd-12-909-2019) and GloGEMflow (Global Glacier Evolution Model flow; Zekollari et al., 2019, The Cryosphere, doi: 10.5194/tc-13-1125-2019).

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
14590	71	49	72	18	For me, the evaluation of glacier models over longer periods (i.e. before the 20th century) is lacking and necessary as it is the relevant timescale for the future changes too. [Hugues Goosse, Belgium]	For me, the evaluation of glacier models over longer periods (i.e. before the 20th century) is lacking and necessary as it is the relevant timescale for the future changes too.
26030	71	51	71	51	“scarcity of accurate data” be more precise: which kind of data are we missing? Which spatial and temporal resolution should these data ideally have? [Marius Schaefer, Chile]	“scarcity of accurate data” be more precise: which kind of data are we missing? Which spatial and temporal resolution should these data ideally have?
42554	72	2	72	2	Careful here: Volume-scaling is an emperical relation between area and volume. It can only be used to 'simulate' (an imperfect way to account for physical process - ice dynamics). [Brian Menounos, Canada]	Careful here: Volume-scaling is an emperical relation between area and volume. It can only be used to 'simulate' (an imperfect way to account for physical process - ice dynamics).
15798	72	3	72	3	only model that accounts for glacier advance/retreat….' --> see previous comment. Now there is also OGGM and GloGEMflow… [Harry Zekollari, Belgium]	only model that accounts for glacier advance/retreat….' --> see previous comment. Now there is also OGGM and GloGEMflow…
39220	72	6	72	6	Change "glaciated" to "glacierized" or "glacier". The term glaciated refers to an area that has been glacier-covered in the past and is ice-free now. [Jacob Yde, Norway]	Change "glaciated" to "glacierized" or "glacier". The term glaciated refers to an area that has been glacier-covered in the past and is ice-free now.
20152	72	6	72	6	is ‘glaciated’ and ‘glacierized’ used indistinctively? (see Table 9.4) [Gwenaelle GREMION, Canada]	is ‘glaciated’ and ‘glacierized’ used indistinctively? (see Table 9.4)
20166	72	6	72	6	I suggest starting a new paragraph at the start of the sentence that begins "A new approach…" Otherwise this paragraph becomes very long. [Gwenaelle GREMION, Canada]	I suggest starting a new paragraph at the start of the sentence that begins "A new approach…" Otherwise this paragraph becomes very long.
15800	72	6	72	8	The way it is ordered now and introduced here, it seems like the model by Shannon et al. (2019) is more sophisticated/advanced than the others.. Consider reordening/reformualting [Harry Zekollari, Belgium]	The way it is ordered now and introduced here, it seems like the model by Shannon et al. (2019) is more sophisticated/advanced than the others.. Consider reordening/reformualting
26716	72	6			"glacierized" instead of "glaciated" [Antoine Rabatel, France]	"glacierized" instead of "glaciated"
26032	72	8	72	8	what is a “high-end scenarios” ? Explain! [Marius Schaefer, Chile]	what is a “high-end scenarios” ? Explain!
20154	72	9	72	9	The citation "Cazenave et al. 2018" is actually the same paper as " WCRP Global Sea Level Budget Group, 2018" (e.g. page 9-68 line 19) and I believe the later citation is the correct one. [Gwenaelle GREMION, Canada]	The citation "Cazenave et al. 2018" is actually the same paper as " WCRP Global Sea Level Budget Group, 2018" (e.g. page 9-68 line 19) and I believe the later citation is the correct one.
15802	72	9	72	10	Consider also referring to the Open Global Glacier Model (OGGM) for this: Maussion et al. (2019, Geoscientific Model Development, doi: doi:10.5194/gmd-12-909-2019) [Harry Zekollari, Belgium]	Consider also referring to the Open Global Glacier Model (OGGM) for this: Maussion et al. (2019, Geoscientific Model Development, doi: doi:?10.5194/gmd-12-909-2019)

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
26720	72	10	72	18	The limitations in current glacier evolution modelling should be better described. Including: 1/ limitations in the input data (climate variables, usually only Temperature and Precipitation), their resolution is generally not adapted to the glacier size, GCM-RCM gives input data at kilometer scales in the best cases, statistical downscalling needs observation for calibration etc... therefore, uncertainties on precipitation amounts and spatial variability at the sub-grid resolution are very high and may induce strong differences in the model results. It is almost the same for temperature even if the spatial variability is lower; 2/ uncertainties related to the SMB model used; 3/ uncertainties related to the representation of the ice dynamics; 4/ uncertainties related to the thickness distribution. Considering all these uncertainties I would say that we have a low confidence (not medium) in the global glacier models to project future glacier changes. Of course we all know that glaciers will continue to shrink and the models show this clearly, not need of a model for that, and we can expect a model to give an accurate timing of glacier shrinkage and water production, and we are still far from this. Future projections will not be improved by including very complex representations of impacts of black carbon or algae (which are several order of magnitude below the role of atmospheric variables), but by having better forcing (climate variable at an accurate resolution, e.g. 100 m, an with accurate amounts), better representation of the mass balance and better knowledge on the ice thickness distribution. [Antoine Rabatel, France]	The limitations in current glacier evolution modelling should be better described. Including: 1/ limitations in the input data (climate variables, usually only Temperature and Precipitation), their resolution is generally not adapted to the glacier size, GCM-RCM gives input data at kilometer scales in the best cases, statistical downscalling needs observation for calibration etc... therefore, uncertainties on precipitation amounts and spatial variability at the sub-grid resolution are very high and may induce strong differences in the model results. It is almost the same for temperature even if the spatial variability is lower; 2/ uncertainties related to the SMB model used; 3/ uncertainties related to the representation of the ice dynamics; 4/ uncertainties related to the thickness distribution. Considering all these uncertainties I would say that we have a low confidence (not medium) in the global glacier models to project future glacier changes. Of course we all know that glaciers will continue to shrink and the models show this clearly, not need of a model for that, and we can expect a model to give an accurate timing of glacier shrinkage and water production, and we are still far from this. Future projections will not be improved by including very complex representations of impacts of black carbon or algae (which are several order of magnitude below the role of atmospheric variables), but by having better
50586	72	11	72	11	scarcity of observations': I think a main weakness of all calculations using climate data is that we have only poor to very poor information about (solid) precipitation amounts in mountain regions. This holds for present measurements and future scenarios. Things get even worse in high, steep and rugged topography. The impact of all other unknows might be small compared to this. [Frank Paul, Switzerland]	scarcity of observations': I think a main weakness of all calculations using climate data is that we have only poor to very poor information about (solid) precipitation amounts in mountain regions. This holds for present measurements and future scenarios. Things get even worse in high, steep and rugged topography. The impact of all other unknows might be small compared to this.
26034	72	11	72	16	very long sentence! Again: “scarcity of observations” of what? [Marius Schaefer, Chile]	very long sentence! Again: “scarcity of observations” of what?
26718	72	13			Here again, the reference my Ménégoz et al. is not adapted. [Antoine Rabatel, France]	Here again, the reference my Ménégoz et al. is not adapted.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
15804	72	16	72	16	For the references, when it comes to projections, a more recent paper by Gilbert et al. is probably more suited than the 2016 paper by this group cited at this point (as the latter is not really a projection paper). Suggested reference: Gilbert et al. (2017, Geophysical Research Letters, doi: 10.1002/2016GL072394) [Harry Zekollari, Belgium]	For the references, when it comes to projections, a more recent paper by Gilbert et al. is probably more suited than the 2016 paper by this group cited at this point (as the latter is not really a projection paper). Suggested reference: Gilbert et al. (2017, Geophysical Research Letters, doi: ?10.1002/2016GL072394)
15806	72	16	72	18	When it comes to regional projections, except for western Canada, there are now also some for High Mountain Asia (Kraaijenbrink et al., 2017, Nature, doi: 10.1038/nature23878), and for the European Alps (Zekollari et al., 2019, The Cryosphere, doi: 10.5194/tc-13-1125-2019) [Harry Zekollari, Belgium]	When it comes to regional projections, except for western Canada, there are now also some for High Mountain Asia (Kraaijenbrink et al., 2017, Nature, doi: ?10.1038/nature23878), and for the European Alps (Zekollari et al., 2019, The Cryosphere, doi: ??10.5194/tc-13-1125-2019)
42556	72	17	72	18	I don't agree with this asessment. Clarke et al., actually describe the way in which their method could be applied to other glacierized environments. All the tools are available to do it. I would recommend that this statement be modified to suggest that computational resources to transfer that sort of analysis to all glaciers would be great. [Brian Menounos, Canada]	I don't agree with this asessment. Clarke et al., actually describe the way in which their method could be applied to other glacierized environments. All the tools are available to do it. I would recommend that this statement be modified to suggest that computational resources to transfer that sort of analysis to all glaciers would be great.
15808	72	21	72	21	Title of the section ('Current imbalance, commitment and attribution') is not really ordered intuitively: present-day, future, past. Consider re-ordening? [Harry Zekollari, Belgium]	Title of the section ('Current imbalance, commitment and attribution') is not really ordered intuitively: present-day, future, past. Consider re-ordening?
49912	72	21	72	52	Need to provide a clearer definition or explanation of what is meant by response time here. It could be to reach a new equilibrium, it could be a 1/e response or...? Is it length, volume or...? [Jonathan Bamber, United Kingdom (of Great Britain and Northern Ireland)]	Need to provide a clearer definition or explanation of what is meant by response time here. It could be to reach a new equilibrium, it could be a 1/e response or...? Is it length, volume or...?
25364	72	23	72	52	Seems like a lot of background (some of this mentioned earlier?) and also many pre-AR5 refs. It is suggested that this section be made shorter and focus more on new results. [Sharon Smith, Canada]	Seems like a lot of background (some of this mentioned earlier?) and also many pre-AR5 refs. It is suggested that this section be made shorter and focus more on new results.
29318	72	23	73	15	Section 9.5.2.4 is quite extensive and can likely be shortened. [Andreas Kääb, Norway]	Section 9.5.2.4 is quite extensive and can likely be shortened.
42530	72	24	72	25	A useful reference here might be Beedle et al., 2009 (doi:10.1029/2009GL039533, 2009) since that paper examines this lag between frontal response (immediate) and delayed response (adjustments to mass change over a decade or more). [Brian Menounos, Canada]	A useful reference here might be Beedle et al., 2009 (doi:10.1029/2009GL039533, 2009) since that paper examines this lag between frontal response (immediate) and delayed response (adjustments to mass change over a decade or more).
26036	72	26	72	27	Replace: “on the melt at the terminus” by: “mass turnover and flow speed”. Perhaps you can find some newer citations? [Marius Schaefer, Chile]	Replace: “on the melt at the terminus” by: “mass turnover and flow speed”. Perhaps you can find some newer citations?

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
50588	72	28	72	28	This might be true for idealized cases, but practically it depends on several further characteristics. This includes glacier hypsometry as well as debris cover. Many very small glaciers tend to get increasingly debris covered with time (maybe also due to increased rockfall resulting from parallel permafrost thawing) and are then very well protected, i.e. less sensitive to climate change. [Frank Paul, Switzerland]	This might be true for idealized cases, but practically it depends on several further characteristics. This includes glacier hypsometry as well as debris cover. Many very small glaciers tend to get increasingly debris covered with time (maybe also due to increased rockfall resulting from parallel permafrost thawing) and are then very well protected, i.e. less sensitive to climate change.
26038	72	28	72	28	“their sensitivity to climate change intensifies due to feedback mechanisms and border effects.” [Marius Schaefer, Chile]	“their sensitivity to climate change intensifies due to feedback mechanisms and border effects.”
15810	72	29	72	29	much-improved inventory of glaciers': is this referring to the Randolph Glacier Inventory? [Harry Zekollari, Belgium]	much-improved inventory of glaciers': is this referring to the Randolph Glacier Inventory?
51532	72	29	72	30	typo -- "there is 'no' information from each……" [Sathiyaseelan Rengaraju, India]	typo -- "there is 'no' information from each……"
15694	72	29	72	30	Several early studies showed that response times can be estimated from glacier inventories: Oerlemans, J. (1989). On the response of valley glaciers to climatic change. In Glacier fluctuations and climatic change (pp. 353-371). Springer, Dordrecht. Haeberli, W., & Hölzle, M. (1995). Application of inventory data for estimating characteristics of and regional climate-change effects on mountain glaciers: a pilot study with the European Alps. Annals of glaciology, 21, 206-212. Hoelzle, M., Haeberli, W., Dischl, M., & Peschke, W. (2003). Secular glacier mass balances derived from cumulative glacier length changes. Global and Planetary Change, 36(4), 295-306. Raper, S. C., & Braithwaite, R. J. (2009). Glacier volume response time and its links to climate and topography based on a conceptual model of glacier hypsometry. The Cryosphere, 3(2), 183-194. [Michael Zemp, Switzerland]	Several early studies showed that response times can be estimated from glacier inventories: Oerlemans, J. (1989). On the response of valley glaciers to climatic change. In Glacier fluctuations and climatic change (pp. 353-371). Springer, Dordrecht. Haeberli, W., & Hölzle, M. (1995). Application of inventory data for estimating characteristics of and regional climate-change effects on mountain glaciers: a pilot study with the European Alps. Annals of glaciology, 21, 206-212. Hoelzle, M., Haeberli, W., Dischl, M., & Peschke, W. (2003). Secular glacier mass balances derived from cumulative glacier length changes. Global and Planetary Change, 36(4), 295-306. Raper, S. C., & Braithwaite, R. J. (2009). Glacier volume response time and its links to climate and topography based on a conceptual model of glacier hypsometry. The Cryosphere, 3(2), 183-194.
20156	72	29	72	30	I guess the correct phrase here should be « […] there is NO information from […] »? [Gwenaelle GREMION, Canada]	I guess the correct phrase here should be « […] there is NO information from […] »?
50590	72	30	72	30	That thisinformation is not stored in inventories might be due to the fact that input such as the balance of the tongue is based on model output using climate data. But in principle the information is available. [Frank Paul, Switzerland]	That thisinformation is not stored in inventories might be due to the fact that input such as the balance of the tongue is based on model output using climate data. But in principle the information is available.
26040	72	31	72	32	volume times scale: how do you define that? Explain [Marius Schaefer, Chile]	volume times scale: how do you define that? Explain

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
20158	72	31	72	32	I don't understand what is meant by "showed that the volume time-scale". Is it "the time required for a step change in mass balance to supply the volume difference between the initial and final steady states" (Johannesson et al., 1989)? If so, I think it would be worthwhile explaining what it is and how it changes with the type of glacier. [Gwenaelle GREMION, Canada]	I don't understand what is meant by "showed that the volume time-scale". Is it "the time required for a step change in mass balance to supply the volume difference between the initial and final steady states" (Johannesson et al., 1989)? If so, I think it would be worthwhile explaining what it is and how it changes with the type of glacier.
20168	72	31	72	32	I'm not sure what the term "volume time scale" refers to. Providing a definition or clarifying the language used here would be helpful. [Gwenaelle GREMION, Canada]	I'm not sure what the term "volume time scale" refers to. Providing a definition or clarifying the language used here would be helpful.
50592	72	33	72	33	A similar study (with basically the same results) was already published by Haeberli and Hoelze back in 1995 (doi.org/10.3189/S0260305500015834). Maybe add? [Frank Paul, Switzerland]	A similar study (with basically the same results) was already published by Haeberli and Hoelze back in 1995 (doi.org/10.3189/S0260305500015834). Maybe add?
26042	72	33	72	33	response time: how do you define that? Related to volume time scale? Explain [Marius Schaefer, Chile]	response time: how do you define that? Related to volume time scale? Explain
42558	72	36	72	36	Remind reader what you are referring to as 'regions'. Many readers will flip between sections of the full report. [Brian Menounos, Canada]	Remind reader what you are referring to as 'regions'. Many readers will flip between sections of the full report.
20160	72	36	72	46	Is all this information from Marzeion et al. 2012? Otherwise, please provide reference(s) [Gwenaelle GREMION, Canada]	Is all this information from Marzeion et al. 2012? Otherwise, please provide reference(s)
50594	72	36	72	52	I do not understand the connection of glacier volume change and sea level contribution to response times. When glaciers melt, they contribute to run-off and sl independent of their response times. This is an immediate (undelayed) response that only depends on the energy balance. Also the commited loss does IMO not depend on response times. I would expect such a comparison only when comparing length changes across glaciers (here response times matter). Maybe I misunderstand what has been written here, but otherwise I suggest to correct all text that relates response times to glacier melt. [Frank Paul, Switzerland]	I do not understand the connection of glacier volume change and sea level contribution to response times. When glaciers melt, they contribute to run-off and sl independent of their response times. This is an immediate (undelayed) response that only depends on the energy balance. Also the commited loss does IMO not depend on response times. I would expect such a comparison only when comparing length changes across glaciers (here response times matter). Maybe I misunderstand what has been written here, but otherwise I suggest to correct all text that relates response times to glacier melt.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
26722	72	37	72	38	I am surprized with the response time mentioned for tropical glaciers. These glaciers are mostly of small size (few km²) and because of the huge mass balance gradient in the lower reaches of the glacier tongues, these are know to react very fastly (by a change in geometry) to surface mass balance changes. Even so-called "annual moraines" resulting from small advances during the dry season can be seen on plenty of glacier forelands. See: - Malecki, J., H. Lovell, W. Ewertowski, ... , A. Warczachowska, A. Rabatel. 2018. The glacial landsystem of a tropical glacier: Charquini Sur, Bolivian Andes. Earth Surface Processes and Landforms, 43 (12), 2584-2602. doi: 10.1002/esp.4417 - Rabatel, A., B. Francou, A. Soruco, J. Gomez, B. Caceres, J.L. Ceballos, R. Basantes, M. Vuille, J.E. Sicart, C. Huggel, M. Scheel, Y. Lejeune, Y. Arnaud, M. Collet, T. Condom, G. Consoli, V. Favier, V. Jomelli, R. Galarraga, P. Ginot, L. Maisincho, M. Ménégoz, J. Mendoza, E. Ramirez, P. Ribstein, W. Suarez, M. Villacis, P. Wagnon. 2013. Current state of glaciers in the tropical Andes: a multi-century perspective on glacier evolution and climate change. The Cryosphere, 7, 81-102. doi: 10.5194/tc-7-81-2013. [Antoine Rabatel, France]	I am surprized with the response time mentioned for tropical glaciers. These glaciers are mostly of small size (few km²) and because of the huge mass balance gradient in the lower reaches of the glacier tongues, these are know to react very fastly (by a change in geometry) to surface mass balance changes. Even so-called "annual moraines" resulting from small advances during the dry season can be seen on plenty of glacier forelands. See: - Malecki, J., H. Lovell, W. Ewertowski, ... , A. Warczachowska, A. Rabatel. 2018. The glacial landsystem of a tropical glacier: Charquini Sur, Bolivian Andes. Earth Surface Processes and Landforms, 43 (12), 2584-2602. doi: 10.1002/esp.4417 - Rabatel, A., B. Francou, A. Soruco, J. Gomez, B. Caceres, J.L. Ceballos, R. Basantes, M. Vuille, J.E. Sicart, C. Huggel, M. Scheel, Y. Lejeune, Y. Arnaud, M. Collet, T. Condom, G. Consoli, V. Favier, V. Jomelli, R. Galarraga, P. Ginot, L. Maisincho, M. Ménégoz, J. Mendoza, E. Ramirez, P. Ribstein, W. Suarez, M. Villacis, P. Wagnon. 2013. Current state of glaciers in the tropical Andes: a multi-century perspective on glacier evolution and climate change. The Cryosphere, 7, 81-102. doi: 10.5194/tc-7-81-2013.
51534	72	37	72	42	while categorizing the 19 regions based on glacier response time, the region with response time less tha 150 years is categorised in region of glaciers with short time scale (line 37) while the response time for glaciers in second category is starting ranging between 50-250 years (line 40). Is it a typo ? or does the range has a specific reason? [Sathiyaseelan Rengaraju, India]	while categorizing the 19 regions based on glacier response time, the region with response time less tha 150 years is categorised in region of glaciers with short time scale (line 37) while the response time for glaciers in second category is starting ranging between 50-250 years (line 40). Is it a typo ? or does the range has a specific reason?
15812	72	39	72	44	%'s mentioned for fraction of total glacier mass (e.g. in line 44: 'these sum up to 66,5% of...'): what are the uncertainties on these numbers? And based on which study? Best to be using the new consensus estimate by Farinotti et al. (2019, Nature Geoscience, doi: 10.1038/s41561-019-0300-3) for this [Harry Zekollari, Belgium]	%'s mentioned for fraction of total glacier mass (e.g. in line 44: 'these sum up to 66,5% of...'): what are the uncertainties on these numbers? And based on which study? Best to be using the new consensus estimate by Farinotti et al. (2019, Nature Geoscience, doi: ?10.1038/s41561-019-0300-3) for this
26724	72	42	72	43	Reformulation needed for iii) [Antoine Rabatel, France]	Reformulation needed for iii)

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
28014	72	44	72	46	Page 72, line 44-46: Why is the range of response time for the majority of ice stored in glaciers 50-800 years? In the text above the longest response time mentioned is 450 years. The 800 years is again mentioned on page 74 (line 45). [roderik van de wal, Netherlands]	Page 72, line 44-46: Why is the range of response time for the majority of ice stored in glaciers 50-800 years? In the text above the longest response time mentioned is 450 years. The 800 years is again mentioned on page 74 (line 45).
20162	72	46	72	47	« […] but their total volume is small. » Do we have real numbers (reference(s)) to back that statement? [Gwenaelle GREMION, Canada]	« […] but their total volume is small. » Do we have real numbers (reference(s)) to back that statement?
26044	72	47	72	48	I propose: “Due to the rapid changes taking place in earth’s climate, glaciers are currently out of balance and, as AR5 stated, is it very likely ...” [Marius Schaefer, Chile]	I propose: “Due to the rapid changes taking place in earth’s climate, glaciers are currently out of balance and, as AR5 stated, is it very likely ...”
15814	72	47	72	48	out of balance with the ongoing climate change': of course, a given state (glacier state) cannot be in equilibrium with a change (climate change). Would it not make more sense to say that 'glaciers are currently out of balance with the current climate [/current climatic conditions]'? [Harry Zekollari, Belgium]	out of balance with the ongoing climate change': of course, a given state (glacier state) cannot be in equilibrium with a change (climate change). Would it not make more sense to say that 'glaciers are currently out of balance with the current climate [/current climatic conditions]'?
20170	72	47	72	49	Saying that the glaciers are "out of balance with the ongoing climate change" is confusing. It would be clearer to say that the response of the glaciers lags behind climate change. [Gwenaelle GREMION, Canada]	Saying that the glaciers are "out of balance with the ongoing climate change" is confusing. It would be clearer to say that the response of the glaciers lags behind climate change.
46612	72	48	72	49	Following the IPCC uncertainty guidance, a likelihood should only be provided if confidence is high or very high. [WGI TSU, France]	Following the IPCC uncertainty guidance, a likelihood should only be provided if confidence is high or very high.
15816	72	48	72	49	committed volume change': indeed. This is supported both by global studies which rely on various simplifications and parameterizations to model the temporal evolution of glaciers (e.g. Marzeion et al., 2018, Nature Climate Change, doi: 10.1038/s41558-018-0093-1). But also appears from detailed high-order modelling studies of individual glaciers (e.g. Jouvet et al., 2011, Journal of Glaciology, doi: 10.3189/002214311798843359; Zekollari and Huybrechts, 2015, Annals of Glaciology, doi: 10.3189/2015AoG70A921) and from theoretical perspectives (e.g. Christian et al., 2018, Journal of Glaciology, doi: 10.1017/jog.2018.57) [Harry Zekollari, Belgium]	committed volume change': indeed. This is supported both by global studies which rely on various simplifications and parameterizations to model the temporal evolution of glaciers (e.g. Marzeion et al., 2018, Nature Climate Change, doi: ?10.1038/s41558-018-0093-1). But also appears from detailed high-order modelling studies of individual glaciers (e.g. Jouvet et al., 2011, Journal of Glaciology, doi: ?10.3189/002214311798843359; Zekollari and Huybrechts, 2015, Annals of Glaciology, doi: ?10.3189/2015AoG70A921) and from theoretical perspectives (e.g. Christian et al., 2018, Journal of Glaciology, doi: ?10.1017/jog.2018.57)
15696	72	48			Observational estimates of committed area and volume losses are available from: Mernild et al (2013, The Cryosphere), Zemp et al. (2015, J. Glaciol.). For refs see above. [Michael Zemp, Switzerland]	Observational estimates of committed area and volume losses are available from: Mernild et al (2013, The Cryosphere), Zemp et al. (2015, J. Glaciol.). For refs see above.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
26726	72	49	72	52	These two sentences and particularly the last one are not clear enough. Reformulation is needed. In addition, the 37 cm of potential SLR related to the ice stored into mountain glaciers is an estimate based on current knowledge of ice thickness distribution. However, it is known that huge uncertainty still exist regarding estimation of ice thickness distribution, therefore, this value could be largely underestimated. [Antoine Rabatel, France]	These two sentences and particularly the last one are not clear enough. Reformulation is needed. In addition, the 37 cm of potential SLR related to the ice stored into mountain glaciers is an estimate based on current knowledge of ice thickness distribution. However, it is known that huge uncertainty still exist regarding estimation of ice thickness distribution, therefore, this value could be largely underestimated.
15820	72	50	72	50	constrained by the total glacier inventory' --> Not sure a volume can be constrained by a total inventory. Probably 'constrained by the total glacier volume' (potentially making the link to an inventory in the second part of this sentence) [Harry Zekollari, Belgium]	constrained by the total glacier inventory' --> Not sure a volume can be constrained by a total inventory. Probably 'constrained by the total glacier volume' (potentially making the link to an inventory in the second part of this sentence)
15818	72	50	72	51	37 cm potential sea-level rise (Clark et al., 2016). Probably better to refer to the new numbers by Farinotti et al. (2019, Nature Geoscience, doi: 10.1038/s41561-019-0300-3) here instead (32+-8cm), being consistent with the rest of the text [Harry Zekollari, Belgium]	37 cm potential sea-level rise (Clark et al., 2016). Probably better to refer to the new numbers by Farinotti et al. (2019, Nature Geoscience, doi: 10.1038/s41561-019-0300-3) here instead (32+-8cm), being consistent with the rest of the text
26046	72	51	72	51	“declining to 1cm/°C” this is a huge change from 8 cm/°C. Try to explain it! [Marius Schaefer, Chile]	“declining to 1cm/°C” this is a huge change from 8 cm/°C. Try to explain it!
20172	72	51	72	52	This sentence would be clearer if it stated that the decline above 3 degrees C is not due to lower rates of glacier loss, but rather to the fact that glacier mass has declined and there are simply less glaciers present to contribute to sea level rise. [Gwenaelle GREMION, Canada]	This sentence would be clearer if it stated that the decline above 3 degrees C is not due to lower rates of glacier loss, but rather to the fact that glacier mass has declined and there are simply less glaciers present to contribute to sea level rise.
15822	72	51	72	52	Ok to refer to the study of Clark et al. (2016) here. But would suggest also referring to the numbers that can be derived from Marzeion et al. (2018, Nature Climate Change, doi: 10.1038/s41558-018-0093-1) [Harry Zekollari, Belgium]	Ok to refer to the study of Clark et al. (2016) here. But would suggest also referring to the numbers that can be derived from Marzeion et al. (2018, Nature Climate Change, doi: ?10.1038/s41558-018-0093-1)

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
20164	72	52	72	52	Are the meltwater storage/refreezing included in these sea-level rise estimations? [please check references below] Pfeffer, W. T., Meier, M. F., & Illangasekare, T. H. (1991). Retention of Greenland runoff by refreezing: implications for projected future sea level change. Journal of Geophysical Research: Oceans, 96(C12), 22117-22124. Harper, J., Humphrey, N., Pfeffer, W. T., Brown, J., & Fettweis, X. (2012). Greenland ice-sheet contribution to sea-level rise buffered by meltwater storage in firn. Nature, 491(7423), 240. Forster, R. R., Box, J. E., Van Den Broeke, M. R., Miège, C., Burgess, E. W., Van Angelen, J. H., ... & Gogineni, S. P. (2014). Extensive liquid meltwater storage in firn within the Greenland ice sheet. Nature Geoscience, 7(2), 95. [Gwenaelle GREMION, Canada]	Are the meltwater storage/refreezing included in these sea-level rise estimations? [please check references below] Pfeffer, W. T., Meier, M. F., & Illangasekare, T. H. (1991). Retention of Greenland runoff by refreezing: implications for projected future sea level change. Journal of Geophysical Research: Oceans, 96(C12), 22117-22124. Harper, J., Humphrey, N., Pfeffer, W. T., Brown, J., & Fettweis, X. (2012). Greenland ice-sheet contribution to sea-level rise buffered by meltwater storage in firn. Nature, 491(7423), 240. Forster, R. R., Box, J. E., Van Den Broeke, M. R., Miège, C., Burgess, E. W., Van Angelen, J. H., ... & Gogineni, S. P. (2014). Extensive liquid meltwater storage in firn within the Greenland ice sheet. Nature Geoscience, 7(2), 95.
50596	73	1	73	1	I agree that there is an impact of response times on length changes, but I do not see the link to mass changes (see above). [Frank Paul, Switzerland]	I agree that there is an impact of response times on length changes, but I do not see the link to mass changes (see above).
26048	73	1	73	4	Eliminate “By” , “.. anthropogenic forcing shows ...” [Marius Schaefer, Chile]	Eliminate “By” , “.. anthropogenic forcing shows ...”
20180	73	4	73	4	Do I understand well, here, that the error (35%) is greater than the actual value (25%)? If yes, this does not seem particularly robust. Maybe use the ranges instead? (i.e. 0-60% for the 1851-2010 period and 45-93% for the 1991-2010 period) [Gwenaelle GREMION, Canada]	Do I understand well, here, that the error (35%) is greater than the actual value (25%)? If yes, this does not seem particularly robust. Maybe use the ranges instead? (i.e. 0-60% for the 1851-2010 period and 45-93% for the 1991-2010 period)
20182	73	4	73	6	The information in this sentence does not seem to originate from the work by Slangen et al. 2016 but from Marzeion et al. 2014. [Gwenaelle GREMION, Canada]	The information in this sentence does not seem to originate from the work by Slangen et al. 2016 but from Marzeion et al. 2014.
52518	73	6	73	7	Would be useful to state here what the relative contributions of the natural forcing factors are (e.g. solar forcing vs. volcanic) to the 1851-2010 are - simply recovery from the little ice age? [John Brian Robin Matthews, France]	Would be useful to state here what the relative contributions of the natural forcing factors are (e.g. solar forcing vs. volcanic) to the 1851-2010 are - simply recovery from the little ice age?
20200	73	7	73	7	Saying that the glacier mass balance would have been negative is a bit confusing, It would be clearer to say that the glaciers would have shrunk. [Gwenaelle GREMION, Canada]	Saying that the glacier mass balance would have been negative is a bit confusing, It would be clearer to say that the glaciers would have shrunk.
15824	73	12	73	14	Roe et al. (2016)' --> this is 'Roe et al. (2017)' [Harry Zekollari, Belgium]	Roe et al. (2016)' --> this is 'Roe et al. (2017)'
50598	73	14	73	14	Roe et al. 2016: This has already been shown by Oerlemans 2000 and Reichert et al. (2002). Maybe add ciations (doi.org/10.3189/172756400781820246 and J. Climate Vol. 15(21), P3069). Maybe add these here. [Frank Paul, Switzerland]	Roe et al. 2016: This has already been shown by Oerlemans 2000 and Reichert et al. (2002). Maybe add ciations (doi.org/10.3189/172756400781820246 and J. Climate Vol. 15(21), P3069). Maybe add these here.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
42560	73	15	73	16	I don't think that any of the references cited here suggest length scale change during the early 20th century can be unequivocally attributed to humans. Late 20th century yes. Is this what authors meant? [Brian Menounos, Canada]	I don't think that any of the references cited here suggest length scale change during the early 20th century can be unequivocally attributed to humans. Late 20th century yes. Is this what authors meant?
48540	73	15	73	16	I still don't have a handle on the likelihood and confidence statements, but this stikes me as a place where a confidence statement may be more appropriate (unless a probability range has been quantified for this): "Altogether, there is high confidence that anthropogenic climate change is required to explain the unprecedented global glacier retreats". Perhaps scan chapter for more instances of this. [Kyle Armour, United States of America]	I still don't have a handle on the likelihood and confidence statements, but this stikes me as a place where a confidence statement may be more appropriate (unless a probability range has been quantified for this): "Altogether, there is high confidence that anthropogenic climate change is required to explain the unprecedented global glacier retreats". Perhaps scan chapter for more instances of this.
15826	73	19	73	19	Should keep in mind that this section will probably have to be strongly revised when the results from GlacierMIP Phase II become available [Harry Zekollari, Belgium]	Should keep in mind that this section will probably have to be strongly revised when the results from GlacierMIP Phase II become available
50600	73	21	73	21	I suggest writing '… is substantial in all regions with glaciers and ...' [Frank Paul, Switzerland]	I suggest writing '… is substantial in all regions with glaciers and ...'
25366	73	21	73	22	Same regions as table table 9.4 and Fig 9.27? [Sharon Smith, Canada]	Same regions as table table 9.4 and Fig 9.27?
15698	73	21			You may start this chapter with a statement about current observational change rates and limited survival time of glaciers in many regions (cf. Zemp et al. 2019, Nature, EDFig 3). [Michael Zemp, Switzerland]	You may start this chapter with a statement about current observational change rates and limited survival time of glaciers in many regions (cf. Zemp et al. 2019, Nature, EDFig 3).
50602	73	22	73	22	I suggest rewriting the comment in brackets as I think this has little to do with glacier response times. In particular, I think it is actually vice versa: Of course, in regions with large glaciers (where the ice is thick) it might take much longer to melt the ice, but most of the mass contributing to sea level will come from the large glaciers with flat, low lying and simply down-wasting tongues. Speaking about typical valley and mountain glaciers in mid-latitudes (i.e. not ice caps) the majority of the mass loss will thus come from glaciers with *long* response times. [Frank Paul, Switzerland]	I suggest rewriting the comment in brackets as I think this has little to do with glacier response times. In particular, I think it is actually vice versa: Of course, in regions with large glaciers (where the ice is thick) it might take much longer to melt the ice, but most of the mass contributing to sea level will come from the large glaciers with flat, low lying and simply down-wasting tongues. Speaking about typical valley and mountain glaciers in mid-latitudes (i.e. not ice caps) the majority of the mass loss will thus come from glaciers with *long* response times.
20202	73	22	73	22	It says on this line "…all models agree that a few regions will lose most…" I believe that the few regions are those where a majority of the glaciers have a short response time. If this is correct, I think it would be better to state this plainly. [Gwenaelle GREMION, Canada]	It says on this line "…all models agree that a few regions will lose most…" I believe that the few regions are those where a majority of the glaciers have a short response time. If this is correct, I think it would be better to state this plainly.
26050	73	26	73	26	" as the spread in projected climate from GCMs is also large. " indicate citation! [Marius Schaefer, Chile]	" as the spread in projected climate from GCMs is also large. " indicate citation!

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
15828	73	26	73	26	forcing models' --> I guess this refers to the climate models here and not the glacier models? Maybe better to be more specific: e.g. 'forcing climate models' [Harry Zekollari, Belgium]	forcing models' --> I guess this refers to the climate models here and not the glacier models? Maybe better to be more specific: e.g. 'forcing climate models'
20174	73	26	73	34	Graphical representation of the projected values for each scenario would be appropriate for improved clarity. [Gwenaelle GREMION, Canada]	Graphical representation of the projected values for each scenario would be appropriate for improved clarity.
26052	73	28	73	31	why do the limits of the uncertainty ranges have uncertainties? Please indicate the posible range of results as value +/- uncertainty, where this uncertainty value comprimses all the uncertainties. Of course you can go further into detail and discuss which specific uncertainty is the main contributor to this overall uncertainty. Where do these values come from? The alues presented in Hock2019 are different! Update! [Marius Schaefer, Chile]	why do the limits of the uncertainty ranges have uncertainties? Please indicate the posible range of results as value +/- uncertainty, where this uncertainty value comprimses all the uncertainties. Of course you can go further into detail and discuss which specific uncertainty is the main contributor to this overall uncertainty. Where do these values come from? The alues presented in Hock2019 are different! Update!
15830	73	28	73	33	Total and relative numbers mentioned here: quite confusing, because these are the numbers from the individual studies most likely, in which the total volume differs. Therefore not consistent with a given total volume (e.g. the one from Farinotti et al., 2019, Nature Geoscience, doi: 10.1038/s41561-019-0300-3). Maybe better to just give the relative changes for every region, and not the total numbers here to avoid confusion? [Harry Zekollari, Belgium]	Total and relative numbers mentioned here: quite confusing, because these are the numbers from the individual studies most likely, in which the total volume differs. Therefore not consistent with a given total volume (e.g. the one from Farinotti et al., 2019, Nature Geoscience, doi: 10.1038/s41561-019-0300-3). Maybe better to just give the relative changes for every region, and not the total numbers here to avoid confusion?
26054	73	32	73	32	explain “high-end scenarios” and explain “JULES” [Marius Schaefer, Chile]	explain “high-end scenarios” and explain “JULES”
26056	73	33	73	33	what do you mean with upper bound? Why is this important ? Values +/- uncertainty should be enough infomration? [Marius Schaefer, Chile]	what do you mean with upper bound? Why is this important ? Values +/- uncertainty should be enough infomration?
26058	73	33	73	33	The results presented in Shannon et al. 2019 are VERY VERY different from the numbers you present for RCP 8.5 in Table 9.4! Any ideas why? [Marius Schaefer, Chile]	The results presented in Shannon et al. 2019 are VERY VERY different from the numbers you present for RCP 8.5 in Table 9.4! Any ideas why?
46614	73	36	73	36	"(66% of total)" - for what scenario and time period? [WGI TSU, France]	"(66% of total)" - for what scenario and time period?
15832	73	36	73	36	66% of total'. Under which RCP is this? The relative contribution will likely depend on the forcing [Harry Zekollari, Belgium]	66% of total'. Under which RCP is this? The relative contribution will likely depend on the forcing
20184	73	36	73	38	Please add a reference here and maybe, inverting the order of the first two sentences would facilitate comprehension. [Gwenaelle GREMION, Canada]	Please add a reference here and maybe, inverting the order of the first two sentences would facilitate comprehension.
50604	73	37	73	38	See comment before, I would just remove the response time thing. I see no relation of glacier response times with their melt contribution (or its timing). [Frank Paul, Switzerland]	See comment before, I would just remove the response time thing. I see no relation of glacier response times with their melt contribution (or its timing).
20186	73	38	73	39	Please add a reference here [Gwenaelle GREMION, Canada]	Please add a reference here
20176	73	40	73	41	RCPS? RCPs. [Gwenaelle GREMION, Canada]	RCPS? RCPs.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
20188	73	41	73	44	First you say that the rates range from 0.7 to 3.2 mm/yr, then you say that the maximum rate is 3.3 mm/yr. This does not really make sense to me, but maybe I got the sentences wrong [Gwenaelle GREMION, Canada]	First you say that the rates range from 0.7 to 3.2 mm/yr, then you say that the maximum rate is 3.3 mm/yr. This does not really make sense to me, but maybe I got the sentences wrong
20190	73	44	73	47	I think the second sentence "Rates at the end of the 21st century are lower than 2015 rates" could be omitted - this is already clear from the first sentence "In projections under RCP2.6, mass loss rates…".Also, I do not think there should be a line break at this point. [Gwenaelle GREMION, Canada]	I think the second sentence "Rates at the end of the 21st century are lower than 2015 rates" could be omitted - this is already clear from the first sentence "In projections under RCP2.6, mass loss rates…".Also, I do not think there should be a line break at this point.
20204	73	45	73	45	The end of the sentence should specify that the steady decline thereafter will be due to the decrease in total glacier mass that is available to be lost (not a true decline in the rate of loss). [Gwenaelle GREMION, Canada]	The end of the sentence should specify that the steady decline thereafter will be due to the decrease in total glacier mass that is available to be lost (not a true decline in the rate of loss).
20192	73	47	71	47	Need to be clear what rate you are referring to. Suggest: "Rates of mass loss…" [Gwenaelle GREMION, Canada]	Need to be clear what rate you are referring to. Suggest: "Rates of mass loss…"
42562	73	47	73	47	Rates of what? Mass I presume. Also revise statement to 'rates of mass loss in 2015' . [Brian Menounos, Canada]	Rates of what? Mass I presume. Also revise statement to 'rates of mass loss in 2015' .
20178	73	47	73	47	The sentence is confusing: "Rates at the end of the 21st century are lower than 2015 rates." [Gwenaelle GREMION, Canada]	The sentence is confusing: "Rates at the end of the 21st century are lower than 2015 rates."
15834	73	47	73	47	Rates at the end of the 21st century are…' --> to what do these 'rates' refer? [Harry Zekollari, Belgium]	Rates at the end of the 21st century are…' --> to what do these 'rates' refer?
52424	73	47	74	4	Consider including also the recent results of Zekollari et al. (2019) Modelling the future evolution of glaciers in the European Alps under the EURO-CORDEX RCM ensemble, The Cryosphere, 13, 1125-1146. [Charalampos Charalampidis, Germany]	Consider including also the recent results of Zekollari et al. (2019) Modelling the future evolution of glaciers in the European Alps under the EURO-CORDEX RCM ensemble, The Cryosphere, 13, 1125-1146.
26728	73	47			In the first sentence of the paragraph: "Rate" of what? [Antoine Rabatel, France]	In the first sentence of the paragraph: "Rate" of what?
20194	73	49	73	52	You already gave most of this information on page 9-73, lines 38-39, though in less detail. Possibly just provide it once in order to be more concise. [Gwenaelle GREMION, Canada]	You already gave most of this information on page 9-73, lines 38-39, though in less detail. Possibly just provide it once in order to be more concise.
20196	73	49	73	52	From Figure 9.28 I would rather say they have high declining rates compared to the other regions [Gwenaelle GREMION, Canada]	From Figure 9.28 I would rather say they have high declining rates compared to the other regions
20198	73	52	74	2	All this information is a repetition except for the confidence metrics. The information that regions with a lot of small glaciers will lose most of their glacier mass by the end of this century is even repeated for the third time in the same section. I think you could rephrase the entire section 9.5.2.5 in order to provide each information just once to increase readability and conciseness [Gwenaelle GREMION, Canada]	All this information is a repetition except for the confidence metrics. The information that regions with a lot of small glaciers will lose most of their glacier mass by the end of this century is even repeated for the third time in the same section. I think you could rephrase the entire section 9.5.2.5 in order to provide each information just once to increase readability and conciseness

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
50606	73	55	73	55	more slowly unfolding contribution to future slr': I think this is not correct. First, it has nothing to do with the (longer) response times of these glaciers, it is just colder in these regions (so it will take some time before the big melting starts). Second, the hypsometry of the glaciers (often ice caps and ice fields) is rather different from mid-latitude glaciers. Once the ELA rises above a certain elevation, the *entire* area of an ice cap (and also ice field) will melt and contribute suddenly very large amounts of water to sea level. This is not a 'slowly unfloding' process, it is rapid and massive (see Greenland Ice Sheet sl contribution in 2012). [Frank Paul, Switzerland]	more slowly unfolding contribution to future slr': I think this is not correct. First, it has nothing to do with the (longer) response times of these glaciers, it is just colder in these regions (so it will take some time before the big melting starts). Second, the hypsometry of the glaciers (often ice caps and ice fields) is rather different from mid-latitude glaciers. Once the ELA rises above a certain elevation, the *entire* area of an ice cap (and also ice field) will melt and contribute suddenly very large amounts of water to sea level. This is not a 'slowly unfloding' process, it is rapid and massive (see Greenland Ice Sheet sl contribution in 2012).
50608	74	1	74	1	I would not use glacier size as a measure for the timing of the sl contribution. I am aware this is tempting, but likely too generalized. Glacier sizes in a mountain range often span 5 to 6 orders of magnitude, glaciers have very different hypsometries (bottom-heavy, top-heavy) and very different ice thickness distributions. The latter two govern where the melt comes from, when, how much, and for how long. [Frank Paul, Switzerland]	I would not use glacier size as a measure for the timing of the sl contribution. I am aware this is tempting, but likely too generalized. Glacier sizes in a mountain range often span 5 to 6 orders of magnitude, glaciers have very different hypsometries (bottom-heavy, top-heavy) and very different ice thickness distributions. The latter two govern where the melt comes from, when, how much, and for how long.
15840	74	2	74	2	New studies on GLOFs that could be included: Veh et al. (2019, Nature Climate Change, doi: 10.1038/s41558-019-0437-5) [Harry Zekollari, Belgium]	New studies on GLOFs that could be included: Veh et al. (2019, Nature Climate Change, doi: ?10.1038/s41558-019-0437-5)
42564	74	4	74	4	Vague: What is meant by 'more limited picture' - Spatially limited? What is meant by more detailed? Sentence needs to be revised to include specifics. [Brian Menounos, Canada]	Vague: What is meant by 'more limited picture' - Spatially limited? What is meant by more detailed? Sentence needs to be revised to include specifics.
25368	74	8	74	8	Could you just say that "glacial meltwater runoff varies greatly regionally"? [Sharon Smith, Canada]	Could you just say that "glacial meltwater runoff varies greatly regionally"?
50610	74	8	74	8	This is maybe more a matter of personal taste, but I would name them RGI regions rather than GTN-G regions. The latter is not wrong but the former I name is maybe more familiar. [Frank Paul, Switzerland]	This is maybe more a matter of personal taste, but I would name them RGI regions rather than GTN-G regions. The latter is not wrong but the former I name is maybe more familiar.
42566	74	8	74	15	Section should cross reference previous chapter that deals with changes in glacier runoff. Also, one of these chapters needs to illustrate (in an informative box) aspects of glaciers that are expected to change (e.g. runoff), the partioning of glacier runoff ino glacier wastage and normal ice melt (even if glacier was in climatic equilibrium), and elements/processes that are most uncertain for any projection work. [Brian Menounos, Canada]	Section should cross reference previous chapter that deals with changes in glacier runoff. Also, one of these chapters needs to illustrate (in an informative box) aspects of glaciers that are expected to change (e.g. runoff), the partioning of glacier runoff ino glacier wastage and normal ice melt (even if glacier was in climatic equilibrium), and elements/processes that are most uncertain for any projection work.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
51536	74	8	74	15	more studies from the latest literature can be added for glacier runoff rates over HinduKushHimalayas e.g. The HinduKushHimalaya assessment 2019 (Bolch et al., 2019) [Sathiyaseelan Rengaraju, India]	more studies from the latest literature can be added for glacier runoff rates over HinduKushHimalayas e.g. The HinduKushHimalaya assessment 2019 (Bolch et al., 2019)
20206	74	9	74	13	First you make the general statement that the runoff increases up to a maximum (peak water) followed by a decline. But Huss and Hock 2018 only found this behaviour for half of the studied basins (for the other basins this tipping point has already been passed). In the following you state that the basins in Central Asia and Southeast Asia show large decreases over the 21st century while the basins in Southwest Asia do not show strong changes. It is not clear to me why you highlight Asia but omit the other regions. In order to address the high variability mentionend on page 9-74 line 8 in total, I would remove the general (and misleading) statement of runoff increase on lines 9 - 10 and clearly indicate in which regions of the world there is an increase, decrease and no change according to the cited publications. [Gwenaelle GREMION, Canada]	First you make the general statement that the runoff increases up to a maximum (peak water) followed by a decline. But Huss and Hock 2018 only found this behaviour for half of the studied basins (for the other basins this tipping point has already been passed). In the following you state that the basins in Central Asia and Southeast Asia show large decreases over the 21st century while the basins in Southwest Asia do not show strong changes. It is not clear to me why you highlight Asia but omit the other regions. In order to address the high variability mentionend on page 9-74 line 8 in total, I would remove the general (and misleading) statement of runoff increase on lines 9 - 10 and clearly indicate in which regions of the world there is an increase, decrease and no change according to the cited publications.
15836	74	9	74	15	Part on runoff. For this, also consider including the new study by Pritchard (2019, Nature, doi: 10.1038/s41586-019-1240-1) [Harry Zekollari, Belgium]	Part on runoff. For this, also consider including the new study by Pritchard (2019, Nature, doi: ?10.1038/s41586-019-1240-1)
20208	74	12	74	12	Where is the information from that basins in Central Asia and Southeast Asia show large decreases in annual glacier runoff over the 21st century? [Gwenaelle GREMION, Canada]	Where is the information from that basins in Central Asia and Southeast Asia show large decreases in annual glacier runoff over the 21st century?
26730	74	31	75	18	I don't really see the interest of sub-sections 9.5.2.6. and 9.5.2.7. These sub-sections illustrate very specific cases, and do we really learn from this? That we have insufficient knowlegde about many glaciological processes. Ok, but many other things could be mentioned in that sense. [Antoine Rabatel, France]	I don't really see the interest of sub-sections 9.5.2.6. and 9.5.2.7. These sub-sections illustrate very specific cases, and do we really learn from this? That we have insufficient knowlegde about many glaciological processes. Ok, but many other things could be mentioned in that sense.
25370	74	33	74	38	Background? Some of this covered earlier? [Sharon Smith, Canada]	Background? Some of this covered earlier?
30146	74	33	74	47	there is no logical link between the first part of the paragraph (about surging glaciers) and the second part (irreversibility) : cut into two sepated paragraphs at line 43 [patrick Wagnon, France]	there is no logical link between the first part of the paragraph (about surging glaciers) and the second part (irreversibility) : cut into two sepated paragraphs at line 43

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
15838	74	33	74	55	For the 'critical thresholds' one that I was expecting to be described here is the 'surface mass balance - elevation' (/'surface mass balance - height') feedback, which can play an important role in the evolution of ice caps (e.g. Giesen and Oerlemans, 2010, The Cryosphere, doi: 10.5194/tc-4-191-2010; Gilbert et al., 2016, Journal of Geophysical Research: Earth Surface, doi 10.1002/2014JF003839; Akesson et al., 2017, The Cryosphere, doi: 10.5194/tc-11-281-2017; Zekollari et al., 2017, The Cryosphere, doi: 10.5194/tc-11-805-2017) and cause fast collapses of these ice bodies once certain threshold values/elevation are crossed [Harry Zekollari, Belgium]	For the 'critical thresholds' one that I was expecting to be described here is the 'surface mass balance - elevation' (/'surface mass balance - height') feedback, which can play an important role in the evolution of ice caps (e.g. Giesen and Oerlemans, 2010, The Cryosphere, doi: ?10.5194/tc-4-191-2010; Gilbert et al., 2016, Journal of Geophysical Research: Earth Surface, doi ?10.1002/2014JF003839; Akesson et al., 2017, The Cryosphere, doi: ?10.5194/tc-11-281-2017; Zekollari et al., 2017, The Cryosphere, doi: ?10.5194/tc-11-805-2017) and cause fast collapses of these ice bodies once certain threshold values/elevation are crossed
20210	74	36	74	38	Unless I overlooked it, I could not find this information in Sevestre and Benn 2015. They found that generally surge-type glaciers have larger areas and are longer than normal glaciers. Furthermore, surge-type glaciers seem to be more complex (more branches) and tend to have lower slopes... [Gwenaelle GREMION, Canada]	Unless I overlooked it, I could not find this information in Sevestre and Benn 2015. They found that generally surge-type glaciers have larger areas and are longer than normal glaciers. Furthermore, surge-type glaciers seem to be more complex (more branches) and tend to have lower slopes...
25372	74	38	74	39	Suggest you join sentences together: Although surge initiation is not related to climate, its frequency can be modulated… [Sharon Smith, Canada]	Suggest you join sentences together: Although surge initiation is not related to climate, its frequency can be modulated…
20212	74	38	74	39	I did see that Eisen et al. 2001 found that the lenght of the surge interval is determined by the average local annual balance. Kienholz et al. 2017 cite Eisen et al. 2001 (and others), stating that "Workers on surge-type glaciers in the Alaska-Yukon region found that climate change prolonged surge recurrence intervals and/or attenuated surge magnitudes". In the work of Kienholz et al. 2017 I did not find a statement on the frequency of surges being related to change of glacier size. [Gwenaelle GREMION, Canada]	I did see that Eisen et al. 2001 found that the lenght of the surge interval is determined by the average local annual balance. Kienholz et al. 2017 cite Eisen et al. 2001 (and others), stating that "Workers on surge-type glaciers in the Alaska-Yukon region found that climate change prolonged surge recurrence intervals and/or attenuated surge magnitudes". In the work of Kienholz et al. 2017 I did not find a statement on the frequency of surges being related to change of glacier size.
39222	74	38	74	43	The text "… the frequency of surges can be modulated by reduction or growth in the glacier size .." is unclear and needs to be rephrased to make it clear to readers what effect a reduction in glacier size will have on the frequency of surges. I am not aware that a robust quantitative assessment of this coupling has been established, so it may be best to delete this sentence. [Jacob Yde, Norway]	The text "… the frequency of surges can be modulated by reduction or growth in the glacier size .." is unclear and needs to be rephrased to make it clear to readers what effect a reduction in glacier size will have on the frequency of surges. I am not aware that a robust quantitative assessment of this coupling has been established, so it may be best to delete this sentence.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
39224	74	39	74	43	This sentence should be deleted. This paragraph focuses on global aspects, so why include a cherry-picking and irrelevant statement about limited information on tidewater glacier surges in Svalbard and Russian Arctic. This is not a significant finding worthy of inclusion in an IPCC report. Also, the statement about "acceleration of surge behavior" should include a time-frame (e.g. decadal) and should be supported by a reference to a quantitative study. Could the same statement be used for "deceleration of surge behavior" of terrestrial terminating glaciers in other regions? If so, the statement is likely irrelevant. Also, Dunse et al. (2015) do not mention anything about acceleration of surge behavior in Svalbard, so this reference should be deleted. It is worth checking whether the references actually support this statement. [Jacob Yde, Norway]	This sentence should be deleted. This paragraph focuses on global aspects, so why include a cherry-picking and irrelevant statement about limited information on tidewater glacier surges in Svalbard and Russian Arctic. This is not a significant finding worthy of inclusion in an IPCC report. Also, the statement about "acceleration of surge behavior" should include a time-frame (e.g. decadal) and should be supported by a reference to a quantitative study. Could the same statement be used for "deceleration of surge behavior" of terrestrial terminating glaciers in other regions? If so, the statement is likely irrelevant. Also, Dunse et al. (2015) do not mention anything about acceleration of surge behavior in Svalbard, so this reference should be deleted. It is worth checking whether the references actually support this statement.
50612	74	40	74	40	I suggest writing 'increased' istead of 'acceleration of'. [Frank Paul, Switzerland]	I suggest writing 'increased' istead of 'acceleration of'.
39226	74	43	74	43	The text suddenly jumps from surging glaciers to small glacier loss. The text needs to be better structured here. [Jacob Yde, Norway]	The text suddenly jumps from surging glaciers to small glacier loss. The text needs to be better structured here.
50614	74	44	74	47	The authors of this Chapter are seemingly really into response times. As mentioned above (sorry for the repetition), I do not think that the irreversibility of glacier mass loss has anything to do with response times (but the delay in the adjustment of the geometry has!). I think the critical points are (as stated above) the ice thickness distribution combined with comparably flat beds of the largest valley glaciers.This means that surface lowering will continue until the bed is reached (i.e. it is unstopable) due to reinforcement (or positive) feedbacks, i.e. it is getting warmer and warmer when the surface reaches increasingly lower elevations. Even for unchanged temperatures, this effect will result in accelerated mass loss until all ice resting on beds at low elevations disappeared. [Frank Paul, Switzerland]	The authors of this Chapter are seemingly really into response times. As mentioned above (sorry for the repetition), I do not think that the irreversibility of glacier mass loss has anything to do with response times (but the delay in the adjustment of the geometry has!). I think the critical points are (as stated above) the ice thickness distribution combined with comparably flat beds of the largest valley glaciers.This means that surface lowering will continue until the bed is reached (i.e. it is unstopable) due to reinforcement (or positive) feedbacks, i.e. it is getting warmer and warmer when the surface reaches increasingly lower elevations. Even for unchanged temperatures, this effect will result in accelerated mass loss until all ice resting on beds at low elevations disappeared.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
39228	74	47	74	47	This statement about irreversibility should be supported by literature references. Also, it must be checked whether the global glacier mass increase during the centuries leading up to the culmination of the Last Glacier Maximum (LGM) was in a similar order as the contemporary glacier mass loss. If so, this statement is false and should be deleted or rephrased. [Jacob Yde, Norway]	This statement about irreversibility should be supported by literature references. Also, it must be checked whether the global glacier mass increase during the centuries leading up to the culmination of the Last Glacier Maximum (LGM) was in a similar order as the contemporary glacier mass loss. If so, this statement is false and should be deleted or rephrased.
50616	74	49	74	49	I suggest writing 'the lower flat glacier tongues' instead of 'ablation area'. Strictly speaking, the latter would imply that we know something about mass balance of these glaciers which is not the case as far as I know. [Frank Paul, Switzerland]	I suggest writing 'the lower flat glacier tongues' instead of 'ablation area'. Strictly speaking, the latter would imply that we know something about mass balance of these glaciers which is not the case as far as I know.
20214	74	49	74	55	Pesonally, I would move this part on the twin collapse of the two Tibetan glaciers to the subsequent section 9.5.2.7 as I would consider it as a hazard. [Gwenaelle GREMION, Canada]	Pesonally, I would move this part on the twin collapse of the two Tibetan glaciers to the subsequent section 9.5.2.7 as I would consider it as a hazard.
20216	74	49	74	55	Are there any other examples of catastrophic glacier collapse that could be included here? [Gwenaelle GREMION, Canada]	Are there any other examples of catastrophic glacier collapse that could be included here?
26060	74	50	74	50	Replace “low angle glaciers” by “glaciers with low surface slope” [Marius Schaefer, Chile]	Replace “low angle glaciers” by “glaciers with low surface slope”
50618	74	51	74	51	Kolka aside, it seems such collapses might happen more often than anticipated earlier, for example Flat Creek (agu.confex.com/agu/fm18/meetingapp.cgi/Paper/452562), Amnye Machen (doi.org/10.3390/rs11060708), or Lenas (doi.org/10.5194/tc-13-997-2019). However, different reaons might be responsible in each case. [Frank Paul, Switzerland]	Kolka aside, it seems such collapses might happen more often than anticipated earlier, for example Flat Creek (agu.confex.com/agu/fm18/meetingapp.cgi/Paper/452562), Amnye Machen (doi.org/10.3390/rs11060708), or Lenas (doi.org/10.5194/tc-13-997-2019). However, different reaons might be responsible in each case.
26062	74	53	74	53	Add after (Gilbert et al.,2018). “The importance of the presence of water for the mobility of rock-ice avalanches was also highlighted by Scheider et al. (2011).” Citation: Schneider, D. , Huggel, C. , Haeberli, W. and Kaitna, R. (2011), Unraveling driving factors for large rock–ice avalanche mobility. Earth Surf. Process. Landforms, 36: 1948-1966. doi:10.1002/esp.2218 [Marius Schaefer, Chile]	Add after (Gilbert et al.,2018). “The importance of the presence of water for the mobility of rock-ice avalanches was also highlighted by Scheider et al. (2011).” Citation: Schneider, D. , Huggel, C. , Haeberli, W. and Kaitna, R. (2011), Unraveling driving factors for large rock–ice avalanche mobility. Earth Surf. Process. Landforms, 36: 1948-1966. doi:10.1002/esp.2218

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
15700	74	53			Recent studies from remote sensing provide evidence that such events of glacier collapse are occurring more often then previously thought, e.g.: Haeberli, Wilfried, et al. "The Kolka-Karmadon rock/ice slide of 20 September 2002: an extraordinary event of historical dimensions in North Ossetia, Russian Caucasus." Journal of Glaciology 50.171 (2004): 533-546. Falaschi, D., Kääb, A., Paul, F., Tadono, T., Rivera, J. A., & Lenzano, L. E. (2019). Brief communication: Collapse of 4 Mm 3 of ice from a cirque glacier in the Central Andes of Argentina. The Cryosphere, 13(3), 997-1004. Paul, F. (2019). Repeat Glacier Collapses and Surges in the Amney Machen Mountain Range, Tibet, Possibly Triggered by a Developing Rock-Slope Instability. Remote Sensing, 11(6), 708. Tielidze, L. G., Kumladze, R. M., Wheate, R. D., & Gamkrelidze, M. (2019). The Devdoraki Glacier Catastrophes, Georgian Caucasus. Hungarian Geographical Bulletin, 68(1), 21-35. Azzoni, R. S., Fugazza, D., Garzonio, C. A., Nicoll, K., Diolaiuti, G. A., Pelfini, M., & Zerboni, A. (2019). Geomorphological effects of the 1840 Ahora Gorge catastrophe on Mount Ararat (Eastern Turkey). Geomorphology, 332, 10-21. Jacquemart, M. F., Loso, M., Hansen, J. S., Sykes, J., & Tiampo, K. F. (2018, December). Instantaneous glacier loss through catastrophic collapse at Flat Creek glacier: disentangling the roles of climate, geology and glacier dynamics in Wrangell-St. Elias National Park and Preserve, Alaska. In AGU Fall Meeting Abstracts. [Michael Zemp, Switzerland]	Recent studies from remote sensing provide evidence that such events of glacier collapse are occurring more often then previously thought, e.g.: Haeberli, Wilfried, et al. "The Kolka-Karmadon rock/ice slide of 20 September 2002: an extraordinary event of historical dimensions in North Ossetia, Russian Caucasus." Journal of Glaciology 50.171 (2004): 533-546. Falaschi, D., Kääb, A., Paul, F., Tadono, T., Rivera, J. A., & Lenzano, L. E. (2019). Brief communication: Collapse of 4 Mm 3 of ice from a cirque glacier in the Central Andes of Argentina. The Cryosphere, 13(3), 997-1004. Paul, F. (2019). Repeat Glacier Collapses and Surges in the Amney Machen Mountain Range, Tibet, Possibly Triggered by a Developing Rock-Slope Instability. Remote Sensing, 11(6), 708. Tielidze, L. G., Kumladze, R. M., Wheate, R. D., & Gamkrelidze, M. (2019). The Devdoraki Glacier Catastrophes, Georgian Caucasus. Hungarian Geographical Bulletin, 68(1), 21-35. Azzoni, R. S., Fugazza, D., Garzonio, C. A., Nicoll, K., Diolaiuti, G. A., Pelfini, M., & Zerboni, A. (2019). Geomorphological effects of the 1840 Ahora Gorge catastrophe on Mount Ararat (Eastern Turkey). Geomorphology, 332, 10-21. Jacquemart, M. F., Loso, M., Hansen, J. S., Sykes, J., & Tiampo, K. F. (2018, December). Instantaneous glacier
26064	74	54	74	55	"… to such failures to provide a sound projection of future increases of the frequency of such events." [Marius Schaefer, Chile]	"… to such failures to provide a sound projection of future increases of the frequency of such events."
20240	75	2	75	18	This section seems to be missing the links to regional changes. [Gwenaelle GREMION, Canada]	This section seems to be missing the links to regional changes.
20242	75	2	75	18	Another hazard that could possibly be included is the risk of tsunamis/large waves from calving glaciers. [Gwenaelle GREMION, Canada]	Another hazard that could possibly be included is the risk of tsunamis/large waves from calving glaciers.
20218	75	2	75	18	Could droughts also be a potential hazards if glacial water serves as the primary water source in some areas? [Gwenaelle GREMION, Canada]	Could droughts also be a potential hazards if glacial water serves as the primary water source in some areas?
25374	75	2			Section 9.5.2.7 - Shouldn't most of this be in Ch 12 or WG2? [Sharon Smith, Canada]	Section 9.5.2.7 - Shouldn't most of this be in Ch 12 or WG2?
15702	75	2			More information for this section can be found in Haeberli and Whiteman (2015, and articles therein). For ref see above. [Michael Zemp, Switzerland]	More information for this section can be found in Haeberli and Whiteman (2015, and articles therein). For ref see above.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
26066	75	4	75	4	“When glaciers shrink, glacial lakes can develop in overdeepenings both in front of retreating glaciers and laterally.” [Marius Schaefer, Chile]	“When glaciers shrink, glacial lakes can develop in overdeepenings both in front of retreating glaciers and laterally.”
42568	75	7	75	7	Shugar et al., 2019 isn't in references. Is this a paper in review? [Brian Menounos, Canada]	Shugar et al., 2019 isn't in references. Is this a paper in review?
20220	75	8	75	9	I could not find this information in the two cited articles. None of the two articles is dealing with the entire region of High Mountain Asia. While Wang et al. 2013b are dealing with glacial lakes and indicate a nr and area estimation of glacial lakes in the Tian Shan Mountains, Zhang et al. 2015 do not seem to address glacial lakes at all. [Gwenaelle GREMION, Canada]	I could not find this information in the two cited articles. None of the two articles is dealing with the entire region of High Mountain Asia. While Wang et al. 2013b are dealing with glacial lakes and indicate a nr and area estimation of glacial lakes in the Tian Shan Mountains, Zhang et al. 2015 do not seem to address glacial lakes at all.
20244	75	9	75	10	This sentence might be a better fit in the preceding section (9.5.2.6 - abrupt changes, thresholds, irreversability). [Gwenaelle GREMION, Canada]	This sentence might be a better fit in the preceding section (9.5.2.6 - abrupt changes, thresholds, irreversability).
20222	75	9	75	10	The information I found in Carrivick and Tweed 2016 differs from the data provided here. Carrivick and Tweed 2016 present data compiled from 20 countries and comprising 1348 glacier floods spanning 10 centuries. They highlight that over 12,000 deaths have been recorded globally due to glacier floods. In more detail they state that glacier floods have directly caused at least: 7 deaths in Iceland, 393 deaths in the European Alps, 5745 deaths in South America and 6300 deaths in central Asia. [Gwenaelle GREMION, Canada]	The information I found in Carrivick and Tweed 2016 differs from the data provided here. Carrivick and Tweed 2016 present data compiled from 20 countries and comprising 1348 glacier floods spanning 10 centuries. They highlight that over 12,000 deaths have been recorded globally due to glacier floods. In more detail they state that glacier floods have directly caused at least: 7 deaths in Iceland, 393 deaths in the European Alps, 5745 deaths in South America and 6300 deaths in central Asia.
50620	75	12	75	12	There is another study (doi.org/10.3189/2014JoG14J104) that found 108 new lakes that formed from 1985 to 2011 in the Palena district of the southern Andes (new area 11.6 km2). [Frank Paul, Switzerland]	There is another study (doi.org/10.3189/2014JoG14J104) that found 108 new lakes that formed from 1985 to 2011 in the Palena district of the southern Andes (new area 11.6 km2).
14562	75	19	75	19	In several places of chapter 9.5 are discussed limitations of available data and the need for new data, but there is no clear picture or synthesis about current data gaps. I think a short subchapter titled Data Gaps or Data needs could be included after subchapter 9.5.2.7. In this short section a synthesis could be added about the present research limitations that need to be addressed and for example, the type, quality, resolution and representativeness of data requested to improve future projection models. [Rivera Andres, Chile]	In several places of chapter 9.5 are discussed limitations of available data and the need for new data, but there is no clear picture or synthesis about current data gaps. I think a short subchapter titled Data Gaps or Data needs could be included after subchapter 9.5.2.7. In this short section a synthesis could be added about the present research limitations that need to be addressed and for example, the type, quality, resolution and representativeness of data requested to improve future projection models.
46654	75	21	75	21	Nothing on subsea permafrost [WGI TSU, France]	Nothing on subsea permafrost

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
20224	75	23	75	24	Is this not the same as the International Permafrost Association definition?-- This definition of permafrost is correct, but I would suggest to add « ground temperature at or below 0°C », in order to include saline soils with unfrozen water but negative temperatures, still (at least technically) permafrost. [Gwenaelle GREMION, Canada]	Is this not the same as the International Permafrost Association definition?-- This definition of permafrost is correct, but I would suggest to add « ground temperature at or below 0°C », in order to include saline soils with unfrozen water but negative temperatures, still (at least technically) permafrost.
42570	75	23	75	24	This section needs a reference. Also, consider permafrost as sharing an information box with glaciers that outlines the major processes that will cause it to change and identifying those components that are most uncertain. [Brian Menounos, Canada]	This section needs a reference. Also, consider permafrost as sharing an information box with glaciers that outlines the major processes that will cause it to change and identifying those components that are most uncertain.
20226	75	23	75	29	Possibly provide some references here [Gwenaelle GREMION, Canada]	Possibly provide some references here
32252	75	23	75	35	This paragraphs states that "permafrost becomes dominant north of 60 deg N, and is also widespread in mountain areas." and the has a few sentences on mountain permafrost. I think it could also be worthwhile to mention how permafrost in warmer lowland regions is highly associated with ecosystems with soils that provide thermal insulation - especially thick organic soils (peat soils). These ecosystem protected permafrost regions are thus sensitive to both warming and any disturbance that reduces their insulative properties - e.g. wildfire which in itself is increasing in frequency. See e.g. Gibson et al. 2018, Wildfire as a major driver of recent permafrost thaw in boreal peatlands, Nature communications, 9,3041. a study which I was involved in. [David Olefeldt, Canada]	This paragraphs states that "permafrost becomes dominant north of 60 deg N, and is also widespread in mountain areas." and the has a few sentences on mountain permafrost. I think it could also be worthwhile to mention how permafrost in warmer lowland regions is highly associated with ecosystems with soils that provide thermal insulation - especially thick organic soils (peat soils). These ecosystem protected permafrost regions are thus sensitive to both warming and any disturbance that reduces their insulative properties - e.g. wildfire which in itself is increasing in frequency. See e.g. Gibson et al. 2018, Wildfire as a major driver of recent permafrost thaw in boreal peatlands, Nature communications, 9,3041. a study which I was involved in.
25376	75	23	75	41	You could probably make this introductory/background section shorter - not all of this is necessary (some of the information gets presented again later) [Sharon Smith, Canada]	You could probably make this introductory/background section shorter - not all of this is necessary (some of the information gets presented again later)
20246	75	26	75	27	"To first order…" Clarify what is meant by this. [Gwenaelle GREMION, Canada]	"To first order…" Clarify what is meant by this.
20228	75	26	75	29	The beginning phrase (to first order) of this sentence does not make sense. [Gwenaelle GREMION, Canada]	The beginning phrase (to first order) of this sentence does not make sense.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
25378	75	27	75	28	Terminology issue - To be more inclusive just say surface temperature rather than soil surface temperature as you can also have rock surface. Also "deep" when referring to ground temperatures means different things to different people so it is suggested that you just say "sub surface temperature" or "ground temperature" as this will integrate the changes at the surface - the thing that changes with depth is time lag and also the amount of filtering of the temporal changes. As mentioned in previous comment you may not even need to include this material as it is covered in the next section. [Sharon Smith, Canada]	Terminology issue - To be more inclusive just say surface temperature rather than soil surface temperature as you can also have rock surface. Also "deep" when referring to ground temperatures means different things to different people so it is suggested that you just say "sub surface temperature" or "ground temperature" as this will integrate the changes at the surface - the thing that changes with depth is time lag and also the amount of filtering of the temporal changes. As mentioned in previous comment you may not even need to include this material as it is covered in the next section.
20248	75	29	76	29	Replace "inception" at the start of this sentence - for example, start the sentence "Widespread permafrost formation at northern high latitudes began in the Pliocene…" [Gwenaelle GREMION, Canada]	Replace "inception" at the start of this sentence - for example, start the sentence "Widespread permafrost formation at northern high latitudes began in the Pliocene…"
20230	75	31	75	31	Gruber (2012) provides more recent estimations of the permafrost area. His model suggests 22% of the Northern Hemisphere and 17 of the Earth's exposed land surface is underlain by permafrost. Reference: Gruber, S. (2012), Derivation and analysis of a high-resolution estimate of global permafrost zonation, The Cryosphere, 6(1), 221-233. [Gwenaelle GREMION, Canada]	Gruber (2012) provides more recent estimations of the permafrost area. His model suggests 22% of the Northern Hemisphere and 17 of the Earth's exposed land surface is underlain by permafrost. Reference: Gruber, S. (2012), Derivation and analysis of a high-resolution estimate of global permafrost zonation, The Cryosphere, 6(1), 221-233.
38580	75	31			a new estimate (published June 2019) is 22%, see https://doi.org/10.1016/j.earscirev.2019.04.023 [Annett Bartsch, Austria]	a new estimate (published June 2019) is 22%, see https://doi.org/10.1016/j.earscirev.2019.04.023
20250	75	33	75	33	Rather than using the term "exposition", replace with "exposure" and perhaps clarify that this means the direction that the slope faces. [Gwenaelle GREMION, Canada]	Rather than using the term "exposition", replace with "exposure" and perhaps clarify that this means the direction that the slope faces.
20232	75	33	75	34	It is not only the exposition determining the distribution of mountain permafrost. I would rather name topography in general (redistribution of snow by wind and avalanches which is also an important factor is for example also depending on the topography…) and also mention the influence of the type of ground material (coarse material having a cooling effect compared to fine-grained material...), its ice content and vegetation cover. All is addressed by Haeberli et al. 2010 [Gwenaelle GREMION, Canada]	It is not only the exposition determining the distribution of mountain permafrost. I would rather name topography in general (redistribution of snow by wind and avalanches which is also an important factor is for example also depending on the topography…) and also mention the influence of the type of ground material (coarse material having a cooling effect compared to fine-grained material...), its ice content and vegetation cover. All is addressed by Haeberli et al. 2010
42574	75	37	75	41	Although methane might be considered as part of the organic carbon discussion in Chapter 5, you should at least alert the reader in here about the importance of melting permafrost in changes in methane. That's a signficant feedback that would cause signficant changes in the rate of SLR. [Brian Menounos, Canada]	Although methane might be considered as part of the organic carbon discussion in Chapter 5, you should at least alert the reader in here about the importance of melting permafrost in changes in methane. That's a signficant feedback that would cause signficant changes in the rate of SLR.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
52522	75	44	75	44	Where is sub-sea permafrost and methane hydrates covered? [John Brian Robin Matthews, France]	Taken into account. Methane hydrates are not a Ch 9 issue. Subsea permafrost is now mentioned: "As summarized in SROCC, consistent recent evidence from observations (e.g., Portnov et al., 2013; Ruppel et al., 2016) and modelling (Angelopoulos et al., 2019) suggests that the extent of subsea permafrost formed before submersion on Arctic continental shelves is much reduced compared to older studies that had estimated that the entire formerly exposed Arctic shelf area was underlain by permafrost. This is supported by observations (Shakhova et al., 2017) that show rapid thaw of recently submerged permafrost on the East Siberian Shelf."
20252	75	46	75	51	Start this paragraph with some information about active layer depths, to set up the reader for the rest of the section (e.g. the active layer is up to a couple of metres in depth and freezes/thaws annually with the greatest depth in late summer). This could be accomplished by moving some of the text later in the section (from page 76 line 41 to page 77 line 11, where active layer thickness is specifically discussed) to the start of the section. [Gwenaelle GREMION, Canada]	Start this paragraph with some information about active layer depths, to set up the reader for the rest of the section (e.g. the active layer is up to a couple of metres in depth and freezes/thaws annually with the greatest depth in late summer). This could be accomplished by moving some of the text later in the section (from page 76 line 41 to page 77 line 11, where active layer thickness is specifically discussed) to the start of the section.
25380	75	46	75	51	Some repetition with previous section so you could make it a bit shorter. Instead of Smith et al. 2010 and Park et al. 2015a, it would be better to refer to Romanovsky et al. (2017 AMAP SWIPA) since it is a more recent reference and is a review article. Also, none of these ideas are new including the statement attributed to Park et al. (i.e. it has been known some time that snow, vegetation etc. modulate ground temepratures and changes in these will result in changes in ground temperature) [Sharon Smith, Canada]	Some repetition with previous section so you could make it a bit shorter. Instead of Smith et al. 2010 and Park et al. 2015a, it would be better to refer to Romanovsky et al. (2017 AMAP SWIPA) since it is a more recent reference and is a review article. Also, none of these ideas are new including the statement attributed to Park et al. (i.e. it has been known some time that snow, vegetation etc. modulate ground temepratures and changes in these will result in changes in ground temperature)
42572	75	47	75	47	Zero what? Provide unit. [Brian Menounos, Canada]	Zero what? Provide unit.
20234	75	50	75	51	stylistic - two uses of "essentially" [Gwenaelle GREMION, Canada]	stylistic - two uses of "essentially"
20236	75	51	75	51	I would add more surface factors that can affect the permafrost thermal regime than only snow, e.g. vegetation, topography, water impounding. They are often linked together, but worth mentioning. [Gwenaelle GREMION, Canada]	I would add more surface factors that can affect the permafrost thermal regime than only snow, e.g. vegetation, topography, water impounding. They are often linked together, but worth mentioning.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
25382	75	53	76	28	There should be reference in this section to Ch 2 (2.3.2.5) which gives overview of trends in permafrost temperature and ALT (might help reduce some of the text). I would also reduce the emphasis on Biskaborn et al. (2019) as it only considers changes over a decade and not the longer-term perspective so reference should also be made to Romanovsky et al. 2017 (SWIPA) and for more up to date information the most recent State of Climate reports (Romanovsky et al. 2018 for Arctic and Noetzli et al. 2018 for other regions including mountain - note the most recet report should be out later this summer so should refer to that). Also Figure 9.29, takes a longer-term view which is based on updated information from the Romanovsky et al. refs. [Sharon Smith, Canada]	There should be reference in this section to Ch 2 (2.3.2.5) which gives overview of trends in permafrost temperature and ALT (might help reduce some of the text). I would also reduce the emphasis on Biskaborn et al. (2019) as it only considers changes over a decade and not the longer-term perspective so reference should also be made to Romanovsky et al. 2017 (SWIPA) and for more up to date information the most recent State of Climate reports (Romanovsky et al. 2018 for Arctic and Noetzli et al. 2018 for other regions including mountain - note the most recet report should be out later this summer so should refer to that). Also Figure 9.29, takes a longer-term view which is based on updated information from the Romanovsky et al. refs.
20238	75	55	75	55	Clarify whether this figure is near surface/active layer/bulk [Gwenaelle GREMION, Canada]	Clarify whether this figure is near surface/active layer/bulk
20270	76	4	76	4	Specify that the Arctic air temperature trends are strongly increasing trends. [Gwenaelle GREMION, Canada]	Specify that the Arctic air temperature trends are strongly increasing trends.
20274	76	5	76	16	Are there references other than the three papers by Romanovsky et al. that could be included here? [Gwenaelle GREMION, Canada]	Are there references other than the three papers by Romanovsky et al. that could be included here?
20272	76	6	76	6	I suggest re-wording part of this sentence to "the heat energy required to change phases from ice to water". [Gwenaelle GREMION, Canada]	I suggest re-wording part of this sentence to "the heat energy required to change phases from ice to water".
25384	76	7	76	7	Use Romanovsky et al. 2017 (SWIPA) instead here - more recent [Sharon Smith, Canada]	Use Romanovsky et al. 2017 (SWIPA) instead here - more recent
20254	76	9	76	9	Clarify what the period that is being referred to is. "since the IPY" is ambiguous as does not clearly define the observational period [Gwenaelle GREMION, Canada]	Clarify what the period that is being referred to is. "since the IPY" is ambiguous as does not clearly define the observational period
20256	76	16	76	16	I think you could add here the reference of Biskaborn et al. 2019, they show the stronger temperature trends in the continuous permafrost compared to the discontinuous permafrost very nicely as well [Gwenaelle GREMION, Canada]	I think you could add here the reference of Biskaborn et al. 2019, they show the stronger temperature trends in the continuous permafrost compared to the discontinuous permafrost very nicely as well
20258	76	16	76	16	An update report to the SWIPA 2017 was release this year, also supporting the conclusion (AMAP Climate Change Update 2019: An Update to Key Findings of Snow, Water, Ice and Permafrost in the Arctic (SWIPA) 2017) [Gwenaelle GREMION, Canada]	An update report to the SWIPA 2017 was release this year, also supporting the conclusion (AMAP Climate Change Update 2019: An Update to Key Findings of Snow, Water, Ice and Permafrost in the Arctic (SWIPA) 2017)
20260	76	19	76	19	Clarify what the period that is being referred to is. "since 2008/9" is ambiguous as does not clearly define the observational period [Gwenaelle GREMION, Canada]	Clarify what the period that is being referred to is. "since 2008/9" is ambiguous as does not clearly define the observational period
20262	76	19	76	19	What is the depth for the 1.15°C increase? Since a depth is given after for the 0.13°C, it is hard to make a direct comparison. [Gwenaelle GREMION, Canada]	What is the depth for the 1.15°C increase? Since a depth is given after for the 0.13°C, it is hard to make a direct comparison.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
20264	76	26	76	26	Clarify that the warming trend is in the permafrost. At present could be interpreted as air T increase [Gwenaelle GREMION, Canada]	Clarify that the warming trend is in the permafrost. At present could be interpreted as air T increase
20266	76	47	76	51	Very long sentence which is quite tricky to follow. Break this up and rephrase [Gwenaelle GREMION, Canada]	Very long sentence which is quite tricky to follow. Break this up and rephrase
20268	76	48	76	48	"…by local soil conditions…) --> remove the word "soil", (snow cover and vegetation are not soil conditions) [Gwenaelle GREMION, Canada]	"…by local soil conditions…) --> remove the word "soil", (snow cover and vegetation are not soil conditions)
25386	76	51	76	51	is this because these sites have lower ice content? [Sharon Smith, Canada]	is this because these sites have lower ice content?
25390	76	53	77	11	A key thing here is that the active layer responds more to shorter-term fluctuations in climate so more interannual variability then is the case with deeper ground temperatures. Therefore, it is more difficult to see the longer-term trend ALT (along with the issues related to ice content and settlement) [Sharon Smith, Canada]	A key thing here is that the active layer responds more to shorter-term fluctuations in climate so more interannual variability then is the case with deeper ground temperatures. Therefore, it is more difficult to see the longer-term trend ALT (along with the issues related to ice content and settlement)
25388	76	55	77	1	Isn't the focus of this section on observed changes rather than modelled? [Sharon Smith, Canada]	Isn't the focus of this section on observed changes rather than modelled?
20276	77	2	77	2	4m or 4cm ?? [Gwenaelle GREMION, Canada]	4m or 4cm ??
20278	77	2	77	5	I think this sentence could be written clearer - "smaller trends" --> I assume you mean smaller trends of ALT increase in colder regions compared to warmer regions? [Gwenaelle GREMION, Canada]	I think this sentence could be written clearer - "smaller trends" --> I assume you mean smaller trends of ALT increase in colder regions compared to warmer regions?
20280	77	9	77	9	I think this sentence can be omitted since on page 9-76, lines 47-50 you already give a detailed global statement on this issue [Gwenaelle GREMION, Canada]	I think this sentence can be omitted since on page 9-76, lines 47-50 you already give a detailed global statement on this issue
20290	77	9	77	9	Clarify that the thaw settlement that occurs when ice-rich permafrost degrades causes ground subsidence and collapse, which decreases active layer thicknesses. [Gwenaelle GREMION, Canada]	Clarify that the thaw settlement that occurs when ice-rich permafrost degrades causes ground subsidence and collapse, which decreases active layer thicknesses.
20282	77	13	77	17	What’s the point here? Can it be said in a more simple way? [Gwenaelle GREMION, Canada]	What’s the point here? Can it be said in a more simple way?

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
13700	77	13	77	26	One might add to the observation of permafrost extent changes the evidence given by sediment core data, indicating a release of material from permafrost material during abrupt warming events within the last deglaciation. A suggested sentence could be (bold is new implemented in the existing text), starting in line 23: "During the Holocene, permafrost aggradation occurred in agreement with cooling phases evidenced by other climatic proxies on millennial and centennial time scales (Treat and Jones, 2018). Organic biomarkers derived from sediment cores in the North Pacific and adjacent seas clearly indicate the mobilization of permafrost carbon - and therefore of permafrost thaw - during phases of cenntenial-scale abrupt northern hemisphere warming and massive melt water pulses across the last deglaciation (Winterfeld et al., 2018; Meyer et al., 2019) . Those evidences confirm the overall sensitivity of permafrost extent to climatic variations on time scales approaching those of anthropogenic climate change. Full references: Winterfeld M, Mollenhauer G, Dummann W, Köhler P, Lembke-Jene L, Meyer V D, Hefter J, McIntyer C, Wacker L, Kokfelt U, Tiedemann R 201.8 Deglacial mobilization of pre- aged terrestrial carbon from degrading permafrost. Nature. Comunications,. 9 3666 DOI: 10.1038/s41467-018-06080-w. Meyer, V. D.; Hefter, J.; Köhler, P.; Tiedemann, R.; Gersonde, R.; Wacker, L., Mollenhauer, G. 2019 Permafrost-carbon mobilization in Beringia caused by deglacial meltwater runoff, sea-level rise and warming. Environmental Research Letters, in press DOI: 10.1088/1748-9326/ab2653 (DOI might need update once the final version is online). [Peter Köhler, Germany]	One might add to the observation of permafrost extent changes the evidence given by sediment core data, indicating a release of material from permafrost material during abrupt warming events within the last deglaciation. A suggested sentence could be (bold is new implemented in the existing text), starting in line 23: "During the Holocene, permafrost aggradation occurred in agreement with cooling phases evidenced by other climatic proxies on millennial and centennial time scales (Treat and Jones, 2018). Organic biomarkers derived from sediment cores in the North Pacific and adjacent seas clearly indicate the mobilization of permafrost carbon - and therefore of permafrost thaw - during phases of cenntenial-scale abrupt northern hemisphere warming and massive melt water pulses across the last deglaciation (Winterfeld et al., 2018; Meyer et al., 2019) . Those evidences confirm the overall sensitivity of permafrost extent to climatic variations on time scales approaching those of anthropogenic climate change. Full references: Winterfeld M, Mollenhauer G, Dummann W, Ko?hler P, Lembke-Jene L, Meyer V D, Hefter J, McIntyer C, Wacker L, Kokfelt U, Tiedemann R 201.8 Deglacial mobilization of pre- aged terrestrial carbon from degrading permafrost. Nature. Comunications,. 9 3666 DOI: 10.1038/s41467-018-06080-w.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
32254	77	13	77	26	I don't agree with the statement that observations of permafrost extent are sparse. Particularly in the discontinuous and sporadic permafrost zone there have been a large number of studies documenting significant loss of permafrost extent, perhaps most well documented in the large peatland dominated regions of Alaska, the Mackenzie River Valley, the Hudson Bay lowlands and in Scandinavia. They are all in general agreement that permafrost extent losses have been 10 to 50% over the last few decades, and several studies have even been able to determine that this rate has been accelerating since ~2000. See: Åkerman HJ, Johansson M (2008) Thawing permafrost and thicker active layers in sub-arctic Sweden. Permafrost and Periglacial Processes 19:279–292. doi: 10.1002/ppp.626; Baltzer JL, Veness T, Chasmer LE, et al (2014) Forests on thawing permafrost: fragmentation, edge effects, and net forest loss. Global Change Biology 20:824–834. doi: 10.1111/gcb.12349; Borge AF, Westermann S, Solheim I, Etzelmüller B (2017) Strong degradation of palsas and peat plateaus in northern Norway during the last 60 years. The Cryosphere 11:1–16. doi: https://doi.org/10.5194/tc-11-1-2017; Camill P (2005) Permafrost Thaw Accelerates in Boreal Peatlands During Late-20th Century Climate Warming. Climatic Change 68:135–152. doi: 10.1007/s10584-005-4785-y; Chasmer L, Hopkinson C (2017) Threshold loss of discontinuous permafrost and landscape evolution. Global Change Biology 23:2672–2686. doi: 10.1111/gcb.13537; Jones BM, Baughman CA, Romanovsky VE, et al (2016) Presence of rapidly degrading permafrost plateaus in south-central Alaska. The Cryosphere 10:2673–2692. doi: https://doi.org/10.5194/tc-10-2673-2016; Mamet SD, Chun KP, Kershaw GGL, et al (2017) Recent Increases in Permafrost Thaw Rates and Areal Loss of Palsas in the Western Northwest Territories, Canada. Permafrost and Periglacial Processes 28:619–633. doi: 10.1002/ppp.1951; Gibson CM, Chasmer LE, Thompson DK, et al (2018) Wildfire as a major driver of recent permafrost thaw in boreal peatlands. Nature Communications 9:3041. doi: 10.1038/s41467-018-05457-1; Payette S, Delwaide A, Caccianiga M, Beauchemin M (2004) Accelerated thawing of subarctic peatland permafrost over the last 50 years. Geophysical Research Letters 31:. doi:	I don't agree with the statement that observations of permafrost extent are sparse. Particularly in the discontinuous and sporadic permafrost zone there have been a large number of studies documenting significant loss of permafrost extent, perhaps most well documented in the large peatland dominated regions of Alaska, the Mackenzie River Valley, the Hudson Bay lowlands and in Scandinavia. They are all in general agreement that permafrost extent losses have been 10 to 50% over the last few decades, and several studies have even been able to determine that this rate has been accelerating since ~2000. See: Åkerman HJ, Johansson M (2008) Thawing permafrost and thicker active layers in sub-arctic Sweden. Permafrost and Periglacial Processes 19:279–292. doi: 10.1002/ppp.626; Baltzer JL, Veness T, Chasmer LE, et al (2014) Forests on thawing permafrost: fragmentation, edge effects, and net forest loss. Global Change Biology 20:824–834. doi: 10.1111/gcb.12349; Borge AF, Westermann S, Solheim I, Etzelmüller B (2017) Strong degradation of palsas and peat plateaus in northern Norway during the last 60 years. The Cryosphere 11:1–16. doi: https://doi.org/10.5194/tc-11-1-2017; Camill P (2005) Permafrost Thaw Accelerates in Boreal Peatlands During Late-20th Century Climate Warming. Climatic Change 68:135–152. doi: 10.1007/s10584-005-4785-y; Chasmer L, Hopkinson C (2017) Threshold loss of
25392	77	20	77	23	Mixing modelling with observation? Unclear from sentence if evidence of permafrost presence over this longer time period? [Sharon Smith, Canada]	Mixing modelling with observation? Unclear from sentence if evidence of permafrost presence over this longer time period?
44984	77	21	77	26	I'm delighted to see the inclusion of information about changes in permafrost extent prior to recent observations. Much more is known about the presence or absence of permafrost during glacial-interglacial cycles, including the inception of permafrost in the Arctic and its survival through the last interglacial period. Such information is relevant evidence for the relation between temperature and the extent of frozen ground, as emphasized in the key summary statement (p 80, line 33). [Darrell Kaufman, United States of America]	I'm delighted to see the inclusion of information about changes in permafrost extent prior to recent observations. Much more is known about the presence or absence of permafrost during glacial-interglacial cycles, including the inception of permafrost in the Arctic and its survival through the last interglacial period. Such information is relevant evidence for the relation between temperature and the extent of frozen ground, as emphasized in the key summary statement (p 80, line 33).
25394	77	23	77	56	Refer to Ch 2 (2.3.2.5) [Sharon Smith, Canada]	Refer to Ch 2 (2.3.2.5)

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
20284	77	31	77	34	In this context I would rather cite Rangecroft et al. 2014: A first rock glacier inventory for the Bolivian Andes. Permafrost & Periglacial Processes, http://dx.doi.org/10.1002/ppp.1816. (instead of Rangecroft et al. 2015) [Gwenaelle GREMION, Canada]	In this context I would rather cite Rangecroft et al. 2014: A ?rst rock glacier inventory for the Bolivian Andes. Permafrost & Periglacial Processes, http://dx.doi.org/10.1002/ppp.1816. (instead of Rangecroft et al. 2015)
20292	77	36	77	37	Does high-altitude regions refer to permafrost zones in mountainous areas? If so, it would be helpful to clarify this. [Gwenaelle GREMION, Canada]	Does high-altitude regions refer to permafrost zones in mountainous areas? If so, it would be helpful to clarify this.
20294	77	38	77	39	The acronym QTP is used a couple of times here - define this. [Gwenaelle GREMION, Canada]	The acronym QTP is used a couple of times here - define this.
42576	77	42	47	47	I find this statement a bit problematic and I don't fully follow the logic here. If the process is well understood (tropospheric warming leads to warming of upper permafrost and tropospheric warming is directly attributed to human activity does one really need a formal study to state that? I would perscribe at least a medium confidence to this and not low. In my opinion low confidence would imply we don't understand the physical process well enough to made any statement. The complexity of snow cover (and its temporal evolution) adds important uncertainty or complexity. [Brian Menounos, Canada]	I find this statement a bit problematic and I don't fully follow the logic here. If the process is well understood (tropospheric warming leads to warming of upper permafrost and tropospheric warming is directly attributed to human activity does one really need a formal study to state that? I would perscribe at least a medium confidence to this and not low. In my opinion low confidence would imply we don't understand the physical process well enough to made any statement. The complexity of snow cover (and its temporal evolution) adds important uncertainty or complexity.
32256	77	42	77	47	Many of the studies listed in my last comment link accelerated rates of permafrost thaw to a warmer climate. In my opinion, this is sufficient at least to increase the confidence to medium for human influence on permafrost dynamics. [David Olefeldt, Canada]	Many of the studies listed in my last comment link accelerated rates of permafrost thaw to a warmer climate. In my opinion, this is sufficient at least to increase the confidence to medium for human influence on permafrost dynamics.
25396	77	42	77	47	This section is a bit confusing. By human influence are you referring to human influence on globabl climate (GHG emissions etc.) or other influences humans may have on the Arctic landscape that may affect permafrost such as vegetation clearing, infrastructure development etc. If the link is made between permafrost and climate change (which has been shown to be due to human influence) then can you say the change in permafrost conditions are linked to human influence? [Sharon Smith, Canada]	This section is a bit confusing. By human influence are you referring to human influence on globabl climate (GHG emissions etc.) or other influences humans may have on the Arctic landscape that may affect permafrost such as vegetation clearing, infrastructure development etc. If the link is made between permafrost and climate change (which has been shown to be due to human influence) then can you say the change in permafrost conditions are linked to human influence?

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
20286	77	42	77	47	In central Yakutia (Siberia), forest cutting for agriculture since the soviet era has triggered widespread permafrost thaw and erosion, for example through active layer deepening, ice wegde melting and thermokarst lake development. So there are indeed examples of permafrost landscape changes associated to human activity. An example of recent reference: Saito et al. 2018, Remote Sensing 10(10): 1579. [Gwenaelle GREMION, Canada]	In central Yakutia (Siberia), forest cutting for agriculture since the soviet era has triggered widespread permafrost thaw and erosion, for example through active layer deepening, ice wegde melting and thermokarst lake development. So there are indeed examples of permafrost landscape changes associated to human activity. An example of recent reference: Saito et al. 2018, Remote Sensing 10(10): 1579.
52414	77	42	77	47	This seems an odd conclusion -- if ground temperature is associated with thaw, and ground temperature changes associated with anthropogenic influence, would not the conclusion be the opposite: that observed permafrost thaw is attributable to human influence? [Pam Pearson, Sweden]	This seems an odd conclusion -- if ground temperature is associated with thaw, and ground temperature changes associated with anthropogenic influence, would not the conclusion be the opposite: that observed permafrost thaw is attributable to human influence?
20288	77	43	77	47	I can see that explicit studies on the anthrophogenic effect as for exampled carried out for glacier (Section 9.5.2.4) and snow (9.5.4.4) changes seem to be lacking with respect to permafrost changes. However, I do not fully share your opinion that this means one can only attribute the observed permafrost changes to human influence with low confidence. On one hand, there is a clear physical link between ground temperatures (and thus permafrost) and surface air temperatures which has been described by many, e.g. '...Sensitivity simulations indicated that changes in air temperature largely explained changes in permafrost area, although interactions among changes in other environmental variables also played a role.' (McGuire et al. 2016). On the other hand, it is by now generally accepted that (surface) air temperature increase since ~ the second half of the 20th century has been coupled to anthropogenic greenhouse gas emissions (e.g. Fyfe et al. 2013, One hundred years of Arctic surface temperature variation due to anthropogenic influence, Scientific Reports, 3, 2645). Is one then not naturally obliged to also accept the fact that permafrost changes are associated with human activity? Could it possibly be that direct studies are lacking due to the obviousness of the matter? [Gwenaelle GREMION, Canada]	I can see that explicit studies on the anthrophogenic effect as for exampled carried out for glacier (Section 9.5.2.4) and snow (9.5.4.4) changes seem to be lacking with respect to permafrost changes. However, I do not fully share your opinion that this means one can only attribute the observed permafrost changes to human influence with low confidence. On one hand, there is a clear physical link between ground temperatures (and thus permafrost) and surface air temperatures which has been described by many, e.g. '...Sensitivity simulations indicated that changes in air temperature largely explained changes in permafrost area, although interactions among changes in other environmental variables also played a role.' (McGuire et al. 2016). On the other hand, it is by now generally accepted that (surface) air temperature increase since ~ the second half of the 20th century has been coupled to anthropogenic greenhouse gas emissions (e.g. Fyfe et al. 2013, One hundred years of Arctic surface temperature variation due to anthropogenic influence, Scientific Reports, 3, 2645). Is one then not naturally obliged to also accept the fact that permafrost changes are associated with human activity? Could it possibly be that direct studies are lacking due to the obviousness of the matter?

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
32266	77	50	79	19	Overall I found this section to read as a less developed draft compared to other sections. A few short paragraphs were completely centered around single citations (e.g. on ice wedge degradation) - even though there are several recent publications on the topic. I also found the section on thermokarst to not meet the standard that I would expect from this report with regards to clarity and precision. I would recommend re-writing a few of the paragraphs, and I'd be happy to contribute if there is interest. I also think it could help the text if map of the permafrost region was included, which indicated the dominant modes of permafrost thaw in different regions - e.g. modified from my publication Olefeldt et al., 2016, Nature Communications, Circumpolar distribution and carbon storage of thermokarst landscapes. The spatial GIS layers are freely available through the ORNL DAAC website. This would show where we have observed and expect further wetland, lake, or hillslope abrupt thaw, along with regions that are considered less likely to have future abrupt thaw. [David Olefeldt, Canada]	Overall I found this section to read as a less developed draft compared to other sections. A few short paragraphs were completely centered around single citations (e.g. on ice wedge degradation) - even though there are several recent publications on the topic. I also found the section on thermokarst to not meet the standard that I would expect from this report with regards to clarity and precision. I would recommend re-writing a few of the paragraphs, and I'd be happy to contribute if there is interest. I also think it could help the text if map of the permafrost region was included, which indicated the dominant modes of permafrost thaw in different regions - e.g. modified from my publication Olefeldt et al., 2016, Nature Communications, Circumpolar distribution and carbon storage of thermokarst landscapes. The spatial GIS layers are freely available through the ORNL DAAC website. This would show where we have observed and expect further wetland, lake, or hillslope abrupt thaw, along with regions that are considered less likely to have future abrupt thaw.
25398	78	1	78	1	Central Canadian Arctic rather than Central Canada [Sharon Smith, Canada]	Central Canadian Arctic rather than Central Canada
42578	78	1	78	1	Permafrost temperatures no, but distribution of permafrost from some some features (e.g. pingos) could be. I think the authors imply 'permafrost temperature' - just make it clear that's what you mean. [Brian Menounos, Canada]	Permafrost temperatures no, but distribution of permafrost from some some features (e.g. pingos) could be. I think the authors imply 'permafrost temperature' - just make it clear that's what you mean.
14576	78	1	78	18	In recent years we have improved our understanding of number and area of rock glaciers along the Andes for example (Barcaza et al., 2017 doi: 10.1017/aog.2017.28), however we have almost no idea of their contribution to water runoff, the total volume of ice storage within these masses and possible water equivalent volume changes. These issues are a data gap that deserves to be mention in this section. [Rivera Andres, Chile]	In recent years we have improved our understanding of number and area of rock glaciers along the Andes for example (Barcaza et al., 2017 doi: 10.1017/aog.2017.28), however we have almost no idea of their contribution to water runoff, the total volume of ice storage within these masses and possible water equivalent volume changes. These issues are a data gap that deserves to be mention in this section.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
38582	78	2	78	7	Remote sensing is in general used to either look for (1) surface indicators of permafrost or (2) to use observable drivers to feed permafrost models. The review of Jorgenson & Grosse covers mostly category (1) with a focus on landscape change (only briefly commenting on modelling). The project Permafrost_cci which is mentioned this context, in the same sentence, follows approach (2) . I would suggest to consider adding the review by Trofaier et al. which specifically adresses use in permafrost modelling at the level as done in the Permafrost_cci project and potential input (https://doi.org/10.1016/j.rse.2017.05.021) [Annett Bartsch, Austria]	Remote sensing is in general used to either look for (1) surface indicators of permafrost or (2) to use observable drivers to feed permafrost models. The review of Jorgenson & Grosse covers mostly category (1) with a focus on landscape change (only briefly commenting on modelling). The project Permafrost_cci which is mentioned this context, in the same sentence, follows approach (2) . I would suggest to consider adding the review by Trofaier et al. which specifically adresses use in permafrost modelling at the level as done in the Permafrost_cci project and potential input (https://doi.org/10.1016/j.rse.2017.05.021)
20296	78	5	78	6	With respect to the progress I think the continuous and significant improvement of spatial and temporal resolutions in spaceborne remote-sensing techniques could be explicitly mentioned here [Gwenaelle GREMION, Canada]	With respect to the progress I think the continuous and significant improvement of spatial and temporal resolutions in spaceborne remote-sensing techniques could be explicitly mentioned here
20312	78	9	78	9	I'm unclear what rock glaciers are - are they glaciers on rocks, or glaciers that contain rocks? [Gwenaelle GREMION, Canada]	I'm unclear what rock glaciers are - are they glaciers on rocks, or glaciers that contain rocks?
20298	78	18	78	18	The year of the release of Buchli's dissertation is 2016 not 2018 [Gwenaelle GREMION, Canada]	The year of the release of Buchli's dissertation is 2016 not 2018
20302	78	20	78	23	You already addressed remote sensing techniques on page 9-78 lines 1-7. I would combine the two paragraphs into one in order to be more concise. [Gwenaelle GREMION, Canada]	You already addressed remote sensing techniques on page 9-78 lines 1-7. I would combine the two paragraphs into one in order to be more concise.
20314	78	20	78	23	These first two sentences aren't necessary, because they are unrelated to the rest of the paragraph on thermokarst processes. These sentences might work better as an introduction paragraph to section 9.5.3.2. [Gwenaelle GREMION, Canada]	These first two sentences aren't necessary, because they are unrelated to the rest of the paragraph on thermokarst processes. These sentences might work better as an introduction paragraph to section 9.5.3.2.
20300	78	20	78	42	Recent efforts in remote sensing have also contributed to provide more accurate numbers about pond and lake spatial coverage across permafrost landscapes, including thermokarst landscapes. For example: Muster et al. 2017, Earth System Science Data 9(1): 317-348. [Gwenaelle GREMION, Canada]	Recent efforts in remote sensing have also contributed to provide more accurate numbers about pond and lake spatial coverage across permafrost landscapes, including thermokarst landscapes. For example: Muster et al. 2017, Earth System Science Data 9(1): 317-348.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
25400	78	23	78	42	There are observations of thermokarst including thaw slumps in northern Canada and some of these studies make links to climate. Olefeldt paper considers potential rather than reports on observed changes. See Ch 2 for refs (but rather limited discussion) but you can also get a summary of observations in Ch 5 (Derksen et al 2019) in Canada's Changing Climate Report. These also include thermokarst lakes as well as thaw slumps Ref: Derksen, C., Burgess, D., Duguay, C., Howell, S., Mudryk, L., Smith, S., Thackeray, C., and Kirchmeier-Young, M. 2019. Chapter 5, Changes in Snow, Ice and Permafrost Across Canada. In Canada's Changing Climate Report. Government of Canada, Ottawa.https://www.nrcan.gc.ca/environment/impacts-adaptation/21177 [Sharon Smith, Canada]	There are observations of thermokarst including thaw slumps in northern Canada and some of these studies make links to climate. Olefeldt paper considers potential rather than reports on observed changes. See Ch 2 for refs (but rather limited discussion) but you can also get a summary of observations in Ch 5 (Derksen et al 2019) in Canada's Changing Climate Report. These also include thermokarst lakes as well as thaw slumps Ref: Derksen, C., Burgess, D., Duguay, C., Howell, S., Mudryk, L., Smith, S., Thackeray, C., and Kirchmeier-Young, M. 2019. Chapter 5, Changes in Snow, Ice and Permafrost Across Canada. In Canada's Changing Climate Report. Government of Canada, Ottawa.https://www.nrcan.gc.ca/environment/impacts-adaptation/21177
42580	78	24	78	24	Consider this term 'thermokarst' to be a term defined in a box devoted to glaciers and permafrost like the way it's down for the coean section of this chapter [Brian Menounos, Canada]	Consider this term 'thermokarst' to be a term defined in a box devoted to glaciers and permafrost like the way it's down for the coean section of this chapter
32258	78	25	78	26	Thermokarst landscapes, as defined in my publication Olefeldt et al., 2016, Nature Comms, are defined as landscapes where we have active (recent), stabilized (old) or potential (future) thermokarst landforms. I.e. it is a bit misleading to say that 20% of the permafrost region is thermokarst, unless it is specified as the afroementioned definition. I may be worthwhile to mention to that each of these three types of thermokarst landscapes have characteristic thermokarst landforms - including thaw slumps, active layer detatchments, erosion gullies, thermokarst lakes, thermokarst basins (drained lakes), thermokarst bogs, thermokarst fens, and more. There are s few really good reviews of all types of thermokarst landforms, e.g. Kokelj and Jorgenson, 2013, Advanced in Thermokarst Researach, Permafrost and Periglacial Processes, 24, 108-119. [David Olefeldt, Canada]	Thermokarst landscapes, as defined in my publication Olefeldt et al., 2016, Nature Comms, are defined as landscapes where we have active (recent), stabilized (old) or potential (future) thermokarst landforms. I.e. it is a bit misleading to say that 20% of the permafrost region is thermokarst, unless it is specified as the afroementioned definition. I may be worthwhile to mention to that each of these three types of thermokarst landscapes have characteristic thermokarst landforms - including thaw slumps, active layer detatchments, erosion gullies, thermokarst lakes, thermokarst basins (drained lakes), thermokarst bogs, thermokarst fens, and more. There are s few really good reviews of all types of thermokarst landforms, e.g. Kokelj and Jorgenson, 2013, Advanced in Thermokarst Researach, Permafrost and Periglacial Processes, 24, 108-119.
32260	78	26	78	28	This sentence is unclear to me. If you mean that initial thermokarst leads to conditions that causes continued thermokarst, I may agree, but then you should also include hillslope thermokarst where this is also true. [David Olefeldt, Canada]	This sentence is unclear to me. If you mean that initial thermokarst leads to conditions that causes continued thermokarst, I may agree, but then you should also include hillslope thermokarst where this is also true.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
32262	78	28	78	28	Lake drainage can also occurr when thaw under the lake causes increased groundwater connectivity, allowing for groundwater recharge and lake loss. [David Olefeldt, Canada]	Lake drainage can also occurr when thaw under the lake causes increased groundwater connectivity, allowing for groundwater recharge and lake loss.
32264	78	35	78	35	Consider also listing Gibson et al., 2018, Nature Communications, Wildfire as a major driver in boreal peatlands, as a reference here. I was involved in this study. [David Olefeldt, Canada]	Consider also listing Gibson et al., 2018, Nature Communications, Wildfire as a major driver in boreal peatlands, as a reference here. I was involved in this study.
25402	78	37	78	38	Whether permafrost will recover depends on severity of burn and whether organic layer destroyed - also depends on whether ground thermal regime was in equilibrium with current climate. Was it ecosystem protected? [Sharon Smith, Canada]	Whether permafrost will recover depends on severity of burn and whether organic layer destroyed - also depends on whether ground thermal regime was in equilibrium with current climate. Was it ecosystem protected?
20316	78	44	78	47	This paragraph needs some additional information about how soil C content affects thermal conductivity, and how this varies among different regions of the world. [Gwenaelle GREMION, Canada]	This paragraph needs some additional information about how soil C content affects thermal conductivity, and how this varies among different regions of the world.
20304	78	47	78	47	date missing from reference [Gwenaelle GREMION, Canada]	date missing from reference
52520	78	50	78	50	Please provide more detail of what gas-emissions craters are [John Brian Robin Matthews, France]	Please provide more detail of what gas-emissions craters are
20306	78	51	78	51	The reference by Leibman et al. 2014 is missing in the reference list [Gwenaelle GREMION, Canada]	The reference by Leibman et al. 2014 is missing in the reference list
25404	78	55	78	55	Ice wedges can be fairly thick so not sure about abrubpt permafrost degradation as complete degradation could take time -- depends on geomorphic response? [Sharon Smith, Canada]	Ice wedges can be fairly thick so not sure about abrubpt permafrost degradation as complete degradation could take time -- depends on geomorphic response?
20310	78	55	78	55	clarify what is meant by "pulse disturbances". Additional Suggestion for a supplemental reference (Canadian Arctic): Godin et al. 2016, Biogeosciences 13(5): 1439-1452. [Gwenaelle GREMION, Canada]	clarify what is meant by "pulse disturbances". Additional Suggestion for a supplemental reference (Canadian Arctic): Godin et al. 2016, Biogeosciences 13(5): 1439-1452.
42582	78	55	78	55	What is meant by 'pulsed disturbance'? [Brian Menounos, Canada]	What is meant by 'pulsed disturbance'?
20308	78	55	79	2	I would add the paper by Jorgenson et al. (2015) to this paragraph (Role of ground ice dynamics and ecological feedbacks in recent ice wedge degradation and stabilization, doi:10.1002/ 2015JF003602). A sentence could be added pertaining to the path of ice-wedge degradation, either leading to further degradation or stabilization. [Gwenaelle GREMION, Canada]	I would add the paper by Jorgenson et al. (2015) to this paragraph (Role of ground ice dynamics and ecological feedbacks in recent ice wedge degradation and stabilization, doi:10.1002/ 2015JF003602). A sentence could be added pertaining to the path of ice-wedge degradation, either leading to further degradation or stabilization.
20318	78	55	79	2	This section also requires more information - there are numerous examples from northwestern Canada. Papers by Kokelj, Burn, Lacelle, and/or Gruber would likely contain additional information that could be used here. [Gwenaelle GREMION, Canada]	This section also requires more information - there are numerous examples from northwestern Canada. Papers by Kokelj, Burn, Lacelle, and/or Gruber would likely contain additional information that could be used here.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
42584	79	5	79	5	Somewhat vague. Provide reader with insight into why these modules aren't working. Is it due to unknown or improperly parameterized physics, mismatch between spatial scales (low resolution of GCM and high resolution of process), both, or some other reason? Some of these factors are listed in following statements, but make it more clear to reader of this section in the topic sentence (i.e. generalize these reasons). [Brian Menounos, Canada]	Somewhat vague. Provide reader with insight into why these modules aren't working. Is it due to unknown or improperly parameterized physics, mismatch between spatial scales (low resolution of GCM and high resolution of process), both, or some other reason? Some of these factors are listed in following statements, but make it more clear to reader of this section in the topic sentence (i.e. generalize these reasons).
20320	79	14	79	18	I could not find any information on the effect of lichen and bryophytes in Slater et al. 2017 and Wang et al. 2016b. The subject is for example addressed in Soudzilovskaia et al. 2013: Dominant bryophyte control over high-latitude soil temperature fluctuations predicted by heat transfer traits, field moisture regime and laws of thermal insulation, Functional Ecology, 27, 1442-1454. --> already in the reference list... [Gwenaelle GREMION, Canada]	I could not find any information on the effect of lichen and bryophytes in Slater et al. 2017 and Wang et al. 2016b. The subject is for example addressed in Soudzilovskaia et al. 2013: Dominant bryophyte control over high-latitude soil temperature fluctuations predicted by heat transfer traits, field moisture regime and laws of thermal insulation, Functional Ecology, 27, 1442-1454. --> already in the reference list...
25406	79	17	79	17	is the effect of vegetation on snow cover considered in these models, for eg. Trapping of snow by shrubs? [Sharon Smith, Canada]	is the effect of vegetation on snow cover considered in these models, for eg. Trapping of snow by shrubs?
20322	79	17	79	17	The reference by Lawrence and Swenson 2011 is missing in the reference list [Gwenaelle GREMION, Canada]	The reference by Lawrence and Swenson 2011 is missing in the reference list
20324	79	18	79	18	The references by Porada et al. 2016 and Druel et al. 2017 are missing in the reference list [Gwenaelle GREMION, Canada]	The references by Porada et al. 2016 and Druel et al. 2017 are missing in the reference list
20326	79	18	79	19	Regarding permafrost carbon dynamic and respiration; What are the modeling assumptions on biochemical carbon respiration? Respiration rate is not the same from 0°C to -8°C (assumed cease of activity). Assumptions on the overall pool may be misleading if scaling assumptions are lineal. [please check reference below] Schaefer, K., & Jafarov, E. (2016). A parameterization of respiration in frozen soils based on substrate availability. Biogeosciences, 13(7). [Gwenaelle GREMION, Canada]	Regarding permafrost carbon dynamic and respiration; What are the modeling assumptions on biochemical carbon respiration? Respiration rate is not the same from 0°C to -8°C (assumed cease of activity). Assumptions on the overall pool may be misleading if scaling assumptions are lineal. [please check reference below] Schaefer, K., & Jafarov, E. (2016). A parameterization of respiration in frozen soils based on substrate availability. Biogeosciences, 13(7).
20334	79	22	79	40	This section on model evaluation (9.5.3.3) could incorporate the part of the preceeding section that discusses progress in modelling (page 79 line 4 to page 79 line 19) in order to shorten section 9.5.3.2, which is quite long, and reduce repetition in the two sections. [Gwenaelle GREMION, Canada]	This section on model evaluation (9.5.3.3) could incorporate the part of the preceeding section that discusses progress in modelling (page 79 line 4 to page 79 line 19) in order to shorten section 9.5.3.2, which is quite long, and reduce repetition in the two sections.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
25408	79	26	79	28	Is this underestimation due to the shallow depths modelled and inadequate consideration of lag effects? [Sharon Smith, Canada]	Is this underestimation due to the shallow depths modelled and inadequate consideration of lag effects?
46616	79	35	79	35	"vary widely" -> Please quantify [WGI TSU, France]	"vary widely" -> Please quantify
20328	79	35	79	35	It should be 1960 instead of 1950 [Gwenaelle GREMION, Canada]	It should be 1960 instead of 1950
20336	79	36	79	38	This point - that the effect of snow insulation is critical in order to accurately model permafrost extent and ALT - is critical and I would recommend starting this paragraph with that statement. [Gwenaelle GREMION, Canada]	This point - that the effect of snow insulation is critical in order to accurately model permafrost extent and ALT - is critical and I would recommend starting this paragraph with that statement.
20330	79	36	79	40	You could possibly cross-link to section 9.5.4.3 (page 9-84, lines 2-10) in the snow chapter where the issue is also addressed. (and Wang et al. 2016b and Slater et al. 2017 are also refrerenced in section 9.5.3.2, lines 10-14, in the same context, another cross-link could possibly be made there as well...) [Gwenaelle GREMION, Canada]	You could possibly cross-link to section 9.5.4.3 (page 9-84, lines 2-10) in the snow chapter where the issue is also addressed. (and Wang et al. 2016b and Slater et al. 2017 are also refrerenced in section 9.5.3.2, lines 10-14, in the same context, another cross-link could possibly be made there as well...)
35284	79	42	80	28	For these plots (9.30 and 9.31), does it make sense to include only the permafrost estimates as diagnosed formn the 0C soil surface temperature, versus also/alternatively the permafrost areas as diagnosed from ALT < 3m in the ESMs? [Charles Koven, United States of America]	For these plots (9.30 and 9.31), does it make sense to include only the permafrost estimates as diagnosed formn the 0C soil surface temperature, versus also/alternatively the permafrost areas as diagnosed from ALT < 3m in the ESMs?
20332	79	45	79	45	[FIGURE 9.30] What about the Southern Hemisphere? Minimal impact on the topic? [Gwenaelle GREMION, Canada]	[FIGURE 9.30] What about the Southern Hemisphere? Minimal impact on the topic?
25448	79	47			Figure 9.30 - unclear why 10 m isn't used everywhere as changes in non soil are important to and also influence thermal regime etc. Considering same depth everywhere would be consistent and reflect change everywhere (choosing only soil depth reflects bias re only concered about carbon or ecosystem consequence but others are concerned about changes in non soil portion). [Sharon Smith, Canada]	Figure 9.30 - unclear why 10 m isn't used everywhere as changes in non soil are important to and also influence thermal regime etc. Considering same depth everywhere would be consistent and reflect change everywhere (choosing only soil depth reflects bias re only concered about carbon or ecosystem consequence but others are concerned about changes in non soil portion).
20338	80	1	80	13	Can authors include any effort to estimate of the contribution by permafrost change for sea level change at present and during the 21st century? [Gwenaelle GREMION, Canada]	Can authors include any effort to estimate of the contribution by permafrost change for sea level change at present and during the 21st century?
16056	80	3	80	35	Suggest including an account of the additional warming contributed by the thawing permafrost. [SAI MING LEE, China]	Suggest including an account of the additional warming contributed by the thawing permafrost.
20340	80	4	80	4	Possibly use the index name as provided in Nelson and Outcalt (1987) 'surface frozen index (SFI)' [Gwenaelle GREMION, Canada]	Possibly use the index name as provided in Nelson and Outcalt (1987) 'surface frozen index (SFI)'
25410	80	4	80	6	Given limitations of frost index approach, how much of an advance is this. (also, probably don't need to cite the Nelson and Outcalt paper) [Sharon Smith, Canada]	Given limitations of frost index approach, how much of an advance is this. (also, probably don't need to cite the Nelson and Outcalt paper)
20342	80	7	80	7	The reference by Chadburn et al. 2017 is missing in the reference list [Gwenaelle GREMION, Canada]	The reference by Chadburn et al. 2017 is missing in the reference list

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
25412	80	9	80	9	Be clear about depth considered as near-surface. Aslo when comparing equilibrium to transient the key thing is that the timing of the equilibrium condition is not considered. [Sharon Smith, Canada]	Be clear about depth considered as near-surface. Aslo when comparing equilibrium to transient the key thing is that the timing of the equilibrium condition is not considered.
20350	80	12	80	13	The sentence that starts "However, these diagnostic equilibrium approaches…" is confusing. In particular, the transient effects and physical processes that aren't considered could be elaborated a bit. [Gwenaelle GREMION, Canada]	The sentence that starts "However, these diagnostic equilibrium approaches…" is confusing. In particular, the transient effects and physical processes that aren't considered could be elaborated a bit.
20344	80	20	80	20	[FIGURE 9.31] I don’t find the legend. [Gwenaelle GREMION, Canada]	[FIGURE 9.31] I don’t find the legend.
25450	80	20			Figure 9.31 - Be clear on MAGT depth - 10 m? explain difference between blue and green lines etc. [Sharon Smith, Canada]	Figure 9.31 - Be clear on MAGT depth - 10 m? explain difference between blue and green lines etc.
20346	80	21	80	21	GMAT abbreviation not given [Gwenaelle GREMION, Canada]	GMAT abbreviation not given
25414	80	31	80	32	See Ch 5 (Derksen et al. 2019) in Canada's Changing Climate Report for information on some of the difficulties of modelling permafrost including lateral heat transfer, impacts of collapse of peatland etc. Also need to be careful about using term "abrupt" - is it the thaw or the geomorphic response that is "abrupt". [Sharon Smith, Canada]	See Ch 5 (Derksen et al. 2019) in Canada's Changing Climate Report for information on some of the difficulties of modelling permafrost including lateral heat transfer, impacts of collapse of peatland etc. Also need to be careful about using term "abrupt" - is it the thaw or the geomorphic response that is "abrupt".
42586	80	31	80	35	Why is this given a high confidence rating when on pg. 77 authors felt link was low? These sections need to be reconciled. [Brian Menounos, Canada]	Why is this given a high confidence rating when on pg. 77 authors felt link was low? These sections need to be reconciled.
25416	80	34	80	35	Why not just say permafrost extent will decrease as it has both vertical and lateral extent. [Sharon Smith, Canada]	Why not just say permafrost extent will decrease as it has both vertical and lateral extent.
32276	80	38	80	51	I think there are a few points to this sections that should be brought up better. First the reversibility of permafrost thaw when associated with abrupt thaw (thermokarst/thermal erosion) is partly dependent on which permafrost zone you consider. Permafrost thaw in sporadic permafrost zones is very highly likely overall irreversible under any future climate scenario. In the discontinuous permafrost zone, you may see some permafrost reaggradation - but very rapid net losses of permafrost extents are aready being reported. In thecontinuous permafrost zone, permafrost re-aggradation is often highly likely, e.g. following thermokarst lake drainage, or in stabilized thaw slumps, but the new ecosystem that forms with permafrost is often very different from the ecosystem that was found there prior to abrupt thaw, different with regrards to both soil characteristics, local hydrology, and vegetation composition. [David Olefeldt, Canada]	I think there are a few points to this sections that should be brought up better. First the reversibility of permafrost thaw when associated with abrupt thaw (thermokarst/thermal erosion) is partly dependent on which permafrost zone you consider. Permafrost thaw in sporadic permafrost zones is very highly likely overall irreversible under any future climate scenario. In the discontinuous permafrost zone, you may see some permafrost reaggradation - but very rapid net losses of permafrost extents are aready being reported. In thecontinuous permafrost zone, permafrost re-aggradation is often highly likely, e.g. following thermokarst lake drainage, or in stabilized thaw slumps, but the new ecosystem that forms with permafrost is often very different from the ecosystem that was found there prior to abrupt thaw, different with regrards to both soil characteristics, local hydrology, and vegetation composition.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
32268	80	40	80	42	Long sentence which could be split, or made to have better structure. [David Olefeldt, Canada]	Long sentence which could be split, or made to have better structure.
25418	80	42	80	43	There are fairly signifcant regions where thaw slumps for example have been observed including parts of northern Canada (see Ch 5 in Canada's Changing Climate Report for references along with recent Nature Comm paper by Lewkowicz & Way). [Sharon Smith, Canada]	There are fairly signifcant regions where thaw slumps for example have been observed including parts of northern Canada (see Ch 5 in Canada's Changing Climate Report for references along with recent Nature Comm paper by Lewkowicz & Way).
32270	80	42	80	45	I don't know what is meant by large scale abrupt permafrost degradation - I've never seen this discussed. Abrupt thaw has in the last few years been used to describe thermokarst and thermal erosion jointly. I.e. abrupt thaw is used to describe land collapse or erosion due to permafrost thaw. By necessity, this type of abrupt thaw can only occur at spatially limited areas at any given time. "Abrupt thaw" should not be used to describe rapid permafrost thaw - the abrupt signifies the landscape change, not the rate of thaw. Here I think the CMIP5 model indicates rapid, widespread thaw. This is not the same as the thermokarst/thermal erosion that has become associated with the use of the term abrupt thaw. I think it may be better to highlight that while abrupt thaw is a local occurrence, overall it is still a major process that can affect a large proportion of the permafrost region (~20%). At the same time, large areas of the permafrost region does not have the soil and climate characteristics that are required for abrupt thaw to occurr with permafrost thaw - any region with shallow soils or low ground ice content is not susceptible to abrupt thaw. [David Olefeldt, Canada]	I don't know what is meant by large scale abrupt permafrost degradation - I've never seen this discussed. Abrupt thaw has in the last few years been used to describe thermokarst and thermal erosion jointly. I.e. abrupt thaw is used to describe land collapse or erosion due to permafrost thaw. By necessity, this type of abrupt thaw can only occur at spatially limited areas at any given time. "Abrupt thaw" should not be used to describe rapid permafrost thaw - the abrupt signifies the landscape change, not the rate of thaw. Here I think the CMIP5 model indicates rapid, widespread thaw. This is not the same as the thermokarst/thermal erosion that has become associated with the use of the term abrupt thaw. I think it may be better to highlight that while abrupt thaw is a local occurrence, overall it is still a major process that can affect a large proportion of the permafrost region (~20%). At the same time, large areas of the permafrost region does not have the soil and climate characteristics that are required for abrupt thaw to occurr with permafrost thaw - any region with shallow soils or low ground ice content is not susceptible to abrupt thaw.
32272	80	45	80	45	I think the section on abrupt large scale permafrost degradation is a red herring and should be omitted. [David Olefeldt, Canada]	I think the section on abrupt large scale permafrost degradation is a red herring and should be omitted.
20348	80	45	80	45	Is the use of "very" appropriate in the context of the confidence language ("likely") used? As it is, the use of "very" could confuse the interpretation of the confidence language used. Would suggest either to remove "very" or change the confidence language used [Gwenaelle GREMION, Canada]	Is the use of "very" appropriate in the context of the confidence language ("likely") used? As it is, the use of "very" could confuse the interpretation of the confidence language used. Would suggest either to remove "very" or change the confidence language used

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
32274	80	48	80	49	This is not clear, and seems to be incorrect. Permafrost may re-aggrade in stabilized thermokarst landforms or drained thermokarst lake basins - yes. But this is not dependent on decay of organic material post thaw. Instead, many stabilized thermokarst landforms (wetlands, basins) have high rates of accumulation of new organic material after thermokarst stabilization, and it is the build-up (not decay) of organic material that increases the insulating properties of the soil and thus allows permafrost to re-aggrade. In colder regions, this may not be necessary and permafrost will re-aggrade even without build up of a organic material. In the discontinuous permafrost zone is it more often required, e.g. in thermokarst bogs. The cycle of thermokarst, stabilization, organic build up, and finally permafrost reaggradation takes ~500 to 1000 years in many boreal peatlands in western Canada. However, with warming this cyclicity is unlikely to continue. [David Olefeldt, Canada]	This is not clear, and seems to be incorrect. Permafrost may re-aggrade in stabilized thermokarst landforms or drained thermokarst lake basins - yes. But this is not dependent on decay of organic material post thaw. Instead, many stabilized thermokarst landforms (wetlands, basins) have high rates of accumulation of new organic material after thermokarst stabilization, and it is the build-up (not decay) of organic material that increases the insulating properties of the soil and thus allows permafrost to re-aggrade. In colder regions, this may not be necessary and permafrost will re-aggrade even without build up of a organic material. In the discontinuous permafrost zone is it more often required, e.g. in thermokarst bogs. The cycle of thermokarst, stabilization, organic build up, and finally permafrost reaggradation takes ~500 to 1000 years in many boreal peatlands in western Canada. However, with warming this cyclicity is unlikely to continue.
38446	80	54	81	1	As done for 9.5.X Sections (Glacier, Permafrost and Lake and river ice), a small introduction paragraph in section 9.5.4 Snow could be written before the beginning 9.5.4.1 Observed changes. Namely it will be helpfull to present a summary of the section and make reference to the other parts of the IPPC where snow-related processes are presented (even if it is mention in the main text) such as Chapter 3 of this report Chapter 2 and 3 of SROCC [Maria Santolaria-Otin, France]	As done for 9.5.X Sections (Glacier, Permafrost and Lake and river ice), a small introduction paragraph in section 9.5.4 Snow could be written before the beginning 9.5.4.1 Observed changes. Namely it will be helpfull to present a summary of the section and make reference to the other parts of the IPPC where snow-related processes are presented (even if it is mention in the main text) such as Chapter 3 of this report Chapter 2 and 3 of SROCC

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
55244	80	54	87	24	[pt 1 of 4] The Report needs to note the effect of a warming climate on snowfall accumulation in ice sheets. In a warming climate, snowfall accumulation on ice sheets can be expected to increase, for two reasons. The first is that warmer air carries more moisture. Each degree Celsius of warming increases saturated water vapor pressure by about 6-7%. The second is through the mechanism of Lake/Ocean-Effect Snowfall (LOES). Both Greenland and Antarctica are surrounded by oceans, which are often covered with sea ice. Evaporation from open seawater is much more rapid than sublimation from sea ice, so when the ice opens it results in dramatically increased snowfall downwind. If a warming climate reduces sea ice coverage in the Arctic, North Atlantic and Southern Oceans, it can be expected to increase snowfall accumulation on the ice sheets, reducing sea-level, and offsetting ice sheet mass losses through melting, iceberg calving, and sublimation. [cont'd] [David Burton, United States of America]	[pt 1 of 4] The Report needs to note the effect of a warming climate on snowfall accumulation in ice sheets. In a warming climate, snowfall accumulation on ice sheets can be expected to increase, for two reasons. The first is that warmer air carries more moisture. Each degree Celsius of warming increases saturated water vapor pressure by about 6-7%. The second is through the mechanism of Lake/Ocean-Effect Snowfall (LOES). Both Greenland and Antarctica are surrounded by oceans, which are often covered with sea ice. Evaporation from open seawater is much more rapid than sublimation from sea ice, so when the ice opens it results in dramatically increased snowfall downwind. If a warming climate reduces sea ice coverage in the Arctic, North Atlantic and Southern Oceans, it can be expected to increase snowfall accumulation on the ice sheets, reducing sea-level, and offsetting ice sheet mass losses through melting, iceberg calving, and sublimation. [cont'd]
55246	80	54	87	24	[pt 2 of 4] Snow accumulation has a large effect on grounded ice mass, which in turn affects sea-level. In both Greenland and Antarctica, snowfall is the most important factor affecting ice sheet mass balance, greater in magnitude than melting, sublimation, or iceberg calving. In fact, in Antarctica, snowfall accumulation is approximately equal to the sum of those other three factors. [cont'd] [David Burton, United States of America]	[pt 2 of 4] Snow accumulation has a large effect on grounded ice mass, which in turn affects sea-level. In both Greenland and Antarctica, snowfall is the most important factor affecting ice sheet mass balance, greater in magnitude than melting, sublimation, or iceberg calving. In fact, in Antarctica, snowfall accumulation is approximately equal to the sum of those other three factors. [cont'd]
55248	80	54	87	24	[pt 3 of 4] The magnitude of ice accretion from snowfall on ice sheets was illustrated by the amazing story of "Glacier Girl." She's a WWII Lockheed P-38 Lightning airplane, which was extracted in pieces from beneath 268 feet(!) of accumulated ice and snow (mostly ice), fifty years after she made an emergency landing on the Greenland Ice Sheet. Here’s a diagram: http://p38assn.org/glacier-girl-recovery.htm That's more than 5 feet of ice per year, which is equivalent to more than 70 feet of annual snowfall, which had piled up on top of the airplane! That snow represents evaporated water, mostly removed from the Arctic and North Atlantic Oceans, which then fell as ocean-effect snow on the Greenland Ice Sheet. [cont'd] [David Burton, United States of America]	[pt 3 of 4] The magnitude of ice accretion from snowfall on ice sheets was illustrated by the amazing story of "Glacier Girl." She's a WWII Lockheed P-38 Lightning airplane, which was extracted in pieces from beneath 268 feet(!) of accumulated ice and snow (mostly ice), fifty years after she made an emergency landing on the Greenland Ice Sheet. Here’s a diagram: http://p38assn.org/glacier-girl-recovery.htm That's more than 5 feet of ice per year, which is equivalent to more than 70 feet of annual snowfall, which had piled up on top of the airplane! That snow represents evaporated water, mostly removed from the Arctic and North Atlantic Oceans, which then fell as ocean-effect snow on the Greenland Ice Sheet. [cont'd]

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
55250	80	54	87	24	[pt 4 of 4[Multiple studies have found that snowfall accumulation in Antarctica has been increasing: https://web.archive.org/web/20180104195908/https://www.washingtonpost.com/news/energy-environment/wp/2018/01/03/large-antarctic-snowfall-increases-could-counter-sea-level-rise-scientists-say/ https://agupubs.onlinelibrary.wiley.com/doi/full/10.1002/2017GL075992 https://www.clim-past.net/13/1491/2017/cp-13-1491-2017.html https://www.nature.com/articles/354058a0 https://www.nature.com/articles/s41558-018-0356-x ### [David Burton, United States of America]	[pt 4 of 4[Multiple studies have found that snowfall accumulation in Antarctica has been increasing: https://web.archive.org/web/20180104195908/https://www.washingtonpost.com/news/energy-environment/wp/2018/01/03/large-antarctic-snowfall-increases-could-counter-sea-level-rise-scientists-say/ https://agupubs.onlinelibrary.wiley.com/doi/full/10.1002/2017GL075992 https://www.clim-past.net/13/1491/2017/cp-13-1491-2017.html https://www.nature.com/articles/354058a0 https://www.nature.com/articles/s41558-018-0356-x ###
51540	80	54			The section has broadly discussed about the SCE, SCD and SWE but have not accounted the contribution of Snowfall and snowmelt to the snow changes in any of the subsectoins. Later in section 9.5.4.5 -- page 86 -- line 14&15, the influence of snowfall and snowmelt over the snow changes has been discussed without discussing about them in the earlier sections. [Sathiyaseelan Rengaraju, India]	The section has broadly discussed about the SCE, SCD and SWE but have not accounted the contribution of Snowfall and snowmelt to the snow changes in any of the subsectoins. Later in section 9.5.4.5 -- page 86 -- line 14&15, the influence of snowfall and snowmelt over the snow changes has been discussed without discussing about them in the earlier sections.
33322	80		87		Section 9.5.4 (Snow) [or section 9.5.4.1; see comment 27 below] would be strengthened by including paleoclimate records of snow, such as: Belmecheri, S., Babst, F., Wahl, E. R., Stahle, D. W., & Trouet, V. (2016). Multi-century evaluation of Sierra Nevada snowpack. Nature Climate Change, 6(1), 2–3. https://doi.org/10.1038/nclimate2809 Pederson, G. T., Gray, S. T., Woodhouse, C. A., Betancourt, J. L., Fagre, D. B., Littell, J. S., … Graumlich, L. J. (2011). The unusual nature of recent snowpack declines in the North American Cordillera. Science, 333(6040), 332–335. https://doi.org/10.1126/science.1201570 [Erika Wise, United States of America]	Section 9.5.4 (Snow) [or section 9.5.4.1; see comment 27 below] would be strengthened by including paleoclimate records of snow, such as: Belmecheri, S., Babst, F., Wahl, E. R., Stahle, D. W., & Trouet, V. (2016). Multi-century evaluation of Sierra Nevada snowpack. Nature Climate Change, 6(1), 2–3. https://doi.org/10.1038/nclimate2809 Pederson, G. T., Gray, S. T., Woodhouse, C. A., Betancourt, J. L., Fagre, D. B., Littell, J. S., … Graumlich, L. J. (2011). The unusual nature of recent snowpack declines in the North American Cordillera. Science, 333(6040), 332–335. https://doi.org/10.1126/science.1201570
42588	81	0	81	0	This introductory section is succinct, well writen and informative. [Brian Menounos, Canada]	This introductory section is succinct, well writen and informative.
25422	81	1			Section 9.5.4.1 - Should make link to Chapter 2 which describes changes in snow cover extent etc. [Sharon Smith, Canada]	Section 9.5.4.1 - Should make link to Chapter 2 which describes changes in snow cover extent etc.
15118	81	3	81	3	Clarify that this is the maximum extent of snow cover. It would also be more intuitive to provide a percentage of the Northern Hemisphere land surface that is snow-covered. [Keith Jennings, United States of America]	Clarify that this is the maximum extent of snow cover. It would also be more intuitive to provide a percentage of the Northern Hemisphere land surface that is snow-covered.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
20352	81	3	81	4	Clarify whether these values are based on monthly mean variability of snow cover over the northern hemisphere land surface and give the observation period. [Gwenaelle GREMION, Canada]	Clarify whether these values are based on monthly mean variability of snow cover over the northern hemisphere land surface and give the observation period.
20354	81	4	81	4	The reference by Brown 2018 is missing in the reference list [Gwenaelle GREMION, Canada]	The reference by Brown 2018 is missing in the reference list
52524	81	9	81	12	Snow depth is also referred to here [John Brian Robin Matthews, France]	Snow depth is also referred to here
55986	81	9	81	12	Snow is described with three variables, SCE, SCD and SWE. I would say that snow depth is also an important variable. For a given SWE, snow depth can take different values depending on the snow density. Snow depth and density affect the soil energy transfer. So maybe snow depth could be introduced there? [Martin Ménégoz, France]	Snow is described with three variables, SCE, SCD and SWE. I would say that snow depth is also an important variable. For a given SWE, snow depth can take different values depending on the snow density. Snow depth and density affect the soil energy transfer. So maybe snow depth could be introduced there?
20356	81	10	81	11	Provide only the abbreviation for SP or SCD - unless there is a clear difference in meaning (in which case make this clear) keep to a single term subsequently in the report to avoid confusion. Currently both SCD and SP are used [Gwenaelle GREMION, Canada]	Provide only the abbreviation for SP or SCD - unless there is a clear difference in meaning (in which case make this clear) keep to a single term subsequently in the report to avoid confusion. Currently both SCD and SP are used
15120	81	11	81	11	Snow cover frequency is also commonly used. [Keith Jennings, United States of America]	Snow cover frequency is also commonly used.
8168	81	12	81	12	SWE also includes liquid water stored within the snowpack, so the definition here is not fully correct. [Samuel Morin, France]	SWE also includes liquid water stored within the snowpack, so the definition here is not fully correct.
55990	81	13	81	15	(-0.6 to -1.4 days per decade -> over which period? [Martin Ménégoz, France]	(-0.6 to -1.4 days per decade -> over which period?
28016	81	17	81	17	Page 81, line 17: Here is stated that the snow cover extent decreases for warming. But the snow cover has a variable extent over the season. So it is not clear for which time of the year this number is true. Is it about the maximum snow cover extent? AND: On page 81, line 37-39: The northern hemispheric snow cover extent sensitivity to warming is expressed here in km^2/K, while the rest of the chapter uses degrees Celsius as unit. Maybe change this to km^2/degree C. [roderik van de wal, Netherlands]	Page 81, line 17: Here is stated that the snow cover extent decreases for warming. But the snow cover has a variable extent over the season. So it is not clear for which time of the year this number is true. Is it about the maximum snow cover extent? AND: On page 81, line 37-39: The northern hemispheric snow cover extent sensitivity to warming is expressed here in km^2/K, while the rest of the chapter uses degrees Celsius as unit. Maybe change this to km^2/degree C.
20358	81	18	81	20	Is it possible to report the reduction of Artic snow extent as an area (m2 or km2) as well as a percentage? It would give the figure more meaning. [Gwenaelle GREMION, Canada]	Is it possible to report the reduction of Artic snow extent as an area (m2 or km2) as well as a percentage? It would give the figure more meaning.
25420	81	20	81	20	Should more recent State of Climate Report (Derksen et al. 2018) be cited here? [Sharon Smith, Canada]	Should more recent State of Climate Report (Derksen et al. 2018) be cited here?
20360	81	24	81	24	Mudryk et al. 2017 seems to be refereing to Thackeray et al. 2016. thus, you could cite Thackeray et al. 2016 directly [Gwenaelle GREMION, Canada]	Mudryk et al. 2017 seems to be refereing to Thackeray et al. 2016. thus, you could cite Thackeray et al. 2016 directly

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
20362	81	24	81	25	Mudryk et al. 2017 show positive SCE trends in fall, with an almost 0 trend in November and then again a slightly positive trend for the winter months, while strongest negative trends are observed in May-June (for period 1981-2010, Figure 1). These results seem to be consistent with findings in Hori et al. 2017 (Figure 10a). This does not really seem to agree with Figure 9.32...Can you explain this. In any case, the way the text is written right now, it sounds like what is provided in Figure 9.32 is consistent with the previously given references, but this does not seem to be the case. I would rephrase to make this clearer. [Gwenaelle GREMION, Canada]	Mudryk et al. 2017 show positive SCE trends in fall, with an almost 0 trend in November and then again a slightly positive trend for the winter months, while strongest negative trends are observed in May-June (for period 1981-2010, Figure 1). These results seem to be consistent with findings in Hori et al. 2017 (Figure 10a). This does not really seem to agree with Figure 9.32...Can you explain this. In any case, the way the text is written right now, it sounds like what is provided in Figure 9.32 is consistent with the previously given references, but this does not seem to be the case. I would rephrase to make this clearer.
51538	81	26	81	26	"SCE reductions of -3% to -5% per decade" -- while using 'reductions' in the sentence it is not necessary to denote the values with a negative sign [Sathiyaseelan Rengaraju, India]	"SCE reductions of -3% to -5% per decade" -- while using 'reductions' in the sentence it is not necessary to denote the values with a negative sign
20366	81	28	81	33	For me it would be more logic to move the paragraph on delayed snow cover onset in fall (page 9-82, lines 9-20) here. At this point i was wondering, why you did not mention the snow cover onset at all while for example Hori et al. 2017 state that "Delayed snow cover onset was observed to be the main driver of decreasing annual snow duration (SCD) trends."... [Gwenaelle GREMION, Canada]	For me it would be more logic to move the paragraph on delayed snow cover onset in fall (page 9-82, lines 9-20) here. At this point i was wondering, why you did not mention the snow cover onset at all while for example Hori et al. 2017 state that "Delayed snow cover onset was observed to be the main driver of decreasing annual snow duration (SCD) trends."...
20364	81	31	81	31	I agree with you that all spring SCD trends from all datasets are negative in Brown et al. 2017. When looking at their Table 3.1, the cited datasets all date back before 1980. It is not fully clear to me why you are setting the year 1980 as threshold between "very likely" and "medium confidence"? [Gwenaelle GREMION, Canada]	I agree with you that all spring SCD trends from all datasets are negative in Brown et al. 2017. When looking at their Table 3.1, the cited datasets all date back before 1980. It is not fully clear to me why you are setting the year 1980 as threshold between "very likely" and "medium confidence"?
20372	81	32	81	32	Write out northern hemisphere, instead of using the acronym NH. [Gwenaelle GREMION, Canada]	Write out northern hemisphere, instead of using the acronym NH.
20374	81	37	81	38	Replace units of K with degrees C, to be consistent with the units used elsewhere in the report. [Gwenaelle GREMION, Canada]	Replace units of K with degrees C, to be consistent with the units used elsewhere in the report.
15122	81	43	81	45	This statement makes it sound like modern snow cover is approximately the same as snow cover in th 1920s and 30s. The figures from the Brown and Robinson (2011) citation show significantly less snow in the early 2000s in April and slightly less in March. This section should be rewritten to reflect the downward trends. [Keith Jennings, United States of America]	This statement makes it sound like modern snow cover is approximately the same as snow cover in th 1920s and 30s. The figures from the Brown and Robinson (2011) citation show significantly less snow in the early 2000s in April and slightly less in March. This section should be rewritten to reflect the downward trends.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
42590	81	44	81	44	Unclear - Are you stating that SCE with uncertainties in the 20s and 30s was comparable to that of present day? If this is the case how does this affect attribution statement made earlier about clear link between extratropical warming and SCE decline? [Brian Menounos, Canada]	Unclear - Are you stating that SCE with uncertainties in the 20s and 30s was comparable to that of present day? If this is the case how does this affect attribution statement made earlier about clear link between extratropical warming and SCE decline?
20368	81	47	81	47	Make clear that this refers to spatial rather than temporal resolution [Gwenaelle GREMION, Canada]	Make clear that this refers to spatial rather than temporal resolution
8170	81	47	81	47	I suggest replacing "alpine" by "mountain". "Alpine" is generally not used for High Mountain Asia and South America, hence this statement could be considered geographically biased, which it is not. [Samuel Morin, France]	I suggest replacing "alpine" by "mountain". "Alpine" is generally not used for High Mountain Asia and South America, hence this statement could be considered geographically biased, which it is not.
20376	81	47	82	7	As currently stands, this section (9.5.4.1) is very long. I recommend moving the paragraph indicated here into a separate section that deals with limitations to current estimates. This new section could also include some aspects of the text from page 82 line 12 to page 82 line 17, and from page 82 line 28 to page 82 line 34. [Gwenaelle GREMION, Canada]	As currently stands, this section (9.5.4.1) is very long. I recommend moving the paragraph indicated here into a separate section that deals with limitations to current estimates. This new section could also include some aspects of the text from page 82 line 12 to page 82 line 17, and from page 82 line 28 to page 82 line 34.
20370	81	52	81	55	It should be 29 degree South, not 25 [Gwenaelle GREMION, Canada]	It should be 29 degree South, not 25
42592	81	53	81	53	Change '>' to 'above' [Brian Menounos, Canada]	Change '>' to 'above'
25424	81	54	81	54	"decrease in SP" better wording? [Sharon Smith, Canada]	"decrease in SP" better wording?
33342	81		83		There are paleoclimate studies of snow that could be integrated into section 9.5.4.1, including: Belmecheri, S., Babst, F., Wahl, E. R., Stahle, D. W., & Trouet, V. (2016). Multi-century evaluation of Sierra Nevada snowpack. Nature Climate Change, 6(1), 2–3. https://doi.org/10.1038/nclimate2809 Pederson, G. T., Gray, S. T., Woodhouse, C. A., Betancourt, J. L., Fagre, D. B., Littell, J. S., … Graumlich, L. J. (2011). The unusual nature of recent snowpack declines in the North American Cordillera. Science, 333(6040), 332–335. https://doi.org/10.1126/science.1201570 [Erika Wise, United States of America]	There are paleoclimate studies of snow that could be integrated into section 9.5.4.1, including: Belmecheri, S., Babst, F., Wahl, E. R., Stahle, D. W., & Trouet, V. (2016). Multi-century evaluation of Sierra Nevada snowpack. Nature Climate Change, 6(1), 2–3. https://doi.org/10.1038/nclimate2809 Pederson, G. T., Gray, S. T., Woodhouse, C. A., Betancourt, J. L., Fagre, D. B., Littell, J. S., … Graumlich, L. J. (2011). The unusual nature of recent snowpack declines in the North American Cordillera. Science, 333(6040), 332–335. https://doi.org/10.1126/science.1201570
20378	82	2	82	3	I think you should be a bit more specific regarding the mentioned negative trends for the European Alps by Hüsler et al. 2014 - Actually these authors report significant trends toward a shorter SCD at lower elevations in the south-east and south-west. However, they do not find any significant trends in the monthly mean SCA over the last 27 yr.... [Gwenaelle GREMION, Canada]	I think you should be a bit more specific regarding the mentioned negative trends for the European Alps by Hüsler et al. 2014 - Actually these authors report signi?cant trends toward a shorter SCD at lower elevations in the south-east and south-west. However, they do not find any signi?cant trends in the monthly mean SCA over the last 27 yr....
8174	82	3	82	5	Statement will need to be updated based on SROCC Final report. [Samuel Morin, France]	Statement will need to be updated based on SROCC Final report.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
15124	82	9	82	20	This paragraph could be deleted if more space is needed. It is highly uncertain as to what effect, if any, Oct/Nov snow cover has on the planet's energy budget and hydrologic cycle. [Keith Jennings, United States of America]	This paragraph could be deleted if more space is needed. It is highly uncertain as to what effect, if any, Oct/Nov snow cover has on the planet's energy budget and hydrologic cycle.
8172	82	17	82	17	"must be paid" -> this is policy-prescriptive. [Samuel Morin, France]	"must be paid" -> this is policy-prescriptive.
20380	82	22	82	24	Mudryk et al. 2018 focus on Canada (as already the title of their publication suggests). They do not address Eurasia and the US. [Gwenaelle GREMION, Canada]	Mudryk et al. 2018 focus on Canada (as already the title of their publication suggests). They do not address Eurasia and the US.
15126	82	22	82	26	Although noted later in the chapter, it should be made abundantly clear here that passive microwave sensors cannot estimate SWE in mountainous and/or forested terrain and deep snowpacks. [Keith Jennings, United States of America]	Although noted later in the chapter, it should be made abundantly clear here that passive microwave sensors cannot estimate SWE in mountainous and/or forested terrain and deep snowpacks.
42594	82	22	82	26	Can you provide more details about the reanalysis products? Are there some months with better agreement than others? Do new reanalysis (e.g. ERA5) do a better job than others? Do these differences stem from differences in data assimilation (4D-var vs. 3D)? If these components are dealth with some other place alert the reader via cross referencing that portion of the report. It's important as these reanalysis products often incorporate similar physics to GCMs and so provide a way to evaluate strengh/weakness in prepresenting physical processes and feedbacks. [Brian Menounos, Canada]	Can you provide more details about the reanalysis products? Are there some months with better agreement than others? Do new reanalysis (e.g. ERA5) do a better job than others? Do these differences stem from differences in data assimilation (4D-var vs. 3D)? If these components are dealth with some other place alert the reader via cross referencing that portion of the report. It's important as these reanalysis products often incorporate similar physics to GCMs and so provide a way to evaluate strengh/weakness in prepresenting physical processes and feedbacks.
20382	82	24	82	26	I agree that Liston and Hiemstra 2011 report considerable regional and inter-dataset variability. However, they state that "Both positive and negative regional trends are distributed throughout the pan-Arctic domain, featuring, for example, spatially distinct areas of increasing and decreasing SWE or snow season length. In spite of strong regional variability, the data clearly show a general snow decrease throughout the Arctic: maximum winter SWE has decreased, snow-cover onset is later, the snow-free date in spring is earlier, and snow-cover duration has decreased." --> In my opinion, the authors do not seem to have only limited confidence in the general global trends [Gwenaelle GREMION, Canada]	I agree that Liston and Hiemstra 2011 report considerable regional and inter-dataset variability. However, they state that "Both positive and negative regional trends are distributed throughout the pan-Arctic domain, featuring, for example, spatially distinct areas of increasing and decreasing SWE or snow season length. In spite of strong regional variability, the data clearly show a general snow decrease throughout the Arctic: maximum winter SWE has decreased, snow-cover onset is later, the snow-free date in spring is earlier, and snow-cover duration has decreased." --> In my opinion, the authors do not seem to have only limited confidence in the general global trends
20384	82	24	82	26	Park et al. 2012 do not directly address the SWE (though they use it to infer snow depth). Therefore, in my opinion it is not the most suited reference at this point. [Gwenaelle GREMION, Canada]	Park et al. 2012 do not directly address the SWE (though they use it to infer snow depth). Therefore, in my opinion it is not the most suited reference at this point.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
13724	82	25			Hazards to mention fromloss of high-latitude permafrost include damage to roads, building and infrastructure used by local people and energy/mining industry most notably in Russia, Alaska and Canada's sub-Arctic land in the Yukon, NW Territories and Nunavut [Simon Donner, Canada]	Hazards to mention fromloss of high-latitude permafrost include damage to roads, building and infrastructure used by local people and energy/mining industry most notably in Russia, Alaska and Canada's sub-Arctic land in the Yukon, NW Territories and Nunavut
20386	82	31	82	32	The reference by Maksyutova et al. 2012 is missing in the reference list [Gwenaelle GREMION, Canada]	The reference by Maksyutova et al. 2012 is missing in the reference list
20388	82	37	82	37	[FIGURE 9.32] Needs to display locations in Figure title. [Gwenaelle GREMION, Canada]	[FIGURE 9.32] Needs to display locations in Figure title.
15128	82	39	82	40	This figure should focus on SCE, as the snow mass estimates from the NOAA product are at too large a spatial scale to have any sort of physical meaning. [Keith Jennings, United States of America]	This figure should focus on SCE, as the snow mass estimates from the NOAA product are at too large a spatial scale to have any sort of physical meaning.
25426	82	39			Figure 9.32 Doesn't fall SCE (Oct) extent have opposite trend (I plotted data from NOAA website for Oct and got + trend) - was there a correction made with the data by the authors? [Sharon Smith, Canada]	Figure 9.32 Doesn't fall SCE (Oct) extent have opposite trend (I plotted data from NOAA website for Oct and got + trend) - was there a correction made with the data by the authors?
33340	82	45	82	46	Stating that a whole suite of products "fail completely" is a very strong claim. Suggest backing this up with citations. [Erika Wise, United States of America]	Stating that a whole suite of products "fail completely" is a very strong claim. Suggest backing this up with citations.
55992	82	45	83	4	The difficulty to assess snow cover changes in mountainous areas is described there. Some information related to snow cover changes in Northern and Southern America is described. I would include just a small sentence saying that snow cover is also decreasing in the European Alps, but with a signal that is not significant all over this mountain range because of a large interannual to decadal natural variability (Beniston et al., 2018). I would also mention that the lack of reliable observational data before the years 2000s strongly limit the possibility to investigate snow cover trends in the Himalaya. Nevertheless, the retreat of the glaciers in this area suggest that snow cover have been also retreating over the last decades. [Martin Ménégoz, France]	The difficulty to assess snow cover changes in mountainous areas is described there. Some information related to snow cover changes in Northern and Southern America is described. I would include just a small sentence saying that snow cover is also decreasing in the European Alps, but with a signal that is not significant all over this mountain range because of a large interannual to decadal natural variability (Beniston et al., 2018). I would also mention that the lack of reliable observational data before the years 2000s strongly limit the possibility to investigate snow cover trends in the Himalaya. Nevertheless, the retreat of the glaciers in this area suggest that snow cover have been also retreating over the last decades.
20396	82	46	82	46	The term "complex terrain" is not clear - it may be better and more accurate to use "high relief" instead. [Gwenaelle GREMION, Canada]	The term "complex terrain" is not clear - it may be better and more accurate to use "high relief" instead.
15130	82	47	82	48	Relevant literature should be cited here. E.g. Molotch, N. P., & Bales, R. C. (2006). SNOTEL representativeness in the Rio Grande headwaters on the basis of physiographics and remotely sensed snow cover persistence. Hydrological Processes: An International Journal, 20(4), 723-739. [Keith Jennings, United States of America]	Relevant literature should be cited here. E.g. Molotch, N. P., & Bales, R. C. (2006). SNOTEL representativeness in the Rio Grande headwaters on the basis of physiographics and remotely sensed snow cover persistence. Hydrological Processes: An International Journal, 20(4), 723-739.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
20398	82	49	82	51	The gradients in temperature and precipitation are driven by elevation changes, rather than the other way around - unless you mean the changes in SWE observed as elevation changes. [Gwenaelle GREMION, Canada]	The gradients in temperature and precipitation are driven by elevation changes, rather than the other way around - unless you mean the changes in SWE observed as elevation changes.
20400	82	51	82	51	Rephrase the end of this sentence as "and both the amount and phase of precipitation (Sospedra-Alfonso et al. 2015). [Gwenaelle GREMION, Canada]	Rephrase the end of this sentence as "and both the amount and phase of precipitation (Sospedra-Alfonso et al. 2015).
42596	82	52	82	52	Some key references missing here that deal with reasons why snow pack might be declining in places like western NA. Luce et al., 2013 DOI: 10.1126/science.1242335. [Brian Menounos, Canada]	Some key references missing here that deal with reasons why snow pack might be declining in places like western NA. Luce et al., 2013 DOI: 10.1126/science.1242335.
20390	82	52	82	52	The refererence by Marty et al. 2017 is missing in the reference list [Gwenaelle GREMION, Canada]	The refererence by Marty et al. 2017 is missing in the reference list
20392	82	54	82	54	The reference by Mote et al. 2018 is missing in the reference list [Gwenaelle GREMION, Canada]	The reference by Mote et al. 2018 is missing in the reference list
20394	82	55	83	1	Beside satellite-borne measurements you should mention models here. Otherwise, the way this paragraph on SWE trends in alpine regions is written, it is a bit confusing. At the beginning (page 9-82 lines 45-46) you state that SWE products from (passive microwave) satellite observations are too coarse in spatial resolution. Here you now talk about SWE series in the Andes saying that they are mostly restricted to satellite-borne measurements... In fact, the study by Cornwell et al. 2016 that you cite in the following is using MODIS data to estimate the fractional snow-covered area (visible and shortwave infrared ranges that is available at much finer spatial resolutions than passive microwave satellite data) together with other forcings and a model in order to simulate SWE... [Gwenaelle GREMION, Canada]	Beside satellite-borne measurements you should mention models here. Otherwise, the way this paragraph on SWE trends in alpine regions is written, it is a bit confusing. At the beginning (page 9-82 lines 45-46) you state that SWE products from (passive microwave) satellite observations are too coarse in spatial resolution. Here you now talk about SWE series in the Andes saying that they are mostly restricted to satellite-borne measurements... In fact, the study by Cornwell et al. 2016 that you cite in the following is using MODIS data to estimate the fractional snow-covered area (visible and shortwave infrared ranges that is available at much finer spatial resolutions than passive microwave satellite data) together with other forcings and a model in order to simulate SWE...
8176	83	7	83	46	I think this section needs a lot of modifications. While I agree with most of the statements, I don't think the content is relevant to the scope of this IPCC report. Indeed, this provides general information about snow observations and modelling, but it provides limited added value in the climate change context. The part starting on line 37 seems better aligned to what I expect to read in an IPCC report (the material above I expect to find in review papers about snow cover physics, modelling and forecasting, potentially independent on climate change). [Samuel Morin, France]	I think this section needs a lot of modifications. While I agree with most of the statements, I don't think the content is relevant to the scope of this IPCC report. Indeed, this provides general information about snow observations and modelling, but it provides limited added value in the climate change context. The part starting on line 37 seems better aligned to what I expect to read in an IPCC report (the material above I expect to find in review papers about snow cover physics, modelling and forecasting, potentially independent on climate change).
42598	83	9	83	9	If acronym 'LiDAR' is used it should be defined. [Brian Menounos, Canada]	If acronym 'LiDAR' is used it should be defined.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
20402	83	9	83	17	I think it would be worth noting the work by Lievens et al. They are creating SWE/snow depth products at 1km spatial resolution and 6 day repeat cycle from Sentinel-1 data which looks very promising in my opinion. A publication that could be cited is underway: Lievens, H., Demuzere, M., Marshall, H.-P., Reichle, R. H., Brucker, L., Brangers, I., de Rosnay, P., Dumont, M., Girotto, M., Immerzeel, W. W., Jonas, T., Kim, E. J., Koch, I., Marty, C., Saloranta, T., Schöber, J., and De Lannoy, G. J. M., Snow depth variability in the Northern Hemisphere mountains observed from space, Nature Communications, in review, 2019. [Gwenaelle GREMION, Canada]	I think it would be worth noting the work by Lievens et al. They are creating SWE/snow depth products at 1km spatial resolution and 6 day repeat cycle from Sentinel-1 data which looks very promising in my opinion. A publication that could be cited is underway: Lievens, H., Demuzere, M., Marshall, H.-P., Reichle, R. H., Brucker, L., Brangers, I., de Rosnay, P., Dumont, M., Girotto, M., Immerzeel, W. W., Jonas, T., Kim, E. J., Koch, I., Marty, C., Saloranta, T., Schöber, J., and De Lannoy, G. J. M., Snow depth variability in the Northern Hemisphere mountains observed from space, Nature Communications, in review, 2019.
20414	83	10	83	10	The term "complex terrain" is not clear - it may be better and more accurate to use "high relief" instead. [Gwenaelle GREMION, Canada]	The term "complex terrain" is not clear - it may be better and more accurate to use "high relief" instead.
20404	83	13	83	13	The reference by Bokhorst et al. 2016 is missing in the reference list [Gwenaelle GREMION, Canada]	The reference by Bokhorst et al. 2016 is missing in the reference list
42600	83	16	83	17	Snow could be part of the information box for readers (also proposed for glaciers and permafrost) where major processes/feedback and undertainties could be identified. [Brian Menounos, Canada]	Snow could be part of the information box for readers (also proposed for glaciers and permafrost) where major processes/feedback and undertainties could be identified.
20406	83	17	83	17	The reference by Qian et al. 2015 is missing in the reference list [Gwenaelle GREMION, Canada]	The reference by Qian et al. 2015 is missing in the reference list
15132	83	19	83	24	This statement does not make it clear that this information is important to passive and active microwave retrievals of snow depth and mass. [Keith Jennings, United States of America]	This statement does not make it clear that this information is important to passive and active microwave retrievals of snow depth and mass.
20408	83	24	83	24	The reference by Domine et al. 2016 is missing in the reference list [Gwenaelle GREMION, Canada]	The reference by Domine et al. 2016 is missing in the reference list
20410	83	28	83	28	The references by Aas et al. 2017 and Boone et al. 2017 are missing in the reference list [Gwenaelle GREMION, Canada]	The references by Aas et al. 2017 and Boone et al. 2017 are missing in the reference list
15134	83	33	83	35	If this has a more direct bearing on snow and climate change, please clarify that these multi-physics models allow for better representation of snow processes and that they can identify shortcomings in other models. [Keith Jennings, United States of America]	If this has a more direct bearing on snow and climate change, please clarify that these multi-physics models allow for better representation of snow processes and that they can identify shortcomings in other models.
28208	83	37	83	46	Possible overlap with section 7.4.2.3 (Surface albedo feedback) - make reference to that section here and decide where this material best fits. [Chad Thackeray, United States of America]	Possible overlap with section 7.4.2.3 (Surface albedo feedback) - make reference to that section here and decide where this material best fits.
20416	83	41	83	42	I suggest clarifying that spring peak in snow shortwave radiative effect is due to rapidly increasing solar radiation at this time of year. [Gwenaelle GREMION, Canada]	I suggest clarifying that spring peak in snow shortwave radiative effect is due to rapidly increasing solar radiation at this time of year.
20412	83	45	83	45	The reference by Perket et al. 2014 is missing in the reference list [Gwenaelle GREMION, Canada]	The reference by Perket et al. 2014 is missing in the reference list

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
55994	84	1	84	10	It could be mentionned here that subgridscale parameterisation is a strategy that will be probably more used to describe the spatial heterogeneity in climate models, used for example to simulate the dependance of the snow cover to the altitude and the orientation (e.g. Younas et al., 2017); Younas, W., Hay, R.W., MacDonald, M.K., ul ISLAM, S. and Déry, S.J., 2017. A strategy to represent impacts of subgrid-scale topography on snow evolution in the Canadian Land Surface Scheme. Annals of Glaciology, 58(75pt1), pp.1-10. [Martin Ménégoz, France]	It could be mentionned here that subgridscale parameterisation is a strategy that will be probably more used to describe the spatial heterogeneity in climate models, used for example to simulate the dependance of the snow cover to the altitude and the orientation (e.g. Younas et al., 2017); Younas, W., Hay, R.W., MacDonald, M.K., ul ISLAM, S. and Déry, S.J., 2017. A strategy to represent impacts of subgrid-scale topography on snow evolution in the Canadian Land Surface Scheme. Annals of Glaciology, 58(75pt1), pp.1-10.
55996	84	1	84	55	The Figure 9.33 is not commented [Martin Ménégoz, France]	The Figure 9.33 is not commented
42602	84	2	84	6	Cross reference these points about permafrost to the points about snowcover in previous section of the report [Brian Menounos, Canada]	Cross reference these points about permafrost to the points about snowcover in previous section of the report
20420	84	2	84	10	You could possibly cross-link to section 9.5.3.2 in the permafrost chapter where the issue is also addressed with respect to correct representation of permafrost extent (page 9-79, lines 10-14 and lines 36-40). [Gwenaelle GREMION, Canada]	You could possibly cross-link to section 9.5.3.2 in the permafrost chapter where the issue is also addressed with respect to correct representation of permafrost extent (page 9-79, lines 10-14 and lines 36-40).
42604	84	12	84	12	People have relationships, data have relations with other datasets [Brian Menounos, Canada]	People have relationships, data have relations with other datasets
42606	84	12	84	18	Somewhat unclear. I presume that the negative bias in sensitivity is due to the factors listed in the next two sentences but it's not clear if this is what was implied. Better linkages between statements are needed [Brian Menounos, Canada]	Somewhat unclear. I presume that the negative bias in sensitivity is due to the factors listed in the next two sentences but it's not clear if this is what was implied. Better linkages between statements are needed
20422	84	16	84	17	The references by Qu and Hall 2014 and Thackeray et al. 2015 are missing in the reference list [Gwenaelle GREMION, Canada]	The references by Qu and Hall 2014 and Thackeray et al. 2015 are missing in the reference list
28210	84	16	84	20	The citations for Thackeray et al. 2015 and Thackeray and Fletcher, 2016* should be switched. Thackeray and Fletcher (2016) show the 40% reduced spread in NH land warming, while Thackeray et al. (2015) reveal positive albedo biases over the boreal forest. [Chad Thackeray, United States of America]	The citations for Thackeray et al. 2015 and Thackeray and Fletcher, 2016* should be switched. Thackeray and Fletcher (2016) show the 40% reduced spread in NH land warming, while Thackeray et al. (2015) reveal positive albedo biases over the boreal forest.
20430	84	22	84	22	The use of "misfits" is a poor word choice - "outliers" would be better. [Gwenaelle GREMION, Canada]	The use of "misfits" is a poor word choice - "outliers" would be better.
20432	84	23	84	23	I'm unclear what the term "snow metamorphosis" means. [Gwenaelle GREMION, Canada]	I'm unclear what the term "snow metamorphosis" means.
15136	84	23	84	24	This should say "snow grain metamorphosis" [Keith Jennings, United States of America]	This should say "snow grain metamorphosis"
42608	84	24	84	24	Can you let reader know what third pole estimates are so bad? Since there's a semicolon linking this statement and previous one, maybe use 'for example' to make link clear [Brian Menounos, Canada]	Can you let reader know what third pole estimates are so bad? Since there's a semicolon linking this statement and previous one, maybe use 'for example' to make link clear

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
20434	84	24	84	24	Does the Third Pole area refer to high-elevation mountain regions? If so, it would be better to state this clearly. [Gwenaelle GREMION, Canada]	Does the Third Pole area refer to high-elevation mountain regions? If so, it would be better to state this clearly.
25428	84	26	84	26	Acronym SAF been defined? [Sharon Smith, Canada]	Acronym SAF been defined?
20424	84	26	84	26	define SAF [Gwenaelle GREMION, Canada]	define SAF
20436	84	26	84	26	Define SAF here. [Gwenaelle GREMION, Canada]	Define SAF here.
15138	84	27	84	28	More material is needed here as the snow albedo feedback is a critical component of climate change modeling. If some models improved while others worsened, it sounds like no improvements were made in aggregate for CMIP5 relative to 3. Can most current-generation climate models accurately simulate the snow-albedo feedback? [Keith Jennings, United States of America]	More material is needed here as the snow albedo feedback is a critical component of climate change modeling. If some models improved while others worsened, it sounds like no improvements were made in aggregate for CMIP5 relative to 3. Can most current-generation climate models accurately simulate the snow-albedo feedback?
20426	84	30	84	32	Brutel-Vuilmet et al. 2013 does not seem the most suited reference here - they do not address the SWE [Gwenaelle GREMION, Canada]	Brutel-Vuilmet et al. 2013 does not seem the most suited reference here - they do not address the SWE
15140	84	30	84	36	This should be rewritten for clarity. I.e., "In cold regions [give a temperature value] SWE changes are predominantly a function of precipitation, while SWE changes in warm regions are controlled by air temperature." [Keith Jennings, United States of America]	This should be rewritten for clarity. I.e., "In cold regions [give a temperature value] SWE changes are predominantly a function of precipitation, while SWE changes in warm regions are controlled by air temperature."
15142	84	30	84	36	Variability in SWE declines can also be due to relative humidity: Harpold, A. A., & Brooks, P. D. (2018). Humidity determines snowpack ablation under a warming climate. Proceedings of the National Academy of Sciences, 115(6), 1215-1220. [Keith Jennings, United States of America]	Variability in SWE declines can also be due to relative humidity: Harpold, A. A., & Brooks, P. D. (2018). Humidity determines snowpack ablation under a warming climate. Proceedings of the National Academy of Sciences, 115(6), 1215-1220.
20418	84	41	84	41	[FIGURE 9.33] Aren’t coordinates needed in this figure? [Gwenaelle GREMION, Canada]	[FIGURE 9.33] Aren’t coordinates needed in this figure?
15144	84	43	84	45	Given the minimal figure space, I don't see why 9.33 would be devoted to just showing the areas with greater than 5 mm of Mar/Apr SWE. Consider a different figure that would show changes in observed and/or modeled SWE from multiple papers (e.g., the already cited Mote et al. (2018) and Beniston et al. (2018) works). [Keith Jennings, United States of America]	Given the minimal figure space, I don't see why 9.33 would be devoted to just showing the areas with greater than 5 mm of Mar/Apr SWE. Consider a different figure that would show changes in observed and/or modeled SWE from multiple papers (e.g., the already cited Mote et al. (2018) and Beniston et al. (2018) works).

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
55998	84	50	84	50	I wonder whether it is a choice to not include a statement about aerosol forcing : total aerosol forcing cool the atmosphere, a process that might increase the snow cover extent, but this is partly compensated by the deposition of black carbon on snow that can decrease the snow cover duration by several days per year (e.g. Flanner et al., 2009, Ménégoz et al., 2013, 2014; Skiles et al., 2018). The comparison between these two effects is described in Quinn et al., (2008). Flanner, M. G., Zender, C. S., Hess, P. G., Mahowald, N. M., Painter, T. H., Ramanathan, V., and Rasch, P. J.: Springtime warming and reduced snow cover from carbonaceous particles, Atmos. Chem. Phys., 9, 2481-2497, https://doi.org/10.5194/acp-9-2481-2009, 2009. Quinn, P.K., Bates, T.S., Baum, E., Doubleday, N., Fiore, A.M., Flanner, M., Fridlind, A., Garrett, T.J., Koch, D., Menon, S. and Shindell, D., 2008. Short-lived pollutants in the Arctic: their climate impact and possible mitigation strategies. Atmospheric Chemistry and Physics, 8(6), pp.1723-1735.; Skiles, S.M., Flanner, M., Cook, J.M., Dumont, M. and Painter, T.H., 2018. Radiative forcing by light-absorbing particles in snow. Nature Climate Change, p.1. Ménégoz, M., Krinner, G., Balkanski, Y., Cozic, A., Boucher, O., and Ciais, P., 2013a: Boreal and temperate snow cover variations induced by black carbon emissions in the middle of the 21st century, The Cryosphere, 7, 537-554; Ménégoz, M., Krinner, G., Balkanski, Y., Boucher, O., Cozic, A., Lim, S., Ginot, P., Laj, P., Gallée, H., Wagnon, P., Marinoni, A. and Jacobi, H.W., 2014: Snow cover sensitivity to black carbon deposition in the Himalaya : from atmospheric and ice core measurements to regional climate simulations, Atmos. Chem. Phys., 14, 4237-4249; [Martin Ménégoz, France]	I wonder whether it is a choice to not include a statement about aerosol forcing : total aerosol forcing cool the atmosphere, a process that might increase the snow cover extent, but this is partly compensated by the deposition of black carbon on snow that can decrease the snow cover duration by several days per year (e.g. Flanner et al., 2009, Ménégoz et al., 2013, 2014; Skiles et al., 2018). The comparison between these two effects is described in Quinn et al., (2008). Flanner, M. G., Zender, C. S., Hess, P. G., Mahowald, N. M., Painter, T. H., Ramanathan, V., and Rasch, P. J.: Springtime warming and reduced snow cover from carbonaceous particles, Atmos. Chem. Phys., 9, 2481-2497, https://doi.org/10.5194/acp-9-2481-2009, 2009. Quinn, P.K., Bates, T.S., Baum, E., Doubleday, N., Fiore, A.M., Flanner, M., Fridlind, A., Garrett, T.J., Koch, D., Menon, S. and Shindell, D., 2008. Short-lived pollutants in the Arctic: their climate impact and possible mitigation strategies. Atmospheric Chemistry and Physics, 8(6), pp.1723-1735.; Skiles, S.M., Flanner, M., Cook, J.M., Dumont, M. and Painter, T.H., 2018. Radiative forcing by light-absorbing particles in snow. Nature Climate Change, p.1. Ménégoz, M., Krinner, G., Balkanski, Y., Cozic, A., Boucher, O., and Ciais, P., 2013a: Boreal and temperate snow cover variations induced by black carbon emissions in the middle of the 21st century,
20438	84	52	84	52	The statement "The physical consistency of the joint evolutions of spring snowpack and surface temperature both in observations and models…" is unclear. [Gwenaelle GREMION, Canada]	The statement "The physical consistency of the joint evolutions of spring snowpack and surface temperature both in observations and models…" is unclear.
20428	84	52	85	14	The two paragraphs are basically the same except for one part of a sentence (page 9-85, lines 1-2 versus page lines 10-12). I prefer the second option [Gwenaelle GREMION, Canada]	The two paragraphs are basically the same except for one part of a sentence (page 9-85, lines 1-2 versus page lines 10-12). I prefer the second option
20440	84	54	84	54	Instead of "that season", specify "spring" instead. [Gwenaelle GREMION, Canada]	Instead of "that season", specify "spring" instead.
52188	84	55			chapter 3 not chapter 2 and note that two versions of this same paragraph have been retained. [Peter Thorne, Ireland]	chapter 3 not chapter 2 and note that two versions of this same paragraph have been retained.
15146	85	1	85	4	More work should be presented here and the British Columbia sentence can be deleted unless it's presented with additional regional information. Example citation: Pierce, D. W., Barnett, T. P., Hidalgo, H. G., Das, T., Bonfils, C., Santer, B. D., ... & Wood, A. W. (2008). Attribution of declining western US snowpack to human effects. Journal of Climate, 21(23), 6425-6444. [Keith Jennings, United States of America]	More work should be presented here and the British Columbia sentence can be deleted unless it's presented with additional regional information. Example citation: Pierce, D. W., Barnett, T. P., Hidalgo, H. G., Das, T., Bonfils, C., Santer, B. D., ... & Wood, A. W. (2008). Attribution of declining western US snowpack to human effects. Journal of Climate, 21(23), 6425-6444.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
20454	85	3	85	4	This sentence states that spring snowpack decline can be attributed to human influence in British Columbia, Canada. Has this not been demonstrated in any other regions of the globe? [Gwenaelle GREMION, Canada]	This sentence states that spring snowpack decline can be attributed to human influence in British Columbia, Canada. Has this not been demonstrated in any other regions of the globe?
15148	85	6	85	14	Delete. Repeat of previous paragraph. [Keith Jennings, United States of America]	Delete. Repeat of previous paragraph.
42610	85	6	85	14	Repeated paragraph [Brian Menounos, Canada]	Repeated paragraph
20456	85	6	85	14	This paragraph is a duplicate of the preceding paragraph, and can be deleted. [Gwenaelle GREMION, Canada]	This paragraph is a duplicate of the preceding paragraph, and can be deleted.
28212	85	17			Relevant to this section is the use of emergent constraints as a way to potentially reduce intermodel spread in projections. Possibly following Line 32. [Chad Thackeray, United States of America]	Relevant to this section is the use of emergent constraints as a way to potentially reduce intermodel spread in projections. Possibly following Line 32.
20458	85	19	85	20	Throughout this section, the terms ensemble and subensemble have been used extensively to refer to collections of models. This wording does not seem correct to me. [Gwenaelle GREMION, Canada]	Throughout this section, the terms ensemble and subensemble have been used extensively to refer to collections of models. This wording does not seem correct to me.
15150	85	19	85	22	Paragraph can be deleted (it is very procedural) unless it is accompanied by further information on actual research findings. [Keith Jennings, United States of America]	Paragraph can be deleted (it is very procedural) unless it is accompanied by further information on actual research findings.
20442	85	22	85	22	The reference by Gutowski et al. 2016 is missing in the reference list [Gwenaelle GREMION, Canada]	The reference by Gutowski et al. 2016 is missing in the reference list
20460	85	22	85	22	A definition for CORDEX would be helpful here. [Gwenaelle GREMION, Canada]	A definition for CORDEX would be helpful here.
42612	85	24	85	29	Complex sentence and difficult to read. I'm not entirely certain I understand what it's trying to state. [Brian Menounos, Canada]	Complex sentence and difficult to read. I'm not entirely certain I understand what it's trying to state.
20444	85	37	85	37	In the figure, I would change the x-axis title to say that it's the difference from the average, not clear as it is. It could be something like: "GMAT change wrt. 1995-2014 mean". [Gwenaelle GREMION, Canada]	In the figure, I would change the x-axis title to say that it's the difference from the average, not clear as it is. It could be something like: "GMAT change wrt. 1995-2014 mean".

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
8178	85	48	86	16	I suggest trying to better distinguish between elevation dependency in future snow cover changes, simply due to the fact that there is a vertical gradient of temperature, hence snow/rain partitioning, which will shift due to future climate change (1st order effect), and a potentiall elevation dependency of the near surface atmospheric warming rate, which is more heterogenous depending on locations and seasons, features a lower confidence altogether and operates at 2nd order, in addition to general warming. SROCC Chapter 2 has attempted to assess this as clearly as possible, to avoid ambiguity in the use of the "EDW" term (warming is not necessarily higher at higher elevation), and to avoid focusing on this particular phenomenon, instead of addressing the first order impact of warming on rain/snow partitioning and snowmelt intensity. [Samuel Morin, France]	I suggest trying to better distinguish between elevation dependency in future snow cover changes, simply due to the fact that there is a vertical gradient of temperature, hence snow/rain partitioning, which will shift due to future climate change (1st order effect), and a potentiall elevation dependency of the near surface atmospheric warming rate, which is more heterogenous depending on locations and seasons, features a lower confidence altogether and operates at 2nd order, in addition to general warming. SROCC Chapter 2 has attempted to assess this as clearly as possible, to avoid ambiguity in the use of the "EDW" term (warming is not necessarily higher at higher elevation), and to avoid focusing on this particular phenomenon, instead of addressing the first order impact of warming on rain/snow partitioning and snowmelt intensity.
20446	85	50	85	50	I don't understand "by a large ensemble of one model", is it a large ensemble of scenarios? [Gwenaelle GREMION, Canada]	I don't understand "by a large ensemble of one model", is it a large ensemble of scenarios?
20448	85	54	85	54	The reference by Pepin et al. 2015 is missing in the reference list [Gwenaelle GREMION, Canada]	The reference by Pepin et al. 2015 is missing in the reference list
20450	85	55	85	55	The reference by Zazulie et al. 2017 is missing in the reference list. Zazulie et al. published the following article in 2017: 'Regional climate of the subtropical central Andes using high-resolution CMIP5 models—part I: past performance (1980–2005)'. But the content of your sentence seems to be taken from ' Regional climate of the Subtropical Central Andes using high-resolution CMIP5 models. Part II: future projections for the twenty-first century' published by Zazulie et al. in 2018 (in Climate Dynamics) [Gwenaelle GREMION, Canada]	The reference by Zazulie et al. 2017 is missing in the reference list. Zazulie et al. published the following article in 2017: 'Regional climate of the subtropical central Andes using high-resolution CMIP5 models—part I: past performance (1980–2005)'. But the content of your sentence seems to be taken from ' Regional climate of the Subtropical Central Andes using high-resolution CMIP5 models. Part II: future projections for the twenty-first century' published by Zazulie et al. in 2018 (in Climate Dynamics)
20452	85	55	86	1	clarify whether "high resolution" refers to spatial resolution, temporal resolution or both [Gwenaelle GREMION, Canada]	clarify whether "high resolution" refers to spatial resolution, temporal resolution or both
15152	86	1	86	1	Clarify whether this is maximum snow depth or another metric. [Keith Jennings, United States of America]	Clarify whether this is maximum snow depth or another metric.
42614	86	4	86	7	The authors describe projected changes in the freezing altitude. As mentioned for glaciers and permafrost it might be useful to think about a graph that shows projected changes in isotherm vs. elevation and areas for different regions [Brian Menounos, Canada]	The authors describe projected changes in the freezing altitude. As mentioned for glaciers and permafrost it might be useful to think about a graph that shows projected changes in isotherm vs. elevation and areas for different regions

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
20478	86	8	86	10	In this sentence, it says that total compensation remains a possibility in the Scandinavian mountains. Instead of saying compensation, it would be better to clarify that there is no net decrease due to increased snowfall. [Gwenaelle GREMION, Canada]	In this sentence, it says that total compensation remains a possibility in the Scandinavian mountains. Instead of saying compensation, it would be better to clarify that there is no net decrease due to increased snowfall.
15154	86	12	86	13	Specify that the declines are in maximum SWE and SCD. [Keith Jennings, United States of America]	Specify that the declines are in maximum SWE and SCD.
20462	86	14	86	16	I could not find the here provided information in Pepin et al. 2015. But as you state on page 9-86, lines 8-10, Beniston et al. 2018 address the issue. However, in their article beside the information you give, I also found the following ' Only the higher and colder regions of the Fennoscandian mountains exhibit positive trends of maximum snow depth and maximum SWE, although trends have recently become negative in these regions too (Johansson et al., 2011; Skaugen et al.,2012; Dyrrdal et al., 2013; Kivinen and Rasmus, 2015).' Hence I support your attribution of low confidence to the subject. [Gwenaelle GREMION, Canada]	I could not find the here provided information in Pepin et al. 2015. But as you state on page 9-86, lines 8-10, Beniston et al. 2018 address the issue. However, in their article beside the information you give, I also found the following ' Only the higher and colder regions of the Fennoscandian mountains exhibit positive trends of maximum snow depth and maximum SWE, although trends have recently become negative in these regions too (Johansson et al., 2011; Skaugen et al.,2012; Dyrrdal et al., 2013; Kivinen and Rasmus, 2015).' Hence I support your attribution of low confidence to the subject.
25430	86	18	86	21	There didn't seem to be much discussion of southern hemisphere - can any conclusions be made about snow cover there? [Sharon Smith, Canada]	There didn't seem to be much discussion of southern hemisphere - can any conclusions be made about snow cover there?
20464	86	18	86	21	Does this conclusion include Oceanic Oscillation inter-annual effect on snow precipitation? [Gwenaelle GREMION, Canada]	Does this conclusion include Oceanic Oscillation inter-annual effect on snow precipitation?
29886	86	24	86	38	It has been published that such abrupt changes in snow cover already happened in the past (doi: 10.1111/gcb.13106) [Christoph Marty, Switzerland]	It has been published that such abrupt changes in snow cover already happened in the past (doi: 10.1111/gcb.13106)
8180	86	24	86	38	Verfaillie et al. (2018) provide an analysis of snow cover changes vs. global warming, showing a linear relationship for all snow-related indicators, in line with the reversibility described in this paragraph. There are other such examples from the Derksen group for NH snow cover vs. global warming. [Samuel Morin, France]	Verfaillie et al. (2018) provide an analysis of snow cover changes vs. global warming, showing a linear relationship for all snow-related indicators, in line with the reversibility described in this paragraph. There are other such examples from the Derksen group for NH snow cover vs. global warming.
25432	86	24			9.5.4.6 - A bit unclear what is meant by abrupt change - what time frame is considered. Also some of the conclusions in the latter part of the section seem to be based on pre-AR5 publications so unclear whether much is new regarding abrupt changes. [Sharon Smith, Canada]	9.5.4.6 - A bit unclear what is meant by abrupt change - what time frame is considered. Also some of the conclusions in the latter part of the section seem to be based on pre-AR5 publications so unclear whether much is new regarding abrupt changes.
20466	86	30	86	30	It should be 'Drijfhout ' [Gwenaelle GREMION, Canada]	It should be 'Drijfhout '
20468	86	34	86	35	I do not understand what you mean by '…and these can be irreversible in the sense used in this report.' Some lines above (27-28) you state that '…there is no reason to expect long-term irreversible changes to seasonal snow cover'. [Gwenaelle GREMION, Canada]	I do not understand what you mean by '…and these can be irreversible in the sense used in this report.' Some lines above (27-28) you state that '…there is no reason to expect long-term irreversible changes to seasonal snow cover'.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
20480	86	43	86	44	Does "regions of complex topography" mean mountainous, high-relief areas? If so, it might be clearer to state this differently. [Gwenaelle GREMION, Canada]	Does "regions of complex topography" mean mountainous, high-relief areas? If so, it might be clearer to state this differently.
20470	86	43	86	46	A general decline in snow cover extent and associated reduction in snowmelt runoff is expected from modeling studies. For example: Krasting et al. 2013, J. Clim., doi:10.1175/JCLI-D-12-00832.1. Such important hydrological changes have the potential to greatly alter arctic/subarctic lake water balance (e.g., complete lake desiccation), and thus water resource accessibility for high-latitude communities. For example: Bouchard et al. 2013, Geophys. Res. Letters 40: 6112-6117, doi:10.1002/2013GL058635. [Gwenaelle GREMION, Canada]	A general decline in snow cover extent and associated reduction in snowmelt runoff is expected from modeling studies. For example: Krasting et al. 2013, J. Clim., doi:10.1175/JCLI-D-12-00832.1. Such important hydrological changes have the potential to greatly alter arctic/subarctic lake water balance (e.g., complete lake desiccation), and thus water resource accessibility for high-latitude communities. For example: Bouchard et al. 2013, Geophys. Res. Letters 40: 6112-6117, doi:10.1002/2013GL058635.
25434	86	43	86	49	Pre-AR5 refs - focus on what's new and perhaps linkages should be made to other chapters? [Sharon Smith, Canada]	Pre-AR5 refs - focus on what's new and perhaps linkages should be made to other chapters?
46618	86	44	86	44	"substantial part of humanity" - how many? [WGI TSU, France]	"substantial part of humanity" - how many?
20472	86	46	86	46	it should be 'Berghuijs' [Gwenaelle GREMION, Canada]	it should be 'Berghuijs'
15156	86	47	86	49	The Musselman et al. (2017) citation showed snowmelt rates decline because of earlier snowmelt onset. They did not provide evidence for any changes to streamflow. [Keith Jennings, United States of America]	The Musselman et al. (2017) citation showed snowmelt rates decline because of earlier snowmelt onset. They did not provide evidence for any changes to streamflow.
20474	86	47	86	49	Point taken, yet, What happens with the snowmelt period compression? It may render shallow snowmelt at slower rates which may not cope with current Projections. [Gwenaelle GREMION, Canada]	Point taken, yet, What happens with the snowmelt period compression? It may render shallow snowmelt at slower rates which may not cope with current Projections.
25436	86	51	86	52	In North America doesn't rain-on-snow events occur in other regions like eastern Canada for example? (We often get rainfall in the winter when there is snow on the ground) [Sharon Smith, Canada]	In North America doesn't rain-on-snow events occur in other regions like eastern Canada for example? (We often get rainfall in the winter when there is snow on the ground)

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
20476	86	51	86	52	Dr. Alexandre Langlois and his team at Sherbrook University, Canada, have done quite a bit of work on rain-on-snow events, specifically in the Canadian Arctic Archipelago (CAA). They have developped a rain-on-snow algorithm (Dolant et al., 2016; https://doi.org/10.1002/hyp.10828), have done a meteorological inventory of rain-on-snow events in the Canadian Arctic Archipelago (Dolant et al., 2017; https://doi.org/10.1080/02723646.2017.1400339) and have shown that the Peary population numbers are impacted by ROS and ice layers (Langlois et al., 2017; https://doi.org/10.1016/j.rse.2016.11.006). The CAA could be mentioned in the AR6 and the consequences on caribou populations added. [Gwenaelle GREMION, Canada]	Dr. Alexandre Langlois and his team at Sherbrook University, Canada, have done quite a bit of work on rain-on-snow events, specifically in the Canadian Arctic Archipelago (CAA). They have developped a rain-on-snow algorithm (Dolant et al., 2016; https://doi.org/10.1002/hyp.10828), have done a meteorological inventory of rain-on-snow events in the Canadian Arctic Archipelago (Dolant et al., 2017; https://doi.org/10.1080/02723646.2017.1400339) and have shown that the Peary population numbers are impacted by ROS and ice layers (Langlois et al., 2017; https://doi.org/10.1016/j.rse.2016.11.006). The CAA could be mentioned in the AR6 and the consequences on caribou populations added.
38584	86	51	86	53	Rain on snow can occur more widespread (although not that frequent as in the already mentioned regions), see figure 3 in doi:10.3390/rs2041142. It is expected that events increase especially over areas such as Western Siberia due to linkage to sea ice conditions, see http://dx.doi.org/10.1098/rsbl.2016.0466 [Annett Bartsch, Austria]	Rain on snow can occur more widespread (although not that frequent as in the already mentioned regions), see figure 3 in doi:10.3390/rs2041142. It is expected that events increase especially over areas such as Western Siberia due to linkage to sea ice conditions, see http://dx.doi.org/10.1098/rsbl.2016.0466
8182	86	52	86	52	There are trends in ROS (depending on elevation) reported for some mountain regions, see SROCC Chapter 2 final draft. [Samuel Morin, France]	There are trends in ROS (depending on elevation) reported for some mountain regions, see SROCC Chapter 2 final draft.
46620	87	3	87	3	"increases in flood risks" -> "increases in flood hazards". Talk about risks when potential impacts on human or ecosystems are being referred to [WGI TSU, France]	"increases in flood risks" -> "increases in flood hazards". Talk about risks when potential impacts on human or ecosystems are being referred to
20482	87	3	87	4	I think the implication at the end of this sentence is that ROS are projected to decrease in low-lying (low-elevation) areas because there will be less snow in future. If this is the case, I think this should be clearly stated. [Gwenaelle GREMION, Canada]	I think the implication at the end of this sentence is that ROS are projected to decrease in low-lying (low-elevation) areas because there will be less snow in future. If this is the case, I think this should be clearly stated.
30088	87	8	87	16	This does not seem like a balanced treatment of the literature. Kretschmer et al. (2016 J.Clim. doi:10.1175/JCLI-D-15-0654.1) use a statistical analysis technique designed to distinguish causality from correlation in the observational record, and find no evidence of the impact of Eurasian snow cover on NH circulation anomalies. That study must surely be mentioned. I would question the confidence level as being as high as "medium"; even "low" seems a bit optimistic, I would have said. [Theodore Shepherd, United Kingdom (of Great Britain and Northern Ireland)]	This does not seem like a balanced treatment of the literature. Kretschmer et al. (2016 J.Clim. doi:10.1175/JCLI-D-15-0654.1) use a statistical analysis technique designed to distinguish causality from correlation in the observational record, and find no evidence of the impact of Eurasian snow cover on NH circulation anomalies. That study must surely be mentioned. I would question the confidence level as being as high as "medium"; even "low" seems a bit optimistic, I would have said.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
20484	87	9	87	9	Expand the acronyms AO and NAO and write out fully. [Gwenaelle GREMION, Canada]	Expand the acronyms AO and NAO and write out fully.
13728	87	12			Analysis and discussion of inter-annual variability (and changes in that variability) in N hemisphere snow extent is important, given recent work on Arctic amplification and possible effect on N American and Eurasian winter weather extremes [Simon Donner, Canada]	Analysis and discussion of inter-annual variability (and changes in that variability) in N hemisphere snow extent is important, given recent work on Arctic amplification and possible effect on N American and Eurasian winter weather extremes
20486	87	20	87	21	This sentence (starting "Although some recent studies…" is confusing. I'm not sure what the relationships are - Indian summer monsoon rainfall and ? [Gwenaelle GREMION, Canada]	This sentence (starting "Although some recent studies…" is confusing. I'm not sure what the relationships are - Indian summer monsoon rainfall and ?
15704	87	26			In other sections and chapters of this report, this is called "freshwater ice"... Personally, I prefer "lake and river ice" as used in previous IPCC reports. Please be consistent in terminology. [Michael Zemp, Switzerland]	In other sections and chapters of this report, this is called "freshwater ice"... Personally, I prefer "lake and river ice" as used in previous IPCC reports. Please be consistent in terminology.
25438	87	26			This section probably could be shorter if pre AR5 material removed and focus on new information - i.e. briefly summarize AR5 conclusion and then discuss advancements. [Sharon Smith, Canada]	This section probably could be shorter if pre AR5 material removed and focus on new information - i.e. briefly summarize AR5 conclusion and then discuss advancements.
20488	87	28	87	30	The information in this paragraph is largely repeated in page 87 lines 34 to 39, and could safely be deleted. [Gwenaelle GREMION, Canada]	The information in this paragraph is largely repeated in page 87 lines 34 to 39, and could safely be deleted.
20490	87	45	87	53	References to support the assertion of later freeze-up and earlier ice melt in large north-flowing rivers are available for the Mackenzie River in northwest Canada (L Lesack and P Marsh papers). [Gwenaelle GREMION, Canada]	References to support the assertion of later freeze-up and earlier ice melt in large north-flowing rivers are available for the Mackenzie River in northwest Canada (L Lesack and P Marsh papers).
20492	88	6	88	6	I would add the rate of warming for ice-free lake for better comparison. [Gwenaelle GREMION, Canada]	I would add the rate of warming for ice-free lake for better comparison.
46622	88	14	88	14	"(+2C)" - Above what termperature reference period? [WGI TSU, France]	"(+2C)" - Above what termperature reference period?
25440	88	36			Section 9.6 - Seems long and repetitive in places. There is also a lot of reference to pre-AR5 material which could probably be removed and more focus on advancements since AR5 (summarize AR5 conclusion but don't repeat the details of the assessment). Refererring to Box 9.2 and other chapters may also help. [Sharon Smith, Canada]	Section 9.6 - Seems long and repetitive in places. There is also a lot of reference to pre-AR5 material which could probably be removed and more focus on advancements since AR5 (summarize AR5 conclusion but don't repeat the details of the assessment). Refererring to Box 9.2 and other chapters may also help.
40082	88	40			definition? Is the meaning here about Global mean sea level change or regional sea level change? The "many processes" differ accordingly. [Michael Tsimplis, China]	definition? Is the meaning here about Global mean sea level change or regional sea level change? The "many processes" differ accordingly.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
55252	88	47		49	The text says, "Corrections to instrumental drifts in the satellite altimetry record have improved the comprehensiveness and reliability of the record and confirmed accelerated sea-level rise in recent decades." It should add, "However, measurement of sea-level by satellite altimetry is stll frought with errors, and less reliable than coastal measurements with tide gauges." (for details and references see my comments on Chapter 1, p.31) [David Burton, United States of America]	The text says, "Corrections to instrumental drifts in the satellite altimetry record have improved the comprehensiveness and reliability of the record and confirmed accelerated sea-level rise in recent decades." It should add, "However, measurement of sea-level by satellite altimetry is stll frought with errors, and less reliable than coastal measurements with tide gauges." (for details and references see my comments on Chapter 1, p.31)
40084	88	49			A basic question is whether the satellite data are "fixed" to some tide gauges or whether they are a truly independent dataset. This depends of course on the way the instrumental drifts are identified and corrected. There is a significant difference if we have one or two independent observation systems to start with. [Michael Tsimplis, China]	A basic question is whether the satellite data are "fixed" to some tide gauges or whether they are a truly independent dataset. This depends of course on the way the instrumental drifts are identified and corrected. There is a significant difference if we have one or two independent observation systems to start with.
40086	88	53		55	Isn't the flooding through precipitation outside the scope of the chapter? [Michael Tsimplis, China]	Isn't the flooding through precipitation outside the scope of the chapter?
40094	89	3			tide gauges were established for navigational purposes and their reference level is still about that. The use on flooding etc is a byproduct and largely irrelevant. [Michael Tsimplis, China]	tide gauges were established for navigational purposes and their reference level is still about that. The use on flooding etc is a byproduct and largely irrelevant.
20496	89	6	91	33	Since the objective of a box is for a better understanding of basic concepts, it is better to explain all the abbreviation given in a box. [Gwenaelle GREMION, Canada]	Since the objective of a box is for a better understanding of basic concepts, it is better to explain all the abbreviation given in a box.
20498	89	6	91	33	In Box 9.2 or in a new box, it is better to include present contribution by each key process to global mean sea-level rise and projected contributions to future global mean sea-level rise for each scenario. The time lag of each process is also an important aspect. This will helps to understand the differences in the magnitude of each component and to understand the centennial to the millennial impact of global warming. [Gwenaelle GREMION, Canada]	In Box 9.2 or in a new box, it is better to include present contribution by each key process to global mean sea-level rise and projected contributions to future global mean sea-level rise for each scenario. The time lag of each process is also an important aspect. This will helps to understand the differences in the magnitude of each component and to understand the centennial to the millennial impact of global warming.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
20500	89	6	91	41	General comment on BOX 9.2: Key processes driving sea-level change. The goal of the box is to summarize the main processes that contribute to relative sea-level change and sea level extremes. My primary comment of BOX 9.2 is its inconsistency. It is quite clear that this box was written by many different authors. Some of the main processes discussed are described concisely while others are much lengthier and detailed. The other stark difference is that some process descriptions refer to sections while other descriptions cite published work. This box should point to upcoming sections for further reading on the specific details and not directly to specific publications where possible. As I understand it the box aims to be a useful reference summarizing processes driving sea-level change. Therefore, I believe the descriptions should be streamlined: more concise than lengthy, and references should point to sections for additional reading rather than very specific references. Specific suggestions on how to rectify these issues are made below on a comment by comment basis. [Gwenaelle GREMION, Canada]	General comment on BOX 9.2: Key processes driving sea-level change. The goal of the box is to summarize the main processes that contribute to relative sea-level change and sea level extremes. My primary comment of BOX 9.2 is its inconsistency. It is quite clear that this box was written by many different authors. Some of the main processes discussed are described concisely while others are much lengthier and detailed. The other stark difference is that some process descriptions refer to sections while other descriptions cite published work. This box should point to upcoming sections for further reading on the specific details and not directly to specific publications where possible. As I understand it the box aims to be a useful reference summarizing processes driving sea-level change. Therefore, I believe the descriptions should be streamlined: more concise than lengthy, and references should point to sections for additional reading rather than very specific references. Specific suggestions on how to rectify these issues are made below on a comment by comment basis.
45194	89	6	91	41	Box 9.2: Key processes driving sea-level change. This is a challenging subject for clear communication - I think authors have done a good job for the FOD. I have a couple of suggestions that may be helpful. 1) Perhaps it would be useful to differentiate between processes contribute to GMSL change and those that ONLY apply to regional sea level change (?) and indicating this in some way in the main text. 2) I thnk it may be helpful to add a second panel to Box 9.2 Figure 1 (or a second figure) that indicates the timescales assocated with the different processes. For example, changes in hydrological cycle are short-lived (interannual and shorter timescales), whereas ice sheet changes have timescales of centuries to millenia? I think this would help the reader hone in on what processes are most relevant depending on their timescale of interest? [Matthew Palmer, United Kingdom (of Great Britain and Northern Ireland)]	Box 9.2: Key processes driving sea-level change. This is a challenging subject for clear communication - I think authors have done a good job for the FOD. I have a couple of suggestions that may be helpful. 1) Perhaps it would be useful to differentiate between processes contribute to GMSL change and those that ONLY apply to regional sea level change (?) and indicating this in some way in the main text. 2) I thnk it may be helpful to add a second panel to Box 9.2 Figure 1 (or a second figure) that indicates the timescales assocated with the different processes. For example, changes in hydrological cycle are short-lived (interannual and shorter timescales), whereas ice sheet changes have timescales of centuries to millenia? I think this would help the reader hone in on what processes are most relevant depending on their timescale of interest?
40090	89	11			density is not determined by temperature only. [Michael Tsimplis, China]	density is not determined by temperature only.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
50958	89	15	89	18	Box 9.2, page 9-89, line 15-18. Please make sure to use the term radiative forcing consistent with chapter 7 (box 7.1, eq. 7.1). What you are referring to here (as radiative forcing being in disequilibrium) is the TOA energy imbalance (deltaN in eq 7.1), not the radiative forcing (deltaF in eq. 7.1) [Terje Berntsen, Norway]	Box 9.2, page 9-89, line 15-18. Please make sure to use the term radiative forcing consistent with chapter 7 (box 7.1, eq. 7.1). What you are referring to here (as radiative forcing being in disequilibrium) is the TOA energy imbalance (deltaN in eq 7.1), not the radiative forcing (deltaF in eq. 7.1)
55254	89	15		18	Need to add the following to the box 9.2 entry for "Global mean thermosteric sea-level rise," and need to delete the word "global" from the title: "However, it should be noted that thermal expansion in the upper layer of the ocean (where most thermal expansion occurs) is local, because gravity balances mass, not volume. Such sea-level rise occurs only where the water warms. It does not affect sea-level elsewhere. Depending on where it occurs, such localized sea-level rise can affect satellite altimetry measurements of sea-level, without affecting coastal sea-levels, because it causes no net lateral flows of water. (Caveat: if the density of the water at the sea floor were to change, that would affect sea-level everywhere, much like raising or lowering the sea floor, itself, would do. However, in practice, there's hardly any of that. Most ocean warming is surface warming.)" [David Burton, United States of America]	Need to add the following to the box 9.2 entry for "Global mean thermosteric sea-level rise," and need to delete the word "global" from the title: "However, it should be noted that thermal expansion in the upper layer of the ocean (where most thermal expansion occurs) is local, because gravity balances mass, not volume. Such sea-level rise occurs only where the water warms. It does not affect sea-level elsewhere. Depending on where it occurs, such localized sea-level rise can affect satellite altimetry measurements of sea-level, without affecting coastal sea-levels, because it causes no net lateral flows of water. (Caveat: if the density of the water at the sea floor were to change, that would affect sea-level everywhere, much like raising or lowering the sea floor, itself, would do. However, in practice, there's hardly any of that. Most ocean warming is surface warming.)"
9772	89	16	89	18	Box 9.2: Something about the phrasing of the last sentence in this definition is awkward. I suggest revising to: "When there is a net downward energy flux from the top of the atmosphere into the ocean due to more incoming than outgoing radiation, the oceans warm, leading to thermal expansion." [Andra Garner, United States of America]	Box 9.2: Something about the phrasing of the last sentence in this definition is awkward. I suggest revising to: "When there is a net downward energy flux from the top of the atmosphere into the ocean due to more incoming than outgoing radiation, the oceans warm, leading to thermal expansion."
7192	89	20	89	29	I would suggest to mention that only the grounded ice counts for the sea level rise while the floating ice does not [Marco Olivieri, Italy]	I would suggest to mention that only the grounded ice counts for the sea level rise while the floating ice does not
55256	89	20		28	[pt 1 of 7] The text says, "The contribution of the Antarctic Ice Sheet (AIS) is dominated by ice dynamics processes, rather than surface mass balance (SMB) changes: ice shelves melt from below (or disintegrate from surface meltwater penetrating crevasses) and reduce buttressing of the outlet glaciers flowing onto the ice shelves." That is incorrect. The largest factor affecting AIS mass balance is snowfall accumulation. It is approximately equal to the SUM of submarine melting, iceberg calving, and sublimation. [cont'd] [David Burton, United States of America]	[pt 1 of 7] The text says, "The contribution of the Antarctic Ice Sheet (AIS) is dominated by ice dynamics processes, rather than surface mass balance (SMB) changes: ice shelves melt from below (or disintegrate from surface meltwater penetrating crevasses) and reduce buttressing of the outlet glaciers flowing onto the ice shelves." That is incorrect. The largest factor affecting AIS mass balance is snowfall accumulation. It is approximately equal to the SUM of submarine melting, iceberg calving, and sublimation. [cont'd]

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
55258	89	20		28	[pt 2 of 7] Antarctic ice accumulation & loss are in almost perfect balance. Some studies show it is gaining ice, some show it is losing ice, but all show that the net rate, whether positive or negative, is so tiny that it could cause less than 3 inches of sea-level change per century. [cont'd] [David Burton, United States of America]	[pt 2 of 7] Antarctic ice accumulation & loss are in almost perfect balance. Some studies show it is gaining ice, some show it is losing ice, but all show that the net rate, whether positive or negative, is so tiny that it could cause less than 3 inches of sea-level change per century. [cont'd]
55260	89	20		28	[pt 3 of 7] Based on ICESat and ERS Zwally et al (2015) found Antarctica is gaining ice: http://sealevel.info/zwally2015.pdf https://www.nasa.gov/feature/goddard/nasa-study-mass-gains-of-antarctic-ice-sheet-greater-than-losses [cont'd] [David Burton, United States of America]	[pt 3 of 7] Based on ICESat and ERS Zwally et al (2015) found Antarctica is gaining ice: http://sealevel.info/zwally2015.pdf https://www.nasa.gov/feature/goddard/nasa-study-mass-gains-of-antarctic-ice-sheet-greater-than-losses [cont'd]
55262	89	20		28	[pt 4 of 7] Based on CryoSat, McMillan (2014) found Antarctica is losing 79 to 241 Gt/yr of ice, though that was based on only 3 years of data. [cont'd] [David Burton, United States of America]	[pt 4 of 7] Based on CryoSat, McMillan (2014) found Antarctica is losing 79 to 241 Gt/yr of ice, though that was based on only 3 years of data. [cont'd]
55264	89	20		28	[pt 5 of 7] Based on GRACE, Shepherd (2012) concluded that Antarctica ice mass change since 1992 has averaged -71 ±83 Gt/yr, which means they couldn't tell whether it's actually gaining or losing ice mass. [cont'd] [David Burton, United States of America]	[pt 5 of 7] Based on GRACE, Shepherd (2012) concluded that Antarctica ice mass change since 1992 has averaged -71 ±83 Gt/yr, which means they couldn't tell whether it's actually gaining or losing ice mass. [cont'd]
55266	89	20		28	[pt 6 of 7] Based on ICESat, Zwally (2012) found that Antarctica is gaining ice mass: +27 to +59 Gt/yr (averaged over five years), or +70 to +170 Gt/yr (averaged over 19 years). [cont'd] [David Burton, United States of America]	[pt 6 of 7] Based on ICESat, Zwally (2012) found that Antarctica is gaining ice mass: +27 to +59 Gt/yr (averaged over five years), or +70 to +170 Gt/yr (averaged over 19 years). [cont'd]
55268	89	20		28	[pt 7 of 7] The range from those various studies, with error bars, is from +170 Gt/yr to -241 Gt/yr, which is equivalent to just -0.47 to +0.67 mm/yr sea-level change, i.e., less than 3 inches of sea-level change per century. In other words, though we don't know with certainty whether Antarctica is gaining or losing ice, we do know that the rate, either way, is very slow, and much slower than common coastal processes like erosion and sedimentation. ### [David Burton, United States of America]	[pt 7 of 7] The range from those various studies, with error bars, is from +170 Gt/yr to -241 Gt/yr, which is equivalent to just -0.47 to +0.67 mm/yr sea-level change, i.e., less than 3 inches of sea-level change per century. In other words, though we don't know with certainty whether Antarctica is gaining or losing ice, we do know that the rate, either way, is very slow, and much slower than common coastal processes like erosion and sedimentation. ###

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
20502	89	23	89	25	It is stated that the AIS sea level contribution is dominated by ice dynamics rather than SMB but the text goes on to give an example of the disintegration from surface melt which leads to hydrofracturing followed by dynamic thinning of outlet glaciers. This statement also claims SMB is not as relevant to AIS mass balance but at the same time it claims ice shelf collapse from SMB feedbacks are important. I think the statement should be revised to state that SMB could be very relevant to AIS mass loss if SMB leads to hydrofracturing and ice shelf collapse. [Gwenaelle GREMION, Canada]	It is stated that the AIS sea level contribution is dominated by ice dynamics rather than SMB but the text goes on to give an example of the disintegration from surface melt which leads to hydrofracturing followed by dynamic thinning of outlet glaciers. This statement also claims SMB is not as relevant to AIS mass balance but at the same time it claims ice shelf collapse from SMB feedbacks are important. I think the statement should be revised to state that SMB could be very relevant to AIS mass loss if SMB leads to hydrofracturing and ice shelf collapse.
9774	89	23	89	31	Surface Mass Balance is mentioned and discussed in the section about ice sheets on Greenland and Antarctica, but is not defined until the section about The contribution of glaciers. If SMB has been mentioned and defined in earlier sections (9.4, and 9.5), it may not need to be fully defined again here--the reference to section 9.5 in the discussion of glaciers in Box 9.2 would likely be sufficient. [Andra Garner, United States of America]	Surface Mass Balance is mentioned and discussed in the section about ice sheets on Greenland and Antarctica, but is not defined until the section about The contribution of glaciers. If SMB has been mentioned and defined in earlier sections (9.4, and 9.5), it may not need to be fully defined again here--the reference to section 9.5 in the discussion of glaciers in Box 9.2 would likely be sufficient.
9776	89	23	89	31	For consistency with other bold/italicized headings in the box, the bold italicized heading for the glaciers section should probably be "Glaciers" not "The contribution of glaciers". I suggest rephrasing the first sentence to something like, "Glaciers make contributions to sea-level change that depend primarily upon their surface mass balance (Section 9.5). [Andra Garner, United States of America]	For consistency with other bold/italicized headings in the box, the bold italicized heading for the glaciers section should probably be "Glaciers" not "The contribution of glaciers". I suggest rephrasing the first sentence to something like, "Glaciers make contributions to sea-level change that depend primarily upon their surface mass balance (Section 9.5).
33244	89	25	89	26	For the GIS it is mentioned that SMB is dominant, but one can get the impression that dynamics is negligible [Kristian Kjelden, Denmark]	For the GIS it is mentioned that SMB is dominant, but one can get the impression that dynamics is negligible
20494	89	25	89	27	In previous sections the abbreviation used for the Greenland Ice sheet is GrIS. Be consistent. [Gwenaelle GREMION, Canada]	In previous sections the abbreviation used for the Greenland Ice sheet is GrIS. Be consistent.
33250	89	26	89	26	Here the abbreviation GIS is used for the Greenland Ice Sheet - but in the remaineder of the chapter GrIS is used. Please update to "GrIS" here and in the remainder of the chapter to avoid confusion. [Kristian Kjelden, Denmark]	Here the abbreviation GIS is used for the Greenland Ice Sheet - but in the remaineder of the chapter GrIS is used. Please update to "GrIS" here and in the remainder of the chapter to avoid confusion.
20504	89	30	90	36	Two suggestions regarding the organization of this section: 1. Move the GRD process (page 90) to below TWS (page 89). 2. Indent or number steric sea-level change and ocean dynamic sea-level change to clarify association with RSL change - the two categories of processes affecting regional variation in sea-level change. [Gwenaelle GREMION, Canada]	Two suggestions regarding the organization of this section: 1. Move the GRD process (page 90) to below TWS (page 89). 2. Indent or number steric sea-level change and ocean dynamic sea-level change to clarify association with RSL change - the two categories of processes affecting regional variation in sea-level change.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
20506	89	31	89	33	Remove the references (Lutz et al., 2016; Ménégoz et al., 2014) and add it (Section 9.5.2) at the end of the paragraph where the specific details and full citations are stated. All of this paragraph's information is taken from Section 9.5.2. The reader should go to this section if they want more information on the contribution of glaciers to sea-level change. [Gwenaelle GREMION, Canada]	Remove the references (Lutz et al., 2016; Ménégoz et al., 2014) and add it (Section 9.5.2) at the end of the paragraph where the specific details and full citations are stated. All of this paragraph's information is taken from Section 9.5.2. The reader should go to this section if they want more information on the contribution of glaciers to sea-level change.
20508	89	33	89	34	Although only a small detail, I thought it could be beneficial to add that glacier melt can be stored within proglacial lakes for significant periods, which could delay a contribution to sea-level (though this is, of course, a very small contribution). [Gwenaelle GREMION, Canada]	Although only a small detail, I thought it could be beneficial to add that glacier melt can be stored within proglacial lakes for significant periods, which could delay a contribution to sea-level (though this is, of course, a very small contribution).
46022	89	34	89	35	If “firn” hasn’t previously been defined, it may be worth defining or using the definition here. [Isaac Pearlman, United States of America]	If “firn” hasn’t previously been defined, it may be worth defining or using the definition here.
20510	89	35	89	37	The sentence should be more concise such as "The refreezing capacity of firn deteriorates with increasing melt" and reader should be pointed to the section of the text that discusses the specific comparison to Greenland peripheral glaciers. The latter does not belong in a short summary of glacier sea-level contribution. Remove the references (Noel et al., 2017) and add (Section 9.5.2) at the end of the paragraph. [Gwenaelle GREMION, Canada]	The sentence should be more concise such as "The refreezing capacity of firn deteriorates with increasing melt" and reader should be pointed to the section of the text that discusses the specific comparison to Greenland peripheral glaciers. The latter does not belong in a short summary of glacier sea-level contribution. Remove the references (Noel et al., 2017) and add (Section 9.5.2) at the end of the paragraph.
20512	89	37	89	39	Remove the references (Dunse et al., 2015; O’Leary and Christoffersen, 2013) and add it (Section 9.5.2) at the end of the paragraph. [Gwenaelle GREMION, Canada]	Remove the references (Dunse et al., 2015; O’Leary and Christoffersen, 2013) and add it (Section 9.5.2) at the end of the paragraph.
20514	89	39	89	41	The term geometry of a glacier includes its ice thickness, therefore the sentence could be streamlined, e.g. "Changes in the glacier volume take decades to centuries to respond, depending on the geometry of the glaciers, elevation, and the strength of the climate forcing (Section 9.5.2). [Gwenaelle GREMION, Canada]	The term geometry of a glacier includes its ice thickness, therefore the sentence could be streamlined, e.g. "Changes in the glacier volume take decades to centuries to respond, depending on the geometry of the glaciers, elevation, and the strength of the climate forcing (Section 9.5.2).
50622	89	39	89	41	See above, I do not understand this. I know that there is also the concept of a volume response time but I think in the context presented here we talk about glacier mass loss. To my knowledge, this is an immediate response to climate forcing (i.e. the energy balance at the glacier surface) and has no delay at all. How long it will take until a glacier is reaching a new dynamic equilibrium is a different question. [Frank Paul, Switzerland]	See above, I do not understand this. I know that there is also the concept of a volume response time but I think in the context presented here we talk about glacier mass loss. To my knowledge, this is an immediate response to climate forcing (i.e. the energy balance at the glacier surface) and has no delay at all. How long it will take until a glacier is reaching a new dynamic equilibrium is a different question.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
15706	89	41			Maybe add a note making the point that, especial in endorheic basins, a (not yet fully quantified) part of the glacier runoff does not reach the ocean but contributes to the terrestrial water storage or evaporation (e.g., Wang et al. 2018, Nature). Wang, J., Song, C., Reager, J. T., Yao, F., Famiglietti, J. S., Sheng, Y., ... & Wada, Y. (2018). Recent global decline in endorheic basin water storages. Nature geoscience, 11(12), 926. [Michael Zemp, Switzerland]	Maybe add a note making the point that, especial in endorheic basins, a (not yet fully quantified) part of the glacier runoff does not reach the ocean but contributes to the terrestrial water storage or evaporation (e.g., Wang et al. 2018, Nature). Wang, J., Song, C., Reager, J. T., Yao, F., Famiglietti, J. S., Sheng, Y., ... & Wada, Y. (2018). Recent global decline in endorheic basin water storages. Nature geoscience, 11(12), 926.
40092	89	51		53	doesn't this statement go against the focus on extremes and mean sea level? [Michael Tsimplis, China]	doesn't this statement go against the focus on extremes and mean sea level?
40088	89				Why extremes and mean sea level only? seasonality, interannual and interdecadal variability are of no importance? or are they driven by different processes? The largest extremes are tsunamis and then storm surges so GMSL and its forcing are not really linked with extremes. [Michael Tsimplis, China]	Why extremes and mean sea level only? seasonality, interannual and interdecadal variability are of no importance? or are they driven by different processes? The largest extremes are tsunamis and then storm surges so GMSL and its forcing are not really linked with extremes.
20516	90	2	90	5	Geocentric sea-level change should not be defined within the section defining relative sea-level change, it should have its own section in this box. The references should be replace with (Section 9.6.2.1.2) which contains the challenges of converting geocentric sea-level estimates to RSL estimates. [Gwenaelle GREMION, Canada]	Geocentric sea-level change should not be defined within the section defining relative sea-level change, it should have its own section in this box. The references should be replace with (Section 9.6.2.1.2) which contains the challenges of converting geocentric sea-level estimates to RSL estimates.
20518	90	5	90	8	The two sentences on regional sea-level change are an oversimplified view of regional sea-level change. It can be expanded signficantly with ocean dynamics, steric contributions, GIA, gravitational effects, rotational feedbacks, ice volume changes, sediment loading, tectonics and mantle convection. I believe this sentence should be removed since discussing regional sea-level change warrants its own section in this Box. That way all the processes that produce deviations away from GMSL could be listed and their time-scale of operation could be stated. [Gwenaelle GREMION, Canada]	The two sentences on regional sea-level change are an oversimplified view of regional sea-level change. It can be expanded signficantly with ocean dynamics, steric contributions, GIA, gravitational effects, rotational feedbacks, ice volume changes, sediment loading, tectonics and mantle convection. I believe this sentence should be removed since discussing regional sea-level change warrants its own section in this Box. That way all the processes that produce deviations away from GMSL could be listed and their time-scale of operation could be stated.
40096	90	8			So what is sea level change that the sections opens with? Perhaps explaining that geocentirc sea-level change is largely irrelevant to coastal risks but crucial in establishing warming as both processes contributing to sea level rise are T related while rsl is crucial for coastal effects but perhaps not directly applicable to global sea level forcing would make everything more precise. [Michael Tsimplis, China]	So what is sea level change that the sections opens with? Perhaps explaining that geocentirc sea-level change is largely irrelevant to coastal risks but crucial in establishing warming as both processes contributing to sea level rise are T related while rsl is crucial for coastal effects but perhaps not directly applicable to global sea level forcing would make everything more precise.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
50968	90	10	90	11	It seems odd to have first a paragraph on thermosteric rise (page 9.89) and then a section on steric rise. I suggest to combine these paragraphs. [Terje Berntsen, Norway]	It seems odd to have first a paragraph on thermosteric rise (page 9.89) and then a section on steric rise. I suggest to combine these paragraphs.
20520	90	10	90	12	This section can absorb the Global mean thermosteric sea-level rise section since there is overlap and they should belong under the same section. [Gwenaelle GREMION, Canada]	This section can absorb the Global mean thermosteric sea-level rise section since there is overlap and they should belong under the same section.
6734	90	14	90	14	I think this definition is inconsistent with the usages in the recent paper Gregory et al. 2019, Fig 3. (cited line 5). Please check. [Joanne Williams, United Kingdom (of Great Britain and Northern Ireland)]	I think this definition is inconsistent with the usages in the recent paper Gregory et al. 2019, Fig 3. (cited line 5). Please check.
38458	90	14	90	23	I don't think this is quite right. Ocean dynamic sea level change is the change in IB-corrected mean sea level relative to the geoid, jointly determined by change in ocean density and circulation. It has zero mean so it doesn't make sense to take about its local value being ten times larger than its mean. Perhaps in this section you mean sterodynamic sea level change, which is the sum of ocean dynamic SLC and global mean thermosteric SLC, whose mean is equal to the latter. Sterodynamic SLC is the part we can simulate with AOGCMs, as the change in zos + the change in zostoga. You also refer to the local decomposition, which is different again; local RSLC is the sum of steric SLC and manometric SLC, the the latter being the new term we propose for the "local mass" or "bottom pressure" contribution. The global mean of RSLC is equal to GMSLR. GMLSR is the sum of global mean thermosteric SLC (since global mean halosteric SLC is negligible) and barystatic SLC (apart from some complication about the density used for conversion). [Jonathan Gregory, United Kingdom (of Great Britain and Northern Ireland)]	I don't think this is quite right. Ocean dynamic sea level change is the change in IB-corrected mean sea level relative to the geoid, jointly determined by change in ocean density and circulation. It has zero mean so it doesn't make sense to take about its local value being ten times larger than its mean. Perhaps in this section you mean sterodynamic sea level change, which is the sum of ocean dynamic SLC and global mean thermosteric SLC, whose mean is equal to the latter. Sterodynamic SLC is the part we can simulate with AOGCMs, as the change in zos + the change in zostoga. You also refer to the local decomposition, which is different again; local RSLC is the sum of steric SLC and manometric SLC, the the latter being the new term we propose for the "local mass" or "bottom pressure" contribution. The global mean of RSLC is equal to GMSLR. GMLSR is the sum of global mean thermosteric SLC (since global mean halosteric SLC is negligible) and barystatic SLC (apart from some complication about the density used for conversion).
40098	90	14		23	the last two sentences are taking about projections/expectations. If the section is a repetition of what has been known by AR5 then it should be said. Also the AMOC behavious is terated with caution ealrier. This section looks inconsistent. [Michael Tsimplis, China]	the last two sentences are taking about projections/expectations. If the section is a repetition of what has been known by AR5 then it should be said. Also the AMOC behavious is terated with caution ealrier. This section looks inconsistent.
50412	90	18	90	19	This statement about forced variability needs citations. Also, locally, internal climate variability may dominate at low-frequencies, e.g. Sérazin, G., Penduff, T., Grégorio, S., Barnier, B., Molines, J.-M., & Terray, L. (2015). Intrinsic Variability of Sea Level from Global Ocean Simulations: Spatiotemporal Scales. Journal of Climate, 28(10), 4279–4292. https://doi.org/10.1175/JCLI-D-14-00554.1 [Chris Wilson, United Kingdom (of Great Britain and Northern Ireland)]	This statement about forced variability needs citations. Also, locally, internal climate variability may dominate at low-frequencies, e.g. Sérazin, G., Penduff, T., Grégorio, S., Barnier, B., Molines, J.-M., & Terray, L. (2015). Intrinsic Variability of Sea Level from Global Ocean Simulations: Spatiotemporal Scales. Journal of Climate, 28(10), 4279–4292. https://doi.org/10.1175/JCLI-D-14-00554.1

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
20522	90	18	90	20	Removing all the listed oscillation/modes and simply stating "decadal oscillation and annular modes (Section 9.6.2.1.2)." The specifics should be left to the actual sections. [Gwenaelle GREMION, Canada]	Removing all the listed oscillation/modes and simply stating "decadal oscillation and annular modes (Section 9.6.2.1.2)." The specifics should be left to the actual sections.
20524	90	20	90	23	The sentence discusses pattern that are expected to emerge in the future, this does not belong in a brief summary box defining the ocean dynamic sea-level contribution. [Gwenaelle GREMION, Canada]	The sentence discusses pattern that are expected to emerge in the future, this does not belong in a brief summary box defining the ocean dynamic sea-level contribution.
38460	90	25	90	25	Gregory et al. suggest that GRD is shorthand for changes in Earth gravity, change in Earth rotation, and Earth deformation. [Jonathan Gregory, United Kingdom (of Great Britain and Northern Ireland)]	Gregory et al. suggest that GRD is shorthand for changes in Earth gravity, change in Earth rotation, and Earth deformation.
20528	90	25	90	26	The first sentence should say something along the lines of: "Graviational Rotational Deformation (GRD) causes regional variability in sea-level change resulting from the redistribution of mass within the solid Earth and the redistribution between terrestrial ice and water reservoirs which perturbs the Earth's inertia tensor (Section 9.6.3.2)." Using the (e.g., Farrell and Clark, 1976; Mitrovica et al., 2001a; 2001b) here might be appropriate since section 9.6.3.2 do not explicitly dive into the details of GRD, the references just reside there. Also mentioning "which perturbs the Earth's inertia tensor" might be more appropriate elsewhere in this section but explaining how a change in mass load influences the Earth's rotation is important. [Gwenaelle GREMION, Canada]	The first sentence should say something along the lines of: "Graviational Rotational Deformation (GRD) causes regional variability in sea-level change resulting from the redistribution of mass within the solid Earth and the redistribution between terrestrial ice and water reservoirs which perturbs the Earth's inertia tensor (Section 9.6.3.2)." Using the (e.g., Farrell and Clark, 1976; Mitrovica et al., 2001a; 2001b) here might be appropriate since section 9.6.3.2 do not explicitly dive into the details of GRD, the references just reside there. Also mentioning "which perturbs the Earth's inertia tensor" might be more appropriate elsewhere in this section but explaining how a change in mass load influences the Earth's rotation is important.
20526	90	25	90	36	This section is a bit weak on its own since it covers aspects of GIA and GRD is inclusive within GIA. I would include this within the GIA definition or at the very least define GIA first then define GRD and be clear on how GRD is a feedback to GIA. For example the elastic solid Earth response is part of the GIA response. [Gwenaelle GREMION, Canada]	This section is a bit weak on its own since it covers aspects of GIA and GRD is inclusive within GIA. I would include this within the GIA definition or at the very least define GIA first then define GRD and be clear on how GRD is a feedback to GIA. For example the elastic solid Earth response is part of the GIA response.
20530	90	27	90	29	It should specify "terrestrial ice mass loss" and RSL fall is stated twice in the same sentence. The sentence can be streamlined as such: "On century timescales or less, terrestrial mass loss leads to local elastic solid Earth uplift and sea-surface fall (within ~2000 km of the shrinking terrestrial reservoir)." [Gwenaelle GREMION, Canada]	It should specify "terrestrial ice mass loss" and RSL fall is stated twice in the same sentence. The sentence can be streamlined as such: "On century timescales or less, terrestrial mass loss leads to local elastic solid Earth uplift and sea-surface fall (within ~2000 km of the shrinking terrestrial reservoir)."
20532	90	29	90	30	sentence should end with more detail, "...to gravitational effects caused by the relaxation of the gravitational deflection proximal to the less massive terrestrial ice." [Gwenaelle GREMION, Canada]	sentence should end with more detail, "...to gravitational effects caused by the relaxation of the gravitational deflection proximal to the less massive terrestrial ice."

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
20534	90	30	90	32	The redistribution of water to the oceans (hydro isostasy) is an inclusive process part of GIA as a feedback to ice mass loss into the oceans. [Gwenaelle GREMION, Canada]	The redistribution of water to the oceans (hydro isostasy) is an inclusive process part of GIA as a feedback to ice mass loss into the oceans.
20536	90	34	90	34	The references (e.g., Larour et al., 2017; Mitrovica et al., 2018) can be replaced by (Section 9.6.3.2). Using the (e.g., Larour et al., 2017; Mitrovica et al., 2018) here might still be appropriate since section 9.6.3.2 does not explicitly dive into the details of GRD, the references just reside in that section and are discussed here. [Gwenaelle GREMION, Canada]	The references (e.g., Larour et al., 2017; Mitrovica et al., 2018) can be replaced by (Section 9.6.3.2). Using the (e.g., Larour et al., 2017; Mitrovica et al., 2018) here might still be appropriate since section 9.6.3.2 does not explicitly dive into the details of GRD, the references just reside in that section and are discussed here.
20538	90	34	90	36	It is interested to state the 40% upper limit to the gravitational and elastic response of ice mass loss. I believe it would also be valuable to state the average far field RSL rise (~10%) to give context on the 40%. Here I would also be inclined to keep the reference since it is the source of this specific claim. [Gwenaelle GREMION, Canada]	It is interested to state the 40% upper limit to the gravitational and elastic response of ice mass loss. I believe it would also be valuable to state the average far field RSL rise (~10%) to give context on the 40%. Here I would also be inclined to keep the reference since it is the source of this specific claim.
20542	90	38	90	38	"...(GIA) is the response of the solid Earth and the global gravity field to past and present changes…", changes include those that are present. [Gwenaelle GREMION, Canada]	"...(GIA) is the response of the solid Earth and the global gravity field to past and present changes…", changes include those that are present.
20540	90	38	90	53	This section has excessive references that should be pointed to by section wherever possible. Many of the references only appear here in the entire document. Furthermore, this section does not talk about the processes involved in GIA, some of that is found in GRD, hence why I think those two sections should be merged. [Gwenaelle GREMION, Canada]	This section has excessive references that should be pointed to by section wherever possible. Many of the references only appear here in the entire document. Furthermore, this section does not talk about the processes involved in GIA, some of that is found in GRD, hence why I think those two sections should be merged.
52382	90	38	90	53	Detail on how GIA effects will vary with proximity to ice sheets can be added alongside the discussion of how lateral heterogeneity in viscosity structure will affect regional differences in GIA. [Emily Orzechowski, United States of America]	Detail on how GIA effects will vary with proximity to ice sheets can be added alongside the discussion of how lateral heterogeneity in viscosity structure will affect regional differences in GIA.
20544	90	39	90	40	The Earth also deforms in an elastic way towards isostatic equilibrium. [Gwenaelle GREMION, Canada]	The Earth also deforms in an elastic way towards isostatic equilibrium.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
20548	90	42	90	43	On the topic of inferring global ice history, I feel like this is missing something on field evidence. Something along the lines of whether it be terrestrial and marine geomorphological, sedimentological or other forms of evidence for the previous geographical extent, and terrestrial evidence (trimlines, other geomorphological evidence for previous ice cover, and cosmogenic nuclide analysis to add both thickness and time constraints) for the previous thickness of ice sheets, is used to help infer past global ice cover and, importantly for this section, help inform GIA models. From Box 1, titled "Methods of reconstructing past sea level and ice volume" in Dutton et al. (2015) (http://dx.doi.org/10.1126/science.aaa4019) "The ice model is constrained by field evidence on the timing, thickness, and geographic extent of ice, as well as..." [Gwenaelle GREMION, Canada]	On the topic of inferring global ice history, I feel like this is missing something on field evidence. Something along the lines of whether it be terrestrial and marine geomorphological, sedimentological or other forms of evidence for the previous geographical extent, and terrestrial evidence (trimlines, other geomorphological evidence for previous ice cover, and cosmogenic nuclide analysis to add both thickness and time constraints) for the previous thickness of ice sheets, is used to help infer past global ice cover and, importantly for this section, help inform GIA models. From Box 1, titled "Methods of reconstructing past sea level and ice volume" in Dutton et al. (2015) (http://dx.doi.org/10.1126/science.aaa4019) "The ice model is constrained by field evidence on the timing, thickness, and geographic extent of ice, as well as..."
20546	90	42	90	47	These two sentences are heavily referenced and discuss how the primary inputs to GIA are obtained. I believe this is not relevant since the goal of this box is to discuss the key processes driving sea-level change. More text should be invested towards discusses the processes involved in GIA: visco-elastic deformation, glacial and hydro isostasy, peripheral forebulge and forebulge collapse, near and far field gravitational effects, ocean syphoning, continental levering, etc. This is why I recommend GRD be merged within the GIA section. [Gwenaelle GREMION, Canada]	These two sentences are heavily referenced and discuss how the primary inputs to GIA are obtained. I believe this is not relevant since the goal of this box is to discuss the key processes driving sea-level change. More text should be invested towards discusses the processes involved in GIA: visco-elastic deformation, glacial and hydro isostasy, peripheral forebulge and forebulge collapse, near and far field gravitational effects, ocean syphoning, continental levering, etc. This is why I recommend GRD be merged within the GIA section.
20550	90	47	90	48	"… large lateral heterogeneity in viscosity and density structure, including in Antarctica." Density structure is also an input to GIA models which is usually assumed as spherically symmetric. [Gwenaelle GREMION, Canada]	"… large lateral heterogeneity in viscosity and density structure, including in Antarctica." Density structure is also an input to GIA models which is usually assumed as spherically symmetric.
20552	90	48	90	49	Streamlined sentence: "Assessing the modern sea-level contribution due to past ice sheet changes (i.e. viscous GIA signal) through the long-term viscous deformation of the solid Earth is critical to interpreting modern records of sea level and" [Gwenaelle GREMION, Canada]	Streamlined sentence: "Assessing the modern sea-level contribution due to past ice sheet changes (i.e. viscous GIA signal) through the long-term viscous deformation of the solid Earth is critical to interpreting modern records of sea level and"

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
8684	90	55	91	16	The description of causes of coastal vertical ground motions could be completed: in particular, this could mention volcanism (e.g., Campii Flegrei in Italy), mining activities (e.g. Vauvert mine in the Rhone Delta), landslides (possibly Vasto coastal landslide in Italy), small subsidence of embankments (e.g., harbors of Brest (France) and Dakar (Senegal), airport of Nice (France)...). I acknowledge my colleague Daniel Raucoules for some suggestions on this topic. [Goneri Le Cozannet, France]	The description of causes of coastal vertical ground motions could be completed: in particular, this could mention volcanism (e.g., Campii Flegrei in Italy), mining activities (e.g. Vauvert mine in the Rhone Delta), landslides (possibly Vasto coastal landslide in Italy), small subsidence of embankments (e.g., harbors of Brest (France) and Dakar (Senegal), airport of Nice (France)...). I acknowledge my colleague Daniel Raucoules for some suggestions on this topic.
20554	91	1	91	4	Following studies also show that intensive flow regulation by dams and coastal defence studtures result in coastal erosion and thus relative sea-level rises. 1) Sampath, DMR., Boski, T., 2018. Key parameters of the sediment surface morphodynamics in an estuary – an assessment of model solutions. Geomorphology. 308, 142–160. https://doi.org/10.1016/j.geomorph.2018.02.017; 2) Sampath, D.M.R., Boski, T., 2016. Morphological response of the saltmarsh habitats of the Guadiana estuary due to flow regulation and sea-level rise, Estuarine, Coastal and Shelf Science. 183 (2016) 314 -326. http://dx.doi.org/10.1016/j.ecss.2016.07.009. [Gwenaelle GREMION, Canada]	Following studies also show that intensive flow regulation by dams and coastal defence studtures result in coastal erosion and thus relative sea-level rises. 1) Sampath, DMR., Boski, T., 2018. Key parameters of the sediment surface morphodynamics in an estuary – an assessment of model solutions. Geomorphology. 308, 142–160. https://doi.org/10.1016/j.geomorph.2018.02.017; 2) Sampath, D.M.R., Boski, T., 2016. Morphological response of the saltmarsh habitats of the Guadiana estuary due to flow regulation and sea-level rise, Estuarine, Coastal and Shelf Science. 183 (2016) 314 -326. http://dx.doi.org/10.1016/j.ecss.2016.07.009.
20556	91	2	91	4	Replace (Syvitski et al., 2009) with (Section 9.6.5.1), otherwise I would add a reference here for (Kuchar et al., 2018) which studied the Mississippi Delta using a sediment isostatic model. "Kuchar, J., Milne, G., Wolstencroft, M., Love, R., Tarasov, L. and Hijma, M., 2018. The influence of sediment isostatic adjustment on sea level change and land motion along the US Gulf Coast. Journal of Geophysical Research: Solid Earth, 123(1), pp.780-796." [Gwenaelle GREMION, Canada]	Replace (Syvitski et al., 2009) with (Section 9.6.5.1), otherwise I would add a reference here for (Kuchar et al., 2018) which studied the Mississippi Delta using a sediment isostatic model. "Kuchar, J., Milne, G., Wolstencroft, M., Love, R., Tarasov, L. and Hijma, M., 2018. The influence of sediment isostatic adjustment on sea level change and land motion along the US Gulf Coast. Journal of Geophysical Research: Solid Earth, 123(1), pp.780-796."
8116	91	2	91	4	Note that RSL as defined in Syvitski et al. (2009) erroneously includes aggradation rate, so this may not be the most suitable reference here. More broadly, the issues discussed in this sentence were already fully recognized in the SAR of the IPCC (Bijlsma et al., 1995). [Torbjorn Tornqvist, United States of America]	Note that RSL as defined in Syvitski et al. (2009) erroneously includes aggradation rate, so this may not be the most suitable reference here. More broadly, the issues discussed in this sentence were already fully recognized in the SAR of the IPCC (Bijlsma et al., 1995).

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
7194	91	8	91	11	The description of the tectonic deformation is too simple I would rephrase: "Tectonic deformation mainly occurs along the plate-bounding faults between different plates. VLM is relevant for the case of RSL when earthquakes occur in the vicinity of the coast and when the fault mechanism results in a sudden uplift of areas that had been subsiding, and vice-versa possibly followed by post sesimic relaxation° (e.g. 1908 Messina Earthquake, Pino et al. 2009; 1964 Alaska Earthquake, Savage and Plafker, 1991). References: Pino, N. A.; Piatanesi, A.; Valensise, G., and Boschi, E., 2009. The 28 December 1908 Messina Straits earthquake (Mw 7.1): a greatearthquake throughout a century of seismology. Seismological Research Letters, 80(2), 243–259. Savage, J. C., and Plafker, G. (1991), Tide gage measurements of uplift along the south coast of Alaska, J. Geophys. Res., 96(B3), 4325– 4335, doi:10.1029/90JB02540. [Marco Olivieri, Italy]	The description of the tectonic deformation is too simple I would rephrase: "Tectonic deformation mainly occurs along the plate-bounding faults between different plates. VLM is relevant for the case of RSL when earthquakes occur in the vicinity of the coast and when the fault mechanism results in a sudden uplift of areas that had been subsiding, and vice-versa possibly followed by post sesimic relaxation° (e.g. 1908 Messina Earthquake, Pino et al. 2009; 1964 Alaska Earthquake, Savage and Plafker, 1991). References: Pino, N. A.; Piatanesi, A.; Valensise, G., and Boschi, E., 2009. The 28 December 1908 Messina Straits earthquake (Mw 7.1): a greatearthquake throughout a century of seismology. Seismological Research Letters, 80(2), 243–259. Savage, J. C., and Plafker, G. (1991), Tide gage measurements of uplift along the south coast of Alaska, J. Geophys. Res., 96(B3), 4325– 4335, doi:10.1029/90JB02540.
7196	91	11	91	11	There is not any mention of the VLM consequence of the inflation deflation of volcanos. Quite common phenomena in the Hawaii an Pacific south of Japan. I would suggest to add a sentence like °The Inflation deflation mechanism in vicinity of active volcanos could affect SLR observation at tide gauges examples are the Miyakejima eruption (Nerem and Mitchum, 2002) and the 1982 Pozzuoli uplift (Berrino et al., 1984). references to be added Berrino, G., Corrado, G., Luongo, G., & Toro, B. (1984). Ground deformation and gravity changes accompanying the 1982 Pozzuoli uplift. Bulletin volcanologique, 47(2), 187-200. Nerem, R., Mitchum, G., 2002. Estimates of vertical crustal motion de- rived from differences of TOPEX/POSEIDON and tide gauge sea level measurements. Geophysical Research Letters 29 (19). [Marco Olivieri, Italy]	There is not any mention of the VLM consequence of the inflation deflation of volcanos. Quite common phenomena in the Hawaii an Pacific south of Japan. I would suggest to add a sentence like °The Inflation deflation mechanism in vicinity of active volcanos could affect SLR observation at tide gauges examples are the Miyakejima eruption (Nerem and Mitchum, 2002) and the 1982 Pozzuoli uplift (Berrino et al., 1984). references to be added Berrino, G., Corrado, G., Luongo, G., & Toro, B. (1984). Ground deformation and gravity changes accompanying the 1982 Pozzuoli uplift. Bulletin volcanologique, 47(2), 187-200. Nerem, R., Mitchum, G., 2002. Estimates of vertical crustal motion de- rived from differences of TOPEX/POSEIDON and tide gauge sea level measurements. Geophysical Research Letters 29 (19).
24374	91	18	91	33	There are a number of missing locally relevant phenomena that may cause ESL (meteo-tsunamis, seiches, monthly to decadal volume changes of semi-enclosed basins or seas such as for example the Baltic Sea) [Ralf Weisse, Germany]	There are a number of missing locally relevant phenomena that may cause ESL (meteo-tsunamis, seiches, monthly to decadal volume changes of semi-enclosed basins or seas such as for example the Baltic Sea)
48972	91	18	91	33	Are anthropogenic contributions to ESL-- i.e., indirect, thru modification of coastlines that amplify tides/surges worth mentioning here? [Laura Reynolds, United States of America]	Are anthropogenic contributions to ESL-- i.e., indirect, thru modification of coastlines that amplify tides/surges worth mentioning here?

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
40100	91	18			a. extreme sea levels concern ONLY coastal extremes as measured at the land ocean border b. the largest are not caused by the reasons stated so this is restricted to atmospherically induced surges. The tidal component is generally well described LOCALLY if there are measurements and their forcing is not climate related (the signal as a response to changing depth and propagation may be). [Michael Tsimplis, China]	a. extreme sea levels concern ONLY coastal extremes as measured at the land ocean border b. the largest are not caused by the reasons stated so this is restricted to atmospherically induced surges. The tidal component is generally well described LOCALLY if there are measurements and their forcing is not climate related (the signal as a response to changing depth and propagation may be).
40102	91	21			the classic configuration of tide gauges does not measure the effect of waves. satellite measurements do also average over larger areas so the reason for having this statement in is a bit worrying, [Michael Tsimplis, China]	the classic configuration of tide gauges does not measure the effect of waves. satellite measurements do also average over larger areas so the reason for having this statement in is a bit worrying,
7862	91	23	91	23	The wave contribution to ESL is characterized by both wave setup and wave runup, with the two processes acting together when reaching the shorelines. [Marta Marcos, Spain]	The wave contribution to ESL is characterized by both wave setup and wave runup, with the two processes acting together when reaching the shorelines.
40104	91	23			I do not believe skew surge levels are of any physical consequence and even as statistics are useful in certain parts of the world. -My personal view with all due respect. [Michael Tsimplis, China]	I do not believe skew surge levels are of any physical consequence and even as statistics are useful in certain parts of the world. -My personal view with all due respect.
40108	91	26		28	How is flood risk defined then? The statement reads as being globally true when in fact it isn't. [Michael Tsimplis, China]	How is flood risk defined then? The statement reads as being globally true when in fact it isn't.
40106	91	26			very selective referencing again for things known for a century… [Michael Tsimplis, China]	very selective referencing again for things known for a century…
24376	91	27	91	27	"considerably higher" is rather unspecific. Specific numbers/values are more informative. [Ralf Weisse, Germany]	"considerably higher" is rather unspecific. Specific numbers/values are more informative.
40110	91	33			very confused section. Perhaps appropriate to a coastal impacts paper but not for this part of the IPCC report. Referencing is also very selective and surely not the best references are included. [Michael Tsimplis, China]	very confused section. Perhaps appropriate to a coastal impacts paper but not for this part of the IPCC report. Referencing is also very selective and surely not the best references are included.
38512	91	46			Starting from this section and beyod, I think this is too long and wordy. It is better to focus on the assessment rathern then a narative paragraph. We need to consider the balance (length) of each section/subsection. [Iskhaq Iskandar, Indonesia]	Starting from this section and beyod, I think this is too long and wordy. It is better to focus on the assessment rathern then a narative paragraph. We need to consider the balance (length) of each section/subsection.
48542	91	48	103	11	An example of a section where the paleo discussion seemed odd to have up front rather than at the end. [Kyle Armour, United States of America]	An example of a section where the paleo discussion seemed odd to have up front rather than at the end.
50414	91	52	91	52	Although matches what is stated in Marcos et al. (2019), 1993 is used to denote the beginning of the satellite altimetry observation era elsewhere in Chapter 9, e.g. p94, line 5. [Chris Wilson, United Kingdom (of Great Britain and Northern Ireland)]	Although matches what is stated in Marcos et al. (2019), 1993 is used to denote the beginning of the satellite altimetry observation era elsewhere in Chapter 9, e.g. p94, line 5.
40112	91	52			So Marcos et al 2019 is the first reference supporting the previous statement? [Michael Tsimplis, China]	So Marcos et al 2019 is the first reference supporting the previous statement?

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
40114	91	53			only in time? [Michael Tsimplis, China]	only in time?
38462	91	54	91	54	TGs need corrections too (different ones). [Jonathan Gregory, United Kingdom (of Great Britain and Northern Ireland)]	TGs need corrections too (different ones).
55270	91	54			Add: "Satellite altimetry measures sea-level only in the open ocean. Satellites cannot measure sea-level at or near the coasts. The measurement record is very short, and the data is subject to numerous sources of error, and is of much lower quality than the best tide gauge measurements. The satellite altimetry data consists of a hodgepodge of different short measurement records (most of them no more than a decade in length), from different instruments, on different satellites, in different orbits, which decay at differing poorly-constrained rates. Data from different satellites often show substantially different sea-level trends, and the measurements are plagued by errors and repeated major revisions, often long after the data was collected." (For references see my comments on chapter 1, p.31.) [David Burton, United States of America]	Add: "Satellite altimetry measures sea-level only in the open ocean. Satellites cannot measure sea-level at or near the coasts. The measurement record is very short, and the data is subject to numerous sources of error, and is of much lower quality than the best tide gauge measurements. The satellite altimetry data consists of a hodgepodge of different short measurement records (most of them no more than a decade in length), from different instruments, on different satellites, in different orbits, which decay at differing poorly-constrained rates. Data from different satellites often show substantially different sea-level trends, and the measurements are plagued by errors and repeated major revisions, often long after the data was collected." (For references see my comments on chapter 1, p.31.)
40116	91	55			Very selective referencing to support statements that have been known for many years. [Michael Tsimplis, China]	Very selective referencing to support statements that have been known for many years.
40118	91	55			meaning of long? [Michael Tsimplis, China]	meaning of long?
40120	92	1			what does this mean : historically more developed coastlines? A bit of European arrogance here? How are the more and less developed coastlines defined here and are there any papers demonstrating that, for example, the chinese or japanese coastlines were less developed than those in Europe or the US. [Michael Tsimplis, China]	what does this mean : historically more developed coastlines? A bit of European arrogance here? How are the more and less developed coastlines defined here and are there any papers demonstrating that, for example, the chinese or japanese coastlines were less developed than those in Europe or the US.
50416	92	2	92	2	Note that the 89 figure refers specifically to the PSMSL RLR dataset(Marcos et al., 2019). [Chris Wilson, United Kingdom (of Great Britain and Northern Ireland)]	Note that the 89 figure refers specifically to the PSMSL RLR dataset(Marcos et al., 2019).
40122	92	2			They have to be precise for the purpose they are going to be used. As tide gauges were originally required to have accuracy of a few cm good for navigational purposes then historically the statement is not true. Satellite measurements have been claiming to have high precision from the start of their operation but this in fact depends on the instrument and the mission. this section is rather misleading in what the actual capabilities are and how the two sets of measurements are not fully independent or directly comparable. [Michael Tsimplis, China]	They have to be precise for the purpose they are going to be used. As tide gauges were originally required to have accuracy of a few cm good for navigational purposes then historically the statement is not true. Satellite measurements have been claiming to have high precision from the start of their operation but this in fact depends on the instrument and the mission. this section is rather misleading in what the actual capabilities are and how the two sets of measurements are not fully independent or directly comparable.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
40124	92	4			there are studies showing that even in the same location different types of tide gauges can give different results. These are after 1964 and are perhaps worthy of a statement. [Michael Tsimplis, China]	there are studies showing that even in the same location different types of tide gauges can give different results. These are after 1964 and are perhaps worthy of a statement.
33246	92	6	92	7	Isolation basins (lakes at different elevation) also informs about previous sea level and are used to develop RSL curves [Kristian Kjelden, Denmark]	Isolation basins (lakes at different elevation) also informs about previous sea level and are used to develop RSL curves
40126	92	8			How large? Do they invalidate them for the purpose of this report? [Michael Tsimplis, China]	How large? Do they invalidate them for the purpose of this report?
40128	92	10			analyses or synthesis? Is GSML only based on point-wise records? [Michael Tsimplis, China]	analyses or synthesis? Is GSML only based on point-wise records?
42662	92	16	95	44	It is true as stated that the last LIG cannot be taken as a guide to present sea level change due to different orbital parameters, but there is no general agreement as stated here that temperature at that time was just 1ºC warmer, as others hold it was much warmer. [Howard Brady, Australia]	It is true as stated that the last LIG cannot be taken as a guide to present sea level change due to different orbital parameters, but there is no general agreement as stated here that temperature at that time was just 1ºC warmer, as others hold it was much warmer.
40130	92	16			This whoile section is not directly relevant. The opening paragraph is about tide gauges and satellite observations and then instead of discussing what is happening the more uncertain and questionably relevant knowledge is decribed. [Michael Tsimplis, China]	This whoile section is not directly relevant. The opening paragraph is about tide gauges and satellite observations and then instead of discussing what is happening the more uncertain and questionably relevant knowledge is decribed.
8118	92	17	92	30	A fourth purpose should be added to illustrate how paleo-RSL data are important for sea-level projections: their critical role in calibrating/validating GIA models, as mentioned on page 90 (lines 42-43). GIA data are a key element of regional RSL projections for the next century and beyond. [Torbjorn Tornqvist, United States of America]	A fourth purpose should be added to illustrate how paleo-RSL data are important for sea-level projections: their critical role in calibrating/validating GIA models, as mentioned on page 90 (lines 42-43). GIA data are a key element of regional RSL projections for the next century and beyond.
31994	92	19	92	22	Please provide estimates for rate of sea level changes for the past periods as well. [Marie-France Loutre, Switzerland]	Please provide estimates for rate of sea level changes for the past periods as well.
20558	92	28	92	28	Define the time period of "the most recent geological records". [Gwenaelle GREMION, Canada]	Define the time period of "the most recent geological records".
56160	92	32	92	32	The definition of mPWP (or MPWP) needs to be consistent between chapters. After the definition of the Pliocene-Pleistocene boundary was changed, the term mid-Pliocene Warm Period is not appropraite any more for interval ~3.3 - 3 Ma (Dowsett et al., 2016 Clim. Past). Instead, it should be named as mid-Piacenzian Warm Period, as done in the Annex II section of AR6. [Ning Zhao, Germany]	The definition of mPWP (or MPWP) needs to be consistent between chapters. After the definition of the Pliocene-Pleistocene boundary was changed, the term mid-Pliocene Warm Period is not appropraite any more for interval ~3.3 - 3 Ma (Dowsett et al., 2016 Clim. Past). Instead, it should be named as mid-Piacenzian Warm Period, as done in the Annex II section of AR6.
31990	92	32	92	32	mid-Pliocene Warm Periods. In table 2. the short acronym is MPWP. Here it is mPWP. Should be check throughout [Marie-France Loutre, Switzerland]	mid-Pliocene Warm Periods. In table 2. the short acronym is MPWP. Here it is mPWP. Should be check throughout

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
44096	92	33	92	35	mPWP may have had spatially heterogenous warming (ranging from 0 to 9 degrees above modern) and increased climate sensitivity at the poles--perhaps this paragraph would have more impact if it briefly detailed implications of local variation in warming for sea level rise. [Sara Kahanamoku, United States of America]	mPWP may have had spatially heterogenous warming (ranging from 0 to 9 degrees above modern) and increased climate sensitivity at the poles--perhaps this paragraph would have more impact if it briefly detailed implications of local variation in warming for sea level rise.
20560	92	35	92	36	"The most robust line of evidence is..." I disagree with this point. Due to massive changes in the gravitational pull of ice sheets during this interval, I would regard these records as rather unreliable. [Gwenaelle GREMION, Canada]	"The most robust line of evidence is..." I disagree with this point. Due to massive changes in the gravitational pull of ice sheets during this interval, I would regard these records as rather unreliable.
28572	92	35	92	36	"The most robust line of evidence is..." I disagree with this point. Due to massive changes in the gravitational pull of ice sheets during this imterval, I would regard these records as rather unreliable! [Thomas Ronge, Germany]	"The most robust line of evidence is..." I disagree with this point. Due to massive changes in the gravitational pull of ice sheets during this imterval, I would regard these records as rather unreliable!
20562	92	38	92	40	"Mantle dynamic topography can yield vertical land motion (and RSL change) exceeding 20 meters per million year (Rovere et al., 2014; Rowley et al., 2013; Austermann et al., 2015), …" add Austermann et al., 2015 reference. "Austermann, J., Pollard, D., Mitrovica, J.X., Moucha, R., Forte, A.M., DeConto, R.M., Rowley, D.B. and Raymo, M.E., 2015. The impact of dynamic topography change on Antarctic ice sheet stability during the mid-Pliocene warm period. Geology, 43(10), pp.927-930." [Gwenaelle GREMION, Canada]	"Mantle dynamic topography can yield vertical land motion (and RSL change) exceeding 20 meters per million year (Rovere et al., 2014; Rowley et al., 2013; Austermann et al., 2015), …" add Austermann et al., 2015 reference. "Austermann, J., Pollard, D., Mitrovica, J.X., Moucha, R., Forte, A.M., DeConto, R.M., Rowley, D.B. and Raymo, M.E., 2015. The impact of dynamic topography change on Antarctic ice sheet stability during the mid-Pliocene warm period. Geology, 43(10), pp.927-930."
57950	92	40	92	42	When discussing estimates of total global ice volume using the oxygen isotope composition of benthic forams, you could include modeling effors made by De Boer et al., (Nature Comm. 2014, doi: 10.1038/ncomms3999), which actually disentangles the ice volume and temperature signal from the benthic d18O record (and earlier papers as well, but one is enough I would say). Moreover, de Boer et al. (GRL, 2017) shows that due to high eccentricity during some periods with the mPWP, the variability of the GrIS and AIS can be of opposite sign, or asynchronous, following precessional variations, making the interpretation of benthic d18O data even more difficult. [Bas de Boer, Netherlands]	When discussing estimates of total global ice volume using the oxygen isotope composition of benthic forams, you could include modeling effors made by De Boer et al., (Nature Comm. 2014, doi: 10.1038/ncomms3999), which actually disentangles the ice volume and temperature signal from the benthic d18O record (and earlier papers as well, but one is enough I would say). Moreover, de Boer et al. (GRL, 2017) shows that due to high eccentricity during some periods with the mPWP, the variability of the GrIS and AIS can be of opposite sign, or asynchronous, following precessional variations, making the interpretation of benthic d18O data even more difficult.
13726	92	42	92	46	Does the data support rain-on-snow events being common only in mountainous regions? They occur in eastern north America, outside of mountainous regions, because of winter temperature variability. [Simon Donner, Canada]	Does the data support rain-on-snow events being common only in mountainous regions? They occur in eastern north America, outside of mountainous regions, because of winter temperature variability.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
44986	92	44			Here and in the equivalent statement in the EC: Instead of “as an analog,” I think it’s important to be more specific about what, exactly, is assessed as “low confidence.” Yes, there is low confidence that the future will play out the same as it did 3.6 million years ago, but that’s a false strawman. The mPWP certainly does contribute to the overall conclusion that sea level is high when temperature is high, which itself is important information that can be used with high confidence. I suggest something more specific and quantitative like, “the uncertainty in reconstructed sea level is ± x m (xx confidence), which is broader than desirable for future planning.” [Darrell Kaufman, United States of America]	Here and in the equivalent statement in the EC: Instead of “as an analog,” I think it’s important to be more specific about what, exactly, is assessed as “low confidence.” Yes, there is low confidence that the future will play out the same as it did 3.6 million years ago, but that’s a false strawman. The mPWP certainly does contribute to the overall conclusion that sea level is high when temperature is high, which itself is important information that can be used with high confidence. I suggest something more specific and quantitative like, “the uncertainty in reconstructed sea level is ± x m (xx confidence), which is broader than desirable for future planning.”
40464	92	45	92	47	While I understand that space is probably at essence, I would at least cite here MIS 11. Sea levels were probably higher than in MIS 5e, as presented in Raymo and Mitrovica (https://www.nature.com/articles/nature10891). This would need to be embedded in a sentence acknowledging that also for other interglacials we know something regarding peak sea level. [Alessio Rovere, Germany]	While I understand that space is probably at essence, I would at least cite here MIS 11. Sea levels were probably higher than in MIS 5e, as presented in Raymo and Mitrovica (https://www.nature.com/articles/nature10891). This would need to be embedded in a sentence acknowledging that also for other interglacials we know something regarding peak sea level.
6736	92	47	92	47	The Last Interglacial (LIG) [reminder of the dates.] [Joanne Williams, United Kingdom (of Great Britain and Northern Ireland)]	The Last Interglacial (LIG) [reminder of the dates.]
40456	93	6	93	6	Technically, it is wrong to use the word "tectonics" here. I would substitute tectonics with "mantle dynamic topography" [Alessio Rovere, Germany]	Technically, it is wrong to use the word "tectonics" here. I would substitute tectonics with "mantle dynamic topography"
46624	93	6	93	6	Following the IPCC uncertainty guidance, a likelihoods should only be provided if confidence is high or very high. [WGI TSU, France]	Following the IPCC uncertainty guidance, a likelihoods should only be provided if confidence is high or very high.
40132	93	6			is this in agreement with the doubts expressed about the LIG ice sheet behaviour earlier in this chapter? [Michael Tsimplis, China]	is this in agreement with the doubts expressed about the LIG ice sheet behaviour earlier in this chapter?
40134	93	8		20	So what is the relevance to this report? Having low confidence in the presence of absence means "I do not know" (equally positive or negative) not that "I have low confidence". But the report in my view is about the status of knowledge not the efforts to answer all the interlinked aspects of valid and interesting research questions. [Michael Tsimplis, China]	So what is the relevance to this report? Having low confidence in the presence of absence means "I do not know" (equally positive or negative) not that "I have low confidence". But the report in my view is about the status of knowledge not the efforts to answer all the interlinked aspects of valid and interesting research questions.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
40458	93	12	93	14	I know that space is limited, but among the studies arguing for a two-stepped sea level I would cite O'Leary et al., 2013, Nature Geoscience. That study implies a much higher oscullation than what is argued for the Bahamas and Seychelles, and being donw in Western Australia provides an interesting counter-argument to the cited work of Pan et al. [Alessio Rovere, Germany]	I know that space is limited, but among the studies arguing for a two-stepped sea level I would cite O'Leary et al., 2013, Nature Geoscience. That study implies a much higher oscullation than what is argued for the Bahamas and Seychelles, and being donw in Western Australia provides an interesting counter-argument to the cited work of Pan et al.
48974	93	19	93	20	and therefore low confidence in associated implications on ice sheet dynamism or asynchronous ice-sheet minima? [Laura Reynolds, United States of America]	and therefore low confidence in associated implications on ice sheet dynamism or asynchronous ice-sheet minima?
44988	93	19	93	20	I appreciate the conservative stance, but “low confidence in the presence or absence of multiple GMSL peaks during the Last Interglacial” is a big contrast to the conclusion in AR5, that “there is evidence for two intra-LIG sea level peaks (high confidence) during which sea level varied by up to 4 m (medium confidence). The millennial-scale rate of sea level rise during these periods exceeded 2 m kyr–1 (high confidence).” From the discussion in the paragraph, it seems that one study (Barlow et al.) is responsible for the reversed assessment. Either the revelation needs to be more fully documented and justified, or the contrast between AR5 and AR6 conclusions needs to be softened. [Darrell Kaufman, United States of America]	I appreciate the conservative stance, but “low confidence in the presence or absence of multiple GMSL peaks during the Last Interglacial” is a big contrast to the conclusion in AR5, that “there is evidence for two intra-LIG sea level peaks (high confidence) during which sea level varied by up to 4 m (medium confidence). The millennial-scale rate of sea level rise during these periods exceeded 2 m kyr–1 (high confidence).” From the discussion in the paragraph, it seems that one study (Barlow et al.) is responsible for the reversed assessment. Either the revelation needs to be more fully documented and justified, or the contrast between AR5 and AR6 conclusions needs to be softened.
48722	93	22	93	27	GMSL contributions should be stated as ranges from litterature, not vague ~... . For Antarctica, the LGM contribution from Briggs et al, 2014 (A data-constrained large ensemble analysis of Antarctic evolution since the Eemian, Quat. Sci. Reviews, 10.1016/j.quascirev.2014.09.003) has an upper bound of 14.3 m and should be cited. [Lev Tarasov, Canada]	GMSL contributions should be stated as ranges from litterature, not vague ~... . For Antarctica, the LGM contribution from Briggs et al, 2014 (A data-constrained large ensemble analysis of Antarctic evolution since the Eemian, Quat. Sci. Reviews, 10.1016/j.quascirev.2014.09.003) has an upper bound of 14.3 m and should be cited.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
40136	93	22		23	Please confirm this with the change in the confidence level in relation to ice sheet behaviour. There are two aspects of this section that need reconsideration: 1) If there is no progress in this aspect why not refer to the conclusions of AR5 and cross reference to the part of that report instead of reviewing everything here again. 2) I can not see this as well connected with the objectives of the report. Interesting science but not necessarily directly relevant to the objective of the report- or, at least, not demonstrated as such. [Michael Tsimplis, China]	Please confirm this with the change in the confidence level in relation to ice sheet behaviour. There are two aspects of this section that need reconsideration: 1) If there is no progress in this aspect why not refer to the conclusions of AR5 and cross reference to the part of that report instead of reviewing everything here again. 2) I can not see this as well connected with the objectives of the report. Interesting science but not necessarily directly relevant to the objective of the report- or, at least, not demonstrated as such.
20568	93	25	93	29	Given the large error associated with the sea-level contribution of each source from Simms et al. (2019), I think it would be helpful to the reader to include the error in brackets following each sea level contribution estimate. [Gwenaelle GREMION, Canada]	Given the large error associated with the sea-level contribution of each source from Simms et al. (2019), I think it would be helpful to the reader to include the error in brackets following each sea level contribution estimate.
50624	93	27	93	27	I suggest removing 'small' as these were likely very large. [Frank Paul, Switzerland]	I suggest removing 'small' as these were likely very large.
14964	93	34	93	37	A new deglacial reconstruction (Brendryen et al, in review in Nature Geoscience) of the Eurasian Ice sheet (EIS) complex suggest that the marine-based sectors of the EIS abruptly collapsed at the Bølling warming and lost an ice volume of between 3.3 and 6.7 m SLE (95% quantiles) within the time span of the MWP-1a. A contribution from the Antarctic ice sheet to the MWP-1a is therefore not needed in order to close the MWP-1a meltwater budget. Reference: Brendryen J., Haflidason H., Yokoyama Y., Haaga K. A., & Hannisdal B. Collapse of Eurasian ice sheets 14,600 years ago was a major source of global Meltwater Pulse 1a. In review in Nature Geoscience. [Jo Brendryen, Norway]	A new deglacial reconstruction (Brendryen et al, in review in Nature Geoscience) of the Eurasian Ice sheet (EIS) complex suggest that the marine-based sectors of the EIS abruptly collapsed at the Bølling warming and lost an ice volume of between 3.3 and 6.7 m SLE (95% quantiles) within the time span of the MWP-1a. A contribution from the Antarctic ice sheet to the MWP-1a is therefore not needed in order to close the MWP-1a meltwater budget. Reference: Brendryen J., Haflidason H., Yokoyama Y., Haaga K. A., & Hannisdal B. Collapse of Eurasian ice sheets 14,600 years ago was a major source of global Meltwater Pulse 1a. In review in Nature Geoscience.
8120	93	34	93	42	Rates of GMSL rise are expressed here in m/kyr. Since most projections use rates in mm/yr, I think it is preferable to do the same here. [Torbjorn Tornqvist, United States of America]	Rates of GMSL rise are expressed here in m/kyr. Since most projections use rates in mm/yr, I think it is preferable to do the same here.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
48724	93	36	93	37	The cited Gregoire et al, 2016 is a flawed studied. Going by the paper and supplement, it for instance doesn't take into account the geographically varying surficial cover of soft sediment which will have have major impact on NAIS geometry and evolution (eg, Tarasov and Peltier, Quat. Sci. Rev, 2004). It only used 7 ensemble parameters with latin hypercube sampling and no geophysical constraints. It also cites the glaciological reconstruction of Tarasov et al (Earth and Plan. Sci. Lett., 2012) as a constraint target but fails to mention that this latter study which used a Bayesian calibration, 39 ensemble parameters, much more climate degrees of freedom, and a large set of Constraint data (RSL, marine limits, present-day vertical velocities, strandlines,..) found a likely range for MWP-1a contributions (albeit over a 500 year window) of 9.4 to 13.2 m eustatic sea level equivalent. There is also likely a 2-4 m Eurasian contribution to mwp1a (another calibration project that will be submitted this fall for publication). [Lev Tarasov, Canada]	The cited Gregoire et al, 2016 is a flawed studied. Going by the paper and supplement, it for instance doesn't take into account the geographically varying surficial cover of soft sediment which will have have major impact on NAIS geometry and evolution (eg, Tarasov and Peltier, Quat. Sci. Rev, 2004). It only used 7 ensemble parameters with latin hypercube sampling and no geophysical constraints. It also cites the glaciological reconstruction of Tarasov et al (Earth and Plan. Sci. Lett., 2012) as a constraint target but fails to mention that this latter study which used a Bayesian calibration, 39 ensemble parameters, much more climate degrees of freedom, and a large set of Constraint data (RSL, marine limits, present-day vertical velocities, strandlines,..) found a likely range for MWP-1a contributions (albeit over a 500 year window) of 9.4 to 13.2 m eustatic sea level equivalent. There is also likely a 2-4 m Eurasian contribution
20570	93	37	93	37	Also check Weber et al. (2014; doi:10.1038/nature13397) for Antarctic MWP-1A contribution [Gwenaelle GREMION, Canada]	Also check Weber et al. (2014; doi:10.1038/nature13397) for Antarctic MWP-1A contribution
20564	93	37	93	40	According to radiocarbon analysis, Boski et al., 2008 show that the Holocene mean sea-level rise in two stages from 13000 to 7500 Cal yr BP at a rate of 7 mm/yr and from 7500 cal yr BP to present at a rate of 0.9 mm/yr in the North Atlantic coast. 1) Boski T, Camacho S, Moura D, Fletcher W, Wilamowski A, Veiga-Pires C, Correia V, Loureiro C, Santana P. 2008. Chronology of post-glacial sea-level rise in two estuaries of the Algarve coast, S. Portugal. Estuarine, Coastal and Shelf Science 77: 230-244. [Gwenaelle GREMION, Canada]	According to radiocarbon analysis, Boski et al., 2008 show that the Holocene mean sea-level rise in two stages from 13000 to 7500 Cal yr BP at a rate of 7 mm/yr and from 7500 cal yr BP to present at a rate of 0.9 mm/yr in the North Atlantic coast. 1) Boski T, Camacho S, Moura D, Fletcher W, Wilamowski A, Veiga-Pires C, Correia V, Loureiro C, Santana P. 2008. Chronology of post-glacial sea-level rise in two estuaries of the Algarve coast, S. Portugal. Estuarine, Coastal and Shelf Science 77: 230-244.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
20566	93	37	93	40	Sampath et al., 2015 used the reconstructed Holocene sea-level rise rates to successfully simulate the sediment infilling in the sheltered environments of the Guadiana estuary during the Holocene. Thus, the accuracy of the reconstructed sea-level rise curves by Boski et al., (2008) has high confidence in accuracy. Sampath, D.M.R., Boski, T., Loureiro, C., Sousa, C., 2015. Modelling of estuarine response to sea-level rise during the Holocene: Application to the Guadiana Estuary - SW Iberia. Geomorphology. 232, 47-64. http://dx.doi.org/10.1016/j.geomorph.2014.12.037 [Gwenaelle GREMION, Canada]	Sampath et al., 2015 used the reconstructed Holocene sea-level rise rates to successfully simulate the sediment infilling in the sheltered environments of the Guadiana estuary during the Holocene. Thus, the accuracy of the reconstructed sea-level rise curves by Boski et al., (2008) has high confidence in accuracy. Sampath, D.M.R., Boski, T., Loureiro, C., Sousa, C., 2015. Modelling of estuarine response to sea-level rise during the Holocene: Application to the Guadiana Estuary - SW Iberia. Geomorphology. 232, 47-64. http://dx.doi.org/10.1016/j.geomorph.2014.12.037
28574	93	37			Also check Weber et al. (2014; doi:10.1038/nature13397) for Antarctic MWP-1A contribution [Thomas Ronge, Germany]	Also check Weber et al. (2014; doi:10.1038/nature13397) for Antarctic MWP-1A contribution
40138	93	40			The previous paragraph said "low confidence", this says "very low confidence". However as a reader I could not see any difference in both paragraph which essentially state: we do not know yet) [Michael Tsimplis, China]	The previous paragraph said "low confidence", this says "very low confidence". However as a reader I could not see any difference in both paragraph which essentially state: we do not know yet)
40460	93	45	93	55	I think that an important activity to cite is a recent atempt to compile a global atlas of Holocene sea level proxies, that is available in Quaternary Science Reviews (https://www.sciencedirect.com/journal/quaternary-science-reviews/special-issue/10JP1J08X2H) [Alessio Rovere, Germany]	I think that an important activity to cite is a recent atempt to compile a global atlas of Holocene sea level proxies, that is available in Quaternary Science Reviews (https://www.sciencedirect.com/journal/quaternary-science-reviews/special-issue/10JP1J08X2H)
20572	93	46	93	46	When referencing Carlson et al (2008) as a source for the final deglaciation of the Laurentide Ice Sheet, I think two more recent papers could be referenced instead, or as well. These are Utting et al. (2016) (Advance, deglacial and sea-level chronology for Foxe Peninsula, Baffin Island, Nunavut, https://doi.org/10.1111/bor.12167) and Ullman et al. (2016) (Final Laurentide ice-sheet deglaciation and Holocene climate-sea level change, https://doi.org/10.1016/j.quascirev.2016.09.014). [Gwenaelle GREMION, Canada]	When referencing Carlson et al (2008) as a source for the final deglaciation of the Laurentide Ice Sheet, I think two more recent papers could be referenced instead, or as well. These are Utting et al. (2016) (Advance, deglacial and sea?level chronology for Foxe Peninsula, Baffin Island, Nunavut, https://doi.org/10.1111/bor.12167) and Ullman et al. (2016) (Final Laurentide ice-sheet deglaciation and Holocene climate-sea level change, https://doi.org/10.1016/j.quascirev.2016.09.014).

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
40140	94	4			I do not understand the structure and the significance here: If what is intended to say is that RSL show significant subcentennial variations but it is unclear whether these reflect GMSL variations because they could be explained by changes in the regional forcing" then it would probably link better. However what exactly is the relevance I do not undertsand: is this supposed to be the basis of uncertainty estimates? Surely if there are several decimeters of GMSL variability at sub-centenial scale this would broaden the range of estimates for the future and the timing that the changes will become apparent (thus casting doubts on the usefulness model predictions which are rather smooth). At the very least, they may do the same for the RSL in the particular region. If they are not really relevant for the future change because perhaps the forcing mechanisms or the phase of the natural cycle is different then they should not appear at all. [Michael Tsimplis, China]	I do not understand the structure and the significance here: If what is intended to say is that RSL show significant subcentennial variations but it is unclear whether these reflect GMSL variations because they could be explained by changes in the regional forcing" then it would probably link better. However what exactly is the relevance I do not undertsand: is this supposed to be the basis of uncertainty estimates? Surely if there are several decimeters of GMSL variability at sub-centenial scale this would broaden the range of estimates for the future and the timing that the changes will become apparent (thus casting doubts on the usefulness model predictions which are rather smooth). At the very least, they may do the same for the RSL in the particular region. If they are not really relevant for the future change because perhaps the forcing mechanisms or the phase of the natural cycle is different then they should not appear at all.
40142	94	16			I am not clear whether: a) this paragraph is still a description of what we already know from AR5 b) what is the confidence in these meta-analyses c) what rate of changes we are talking about and with what error bars. This is not comparable at all with the other parts of the report. It does not matter only which way GMSL was going but, primarily, how much change was there. [Michael Tsimplis, China]	I am not clear whether: a) this paragraph is still a description of what we already know from AR5 b) what is the confidence in these meta-analyses c) what rate of changes we are talking about and with what error bars. This is not comparable at all with the other parts of the report. It does not matter only which way GMSL was going but, primarily, how much change was there.
8122	94	18	94	19	It isn't clear where the 67% probability that GMSL rise from 1980-2000 was faster than earlier 20-yr time increments originates from; I could not find this in Kemp et al. (2018). [Torbjorn Tornqvist, United States of America]	It isn't clear where the 67% probability that GMSL rise from 1980-2000 was faster than earlier 20-yr time increments originates from; I could not find this in Kemp et al. (2018).
40144	94	26			Why should model testing target be an issue for an Intergovernmental Panel report advising governments and international stakeholders on the status of the earth's climate? [Michael Tsimplis, China]	Why should model testing target be an issue for an Intergovernmental Panel report advising governments and international stakeholders on the status of the earth's climate?
28018	94	33	94	33	Page 94: Global mean sea level rise is compared for different periods at 20 year intervals. Why does the analysis use this interval? [roderik van de wal, Netherlands]	Page 94: Global mean sea level rise is compared for different periods at 20 year intervals. Why does the analysis use this interval?
20574	94	34	94	34	Define the time period of "long" tide gauge records. [Gwenaelle GREMION, Canada]	Define the time period of "long" tide gauge records.
50418	94	35	94	35	Figure 9.35 is of low resolution/poor quality in this draft, so not possible to fully scrutinise statements based on it. [Chris Wilson, United Kingdom (of Great Britain and Northern Ireland)]	Figure 9.35 is of low resolution/poor quality in this draft, so not possible to fully scrutinise statements based on it.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
40146	95	2			Perhaps a statement saying that tide gauges do not measure GMSL but RSL will help. Estimating GMSL from RSL is then an exercise "correcting" the tide gauges for the spatial variability of different contributory factors. Of course where one corrects coherent patterns two things can happen: one is that the uncertainty in the original estimate increases by incorporating the uncertainty of the various factors and second spatially coherent signals can be introduced. Therefore in my view and with all due respect to the authors of the section the AR5 (and earlier) estimates and the new reconstructions only indicate the potential range GMSL values estimated by the tide gauge dataset and the understanding we have in the various contributory components. This is reflected in the overlapping uncertainties in the last sentence of the section. To the extent that the implication is to argue or imply an acceleration on the basis of a VLM correction or "improved" averaging I think the report gives the wrong message. As the uncertainties of the past and the AR5 and the stated rates overlap I can not see how the "very likely" estimated of AR5 has been changed in a "very likely" estimate indicating lower values. I doubt it reflects any consensus in the field. This does not mean that I doubt the validity of the published works. It is simply that the corrections increase the uncertainty and provide for different ways of summing parts up, lowering the overall confidence. [Michael Tsimplis, China]	Perhaps a statement saying that tide gauges do not measure GMSL but RSL will help. Estimating GMSL from RSL is then an exercise "correcting" the tide gauges for the spatial variability of different contributory factors. Of course where one corrects coherent patterns two things can happen: one is that the uncertainty in the original estimate increases by incorporating the uncertainty of the various factors and second spatially coherent signals can be introduced. Therefore in my view and with all due respect to the authors of the section the AR5 (and earlier) estimates and the new reconstructions only indicate the potential range GMSL values estimated by the tide gauge dataset and the understanding we have in the various contributory components. This is reflected in the overlapping uncertainties in the last sentence of the section. To the extent that the implication is to argue or imply an acceleration on the basis of a VLM correction or "improved" averaging I think the report gives the wrong message. As the uncertainties of the past and the AR5 and the stated rates overlap I can not see how the "very likely" estimated of AR5 has been changed in a "very likely" estimate indicating lower values. I doubt it reflects any consensus in the field. This does not mean that I doubt the validity of the published works. It is simply that the corrections increase the uncertainty and provide for different ways of

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
55272	95	3			[pt 1 of 2] Insert: "The best long individual measurement records show no significant, sustained acceleration in rate of sea-level rise, since the 1920s (or, in most cases, even earlier). A particularly high-quality, but otherwise typical, measurement record is the one from Honolulu. It has a continuous, 113-year measurement record. It's mid-Pacific location is ideal, because Oahu is an old, stable island, with very little vertical land motion, because Hawaii gets only small tides, and because its location, near the pivot point of the east-west Pacific "teeter-totter," means it's little affected by ENSO "slosh." It has measured no acceleration at all in 113 years, even as CO2 levels rose from 298 ppmv to the current 410 ppmv. Here's a graph of sea-level at Honolulu, juxtaposed with CO2: https://sealevel.info/1612340_Honolulu_vs_CO2_annot3.png [cont'd] [David Burton, United States of America]	[pt 1 of 2] Insert: "The best long individual measurement records show no significant, sustained acceleration in rate of sea-level rise, since the 1920s (or, in most cases, even earlier). A particularly high-quality, but otherwise typical, measurement record is the one from Honolulu. It has a continuous, 113-year measurement record. It's mid-Pacific location is ideal, because Oahu is an old, stable island, with very little vertical land motion, because Hawaii gets only small tides, and because its location, near the pivot point of the east-west Pacific "teeter-totter," means it's little affected by ENSO "slosh." It has measured no acceleration at all in 113 years, even as CO2 levels rose from 298 ppmv to the current 410 ppmv. Here's a graph of sea-level at Honolulu, juxtaposed with CO2: https://sealevel.info/1612340_Honolulu_vs_CO2_annot3.png [cont'd]
55274	95	3			[pt 2 of 2] Some of the longest tide gauge measurement records did record a slight acceleration in sea-level trend between the mid-1850s and about 1930, as the LIA ended. The largest such acceleration was at Brest, France, where the sea-level trend was flat (+0.0 ±0.2 mm/yr) in the 1800s, but +1.5 ±0.2 mm/yr since 1900. http://sealevel.info/190-091_Brest_1807-1900_vs_1900-2016.png ### [David Burton, United States of America]	[pt 2 of 2] Some of the longest tide gauge measurement records did record a slight acceleration in sea-level trend between the mid-1850s and about 1930, as the LIA ended. The largest such acceleration was at Brest, France, where the sea-level trend was flat (+0.0 ±0.2 mm/yr) in the 1800s, but +1.5 ±0.2 mm/yr since 1900. http://sealevel.info/190-091_Brest_1807-1900_vs_1900-2016.png ###

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
40148	95	4			The tide gauge estimates are presented as independent from the satellite records. To what extent is this true? At least some GSML estimates from tide-gauges take into account the spatial distribution from satellite data- there is an assumption there that such patterns persisted during the whole tide-gauge record (which could be doubted if (a) the inter-centennial variability argued earlier is not a reflection of GMSL but local RSL and (b) iis indeed relevant to current sea level change. Also- I do believe that there have been stages in the development of the altimetry database when some tide gauges have been used for the correction of drifting. This is also an argument that ithere is some interdependency between the GMSL estimates derived and they are not, strictly speaking completely independent. The work of Calafat et al. on the validity of reconstructions as well as some work done by Woodworth showing that they are a weighted average of the tide gauges may be relevant in demystifying reconstructions and the fact that their differences are very much a matter of the selction criteria imposed. [Michael Tsimplis, China]	The tide gauge estimates are presented as independent from the satellite records. To what extent is this true? At least some GSML estimates from tide-gauges take into account the spatial distribution from satellite data- there is an assumption there that such patterns persisted during the whole tide-gauge record (which could be doubted if (a) the inter-centennial variability argued earlier is not a reflection of GMSL but local RSL and (b) iis indeed relevant to current sea level change. Also- I do believe that there have been stages in the development of the altimetry database when some tide gauges have been used for the correction of drifting. This is also an argument that ithere is some interdependency between the GMSL estimates derived and they are not, strictly speaking completely independent. The work of Calafat et al. on the validity of reconstructions as well as some work done by Woodworth showing that they are a weighted average of the tide gauges may be relevant in demystifying reconstructions and the fact that their differences are very much a matter of the selction criteria imposed.
40150	95	6			What does commonly mean? Why is this value selected? How does it affect the rest of the section and especially the trends determined by altimetry? [Michael Tsimplis, China]	What does commonly mean? Why is this value selected? How does it affect the rest of the section and especially the trends determined by altimetry?
40152	95	14			Perhaps these "drift" corrections should be explained- are they so large so as to modify the trends significantly? [Michael Tsimplis, China]	Perhaps these "drift" corrections should be explained- are they so large so as to modify the trends significantly?
40154	95	22			is it correct that the altimeter data are more accurate? There may be more confidence that because the spatial coverage is higher the GMSL estimates are likely to be more accurate but the sentence does not say this. Individual measurements are less accurate than tide gauge measurements AND not very relevant to coastal and polar regions. [Michael Tsimplis, China]	is it correct that the altimeter data are more accurate? There may be more confidence that because the spatial coverage is higher the GMSL estimates are likely to be more accurate but the sentence does not say this. Individual measurements are less accurate than tide gauge measurements AND not very relevant to coastal and polar regions.
40156	95	23			add at the end: as determined by tide gauges [Michael Tsimplis, China]	add at the end: as determined by tide gauges
46626	95	26	95	29	"SROCC concluded that…" - Reference to SROCC section needed [WGI TSU, France]	"SROCC concluded that…" - Reference to SROCC section needed

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
20576	95	29	95	39	According to Antunes 2019, a mean sea level rise of 1.14 m was obtained for the epoch of 2100, with a likely range of 5 - 95% of probability between 0.39 m and 1.89 m. The analysis is based on one of the longest time series of tide gauge data in the world. The tide gauge in Cascais (North Atlantic Ocean), Portugal was installed in 1882 and it is still in use. Antunes, C., 2019. Assessment of sea level rise at the west coast of Portugal Mainland and its projection for the 21st century. Journal of Marine. Science and Engineering. 7, 61. [Gwenaelle GREMION, Canada]	According to Antunes 2019, a mean sea level rise of 1.14 m was obtained for the epoch of 2100, with a likely range of 5 - 95% of probability between 0.39 m and 1.89 m. The analysis is based on one of the longest time series of tide gauge data in the world. The tide gauge in Cascais (North Atlantic Ocean), Portugal was installed in 1882 and it is still in use. Antunes, C., 2019. Assessment of sea level rise at the west coast of Portugal Mainland and its projection for the 21st century. Journal of Marine. Science and Engineering. 7, 61.
40158	95	32			what is the relevance of mentioning this anti-correlation? [Michael Tsimplis, China]	what is the relevance of mentioning this anti-correlation?
36694	95	35	95	35	Persian Gulf [Pakdaman Morteza, Iran]	Persian Gulf
40572	95	35	95	35	Please use "Persian Gulf " instead of "Arabian Gulf" [Yashar Falamarzi, Iran]	Please use "Persian Gulf " instead of "Arabian Gulf"
46280	95	35	95	35	Please change the wrong phrase of the "Arabian Gulf" to "Persian Gulf" [sadegh zeyaeyan, Iran]	Please change the wrong phrase of the "Arabian Gulf" to "Persian Gulf"
57556	95	35	95	35	Please change the wrong phrase of the "Arabian Gulf" to "Persian Gulf" [Sahar Tajbakhsh Mosalman, Iran]	Please change the wrong phrase of the "Arabian Gulf" to "Persian Gulf"
46392	95	35			According to Official documents of the United Nations (e.g. AD/311/1/GEN, ST/CS/SER.A/29/ADD.1, ...), the Arabian Gulf should be changed to "Persian Gulf". [sadegh zeyaeyan, Iran]	According to Official documents of the United Nations (e.g. AD/311/1/GEN, ST/CS/SER.A/29/ADD.1, ...), the Arabian Gulf should be changed to "Persian Gulf".
57668	95	35			According to Official documents of the United Nations (e.g. AD/311/1/GEN, ST/CS/SER.A/29/ADD.1, ...), the Arabian Gulf should be changed to "Persian Gulf". [Sahar Tajbakhsh Mosalman, Iran]	According to Official documents of the United Nations (e.g. AD/311/1/GEN, ST/CS/SER.A/29/ADD.1, ...), the Arabian Gulf should be changed to "Persian Gulf".
26182	95	35			Persian Gulf [iman babaeian, Iran]	Persian Gulf
13998	95	35			According to Official documents of the United Nations (e.g. AD/311/1/GEN, ST/CS/SER.A/29/ADD.1, ...), the Arabian Gulf should be changed to "Persian Gulf". [saeedeh Kouzegaran, Iran]	According to Official documents of the United Nations (e.g. AD/311/1/GEN, ST/CS/SER.A/29/ADD.1, ...), the Arabian Gulf should be changed to "Persian Gulf".
13290	95	35			Persian Gulf [Mansoureh Kouhi, Iran]	Persian Gulf
40160	95	37			what do you mean previous estimates? The AR5? For which period? Which GMSL? Most of these studies were published before the "newer" estimates of GMSL therefore they agree with the Church et al and predecessors estimates. So the statement here does not make sense. Also there have been many other regional studies going back several decades so the selection of some but no other regional studies opens an argument that this is not a complete review but a selective one. [Michael Tsimplis, China]	what do you mean previous estimates? The AR5? For which period? Which GMSL? Most of these studies were published before the "newer" estimates of GMSL therefore they agree with the Church et al and predecessors estimates. So the statement here does not make sense. Also there have been many other regional studies going back several decades so the selection of some but no other regional studies opens an argument that this is not a complete review but a selective one.
40162	95	39			So everywhere else there is no natural variability? I find all this collection of information not really relevant to the issues of the report. [Michael Tsimplis, China]	So everywhere else there is no natural variability? I find all this collection of information not really relevant to the issues of the report.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
48976	95	42	95	44	Specify shallow or deep sediment compaction, and whether it is anthropgenic, natural, or a combination of both. [Laura Reynolds, United States of America]	Specify shallow or deep sediment compaction, and whether it is anthropgenic, natural, or a combination of both.
20578	95	42	95	44	On the topic of sediment compaction and, in particular, the fact that many tide gauges are anchored below thick layers of unconsolidated sediment in low elevation coastal zones (from the referenced Keogh and Tornqvist, 2019), I think it could be a good idea to also mention that many tide gauges are anchored not just beneath but also within the unconsolidated sediment. Although that is often the case, I also think it could be worth including that in coastal Louisiana, 60% of subsidence occurs in the uppermost 5 to 1 m (Jankowski et al., 2017, referenced in Keogh and Tornqvist (2019)). [Gwenaelle GREMION, Canada]	On the topic of sediment compaction and, in particular, the fact that many tide gauges are anchored below thick layers of unconsolidated sediment in low elevation coastal zones (from the referenced Keogh and Tornqvist, 2019), I think it could be a good idea to also mention that many tide gauges are anchored not just beneath but also within the unconsolidated sediment. Although that is often the case, I also think it could be worth including that in coastal Louisiana, 60% of subsidence occurs in the uppermost 5 to 1 m (Jankowski et al., 2017, referenced in Keogh and Tornqvist (2019)).
20580	95	43	95	44	added the reference Kuchar et al., 2018: "...where tide gauges are anchored below a thick layer of unconsolidated sediment (Kuchar et al., 2018; Keogh and Törnqvist, 2019)." [Gwenaelle GREMION, Canada]	added the reference Kuchar et al., 2018: "...where tide gauges are anchored below a thick layer of unconsolidated sediment (Kuchar et al., 2018; Keogh and Törnqvist, 2019)."
45196	95	49	96	4	Table 9.5. All table columns should be based on defined time wel-defined periods. Hence the columns that read "1901-end" and "1993-end" need to replaced with data for time periods that are common to all estimates. [Matthew Palmer, United Kingdom (of Great Britain and Northern Ireland)]	Table 9.5. All table columns should be based on defined time wel-defined periods. Hence the columns that read "1901-end" and "1993-end" need to replaced with data for time periods that are common to all estimates.
50420	95	49	96	4	Table 9.5 needs more description about derivation of the trends that it contains. The last four rows need more detailed citation. [Chris Wilson, United Kingdom (of Great Britain and Northern Ireland)]	Table 9.5 needs more description about derivation of the trends that it contains. The last four rows need more detailed citation.
6738	95	50	95	50	Table9.5 Church and White 2011 - End year listed as 2013, 2 years after publication date? [Joanne Williams, United Kingdom (of Great Britain and Northern Ireland)]	Table9.5 Church and White 2011 - End year listed as 2013, 2 years after publication date?
6740	95	50	95	50	Table 9.5 - I suggest that the format is adjusted to align 1993-end on top panel and 1993-2005 on lower panel, (or some other change to indicate clear change in dates for a given column). [Joanne Williams, United Kingdom (of Great Britain and Northern Ireland)]	Table 9.5 - I suggest that the format is adjusted to align 1993-end on top panel and 1993-2005 on lower panel, (or some other change to indicate clear change in dates for a given column).
40174	96	6			I think we can have high confidence that regional sea level in some parts have accelerated, but, with due respect the extent that this has been an acceleration to GMSL is not of high confidence. In all studies the basis are the few observations and physical or statistical projections backwards in time of the same information. The level of confidence must be much lower, perhaps more likely than not. [Michael Tsimplis, China]	I think we can have high confidence that regional sea level in some parts have accelerated, but, with due respect the extent that this has been an acceleration to GMSL is not of high confidence. In all studies the basis are the few observations and physical or statistical projections backwards in time of the same information. The level of confidence must be much lower, perhaps more likely than not.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
40176	96	6			It is very frustrating that the IPCC has asked for revision of this chapter when this is clearly going to be a rubber stamp on whatever the SROCC is going to produce. There is not really much review that can be done on undisclosed reports still under consideration. [Michael Tsimplis, China]	It is very frustrating that the IPCC has asked for revision of this chapter when this is clearly going to be a rubber stamp on whatever the SROCC is going to produce. There is not really much review that can be done on undisclosed reports still under consideration.
40178	96	6			It is clear from the previous sections that sea level has accelerated after 1993 during the 20th century. This change of rate is much higher than that argued here. It must be clarified whether the estimates of longterm acceleration are affected by the values after 1993. Otherwise the, after 1993 results affect both the long term and the currently acceleration providing double counting. [Michael Tsimplis, China]	It is clear from the previous sections that sea level has accelerated after 1993 during the 20th century. This change of rate is much higher than that argued here. It must be clarified whether the estimates of longterm acceleration are affected by the values after 1993. Otherwise the, after 1993 results affect both the long term and the currently acceleration providing double counting.
20584	96	20	96	20	Add clarification to heading: Identification of 20th Century sea-level rise acceleration. [Gwenaelle GREMION, Canada]	Add clarification to heading: Identification of 20th Century sea-level rise acceleration.
28020	96	20	96	20	Page 97: A range was given for the growth of mean sea level rise; and there was stated that we have high confidence that there has been growth of the rate of sea level rise. However, the first estimate which was given (0.0045 +/- 0.0092 mm year^-2) has an error which is larger than the acceleration itself. [roderik van de wal, Netherlands]	Page 97: A range was given for the growth of mean sea level rise; and there was stated that we have high confidence that there has been growth of the rate of sea level rise. However, the first estimate which was given (0.0045 +/- 0.0092 mm year^-2) has an error which is larger than the acceleration itself.
20582	96	22	96	23	Cascais tideguage data (North Atlantic Ocean) analysis also shows increase in sea-level rise acceleration from 1980-2017, SLR acceleration is 0.100 ±0.030 mm/yr2; 1992-2016, SLR acceleration is 0.152 ±0.032 mm/yr2 (Antunes, 2019). [Gwenaelle GREMION, Canada]	Cascais tideguage data (North Atlantic Ocean) analysis also shows increase in sea-level rise acceleration from 1980-2017, SLR acceleration is 0.100 ±0.030 mm/yr2; 1992-2016, SLR acceleration is 0.152 ±0.032 mm/yr2 (Antunes, 2019).
7200	96	22	97	31	I suggest to mention the case of the Pinatubo eruption whose stratospheric injection reduced the albedo and slowed for a decade the sea-level rise. This results in an acceleration when considering the time span covered by the altimetry era. I have difficulties to suggest the appropriate sentence and position in the chapeter. Sorry about it. Reference: Fasullo, J. T., Nerem, R. S., & Hamlington, B. (2016). Is the detection of accelerated sea level rise imminent?. Scientific reports, 6, 31245. [Marco Olivieri, Italy]	I suggest to mention the case of the Pinatubo eruption whose stratospheric injection reduced the albedo and slowed for a decade the sea-level rise. This results in an acceleration when considering the time span covered by the altimetry era. I have difficulties to suggest the appropriate sentence and position in the chapeter. Sorry about it. Reference: Fasullo, J. T., Nerem, R. S., & Hamlington, B. (2016). Is the detection of accelerated sea level rise imminent?. Scientific reports, 6, 31245.
40166	96	23			how can locations regional and GMSL be together? [Michael Tsimplis, China]	how can locations regional and GMSL be together?

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
40168	96	24			Again this is not new. The work has been done much earlier for tide-gauges alone. In one sense this confirms that geological records can be reliable too rather than adding confidence on the pre-existing knowledge. [Michael Tsimplis, China]	Again this is not new. The work has been done much earlier for tide-gauges alone. In one sense this confirms that geological records can be reliable too rather than adding confidence on the pre-existing knowledge.
20586	96	25	96	25	Precise language should be used so instead of "… RSL change increasing by between about 0.8 and 2.5 mm/yr…" use "RSL change increasing 0.8 and 2.5 mm/yr…". There is no need for ambiguity. [Gwenaelle GREMION, Canada]	Precise language should be used so instead of "… RSL change increasing by between about 0.8 and 2.5 mm/yr…" use "RSL change increasing 0.8 and 2.5 mm/yr…". There is no need for ambiguity.
45968	96	25	96	44	SROCC concluding that sea-level patterns since 1970 in the Pacific and Indian Ocean were primarily driven by surface winds associated with ENSO, IPO, NGPO and IOD, and that, in the Atlantic Ocean, these were primarily driven by NAO and AMOC. Nevertheless, in countries, the unusually high rates of sea level rise being assessed in shorter time periods (after 1970), can be an additional source of uncertainty. It is thus important that this subsection inccludes a tool for assessing the absolute sea level rates (possibly, in a Box). [Lourdes Tibig, Philippines]	SROCC concluding that sea-level patterns since 1970 in the Pacific and Indian Ocean were primarily driven by surface winds associated with ENSO, IPO, NGPO and IOD, and that, in the Atlantic Ocean, these were primarily driven by NAO and AMOC. Nevertheless, in countries, the unusually high rates of sea level rise being assessed in shorter time periods (after 1970), can be an additional source of uncertainty. It is thus important that this subsection inccludes a tool for assessing the absolute sea level rates (possibly, in a Box).
40170	96	27			as the tide gauge dataset is spatially biased it is very surpising that there ishigh confidence of accelation globally. [Michael Tsimplis, China]	as the tide gauge dataset is spatially biased it is very surpising that there ishigh confidence of accelation globally.
40172	96	36		39	So i) what is stated is the change in trends not the acceleration (0.5*a)? The value for the 19th century stated is not different from 0 so the statement made that the rate of change has increased in the last two centirues is not supported by the numbers you state. [Michael Tsimplis, China]	So i) what is stated is the change in trends not the acceleration (0.5*a)? The value for the 19th century stated is not different from 0 so the statement made that the rate of change has increased in the last two centirues is not supported by the numbers you state.
55276	96	40			Add: "Individual high quality tide gauge records further narrow it down the acceleration to beweeen the mid-1850s and about 1930. The best-quality long measurement records have show no significant, sustained acceleration since then." [David Burton, United States of America]	Add: "Individual high quality tide gauge records further narrow it down the acceleration to beweeen the mid-1850s and about 1930. The best-quality long measurement records have show no significant, sustained acceleration since then."

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
40164	96				Table - On the more "accurate" or spatial complete satellite data this table shows that processing can lead to differences in the estimates as large as 0.85 mm/yr for 1993-2005, 0.4 mm/yr for 2006/2018 . Also you have said that the GIA correction used may be different by at least 0.1 mm/yr. Yet the errors stated here are smaller than the uncertainty in ONE forcing factor. Perhaps in your assessment the uncertainty in the corrections imposed should be included. [Michael Tsimplis, China]	Table - On the more "accurate" or spatial complete satellite data this table shows that processing can lead to differences in the estimates as large as 0.85 mm/yr for 1993-2005, 0.4 mm/yr for 2006/2018 . Also you have said that the GIA correction used may be different by at least 0.1 mm/yr. Yet the errors stated here are smaller than the uncertainty in ONE forcing factor. Perhaps in your assessment the uncertainty in the corrections imposed should be included.
55278	97	1			The text reads, "Tide gauge records support a continued long-term acceleration over the 20th century." That is inaccurate. It should read, "Some tide gauge records support a small acceleration during the first thirty years of the 20th century, but no significant acceleration since then." Church & White (2006), Burton (2012) doi:10.1007/s11069-012-0159-8. [David Burton, United States of America]	The text reads, "Tide gauge records support a continued long-term acceleration over the 20th century." That is inaccurate. It should read, "Some tide gauge records support a small acceleration during the first thirty years of the 20th century, but no significant acceleration since then." Church & White (2006), Burton (2012) doi:10.1007/s11069-012-0159-8.
7198	97	4	97	5	I suggest to include the work by Spada et al. 2015, who used an heuristic approach by merging the results of a large set of SLR assesments. Reference: G. Spada, G, M. Olivieri, G. Galassi 2015, A heuristic evaluation of long-term global sea-level acceleration, Geophysical Research Letter, 42 (10), 4166-4172, doi://10.1002/2015GL063837View [Marco Olivieri, Italy]	I suggest to include the work by Spada et al. 2015, who used an heuristic approach by merging the results of a large set of SLR assesments. Reference: G. Spada, G, M. Olivieri, G. Galassi 2015, A heuristic evaluation of long-term global sea-level acceleration, Geophysical Research Letter, 42 (10), 4166-4172, doi://10.1002/2015GL063837View
48978	97	8	97	20	Clarify in this paragraph that the statements are describing GMSL; at present it seems to conflict with the next paragraph. [Laura Reynolds, United States of America]	Clarify in this paragraph that the statements are describing GMSL; at present it seems to conflict with the next paragraph.
20588	97	12	97	14	Precise language should be used so instead of "… from a value of about 2.5 mm/yr over 1993-2002 to about 4.2 mm/yr over 2008-2017, with an acceleration of about 0.1 mm yr-2 over the satellite era …" use "… from 2.5 mm/yr over 1993-2002 to 4.2 mm/yr over 2008-2017, with an acceleration of 0.1 mm yr-2 over the satellite era". [Gwenaelle GREMION, Canada]	Precise language should be used so instead of "… from a value of about 2.5 mm/yr over 1993-2002 to about 4.2 mm/yr over 2008-2017, with an acceleration of about 0.1 mm yr-2 over the satellite era …" use "… from 2.5 mm/yr over 1993-2002 to 4.2 mm/yr over 2008-2017, with an acceleration of 0.1 mm yr-2 over the satellite era".
50422	97	13	97	14	The 0.1 mm/yr2 value could be given greater precision, e.g. 0.084 +/- 0.025 mm/yr2 (Nerem et al., 2018) to match that of the other accelerations in the preceding paragraph. That would make it easier to compare. [Chris Wilson, United Kingdom (of Great Britain and Northern Ireland)]	The 0.1 mm/yr2 value could be given greater precision, e.g. 0.084 +/- 0.025 mm/yr2 (Nerem et al., 2018) to match that of the other accelerations in the preceding paragraph. That would make it easier to compare.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
7864	97	14	97	20	The reference Dangendorf et al (2019) is relevant to this discussion. In particular, they show, on the basis of a GMSL reconstruction, a sustained acceleration since ~1970, of comparable magnitude of the acceleration detected with altimetry by Nerem et al (2018) [Marta Marcos, Spain]	The reference Dangendorf et al (2019) is relevant to this discussion. In particular, they show, on the basis of a GMSL reconstruction, a sustained acceleration since ~1970, of comparable magnitude of the acceleration detected with altimetry by Nerem et al (2018)
52236	97	22	97	22	Suggest adding "individual" before "tide gauges" [Daniel Gilford, United States of America]	Suggest adding "individual" before "tide gauges"
40180	97	22		31	We can not ignore the superiority of direct observations from estimates though. I think this last paragraph is misconceived. Even if it it true that 10 of the existing long term tide gauges will be unable to detect accelerations the conclusion is NOT that therefore there is acceleration nor that, by combining them in GMSL timeseries somehow we statistically extract the signal that it is there but it is undetectable. It would matter how we combine them to obtain any acceleration signal that is not stronger than the variability in each tide gauge. In other words each tide gauges only bounds the limits of acceleration that can be extracted. Perhaps the only reasonable suggestion (but not for this report) would be to install tide gauges where there is less variability and detection will be faster in the future, rather than focusing only on the existing records. I do think the paragraph is misleading. [Michael Tsimplis, China]	We can not ignore the superiority of direct observations from estimates though. I think this last paragraph is misconceived. Even if it it true that 10 of the existing long term tide gauges will be unable to detect accelerations the conclusion is NOT that therefore there is acceleration nor that, by combining them in GMSL timeseries somehow we statistically extract the signal that it is there but it is undetectable. It would matter how we combine them to obtain any acceleration signal that is not stronger than the variability in each tide gauge. In other words each tide gauges only bounds the limits of acceleration that can be extracted. Perhaps the only reasonable suggestion (but not for this report) would be to install tide gauges where there is less variability and detection will be faster in the future, rather than focusing only on the existing records. I do think the paragraph is misleading.
6742	97	24	97	24	Hughes & Williams 2010 [Hughes, C. W.; Williams, S. D. P.. 2010 The color of sea level: importance of spatial variations in spectral shape for assessing the significance of trends. Journal of Geophysical Research, 115, C10048. 18, https://doi.org/10.1029/2010JC006102] shows that a trend in sea-surface height requires around 10 years to detect to 1mm accuracy in many shelf-sea locations (and that is assuming no VLM). [Joanne Williams, United Kingdom (of Great Britain and Northern Ireland)]	Hughes & Williams 2010 [Hughes, C. W.; Williams, S. D. P.. 2010 The color of sea level: importance of spatial variations in spectral shape for assessing the significance of trends. Journal of Geophysical Research, 115, C10048. 18, https://doi.org/10.1029/2010JC006102] shows that a trend in sea-surface height requires around 10 years to detect to 1mm accuracy in many shelf-sea locations (and that is assuming no VLM).
50424	97	31	97	31	The periods mentioned in Haigh et al. (2014), in the same paragraph, extend to the 2050s, which is more than two decades in the future. [Chris Wilson, United Kingdom (of Great Britain and Northern Ireland)]	The periods mentioned in Haigh et al. (2014), in the same paragraph, extend to the 2050s, which is more than two decades in the future.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
45202	97	34	99	6	Section 9.6.2.3: Sea Level Budget. There is a lot of useful information in this section, but I think being slightly re-structured might make it easier to follow. I would suggest starting the with the observation-based budget closure first, and then discuss the ability of models to reproduce the observed budget(s). [Matthew Palmer, United Kingdom (of Great Britain and Northern Ireland)]	Section 9.6.2.3: Sea Level Budget. There is a lot of useful information in this section, but I think being slightly re-structured might make it easier to follow. I would suggest starting the with the observation-based budget closure first, and then discuss the ability of models to reproduce the observed budget(s).
45198	97	36	97	45	A key point that need to be clearly made is that we compare estimates of the total sea-level change to INDEPENDENT estimates of the sum of the components. [Matthew Palmer, United Kingdom (of Great Britain and Northern Ireland)]	A key point that need to be clearly made is that we compare estimates of the total sea-level change to INDEPENDENT estimates of the sum of the components.
52190	97	44			The improvements in observations (should be) covered in chapter 1 and not chapter 2. [Peter Thorne, Ireland]	The improvements in observations (should be) covered in chapter 1 and not chapter 2.
45200	97	47	97	51	I suggest removing this paragraph on sea level budget studies for the paleo-record. It sounds like a budget is assumed rather than demonstrated, therefore I don't think it adds anything to this section. [Matthew Palmer, United Kingdom (of Great Britain and Northern Ireland)]	I suggest removing this paragraph on sea level budget studies for the paleo-record. It sounds like a budget is assumed rather than demonstrated, therefore I don't think it adds anything to this section.
40182	97	54			This is not new data though but new combinations of existing data, therefore they are about reinterpretation and the limits of the available information. [Michael Tsimplis, China]	This is not new data though but new combinations of existing data, therefore they are about reinterpretation and the limits of the available information.
33248	98	1	98	3	Kjeldsen et al, 2015, (doi:10.1038/nature16183) provides two estimates for two century Greenland Ice Sheet, one geodetic mass balance based on observations from aerial photos, and one based on an emperical modeling apporach. The geodetic estimate is regarded as a conservative minimum estimate. [Kristian Kjelden, Denmark]	Kjeldsen et al, 2015, (doi:10.1038/nature16183) provides two estimates for two century Greenland Ice Sheet, one geodetic mass balance based on observations from aerial photos, and one based on an emperical modeling apporach. The geodetic estimate is regarded as a conservative minimum estimate.
40184	98	1			Not accurate if the broader error bars are taken into account. AR5 and current estimates are overlapping. [Michael Tsimplis, China]	Not accurate if the broader error bars are taken into account. AR5 and current estimates are overlapping.
40186	98	11			What does "underestimated temperature increase" mean? [Michael Tsimplis, China]	What does "underestimated temperature increase" mean?
40190	98	48			This paragraph is inconclusive - what is it gained by its inclusion. [Michael Tsimplis, China]	This paragraph is inconclusive - what is it gained by its inclusion.
40188	98				Next couple of pages - what exactly are we supposed to review here? How do you know the confidence you have in numbers you have not yet decided upon? [Michael Tsimplis, China]	Next couple of pages - what exactly are we supposed to review here? How do you know the confidence you have in numbers you have not yet decided upon?
6371	99	10	100	1	Table 9.6 can be expanded with current and new literature (it is overloaded with pre SR5 data) and being inserted in the supplementary material [Baruch Rinkevich, Israel]	Table 9.6 can be expanded with current and new literature (it is overloaded with pre SR5 data) and being inserted in the supplementary material
44098	99	10	100	2	Why are data binned as shown? [Sara Kahanamoku, United States of America]	Why are data binned as shown?

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
15708	99	16			You may want to add Zemp et al. (2019, Nature) for 1961-2016, including/excluding peripheral glaciers in GRL and ANT as well as Wouters et al. (2019, Frontiers) for 2002-2016, excluding peripheral glaciers in GRL and ANT. [Michael Zemp, Switzerland]	You may want to add Zemp et al. (2019, Nature) for 1961-2016, including/excluding peripheral glaciers in GRL and ANT as well as Wouters et al. (2019, Frontiers) for 2002-2016, excluding peripheral glaciers in GRL and ANT.
20590	100	7	100	7	I cannot find 'TG' defined anywhere. [Gwenaelle GREMION, Canada]	I cannot find 'TG' defined anywhere.
47818	101	11	101	11	This is repeated in Chapter 5 and 7 but is currently consistent. The statistic comes from Frolicher 2015,. [WGI TSU, France]	This is repeated in Chapter 5 and 7 but is currently consistent. The statistic comes from Frolicher 2015,.
50960	101	18	101	20	It seems a bit odd to say that changes in heat storage (in the oceans) have direct implications for global sea level as it leads to melt of land-based ice. However, they both have a common cause (a radiative imbalance at TOA due to increased GHGs). [Terje Berntsen, Norway]	It seems a bit odd to say that changes in heat storage (in the oceans) have direct implications for global sea level as it leads to melt of land-based ice. However, they both have a common cause (a radiative imbalance at TOA due to increased GHGs).
40192	101	18		24	I believe this paragraph is an objective assessment of our knowledge status. Thus it follows that as the budget is not closed before that period and the claimed acceleration is not based on direct observations but meta data the confidence in the 20th century acceleration can not be as high as those after 1971. [Michael Tsimplis, China]	I believe this paragraph is an objective assessment of our knowledge status. Thus it follows that as the budget is not closed before that period and the claimed acceleration is not based on direct observations but meta data the confidence in the 20th century acceleration can not be as high as those after 1971.
49290	101	35	101	41	Please assess the GMSL values, over the selected periods, given here in comparison to the annual rates given, over the different selected periods, in section 9.6.2.1.2, on pg 9-95, lines 1-2, and line 21. [Zelina Zaiton Ibrahim, Malaysia]	Please assess the GMSL values, over the selected periods, given here in comparison to the annual rates given, over the different selected periods, in section 9.6.2.1.2, on pg 9-95, lines 1-2, and line 21.
40194	101	35			use cm or m. The whole report must have some consistency. [Michael Tsimplis, China]	use cm or m. The whole report must have some consistency.
40196	101	38			How is this determined if the ranges in the earlier parts of the report are not well defined? [Michael Tsimplis, China]	How is this determined if the ranges in the earlier parts of the report are not well defined?
50426	102	22	102	26	These two sentences need clarification or elaboration. [Chris Wilson, United Kingdom (of Great Britain and Northern Ireland)]	These two sentences need clarification or elaboration.
46024	102	24	102	24	Should be “ice sheet dynamics” instead of “ice sheet dynamical changes” [Isaac Pearlman, United States of America]	Should be “ice sheet dynamics” instead of “ice sheet dynamical changes”
20592	102	28	102	28	regional RSL is redundant [Gwenaelle GREMION, Canada]	regional RSL is redundant
44454	102	28	102	38	The following reference may be relevant: Llovel W., Penduff T., Meyssignac B., Molines J.-M., Terray L., Bessières L. and Barnier B. (2018), Contributions of atmospheric forcing and chaotic ocean variability to regional sea level trends over 1993-2015, Geophysical Research Letters, 45,https://doi.org/10.1029/2018GL080838. [Anne Marie Treguier, France]	The following reference may be relevant: Llovel W., Penduff T., Meyssignac B., Molines J.-M., Terray L., Bessières L. and Barnier B. (2018), Contributions of atmospheric forcing and chaotic ocean variability to regional sea level trends over 1993-2015, Geophysical Research Letters, 45,https://doi.org/10.1029/2018GL080838.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
7866	102	28	102	38	The following study could also be included: in Marcos et al (2017) (doi 10.1007/s10712-016-9373-3) there is a quantification of the minimum anthropogenic contribution to observed regional sea level rise in different areas, ranging from 20% in the Hawaiian archipielago to 80% in the North and Baltic Sea (Table 1 in the cited paper) [Marta Marcos, Spain]	The following study could also be included: in Marcos et al (2017) (doi 10.1007/s10712-016-9373-3) there is a quantification of the minimum anthropogenic contribution to observed regional sea level rise in different areas, ranging from 20% in the Hawaiian archipielago to 80% in the North and Baltic Sea (Table 1 in the cited paper)
40198	102	28		38	I do not think this paragraph is helpful or informative (within the context of the report0 and would suggest deleting it. [Michael Tsimplis, China]	I do not think this paragraph is helpful or informative (within the context of the report0 and would suggest deleting it.
28576	102	28			regional RSL is redundant [Thomas Ronge, Germany]	regional RSL is redundant
50428	102	40	102	44	There is evidence that the ratio of internal to forced low-frequency sea level variability also depends on model resolution. It might be helpful to comment on this, given that most models are coarse resolution. See: Sérazin, G., Penduff, T., Grégorio, S., Barnier, B., Molines, J.-M., & Terray, L. (2015). Intrinsic Variability of Sea Level from Global Ocean Simulations: Spatiotemporal Scales. Journal of Climate, 28(10), 4279–4292. https://doi.org/10.1175/JCLI-D-14-00554.1 [Chris Wilson, United Kingdom (of Great Britain and Northern Ireland)]	There is evidence that the ratio of internal to forced low-frequency sea level variability also depends on model resolution. It might be helpful to comment on this, given that most models are coarse resolution. See: Sérazin, G., Penduff, T., Grégorio, S., Barnier, B., Molines, J.-M., & Terray, L. (2015). Intrinsic Variability of Sea Level from Global Ocean Simulations: Spatiotemporal Scales. Journal of Climate, 28(10), 4279–4292. https://doi.org/10.1175/JCLI-D-14-00554.1
40200	102	40		55	This paragraph needs to be reconsidered. It mixes speculation with results of model studies and local attribution (whatever this is) to global attribution, RSl and ESL to conclude that the we do not have a global study yet. Very confusing pargarpah and each sentence raises at least one question. [Michael Tsimplis, China]	This paragraph needs to be reconsidered. It mixes speculation with results of model studies and local attribution (whatever this is) to global attribution, RSl and ESL to conclude that the we do not have a global study yet. Very confusing pargarpah and each sentence raises at least one question.
28022	102	50	102	52	Page 102, line 50-52: An explanation/example is given of how ESL can be attributed to RSL change in the United States. I found this explanation to be vague and it was not clear to me how attribution here worked. Perhaps rewrite this to show case more what is concluded from these type of studies, instead of this confusing story about attribution. [roderik van de wal, Netherlands]	Page 102, line 50-52: An explanation/example is given of how ESL can be attributed to RSL change in the United States. I found this explanation to be vague and it was not clear to me how attribution here worked. Perhaps rewrite this to show case more what is concluded from these type of studies, instead of this confusing story about attribution.
48544	103	3	103	6	The Indian Ocean indeed shows small internal variability in models, but it has shown large fluctuations in warming rate over the historical record. Thre is an active debate about whether that's forced or variability, but this could complicate this picture. [Kyle Armour, United States of America]	The Indian Ocean indeed shows small internal variability in models, but it has shown large fluctuations in warming rate over the historical record. Thre is an active debate about whether that's forced or variability, but this could complicate this picture.
40204	103	3		11	Why does it matter when this anthropogenically forced signal will "emerge"? I can not follow at all the logic unless this will be a starting point for stop reporting on this until 2040… [Michael Tsimplis, China]	Why does it matter when this anthropogenically forced signal will "emerge"? I can not follow at all the logic unless this will be a starting point for stop reporting on this until 2040…

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
40202	103	4			The previous paragraph said it is already detectable. [Michael Tsimplis, China]	The previous paragraph said it is already detectable.
45204	103	16	103	17	My view is that section 9.6.3.1 should simply review the literature and be used in providing context for a new set of sea level projections, that are described in subsequent sections (section 9.6.3.1 does not constitute the AR6 projections). So there are not really "two approaches" to the sea level projections (?). I think it is important that AR6 provides a clearly defined methodology for the sea level (and other) projections it presents and discusses these in light of the literature and previous IPCC reports. [Matthew Palmer, United Kingdom (of Great Britain and Northern Ireland)]	My view is that section 9.6.3.1 should simply review the literature and be used in providing context for a new set of sea level projections, that are described in subsequent sections (section 9.6.3.1 does not constitute the AR6 projections). So there are not really "two approaches" to the sea level projections (?). I think it is important that AR6 provides a clearly defined methodology for the sea level (and other) projections it presents and discusses these in light of the literature and previous IPCC reports.
40208	103	16		29	This is rather complicated. Do you actually assess all these projections and on what criteria? Why is it needed to do all these layers of assessment? Why updating SROCC which otherwise it is followed elsewhere in the report? This appears inconsistent. The 2nd and 3rd from the last are not needed in my view, 9.6.3.4 because they are "unlikely" 9.6.3.5 because this is a report on the status of knowledge not a wish list or a call for funding. Long term commitments could play a role in driving home the fact that, aspects of warming will have longer term consequences. [Michael Tsimplis, China]	This is rather complicated. Do you actually assess all these projections and on what criteria? Why is it needed to do all these layers of assessment? Why updating SROCC which otherwise it is followed elsewhere in the report? This appears inconsistent. The 2nd and 3rd from the last are not needed in my view, 9.6.3.4 because they are "unlikely" 9.6.3.5 because this is a report on the status of knowledge not a wish list or a call for funding. Long term commitments could play a role in driving home the fact that, aspects of warming will have longer term consequences.
40206	103	16			What does generally moderately comparable actually mean? [Michael Tsimplis, China]	What does generally moderately comparable actually mean?
20600	103	28	103	28	Remove 'the potential to reduce the uncertainty in projections (9.6.3.5)' as this is not a sub-section. [Gwenaelle GREMION, Canada]	Remove 'the potential to reduce the uncertainty in projections (9.6.3.5)' as this is not a sub-section.
20602	103	29	103	29	Replace '9.6.3.6' by '9.6.3.5'. [Gwenaelle GREMION, Canada]	Replace '9.6.3.6' by '9.6.3.5'.
9786	103	45	103	47	The definition here says that probabilistic projections consider outcomes at "many different" probability levels. While this is true, "many different" seems more vague and subjective than is necessary--I suggest changing this to "more than three" based on the descriptions in Horton et al., 2018a. [Andra Garner, United States of America]	The definition here says that probabilistic projections consider outcomes at "many different" probability levels. While this is true, "many different" seems more vague and subjective than is necessary--I suggest changing this to "more than three" based on the descriptions in Horton et al., 2018a.
20594	103	46	103	46	explicit' -> 'explicitly' [Gwenaelle GREMION, Canada]	explicit' -> 'explicitly'
20604	103	53	104	1	I think a reference for this statement is needed since you provide confidence levels for SEMs to describe the climate - SL change relationship (present and future). [Gwenaelle GREMION, Canada]	I think a reference for this statement is needed since you provide confidence levels for SEMs to describe the climate - SL change relationship (present and future).
20596	103	53	104	3	Great to comment on, but may be helpful to spell out more clearly. (i.e. future evolution is outside the statistical sample from past climate). [Gwenaelle GREMION, Canada]	Great to comment on, but may be helpful to spell out more clearly. (i.e. future evolution is outside the statistical sample from past climate).

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
20598	103	53	104	3	This sentence is very long, and it could improve clarity if it were split into shorter sentences. [Gwenaelle GREMION, Canada]	This sentence is very long, and it could improve clarity if it were split into shorter sentences.
20606	104	2	104	3	This is worded in a confusing way. Does this incorporate SEMs calibrated with other data (i.e. those not calibrated only to the tide gauge record)? [Gwenaelle GREMION, Canada]	This is worded in a confusing way. Does this incorporate SEMs calibrated with other data (i.e. those not calibrated only to the tide gauge record)?
40210	104	6			delete s [Michael Tsimplis, China]	delete s
20608	104	8	104	8	(CDFs) GMSL' -> '(CDFs) of GMSL' [Gwenaelle GREMION, Canada]	(CDFs) GMSL' -> '(CDFs) of GMSL'
20610	104	13	104	14	I haven't seen 'deep uncertainty' defined in the AR6 IPCC uncertainty language doc. I've seen in defined for AR5. Just make sure that it is still applicable for the current guidelines. [Gwenaelle GREMION, Canada]	I haven't seen 'deep uncertainty' defined in the AR6 IPCC uncertainty language doc. I've seen in defined for AR5. Just make sure that it is still applicable for the current guidelines.
20612	104	15	104	15	Italicize 'deep uncertainty' [Gwenaelle GREMION, Canada]	Italicize 'deep uncertainty'
20614	104	15	104	17	3 cases where 'limited agreement' -> 'low agreement', and need to be italicized [Gwenaelle GREMION, Canada]	3 cases where 'limited agreement' -> 'low agreement', and need to be italicized
40212	104	15			why not in italics here? [Michael Tsimplis, China]	why not in italics here?
38464	104	17	104	19	More explanation of what p-boxes is needed, since it's an unfamiliar concept. How is "plausible" defined and how does it relate to the IPCC standard probability and confidence language? It's essential to characterise the SL projections in the same terms as other projections, so that users will know how to interpret them. The needs of decision-makers in interpreting uncertainties in SL projections are discussed by Hinkel et al. (2019)10.1029/2018ef001071. [Jonathan Gregory, United Kingdom (of Great Britain and Northern Ireland)]	More explanation of what p-boxes is needed, since it's an unfamiliar concept. How is "plausible" defined and how does it relate to the IPCC standard probability and confidence language? It's essential to characterise the SL projections in the same terms as other projections, so that users will know how to interpret them. The needs of decision-makers in interpreting uncertainties in SL projections are discussed by Hinkel et al. (2019)10.1029/2018ef001071.
33270	104	25	104	26	I did not find a discussion on the choice to treat the SEJ of Bamber et al. 2019 with a lower confidence than an older projections. For example it seems strange to give a higher confidence to projections based on an older SEJ like Grinstead et al. 2015 and Jevrejeva et al. 2014. Does it mean negative learning took place between 2013 and 2018? Also assigning higher confience to projections based on very simple models like Bakker et al. 2017, Mengel et al. 2016 Nauels et al. 2017 does not seem justified to me. These models have enormous structural uncertainty and a good amount of "non-structured" expert judgement is requiered to build them. [Dewi Le Bars, Netherlands]	I did not find a discussion on the choice to treat the SEJ of Bamber et al. 2019 with a lower confidence than an older projections. For example it seems strange to give a higher confidence to projections based on an older SEJ like Grinstead et al. 2015 and Jevrejeva et al. 2014. Does it mean negative learning took place between 2013 and 2018? Also assigning higher confience to projections based on very simple models like Bakker et al. 2017, Mengel et al. 2016 Nauels et al. 2017 does not seem justified to me. These models have enormous structural uncertainty and a good amount of "non-structured" expert judgement is requiered to build them.
20616	104	29	104	31	Consider removing this sentence as it is a repetition of the previous sentence. [Gwenaelle GREMION, Canada]	Consider removing this sentence as it is a repetition of the previous sentence.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
20618	104	31	104	32	I do not agree that the level of agreement in GMSL projections is low for RCP2.6 (2100) in Fig. 9.37b, compared to RCP2.6 (2050) in Fig. 9.37a. I would slightly rephrase the sentence: 'For 2100, Figures 9.37b,d,f reveal a lower level of agreement, particularly for higher emission scenarios…' [Gwenaelle GREMION, Canada]	I do not agree that the level of agreement in GMSL projections is low for RCP2.6 (2100) in Fig. 9.37b, compared to RCP2.6 (2050) in Fig. 9.37a. I would slightly rephrase the sentence: 'For 2100, Figures 9.37b,d,f reveal a lower level of agreement, particularly for higher emission scenarios…'
8696	104	39	105	41	I think that the method to produce very likely range is very good. However, there may be one issue: some of the probabilistic projections multiply the standard deviation of CMIP-5 models outcomes by 1,64, in order to reflect the IPCC AR5 WG1 Ch12 statement that “global mean surface air temperature change is likely to lie within the 5 to 95% range of the projections of CMIP5 models”. While this seems very well justified on the high end side of the distribution, I wonder if it can be justified on the low end tail. This procedure may explain the very small 5th percentile for RCP4,5 2100 (22cm), which some may say lacks credibility because this would mean a slow down of sea-level rise in the 21th century. [Goneri Le Cozannet, France]	I think that the method to produce very likely range is very good. However, there may be one issue: some of the probabilistic projections multiply the standard deviation of CMIP-5 models outcomes by 1,64, in order to reflect the IPCC AR5 WG1 Ch12 statement that “global mean surface air temperature change is likely to lie within the 5 to 95% range of the projections of CMIP5 models”. While this seems very well justified on the high end side of the distribution, I wonder if it can be justified on the low end tail. This procedure may explain the very small 5th percentile for RCP4,5 2100 (22cm), which some may say lacks credibility because this would mean a slow down of sea-level rise in the 21th century.
40214	104	39			meaning of generous in statistical terms? Is it closer to "likely"? This subdivision of already non-numerical levels of confidence is obscuring the assessment. [Michael Tsimplis, China]	meaning of generous in statistical terms? Is it closer to "likely"? This subdivision of already non-numerical levels of confidence is obscuring the assessment.
40216	104	41			for each individual model? Is this what you are saying? [Michael Tsimplis, China]	for each individual model? Is this what you are saying?
40218	104	43			any supporting reference for this? [Michael Tsimplis, China]	any supporting reference for this?
9788	104	45	105	8	Should there be references included to note which studies are producing the lowest and highest values from the literature for the various RCPs? Readers may find it useful. [Andra Garner, United States of America]	Should there be references included to note which studies are producing the lowest and highest values from the literature for the various RCPs? Readers may find it useful.
12884	104	45	105	8	Make a table for the GMSL and MICI contribution to GMSL. [Durwood Zaelke, United States of America]	Make a table for the GMSL and MICI contribution to GMSL.
12714	104	45	105	8	Make a table for the GMSL and MICI contribution to GMSL [Kristin Campbell, United States of America]	Make a table for the GMSL and MICI contribution to GMSL
16058	104	45	105	8	The projections of sea level rise for RCP6.0 should also be included in this paragraph for completeness and the reference by the policy and decision makers. [SAI MING LEE, China]	The projections of sea level rise for RCP6.0 should also be included in this paragraph for completeness and the reference by the policy and decision makers.
20620	104	46	104	52	In order to shorten and make the text clearer, I would write a single sentence including the three different RCPs for 2000-2050, e.g.: 'The very likely range of literature values for GMSL rise over 2000-2050 is 12-41 cm for RCP2.6, 13-43 cm for RCP4.5, and 14-48 cm for RCP8.5.' [Gwenaelle GREMION, Canada]	In order to shorten and make the text clearer, I would write a single sentence including the three different RCPs for 2000-2050, e.g.: 'The very likely range of literature values for GMSL rise over 2000-2050 is 12-41 cm for RCP2.6, 13-43 cm for RCP4.5, and 14-48 cm for RCP8.5.'

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
38466	104	47	104	52	It would be clearer and more consistent with other projections to make these statements as very likely ranges, with assessed confidence. [Jonathan Gregory, United Kingdom (of Great Britain and Northern Ireland)]	It would be clearer and more consistent with other projections to make these statements as very likely ranges, with assessed confidence.
40220	104	47		52	is this really meaningful for projections? Should the amount already experienced between 2000-2019 be subtracted and state what the rest is? [Michael Tsimplis, China]	is this really meaningful for projections? Should the amount already experienced between 2000-2019 be subtracted and state what the rest is?
20622	105	2	105	8	In order to shorten and make the text clearer, I would write a single sentence including the three different RCPs for 2000-2100, e.g.: 'The very likely range of literature values for GMSL rise over 2000-2100 is 24-82 cm for RCP2.6, 22-100 cm for RCP4.5, and 45-183 cm for RCP8.5.' [Gwenaelle GREMION, Canada]	In order to shorten and make the text clearer, I would write a single sentence including the three different RCPs for 2000-2100, e.g.: 'The very likely range of literature values for GMSL rise over 2000-2100 is 24-82 cm for RCP2.6, 22-100 cm for RCP4.5, and 45-183 cm for RCP8.5.'
20624	105	10	105	13	You need to add at least one reference for this statement (MICI contribution to GMSL rise). For example: DeConto, R. M. and D. Pollard (2016). Contribution of Antarctica to past and future sea-level rise. Nature, doi: 10.1038/nature17145. [Gwenaelle GREMION, Canada]	You need to add at least one reference for this statement (MICI contribution to GMSL rise). For example: DeConto, R. M. and D. Pollard (2016). Contribution of Antarctica to past and future sea-level rise. Nature, doi: 10.1038/nature17145.
40222	105	12			meaning of substantial? Does this include all studies that have 50 cm MISI contribution or more or something else? [Michael Tsimplis, China]	meaning of substantial? Does this include all studies that have 50 cm MISI contribution or more or something else?
20626	105	19	105	24	I do not agree with the reasoning here, because you are excluding the RCP8.5 scenario from the very likely range for 2000-2050. Instead of assuming that the very likely range of GMSL rise between 2000 and 2050 will be similar to RCP2.6 and RCP4.5 ranges, it would be more interesting here to provide the GMSL projections coming from the different studies (e.g. Bittermann et al., 2017), and to compare them to the RCP ranges discussed above. [Gwenaelle GREMION, Canada]	I do not agree with the reasoning here, because you are excluding the RCP8.5 scenario from the very likely range for 2000-2050. Instead of assuming that the very likely range of GMSL rise between 2000 and 2050 will be similar to RCP2.6 and RCP4.5 ranges, it would be more interesting here to provide the GMSL projections coming from the different studies (e.g. Bittermann et al., 2017), and to compare them to the RCP ranges discussed above.
20628	105	26	105	32	You forgot to specify the period over which these projections are valid (i.e. 2000-2100 I guess). Furthermore, I think it is interesting to add that the ranges given by the 1.5°C and 2°C scenarios are about similar to RCP2.6 and RCP4.5 scenarios, respectively. [Gwenaelle GREMION, Canada]	You forgot to specify the period over which these projections are valid (i.e. 2000-2100 I guess). Furthermore, I think it is interesting to add that the ranges given by the 1.5°C and 2°C scenarios are about similar to RCP2.6 and RCP4.5 scenarios, respectively.
40224	105	34		41	Very vague discussion. [Michael Tsimplis, China]	Very vague discussion.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
55280	105	42			However, Burton (2012) contends that, "Since the rate of sea level rise has not increased significantly in response to the last 3/4 century of CO2 emissions, there is no reason to expect that it will do so in response to the next 3/4 century of CO2 emissions. The best prediction for sea level in the future is simply a linear projection of the history of sea level at the same location in the past, or about 7-8 inches by 2080, for Long Island." doi:10.1007/s11069-012-0159-8 [David Burton, United States of America]	However, Burton (2012) contends that, "Since the rate of sea level rise has not increased significantly in response to the last 3/4 century of CO2 emissions, there is no reason to expect that it will do so in response to the next 3/4 century of CO2 emissions. The best prediction for sea level in the future is simply a linear projection of the history of sea level at the same location in the past, or about 7-8 inches by 2080, for Long Island." doi:10.1007/s11069-012-0159-8
38468	105	46	105	47	It is unclear to me which grey lines in Fig 37 delimit the p-boxes. [Jonathan Gregory, United Kingdom (of Great Britain and Northern Ireland)]	It is unclear to me which grey lines in Fig 37 delimit the p-boxes.
49468	106	2	106	15	Thermosteric sea-level is strongly dependent on the spatial distribution of ocean mixing, and hence on the model mixing parameterizations. See Melet, Angelique, Sonya Legg, and Robert Hallberg, May 2016: Climatic impacts of parameterized local and remote tidal mixing. Journal of Climate, 29(10), DOI:10.1175/JCLI-D-15-0153.1. [Sonya Legg, United States of America]	Thermosteric sea-level is strongly dependent on the spatial distribution of ocean mixing, and hence on the model mixing parameterizations. See Melet, Angelique, Sonya Legg, and Robert Hallberg, May 2016: Climatic impacts of parameterized local and remote tidal mixing. Journal of Climate, 29(10), DOI:10.1175/JCLI-D-15-0153.1.
45206	106	2	106	15	There are a couple of points made in this paragraph that I do not agree with. 1) the improved ocean observations are cited as the main reason for model improvements. I think some mention should be made of increased computing resources, improved model resolution and process understanding, which have also played an equally important role. 2) The final sentence suggests that ocean parameterizations/resolution are the primary reasons for uncertainty in thermosteric and ocean dynamic sea-level change. While this claim is reasonable for ocean dynamic seal-level change, it is at best only marginally true for global thermosteric sea-level change: Kuhlbrodt and Gregory (2012) showed that variations in ocean heat uptake efficiency (associated with model spread in vertical heat transport processes) explains about 50% of the spread in ocean heat uptake. There must also be some uncertainty associated with climate change scenario for the future projections (?) [Matthew Palmer, United Kingdom (of Great Britain and Northern Ireland)]	There are a couple of points made in this paragraph that I do not agree with. 1) the improved ocean observations are cited as the main reason for model improvements. I think some mention should be made of increased computing resources, improved model resolution and process understanding, which have also played an equally important role. 2) The final sentence suggests that ocean parameterizations/resolution are the primary reasons for uncertainty in thermosteric and ocean dynamic sea-level change. While this claim is reasonable for ocean dynamic seal-level change, it is at best only marginally true for global thermosteric sea-level change: Kuhlbrodt and Gregory (2012) showed that variations in ocean heat uptake efficiency (associated with model spread in vertical heat transport processes) explains about 50% of the spread in ocean heat uptake. There must also be some uncertainty associated with climate change scenario for the future projections (?)
40226	106	5			do you mean assimilating instead of representing? [Michael Tsimplis, China]	do you mean assimilating instead of representing?
20632	106	10	106	12	and even though' -> 'despite' This section of the paragraph is very confusingly written, and should be reworked to help the point come across [Gwenaelle GREMION, Canada]	and even though' -> 'despite' This section of the paragraph is very confusingly written, and should be reworked to help the point come across

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
20630	106	11	106	11	Confusing phrasing: unsure what you mean by 'different phases of climate variability' [Gwenaelle GREMION, Canada]	Confusing phrasing: unsure what you mean by 'different phases of climate variability'
20634	106	12	106	15	This point is very important, and it is lost down here. It should come in much sooner, and more clearly. [Gwenaelle GREMION, Canada]	This point is very important, and it is lost down here. It should come in much sooner, and more clearly.
40228	106	15			This paragraph is not entirely consistent with the assessment of oceanic models earlier in the chapter. It could be that the sea level representation is better than the other parameters but as sea level is, to my knowledge, a derivative parameter the sections must be consistent. [Michael Tsimplis, China]	This paragraph is not entirely consistent with the assessment of oceanic models earlier in the chapter. It could be that the sea level representation is better than the other parameters but as sea level is, to my knowledge, a derivative parameter the sections must be consistent.
40230	106	17		23	The patterns of open ocean sea level change is not really of any use- changes in oceanic circulation are those that matter for the systems (eco and bio) and what happens at the various coasts are important for humans. At best is a tracer of changes easier to measure. [Michael Tsimplis, China]	The patterns of open ocean sea level change is not really of any use- changes in oceanic circulation are those that matter for the systems (eco and bio) and what happens at the various coasts are important for humans. At best is a tracer of changes easier to measure.
38470	106	18	106	18	Causes of the spread among models in terms of ocean heat uptake processes and the influence of different ocean surface flux changes on ocean dynamic sea level change have been investigated by Bouttes et al (2014) 10.1088/1748-9326/9/3/034004, Exarchou et al (2015) 10.1175/jcli-d-14-00235.1, Kuhlbrodt et al (2015) 10.1007/s00382-015-2534-0, Gregory et al (2016) 10.5194/gmd-9-3993-2016, Saenko et al (2015) 10.1002/2015jc010928, Saenko et al (2018) 10.1175/jcli-d-18-0186.1, and probably other papers. I think there's quite a lot of literature to be discussed since AR5 on the uncertainty in sterodynamic projections, and the treatment here is too brief compared with that of other effects below, given the large contribution and uncertainty from these effects. [Jonathan Gregory, United Kingdom (of Great Britain and Northern Ireland)]	Causes of the spread among models in terms of ocean heat uptake processes and the influence of different ocean surface flux changes on ocean dynamic sea level change have been investigated by Bouttes et al (2014) 10.1088/1748-9326/9/3/034004, Exarchou et al (2015) 10.1175/jcli-d-14-00235.1, Kuhlbrodt et al (2015) 10.1007/s00382-015-2534-0, Gregory et al (2016) 10.5194/gmd-9-3993-2016, Saenko et al (2015) 10.1002/2015jc010928, Saenko et al (2018) 10.1175/jcli-d-18-0186.1, and probably other papers. I think there's quite a lot of literature to be discussed since AR5 on the uncertainty in sterodynamic projections, and the treatment here is too brief compared with that of other effects below, given the large contribution and uncertainty from these effects.
20636	106	18	106	18	different' -> 'specific' [Gwenaelle GREMION, Canada]	different' -> 'specific'
20644	106	22	106	23	What are 'enhanced SSH increase' and 'reduced SSH increase'? This deserves an explanation. [Gwenaelle GREMION, Canada]	What are 'enhanced SSH increase' and 'reduced SSH increase'? This deserves an explanation.
20638	106	27	106	27	generation' -> 'development' [Gwenaelle GREMION, Canada]	generation' -> 'development'

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
38472	106	27	106	29	While there has certainly been a lot of progress, I think this may overstate how far we have got. Probably a couple of CMIP6 models will include an interactive Greenland ice-sheet and none will include Antarctica interactively. There is a substantial number of ice-sheet models, not coupled to AOGCMs, making coordinated projections in ISMIP6; these do include parametrisations of ice-shelf processes and MISI, but not MICI, which is more controversial and doubtful. [Jonathan Gregory, United Kingdom (of Great Britain and Northern Ireland)]	While there has certainly been a lot of progress, I think this may overstate how far we have got. Probably a couple of CMIP6 models will include an interactive Greenland ice-sheet and none will include Antarctica interactively. There is a substantial number of ice-sheet models, not coupled to AOGCMs, making coordinated projections in ISMIP6; these do include parametrisations of ice-shelf processes and MISI, but not MICI, which is more controversial and doubtful.
20850	106	29	106	29	These results seem too specific for the point of this paragraph. I would suggest focusing on how different models are targeting specific physics, therefore leading to spread in the results. [Gwenaelle GREMION, Canada]	These results seem too specific for the point of this paragraph. I would suggest focusing on how different models are targeting specific physics, therefore leading to spread in the results.
20646	106	29	106	32	This sentence needs references to support it. For example, for perturbed parameter ensembles for Antarctica: DeConto, R. M. and D. Pollard (2016). Contribution of Antarctica to past and future sea-level rise. Nature, doi: 10.1038/nature17145. [Gwenaelle GREMION, Canada]	This sentence needs references to support it. For example, for perturbed parameter ensembles for Antarctica: DeConto, R. M. and D. Pollard (2016). Contribution of Antarctica to past and future sea-level rise. Nature, doi: 10.1038/nature17145.
20640	106	35	106	35	new was available literature' -> 'new literature was available' [Gwenaelle GREMION, Canada]	new was available literature' -> 'new literature was available'
38474	106	37	106	37	Projections of what? [Jonathan Gregory, United Kingdom (of Great Britain and Northern Ireland)]	Projections of what?
20648	106	37	106	37	Are these ranges valid for Antarctica only or for both ice sheets? You need to specify it in this sentence, as this is not clear. [Gwenaelle GREMION, Canada]	Are these ranges valid for Antarctica only or for both ice sheets? You need to specify it in this sentence, as this is not clear.
40232	106	39		40	Not much comment can be made except that there is overlap with the earlier part of the report and apparent inconsistencies: this part appears mauch more confident about model capabilities than the earlier sections. [Michael Tsimplis, China]	Not much comment can be made except that there is overlap with the earlier part of the report and apparent inconsistencies: this part appears mauch more confident about model capabilities than the earlier sections.
50626	106	42	106	42	I suggest adding 'as well as unknown precipitation amounts'. [Frank Paul, Switzerland]	I suggest adding 'as well as unknown precipitation amounts'.
46628	106	42	106	55	Suggest to provide callout to 9.5.2.3 (Model evaluation) and 9.5.2.5 (Projections) [WGI TSU, France]	Suggest to provide callout to 9.5.2.3 (Model evaluation) and 9.5.2.5 (Projections)
20642	106	51	106	55	Despite projections being in slightly different orders of magnitude, it would be helpful to present this section in consistent units with previous sections (i.e. cm). [Gwenaelle GREMION, Canada]	Despite projections being in slightly different orders of magnitude, it would be helpful to present this section in consistent units with previous sections (i.e. cm).
40234	106	51		54	I would suggest consistency in the units used will make it easier to the reader. [Michael Tsimplis, China]	I would suggest consistency in the units used will make it easier to the reader.
50628	107	1	107	1	See comment before, I would just remove the response time thing. 'glaciers will lose … that have larger glaciers' [Frank Paul, Switzerland]	See comment before, I would just remove the response time thing. 'glaciers will lose … that have larger glaciers'

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
20650	107	5	107	14	It may be useful to more explicitly cite why these numbers can't be converted to equivalent GMSL, with associated confidence language. And to place context of these numbers, compared to previous sections (i.e. cm equivalent GMSL rise). [Gwenaelle GREMION, Canada]	It may be useful to more explicitly cite why these numbers can't be converted to equivalent GMSL, with associated confidence language. And to place context of these numbers, compared to previous sections (i.e. cm equivalent GMSL rise).
40236	107	5		14	These were all available at AR5 is this the same assessment? If so do say there is no change. [Michael Tsimplis, China]	These were all available at AR5 is this the same assessment? If so do say there is no change.
37920	107	5			Groundwater depletion is covered here. But is there also expected to be increased impoundment of water in artificial reservoirs? There is talk earlier of the many people whose water supply is fed by melting glaciers or seasonal snow cover. Is it expected that there will have to be an increase in reservoir impoundment to ensure that these people have reliable water supply? [Adrian Simmons, United Kingdom (of Great Britain and Northern Ireland)]	Groundwater depletion is covered here. But is there also expected to be increased impoundment of water in artificial reservoirs? There is talk earlier of the many people whose water supply is fed by melting glaciers or seasonal snow cover. Is it expected that there will have to be an increase in reservoir impoundment to ensure that these people have reliable water supply?
46026	107	7	103	11	For regional sea level contribution, is it worth mentioning the influence of decreased gravitational force as ice sheets melt and collapse? For example, melting in the West Antarctic ice sheet will particularly contribute to rising sea level on the Pacific coast of United States. [Isaac Pearlman, United States of America]	For regional sea level contribution, is it worth mentioning the influence of decreased gravitational force as ice sheets melt and collapse? For example, melting in the West Antarctic ice sheet will particularly contribute to rising sea level on the Pacific coast of United States.
20656	107	16	107	16	GRD is defined marginally different than in the BOX 9.2. [Gwenaelle GREMION, Canada]	GRD is defined marginally different than in the BOX 9.2.
38476	107	16	108	3	I think there's too much detail in this part, which is relatively less important or less uncertain than sterodynamic, ice sheet and glacier contributions. Earthquakes are not anthropogenic and therefore not really within the scope except as an issue to be considered in correction of TGs. [Jonathan Gregory, United Kingdom (of Great Britain and Northern Ireland)]	I think there's too much detail in this part, which is relatively less important or less uncertain than sterodynamic, ice sheet and glacier contributions. Earthquakes are not anthropogenic and therefore not really within the scope except as an issue to be considered in correction of TGs.
40238	107	16		22	Size of the effects? Not sure why this fits here and not where RSL is discussed. [Michael Tsimplis, China]	Size of the effects? Not sure why this fits here and not where RSL is discussed.
20652	107	24	107	24	Convert 'relatively well understood' to IPCC confidence language [Gwenaelle GREMION, Canada]	Convert 'relatively well understood' to IPCC confidence language
40240	107	24		37	Quantify. Are these important uncertainties within the context of the suggested changes and how much difference is due to these uncertainties in the various RSL/GMSL projections? If non important remove. [Michael Tsimplis, China]	Quantify. Are these important uncertainties within the context of the suggested changes and how much difference is due to these uncertainties in the various RSL/GMSL projections? If non important remove.
6744	107	39	107	39	No mention of use of GNSS to measure VLM? [Joanne Williams, United Kingdom (of Great Britain and Northern Ireland)]	No mention of use of GNSS to measure VLM?
20654	107	39	107	39	Add acronym of vertical land motion (VLM) in brackets. [Gwenaelle GREMION, Canada]	Add acronym of vertical land motion (VLM) in brackets.
40242	107	39			small spatial scales [Michael Tsimplis, China]	small spatial scales
40244	107	43			I do not think that any of the other projections are easy either. [Michael Tsimplis, China]	I do not think that any of the other projections are easy either.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
40246	108	3			THis paragraph does not say anything relevant. If this is included something on tsunamis must be included in the ESL. [Michael Tsimplis, China]	THis paragraph does not say anything relevant. If this is included something on tsunamis must be included in the ESL.
45208	108	6	111	5	Section 9.6.3.3 Updated Projections: I think it would be great if we could show traceabilty to the AR5 global mean sea level projections for the AR6 projections. In an ideal world, I think we would do the following: 1) first show the results for AR5 methods with the new SSP scenarios, to isolate the differences arising from climate change scenarios; 2) show the results for AR5 methods using the new SSP scenarios and CMIP6 models; 3) Present the results with AR6 methods, new SSP scenarios and CMIP6 models. [Matthew Palmer, United Kingdom (of Great Britain and Northern Ireland)]	Section 9.6.3.3 Updated Projections: I think it would be great if we could show traceabilty to the AR5 global mean sea level projections for the AR6 projections. In an ideal world, I think we would do the following: 1) first show the results for AR5 methods with the new SSP scenarios, to isolate the differences arising from climate change scenarios; 2) show the results for AR5 methods using the new SSP scenarios and CMIP6 models; 3) Present the results with AR6 methods, new SSP scenarios and CMIP6 models.
40248	108	6			The IPCC report must contain ONLY the most "trusted" (on expert judgement) projections, in my view and a statement on the changes from the AR5. [Michael Tsimplis, China]	The IPCC report must contain ONLY the most "trusted" (on expert judgement) projections, in my view and a statement on the changes from the AR5.
32428	108	18	108	24	These severe uncertainties must be highlighted in the Excecutive summary for increased credibility for this report and WG1’s fine work ! [Martin Hovland, Norway]	These severe uncertainties must be highlighted in the Excecutive summary for increased credibility for this report and WG1’s fine work !
20658	108	21	108	21	offline' -> 'separately' [Gwenaelle GREMION, Canada]	offline' -> 'separately'
40250	108	21			This does not mean anything to non-experts. Computed separately and added on perhaps? [Michael Tsimplis, China]	This does not mean anything to non-experts. Computed separately and added on perhaps?
20660	108	27	108	27	offline' -> 'separate' [Gwenaelle GREMION, Canada]	offline' -> 'separate'
40252	108	31			Isn't this paragraph crucial for ALL projections whether updated or not? If it appears only here then does it signify that it is not applicable to all previous projections? [Michael Tsimplis, China]	Isn't this paragraph crucial for ALL projections whether updated or not? If it appears only here then does it signify that it is not applicable to all previous projections?
52192	109	7	109	8	Why is there only ambition to go to 2150 given that we know sea-levels will change for millenia even after forcings are stabalised? Surely it is policy relevant to go much further forwards in time even if uncertainties are large and confidence low? Maybe refer the reader to the later section 9.6.3.5 or integrate these into one? [Peter Thorne, Ireland]	Why is there only ambition to go to 2150 given that we know sea-levels will change for millenia even after forcings are stabalised? Surely it is policy relevant to go much further forwards in time even if uncertainties are large and confidence low? Maybe refer the reader to the later section 9.6.3.5 or integrate these into one?
20662	109	13	109	21	It is useful data for coastal modellers, If the authors can provide probability density functions against the envelope of each sea-level rise scenario. See Antunes., 2019 for example. The functions can be used for simulating coastal evolution and impact assessments using probabilistic models. [Gwenaelle GREMION, Canada]	It is useful data for coastal modellers, If the authors can provide probability density functions against the envelope of each sea-level rise scenario. See Antunes., 2019 for example. The functions can be used for simulating coastal evolution and impact assessments using probabilistic models.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
46028	109	36	110	2	Is it possible to include the percent of each GMSL contributing factor? For example, under RCP2.6 thermosteric contribution to projected increase in GMSL is 0.14 or XX% of total. [Isaac Pearlman, United States of America]	Is it possible to include the percent of each GMSL contributing factor? For example, under RCP2.6 thermosteric contribution to projected increase in GMSL is 0.14 or XX% of total.
40254	109				Table- RCP1.9 - difficult to see its usefulness. Last rows of Table add uncertainties. [Michael Tsimplis, China]	Table- RCP1.9 - difficult to see its usefulness. Last rows of Table add uncertainties.
12886	110	22	111	1	Once the numbers are entered into Table 9.8, the information should be featured in the Executive Summary of this section and possibly even the overall executive summary, putting the focus on the changes for the 1–2 range and the 1.5–2.5 range. [Durwood Zaelke, United States of America]	Once the numbers are entered into Table 9.8, the information should be featured in the Executive Summary of this section and possibly even the overall executive summary, putting the focus on the changes for the 1–2 range and the 1.5–2.5 range.
45210	110	22	111	2	Table 9.8: I've never really been comfortable with the idea of categorising sea level rise according to surface temperature rise, because the the large degree of committed sea level rise. My concern is that the table will mis-lead readers and over-emphasise the 2100 time-horizon. I think one of the improvements we can make in AR6 over AR5 is more explicit treatment of the period out to 2300 for the sea level projections. However, I can see that the authors have a placeholder to discuss the committed sea level rise - it is imperative that this information is included. I would suggest that some indicative timescale for sea level rates reaching zero (or close to zero) is also included. [Matthew Palmer, United Kingdom (of Great Britain and Northern Ireland)]	Table 9.8: I've never really been comfortable with the idea of categorising sea level rise according to surface temperature rise, because the the large degree of committed sea level rise. My concern is that the table will mis-lead readers and over-emphasise the 2100 time-horizon. I think one of the improvements we can make in AR6 over AR5 is more explicit treatment of the period out to 2300 for the sea level projections. However, I can see that the authors have a placeholder to discuss the committed sea level rise - it is imperative that this information is included. I would suggest that some indicative timescale for sea level rates reaching zero (or close to zero) is also included.
52238	111	5	112	7	This section could be aided by a short discussion of how the SEJ results from Bamber et al. (2019) suggest growing uncertainty associate with deep uncertainties in the ice-sheets, meaning we now expect that more high-end surprises are possible than we did before (in the previous SEJ styudy, Bamber 2013, and in AR5) [Daniel Gilford, United States of America]	This section could be aided by a short discussion of how the SEJ results from Bamber et al. (2019) suggest growing uncertainty associate with deep uncertainties in the ice-sheets, meaning we now expect that more high-end surprises are possible than we did before (in the previous SEJ styudy, Bamber 2013, and in AR5)
40256	111	5			This section have very little scientific substance and turns around the possibility of one aspect of our current understanding being fundamentally erroneous, i.e. ice sheet collapse. What is the enhanced confidence mentioned? [Michael Tsimplis, China]	This section have very little scientific substance and turns around the possibility of one aspect of our current understanding being fundamentally erroneous, i.e. ice sheet collapse. What is the enhanced confidence mentioned?

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
12888	111	6	111	13	High impact and uncertainty are important to the overall discussion because they highlight the potential risk, which is an important consideration in urging fast action on climate mitigation to avoid the worst of impacts. Xu and Ramanathan (2017) Well below 2 °C: Mitigation strategies for avoiding dangerous to catastrophic climate changes, Proc. Natl. Acad. Sciences and and Committee to Prevent Extreme Climate Change (2017) Well Under 2 Degrees Celsius: Fast Action Policies to Protect People and the Planet from Extreme Climate Change; Ramanathan and Feng (2008) On avoiding dangerous anthropogenic interference with the climate system: Formidable challenges ahead, Proc. Natl. Acad. Sci., doi: 10.1073/pnas.0803838105; Weitzman M. (2011). Fat-Tailed Uncertainty in the Economics of Catastrophic Climate Change. Review of Environmental Economics and Policy 5(2):275-292; Spratt D. & Dunlop I. (2019) Existential climate-related security risk: A scenario approach, Policy Paper, Breakthrough – National Centre for Climate Restoration. [Durwood Zaelke, United States of America]	High impact and uncertainty are important to the overall discussion because they highlight the potential risk, which is an important consideration in urging fast action on climate mitigation to avoid the worst of impacts. Xu and Ramanathan (2017) Well below 2 °C: Mitigation strategies for avoiding dangerous to catastrophic climate changes, Proc. Natl. Acad. Sciences and and Committee to Prevent Extreme Climate Change (2017) Well Under 2 Degrees Celsius: Fast Action Policies to Protect People and the Planet from Extreme Climate Change; Ramanathan and Feng (2008) On avoiding dangerous anthropogenic interference with the climate system: Formidable challenges ahead, Proc. Natl. Acad. Sci., doi: 10.1073/pnas.0803838105; Weitzman M. (2011). Fat-Tailed Uncertainty in the Economics of Catastrophic Climate Change. Review of Environmental Economics and Policy 5(2):275-292; Spratt D. & Dunlop I. (2019) Existential climate-related security risk: A scenario approach, Policy Paper, Breakthrough – National Centre for Climate Restoration.
42352	111	6	111	13	High impact and uncertainty are important to the overall discussion because they highlight the potential risk, which is an important consideration in urging fast action on climate mitigation to avoid the worst of impacts. Xu and Ramanathan (2017) Well below 2 °C: Mitigation strategies for avoiding dangerous to catastrophic climate changes, Proc. Natl. Acad. Sciences and and Committee to Prevent Extreme Climate Change (2017) Well Under 2 Degrees Celsius: Fast Action Policies to Protect People and the Planet from Extreme Climate Change; Ramanathan and Feng (2008) On avoiding dangerous anthropogenic interference with the climate system: Formidable challenges ahead, Proc. Natl. Acad. Sci., doi: 10.1073/pnas.0803838105; Weitzman M. (2011). Fat-Tailed Uncertainty in the Economics of Catastrophic Climate Change. Review of Environmental Economics and Policy 5(2):275-292; Spratt D. & Dunlop I. (2019) Existential climate-related security risk: A scenario approach, Policy Paper, Breakthrough – National Centre for Climate Restoration. [Gabrielle Dreyfus, United States of America]	High impact and uncertainty are important to the overall discussion because they highlight the potential risk, which is an important consideration in urging fast action on climate mitigation to avoid the worst of impacts. Xu and Ramanathan (2017) Well below 2 °C: Mitigation strategies for avoiding dangerous to catastrophic climate changes, Proc. Natl. Acad. Sciences and and Committee to Prevent Extreme Climate Change (2017) Well Under 2 Degrees Celsius: Fast Action Policies to Protect People and the Planet from Extreme Climate Change; Ramanathan and Feng (2008) On avoiding dangerous anthropogenic interference with the climate system: Formidable challenges ahead, Proc. Natl. Acad. Sci., doi: 10.1073/pnas.0803838105; Weitzman M. (2011). Fat-Tailed Uncertainty in the Economics of Catastrophic Climate Change. Review of Environmental Economics and Policy 5(2):275-292; Spratt D. & Dunlop I. (2019) Existential climate-related security risk: A scenario approach, Policy Paper, Breakthrough – National Centre for Climate Restoration.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
12716	111	6	111	13	High impact and uncertainty are important to the overall discussion because they highlight the potential risk, which is an important consideration in urging swift action on climate mitigation to avoid the worst of impacts. Xu and Ramanathan (2017) Well below 2 °C: Mitigation strategies for avoiding dangerous to catastrophic climate changes, Proc. Natl. Acad. Sciences and and Committee to Prevent Extreme Climate Change (2017) Well Under 2 Degrees Celsius: Fast Action Policies to Protect People and the Planet from Extreme Climate Change; Ramanathan and Feng (2008) On avoiding dangerous anthropogenic interference with the climate system: Formidable challenges ahead, Proc. Natl. Acad. Sci., doi: 10.1073/pnas.0803838105; Weitzman M. (2011). Fat-Tailed Uncertainty in the Economics of Catastrophic Climate Change. Review of Environmental Economics and Policy 5(2):275-292; Spratt D. & Dunlop I. (2019) Existential climate-related security risk: A scenario approach, Policy Paper, Breakthrough – National Centre for Climate Restoration. [Kristin Campbell, United States of America]	High impact and uncertainty are important to the overall discussion because they highlight the potential risk, which is an important consideration in urging swift action on climate mitigation to avoid the worst of impacts. Xu and Ramanathan (2017) Well below 2 °C: Mitigation strategies for avoiding dangerous to catastrophic climate changes, Proc. Natl. Acad. Sciences and and Committee to Prevent Extreme Climate Change (2017) Well Under 2 Degrees Celsius: Fast Action Policies to Protect People and the Planet from Extreme Climate Change; Ramanathan and Feng (2008) On avoiding dangerous anthropogenic interference with the climate system: Formidable challenges ahead, Proc. Natl. Acad. Sci., doi: 10.1073/pnas.0803838105; Weitzman M. (2011). Fat-Tailed Uncertainty in the Economics of Catastrophic Climate Change. Review of Environmental Economics and Policy 5(2):275-292; Spratt D. & Dunlop I. (2019) Existential climate-related security risk: A scenario approach, Policy Paper, Breakthrough – National Centre for Climate Restoration.
38478	111	6	111	26	I appreciate that you can't properly yet make your assessment yet of GMSLR at 2100. Therefore I don't think it's right to state that the likely range is higher than it was in the AR5. You show 0.55-1.40 m for RCP8.5 in the table, referred to SROCC, which is indeed higher than the AR5, but with no explanation or references. Since this is a critical issue, it will require very careful treatment in the second draft. SROCC is not primary scientific literature. If your assessment is that the likely range by 2100 is higher than it was in the AR5, you need to explain this in terms of the primary literature. Personally I do not think there is justification in post-AR5 literature for a higher likely range than in AR5. [Jonathan Gregory, United Kingdom (of Great Britain and Northern Ireland)]	I appreciate that you can't properly yet make your assessment yet of GMSLR at 2100. Therefore I don't think it's right to state that the likely range is higher than it was in the AR5. You show 0.55-1.40 m for RCP8.5 in the table, referred to SROCC, which is indeed higher than the AR5, but with no explanation or references. Since this is a critical issue, it will require very careful treatment in the second draft. SROCC is not primary scientific literature. If your assessment is that the likely range by 2100 is higher than it was in the AR5, you need to explain this in terms of the primary literature. Personally I do not think there is justification in post-AR5 literature for a higher likely range than in AR5.
38480	111	8	111	8	As I've noted above, I think "plausible" is a word needing explanation. We shouldn't try to sidestep the difficulty of probabilities by using other words! Is the complete disappearance of both ice sheets by 2100 "physically plausible", for instance? It doesn't violate physical laws. [Jonathan Gregory, United Kingdom (of Great Britain and Northern Ireland)]	As I've noted above, I think "plausible" is a word needing explanation. We shouldn't try to sidestep the difficulty of probabilities by using other words! Is the complete disappearance of both ice sheets by 2100 "physically plausible", for instance? It doesn't violate physical laws.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
40258	111	8			With all due respect this is a very bad argument. The IPCC report is about policy making not the potentially more catastrophic scenarios especially when they are unlikely. [Michael Tsimplis, China]	With all due respect this is a very bad argument. The IPCC report is about policy making not the potentially more catastrophic scenarios especially when they are unlikely.
40260	111	10			and it will rise more if the criterion is the one you have set out earlier. The report indicates so many areas where interesting work can tak place. This direction is not helpful. [Michael Tsimplis, China]	and it will rise more if the criterion is the one you have set out earlier. The report indicates so many areas where interesting work can tak place. This direction is not helpful.
12890	111	15	111	26	High impact and uncertainty are important to the overall discussion because they highlight the potential risk, which is an important consideration in urging fast action on climate mitigation to avoid the worst of impacts. Xu and Ramanathan (2017) Well below 2 °C: Mitigation strategies for avoiding dangerous to catastrophic climate changes, Proc. Natl. Acad. Sciences and and Committee to Prevent Extreme Climate Change (2017) Well Under 2 Degrees Celsius: Fast Action Policies to Protect People and the Planet from Extreme Climate Change; Ramanathan and Feng (2008) On avoiding dangerous anthropogenic interference with the climate system: Formidable challenges ahead, Proc. Natl. Acad. Sci., doi: 10.1073/pnas.0803838105; Weitzman M. (2011). Fat-Tailed Uncertainty in the Economics of Catastrophic Climate Change. Review of Environmental Economics and Policy 5(2):275-292; Spratt D. & Dunlop I. (2019) Existential climate-related security risk: A scenario approach, Policy Paper, Breakthrough – National Centre for Climate Restoration. [Durwood Zaelke, United States of America]	High impact and uncertainty are important to the overall discussion because they highlight the potential risk, which is an important consideration in urging fast action on climate mitigation to avoid the worst of impacts. Xu and Ramanathan (2017) Well below 2 °C: Mitigation strategies for avoiding dangerous to catastrophic climate changes, Proc. Natl. Acad. Sciences and and Committee to Prevent Extreme Climate Change (2017) Well Under 2 Degrees Celsius: Fast Action Policies to Protect People and the Planet from Extreme Climate Change; Ramanathan and Feng (2008) On avoiding dangerous anthropogenic interference with the climate system: Formidable challenges ahead, Proc. Natl. Acad. Sci., doi: 10.1073/pnas.0803838105; Weitzman M. (2011). Fat-Tailed Uncertainty in the Economics of Catastrophic Climate Change. Review of Environmental Economics and Policy 5(2):275-292; Spratt D. & Dunlop I. (2019) Existential climate-related security risk: A scenario approach, Policy Paper, Breakthrough – National Centre for Climate Restoration.
12892	111	15	111	26	The multi-century/millennial SLR (Section 9.6.3.5, 9-112 L11 to 9-113 L44) should be referenced in the Exec Summary because it highlights the ongoing problem of SLR that doesn't magically stop at 2100, but is instead tied to a threshold; also important to always note the delay from emissions and temp and when the eventual SLR will occur. [Durwood Zaelke, United States of America]	The multi-century/millennial SLR (Section 9.6.3.5, 9-112 L11 to 9-113 L44) should be referenced in the Exec Summary because it highlights the ongoing problem of SLR that doesn't magically stop at 2100, but is instead tied to a threshold; also important to always note the delay from emissions and temp and when the eventual SLR will occur.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
42354	111	15	111	26	Authors should be cautious about stating upper limits based more on limited publication base than an understanding of the physical processes. Recent evaluation using structured expert judgement suggests a higher tail than suggested in the literature. See Jonathan L. Bamber, Michael Oppenheimer, Robert E. Kopp, Willy P. Aspinall, and Roger M. Cooke (2019) Ice sheet contributions to future sea-level rise from structured expert judgment, Proc. Natl. Acad. Sci., https://doi.org/10.1073/pnas.1817205116. High impact and uncertainty are important to the overall discussion because they highlight the potential risk, which is an important consideration in urging fast action on climate mitigation to avoid the worst of impacts. Xu and Ramanathan (2017) Well below 2 °C: Mitigation strategies for avoiding dangerous to catastrophic climate changes, Proc. Natl. Acad. Sciences and and Committee to Prevent Extreme Climate Change (2017) Well Under 2 Degrees Celsius: Fast Action Policies to Protect People and the Planet from Extreme Climate Change; Ramanathan and Feng (2008) On avoiding dangerous anthropogenic interference with the climate system: Formidable challenges ahead, Proc. Natl. Acad. Sci., doi: 10.1073/pnas.0803838105; Weitzman M. (2011). Fat-Tailed Uncertainty in the Economics of Catastrophic Climate Change. Review of Environmental Economics and Policy 5(2):275-292; Spratt D. & Dunlop I. (2019) Existential climate-related security risk: A scenario approach, Policy Paper, Breakthrough – National Centre for Climate Restoration. [Gabrielle Dreyfus, United States of America]	Authors should be cautious about stating upper limits based more on limited publication base than an understanding of the physical processes. Recent evaluation using structured expert judgement suggests a higher tail than suggested in the literature. See Jonathan L. Bamber, Michael Oppenheimer, Robert E. Kopp, Willy P. Aspinall, and Roger M. Cooke (2019) Ice sheet contributions to future sea-level rise from structured expert judgment, Proc. Natl. Acad. Sci., https://doi.org/10.1073/pnas.1817205116. High impact and uncertainty are important to the overall discussion because they highlight the potential risk, which is an important consideration in urging fast action on climate mitigation to avoid the worst of impacts. Xu and Ramanathan (2017) Well below 2 °C: Mitigation strategies for avoiding dangerous to catastrophic climate changes, Proc. Natl. Acad. Sciences and and Committee to Prevent Extreme Climate Change (2017) Well Under 2 Degrees Celsius: Fast Action Policies to Protect People and the Planet from Extreme Climate Change; Ramanathan and Feng (2008) On avoiding dangerous anthropogenic interference with the climate system: Formidable challenges ahead, Proc. Natl. Acad. Sci., doi: 10.1073/pnas.0803838105; Weitzman M. (2011). Fat-Tailed Uncertainty in the Economics of Catastrophic Climate Change. Review of Environmental Economics and Policy 5(2):275-292; Spratt D. & Dunlop I. (2019)

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
12718	111	15	111	26	High impact and uncertainty are important to the overall discussion because they highlight the potential risk, which is an important consideration in urging swift action on climate mitigation to avoid the worst of impacts. Xu and Ramanathan (2017) Well below 2 °C: Mitigation strategies for avoiding dangerous to catastrophic climate changes, Proc. Natl. Acad. Sciences and and Committee to Prevent Extreme Climate Change (2017) Well Under 2 Degrees Celsius: Fast Action Policies to Protect People and the Planet from Extreme Climate Change; Ramanathan and Feng (2008) On avoiding dangerous anthropogenic interference with the climate system: Formidable challenges ahead, Proc. Natl. Acad. Sci., doi: 10.1073/pnas.0803838105; Weitzman M. (2011). Fat-Tailed Uncertainty in the Economics of Catastrophic Climate Change. Review of Environmental Economics and Policy 5(2):275-292; Spratt D. & Dunlop I. (2019) Existential climate-related security risk: A scenario approach, Policy Paper, Breakthrough – National Centre for Climate Restoration. [Kristin Campbell, United States of America]	High impact and uncertainty are important to the overall discussion because they highlight the potential risk, which is an important consideration in urging swift action on climate mitigation to avoid the worst of impacts. Xu and Ramanathan (2017) Well below 2 °C: Mitigation strategies for avoiding dangerous to catastrophic climate changes, Proc. Natl. Acad. Sciences and and Committee to Prevent Extreme Climate Change (2017) Well Under 2 Degrees Celsius: Fast Action Policies to Protect People and the Planet from Extreme Climate Change; Ramanathan and Feng (2008) On avoiding dangerous anthropogenic interference with the climate system: Formidable challenges ahead, Proc. Natl. Acad. Sci., doi: 10.1073/pnas.0803838105; Weitzman M. (2011). Fat-Tailed Uncertainty in the Economics of Catastrophic Climate Change. Review of Environmental Economics and Policy 5(2):275-292; Spratt D. & Dunlop I. (2019) Existential climate-related security risk: A scenario approach, Policy Paper, Breakthrough – National Centre for Climate Restoration.
12720	111	15	111	26	The multi-century/millennial SLR (Section 9.6.3.5, 9-112 L11 to 9-113 L44) should be referenced in the Exec Summary because it highlights the ongoing problem of SLR that doesn't magically stop at 2100, but is instead tied to a threshold; also important to always note the delay from emissions and temp and when the eventual SLR will occur. [Kristin Campbell, United States of America]	The multi-century/millennial SLR (Section 9.6.3.5, 9-112 L11 to 9-113 L44) should be referenced in the Exec Summary because it highlights the ongoing problem of SLR that doesn't magically stop at 2100, but is instead tied to a threshold; also important to always note the delay from emissions and temp and when the eventual SLR will occur.
20664	111	29	111	30	I think you should also include the marine ice sheet instability (MISI) in the key unknown uncertainties in this sentence. In Box 9.1, you do not claim that MICI is more uncertain than MISI. It is just that the concept of MICI is more recent than MISI, but the uncertainty linked to MISI still exists (even if the concept of MISI has been known for decades). References that discuss MISI and MICI: 1) Pattyn, F. et al. (2018). The Greenland and Antarctic ice sheets under 1.5 °C global warming. Nature Climate Change, doi: 10.1038/s41558-018-0305-8, 2) DeConto, R. M. and D. Pollard (2016). Contribution of Antarctica to past and future sea-level rise. Nature, doi: 10.1038/nature17145. [Gwenaelle GREMION, Canada]	I think you should also include the marine ice sheet instability (MISI) in the key unknown uncertainties in this sentence. In Box 9.1, you do not claim that MICI is more uncertain than MISI. It is just that the concept of MICI is more recent than MISI, but the uncertainty linked to MISI still exists (even if the concept of MISI has been known for decades). References that discuss MISI and MICI: 1) Pattyn, F. et al. (2018). The Greenland and Antarctic ice sheets under 1.5 °C global warming. Nature Climate Change, doi: 10.1038/s41558-018-0305-8, 2) DeConto, R. M. and D. Pollard (2016). Contribution of Antarctica to past and future sea-level rise. Nature, doi: 10.1038/nature17145.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
49292	112	11	112	29	It may be more useful to tabulate the information given in the first part of this paragraph to allow for easier comparison and conclusion of confidence and likelihood. [Zelina Zaiton Ibrahim, Malaysia]	It may be more useful to tabulate the information given in the first part of this paragraph to allow for easier comparison and conclusion of confidence and likelihood.
20666	112	11	112	29	If the authors can provide sea-level rise projection time series envelops (charts with 5-95% limit GMSL rise time series curves) from 2000 beyond 2100 at least for main four scenarios, the projections can be used in coastal system evolution simulations and impact assessment models. [Gwenaelle GREMION, Canada]	If the authors can provide sea-level rise projection time series envelops (charts with 5-95% limit GMSL rise time series curves) from 2000 beyond 2100 at least for main four scenarios, the projections can be used in coastal system evolution simulations and impact assessment models.
42356	112	11	113	44	Important to include in executive summary the multi-century/millennial SLR. Commitment to sea level rise due to ice mass loss should note not only commitment to level of SLR committed, but rate of potential change. See for example WWW.ICCINET.ORG/THRESHOLDS and references therein, such as Joughin, I., Smith, B.E., and Medley, B. (2014). Marine ice sheet collapse potentially under way for the Thwaites Glacier Basin, West Antarctica. Science, 344(6185), 735–738. [Gabrielle Dreyfus, United States of America]	Important to include in executive summary the multi-century/millennial SLR. Commitment to sea level rise due to ice mass loss should note not only commitment to level of SLR committed, but rate of potential change. See for example WWW.ICCINET.ORG/THRESHOLDS and references therein, such as Joughin, I., Smith, B.E., and Medley, B. (2014). Marine ice sheet collapse potentially under way for the Thwaites Glacier Basin, West Antarctica. Science, 344(6185), 735–738.
8124	112	12	112	29	A lot of the information provided in this paragraph could probably be captured more effectively in a table. [Torbjorn Tornqvist, United States of America]	A lot of the information provided in this paragraph could probably be captured more effectively in a table.
20668	112	13	112	14	2 cases where 'deep uncertainty' should be italicized [Gwenaelle GREMION, Canada]	2 cases where 'deep uncertainty' should be italicized
44990	112	18	112	49	I am responsible for the assessment of paleo temperatures in CH2. Let's be sure that we use the same value for CH9 and CH2. CH9 could also refer to CH2 for a more complete discussion of the evidence for LIG GMST, and (hopefully) the data cited in Annex II. [Darrell Kaufman, United States of America]	I am responsible for the assessment of paleo temperatures in CH2. Let's be sure that we use the same value for CH9 and CH2. CH9 could also refer to CH2 for a more complete discussion of the evidence for LIG GMST, and (hopefully) the data cited in Annex II.
20672	112	23	112	26	This sentence is a repetition from what you say some lines before (L14-18). Consider removing. [Gwenaelle GREMION, Canada]	This sentence is a repetition from what you say some lines before (L14-18). Consider removing.
46630	112	23	112	29	Following the IPCC uncertainty guidance, a likelihood should only be provided if confidence is high or very high. [WGI TSU, France]	Following the IPCC uncertainty guidance, a likelihood should only be provided if confidence is high or very high.
9792	112	32	112	32	Figure 9.41b seems to be the incorrect figure reference--I'm not sure which figure was meant to be included here. [Andra Garner, United States of America]	Figure 9.41b seems to be the incorrect figure reference--I'm not sure which figure was meant to be included here.
20674	112	32	112	32	Is Figure 9.41b the right figure you wanted to mention here? [Gwenaelle GREMION, Canada]	Is Figure 9.41b the right figure you wanted to mention here?
46030	112	35	112	39	The same sentence is repeated with the 10,000-year and 2000-year commitment – meant to be the same? Or should distinguish between the two more clearly. [Isaac Pearlman, United States of America]	The same sentence is repeated with the 10,000-year and 2000-year commitment – meant to be the same? Or should distinguish between the two more clearly.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
6321	112	43	113	5	Reading this section, one gets the impression that paleo and future temperature and sea-level changes are incompatible, thus questioning paleoclimate reconstructions or ice-sheet and or climate models. However, this is not the case since, as is mentioned previously in this chapter, the LIG is not a direct analog for the future. In my opinion, what this section actually shows is that GMST's are likely only weakely correlated to GMSL. The focus on GMST doesn't do justice to the compexity of the climate system. I think this should be made more clear. [Pepijn Bakker, Netherlands]	Reading this section, one gets the impression that paleo and future temperature and sea-level changes are incompatible, thus questioning paleoclimate reconstructions or ice-sheet and or climate models. However, this is not the case since, as is mentioned previously in this chapter, the LIG is not a direct analog for the future. In my opinion, what this section actually shows is that GMST's are likely only weakely correlated to GMSL. The focus on GMST doesn't do justice to the compexity of the climate system. I think this should be made more clear.
9794	112	48	112	48	Is it possible to change "unlikely exceeded 10 m" to "likely did not exceed 10 m"? I think that changing the phrasing would allow for smoother reading and quicker comprehension of the passage. [Andra Garner, United States of America]	Is it possible to change "unlikely exceeded 10 m" to "likely did not exceed 10 m"? I think that changing the phrasing would allow for smoother reading and quicker comprehension of the passage.
20670	112	53	112	55	The difference in statistical samples of the rate of change of GMST/GMSL between the Last Interglacial and current projections make it difficult for me to agree with the medium confidence assigned to this statement. [Gwenaelle GREMION, Canada]	The difference in statistical samples of the rate of change of GMST/GMSL between the Last Interglacial and current projections make it difficult for me to agree with the medium confidence assigned to this statement.
44992	113	4			Let's be sure that this value is the same for CH9 and CH2. CH9 could also refer to CH2 for a more complete discussion of the evidence for EECO GMST. [Darrell Kaufman, United States of America]	Let's be sure that this value is the same for CH9 and CH2. CH9 could also refer to CH2 for a more complete discussion of the evidence for EECO GMST.
6323	113	18	113	20	This line suggests that there is a relatively easy (perhaps even linear) relationship between sea-level rise commitment and temperature, and that this relationship is well known. Considering the difficulty that most ice-sheet / climate models have to explain paleo ice sheet changes and the uncertain impact in changes in AMOC, Southern Ocean and subsurface ice-shelf melting to name just a few, it seems to me that such a relationship is likely uncertain, complex and non-linear. [Pepijn Bakker, Netherlands]	This line suggests that there is a relatively easy (perhaps even linear) relationship between sea-level rise commitment and temperature, and that this relationship is well known. Considering the difficulty that most ice-sheet / climate models have to explain paleo ice sheet changes and the uncertain impact in changes in AMOC, Southern Ocean and subsurface ice-shelf melting to name just a few, it seems to me that such a relationship is likely uncertain, complex and non-linear.
20676	113	18	113	20	This statement could benefit from including IPCC confidence language. [Gwenaelle GREMION, Canada]	This statement could benefit from including IPCC confidence language.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
12894	113	18	113	31	Mention the contribution from non-CO2 forcers, specifically SLCP forcers. Rate of SLR tied to rate of warming, which can be slowed through reductions of SLCPs. Hu A., et al. (2013) Mitigation of short-lived climate pollutants slows sea-level rise, NATURE CLIMATE CHANGE 3:730–734; UNEP & WMO (2011) INTEGRATED ASSESSMENT OF BLACK CARBON AND TROPOSPHERIC OZONE: SUMMARY FOR DECISION MAKERS. [Durwood Zaelke, United States of America]	Mention the contribution from non-CO2 forcers, specifically SLCP forcers. Rate of SLR tied to rate of warming, which can be slowed through reductions of SLCPs. Hu A., et al. (2013) Mitigation of short-lived climate pollutants slows sea-level rise, NATURE CLIMATE CHANGE 3:730–734; UNEP & WMO (2011) INTEGRATED ASSESSMENT OF BLACK CARBON AND TROPOSPHERIC OZONE: SUMMARY FOR DECISION MAKERS.
12896	113	18	113	31	In section 9.6.5.2, open the section by noting that rising seas have other implications beyond inundating the land, and the impacts to small islands and how soon these impacts can be felt. Overall, this section could highlight how soon these impacts could happen in other places and that it is far before the full SLR happens. Storlazzi C. D., et al. (2018) Most atolls will be uninhabitable by the mid-21st century because of sea-level rise exacerbating wave-driven flooding, SCIENCE ADVANCES 4(eaap9741):1–9, 1 (“Sea levels are rising, with the highest rates in the tropics, where thousands of low-lying coral atoll islands are located. Most studies on the resilience of these islands to sea-level rise have projected that they will experience minimal inundation impacts until at least the end of the 21st century. However, these have not taken into account the additional hazard of wave-driven overwash or its impact on freshwater availability. We project the impact of sea-level rise and wave-driven flooding on atoll infrastructure and freshwater availability under a variety of climate change scenarios. We show that, on the basis of current greenhouse gas emission rates, the nonlinear interactions between sea-level rise and wave dynamics over reefs will lead to the annual wave-driven overwash of most atoll islands by the mid-21st century. This annual flooding will result in the islands becoming uninhabitable because of frequent damage to infrastructure and the inability of their freshwater aquifers to recover between overwash events. This study provides critical information for understanding the timing and magnitude of climate change impacts on atoll islands that will result in significant, unavoidable geopolitical issues if it becomes necessary to abandon and relocate low-lying island states.”). [Durwood Zaelke, United States of America]	In section 9.6.5.2, open the section by noting that rising seas have other implications beyond inundating the land, and the impacts to small islands and how soon these impacts can be felt. Overall, this section could highlight how soon these impacts could happen in other places and that it is far before the full SLR happens. Storlazzi C. D., et al. (2018) Most atolls will be uninhabitable by the mid-21st century because of sea-level rise exacerbating wave-driven flooding, SCIENCE ADVANCES 4(eaap9741):1–9, 1 (“Sea levels are rising, with the highest rates in the tropics, where thousands of low-lying coral atoll islands are located. Most studies on the resilience of these islands to sea-level rise have projected that they will experience minimal inundation impacts until at least the end of the 21st century. However, these have not taken into account the additional hazard of wave-driven overwash or its impact on freshwater availability. We project the impact of sea-level rise and wave-driven flooding on atoll infrastructure and freshwater availability under a variety of climate change scenarios. We show that, on the basis of current greenhouse gas emission rates, the nonlinear interactions between sea-level rise and wave dynamics over reefs will lead to the annual wave-driven overwash of most atoll islands by the mid-21st century. This annual flooding will result in the islands becoming uninhabitable because of frequent damage
42358	113	18	113	31	Mention the contribution from non-CO2 forcers, specifically SLCP forcers. Rate of SLR tied to rate of warming, which can be slowed through reductions of SLCPs. Hu A., et al. (2013) Mitigation of short-lived climate pollutants slows sea-level rise, NATURE CLIMATE CHANGE 3:730–734; UNEP & WMO (2011) INTEGRATED ASSESSMENT OF BLACK CARBON AND TROPOSPHERIC OZONE: SUMMARY FOR DECISION MAKERS. [Gabrielle Dreyfus, United States of America]	Mention the contribution from non-CO2 forcers, specifically SLCP forcers. Rate of SLR tied to rate of warming, which can be slowed through reductions of SLCPs. Hu A., et al. (2013) Mitigation of short-lived climate pollutants slows sea-level rise, NATURE CLIMATE CHANGE 3:730–734; UNEP & WMO (2011) INTEGRATED ASSESSMENT OF BLACK CARBON AND TROPOSPHERIC OZONE: SUMMARY FOR DECISION MAKERS.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
42360	113	18	113	31	Commitment to sea level rise due to ice mass loss should note not only commitment to level of SLR committed, but rate of potential change. See for example WWW.ICCINET.ORG/THRESHOLDS and references therein, such as Joughin, I., Smith, B.E., and Medley, B. (2014). Marine ice sheet collapse potentially under way for the Thwaites Glacier Basin, West Antarctica. Science, 344(6185), 735–738. [Gabrielle Dreyfus, United States of America]	Commitment to sea level rise due to ice mass loss should note not only commitment to level of SLR committed, but rate of potential change. See for example WWW.ICCINET.ORG/THRESHOLDS and references therein, such as Joughin, I., Smith, B.E., and Medley, B. (2014). Marine ice sheet collapse potentially under way for the Thwaites Glacier Basin, West Antarctica. Science, 344(6185), 735–738.
12722	113	18	113	31	Mention in here the contribution by non-CO2 (specifically SLCP) forcers. Rate of SLR tied to rate of warming, which can be slowed through reductions of SLCPs. Hu A., et al. (2013) Mitigation of short-lived climate pollutants slows sea-level rise, NATURE CLIMATE CHANGE 3:730–734; UNEP & WMO (2011) INTEGRATED ASSESSMENT OF BLACK CARBON AND TROPOSPHERIC OZONE: SUMMARY FOR DECISION MAKERS. [Kristin Campbell, United States of America]	Mention in here the contribution by non-CO2 (specifically SLCP) forcers. Rate of SLR tied to rate of warming, which can be slowed through reductions of SLCPs. Hu A., et al. (2013) Mitigation of short-lived climate pollutants slows sea-level rise, NATURE CLIMATE CHANGE 3:730–734; UNEP & WMO (2011) INTEGRATED ASSESSMENT OF BLACK CARBON AND TROPOSPHERIC OZONE: SUMMARY FOR DECISION MAKERS.
12724	113	18	113	31	In section 9.6.5.2, open the section by noting that rising seas have other implications beyond inundating the land, and the impacts to small islands and how soon these impacts can be felt. Overall, this section could highlight how soon these impacts could happen in other places and that it is far before the full SLR happens. Storlazzi C. D., et al. (2018) Most atolls will be uninhabitable by the mid-21st century because of sea-level rise exacerbating wave-driven flooding, SCIENCE ADVANCES 4(eaap9741):1–9, 1 (“Sea levels are rising, with the highest rates in the tropics, where thousands of low-lying coral atoll islands are located. Most studies on the resilience of these islands to sea-level rise have projected that they will experience minimal inundation impacts until at least the end of the 21st century. However, these have not taken into account the additional hazard of wave-driven overwash or its impact on freshwater availability. We project the impact of sea-level rise and wave-driven flooding on atoll infrastructure and freshwater availability under a variety of climate change scenarios. We show that, on the basis of current greenhouse gas emission rates, the nonlinear interactions between sea-level rise and wave dynamics over reefs will lead to the annual wave-driven overwash of most atoll islands by the mid-21st century. This annual flooding will result in the islands becoming uninhabitable because of frequent damage to infrastructure and the inability of their freshwater aquifers to recover between overwash events. This study provides critical information for understanding the timing and magnitude of climate change impacts on atoll islands that will result in significant, unavoidable geopolitical issues if it becomes necessary to abandon and relocate low-lying island states.”). [Kristin Campbell, United States of America]	In section 9.6.5.2, open the section by noting that rising seas have other implications beyond inundating the land, and the impacts to small islands and how soon these impacts can be felt. Overall, this section could highlight how soon these impacts could happen in other places and that it is far before the full SLR happens. Storlazzi C. D., et al. (2018) Most atolls will be uninhabitable by the mid-21st century because of sea-level rise exacerbating wave-driven flooding, SCIENCE ADVANCES 4(eaap9741):1–9, 1 (“Sea levels are rising, with the highest rates in the tropics, where thousands of low-lying coral atoll islands are located. Most studies on the resilience of these islands to sea-level rise have projected that they will experience minimal inundation impacts until at least the end of the 21st century. However, these have not taken into account the additional hazard of wave-driven overwash or its impact on freshwater availability. We project the impact of sea-level rise and wave-driven flooding on atoll infrastructure and freshwater availability under a variety of climate change scenarios. We show that, on the basis of current greenhouse gas emission rates, the nonlinear interactions between sea-level rise and wave dynamics over reefs will lead to the annual wave-driven overwash of most atoll islands by the mid-21st century. This annual flooding will result in the islands becoming uninhabitable because of frequent damage

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
52240	113	33	113	44	This paragraph should include a couple sentences noting that even short-lived climate polutants come with long-term commitments to SLR, throug thermosteric effects (Zickfeld et al. 2017) which can mean committed changes for centuries. This result implied that the Montreal Protocol was partially sucessful at reducing these long-term commtments (it avoided 13.8 cm (4.5–14.0 cm) of thermosteric rise in GMSL), but continued methane emissions are increasing our commitments. In the case of methane ~70% of its effects on raising GMSL persist for 100yr. after emissions stop, and 40% persists after 500yr. Citation: Zickfield, K., S. Solomon, and D. M. Gilford, 2017: Centuries of Thermal Sea Level Rise Due to Anthropogenic Emissions of Short-Lived Greenhouse Gases. PNAS, 114, 657–662. [Daniel Gilford, United States of America]	This paragraph should include a couple sentences noting that even short-lived climate polutants come with long-term commitments to SLR, throug thermosteric effects (Zickfeld et al. 2017) which can mean committed changes for centuries. This result implied that the Montreal Protocol was partially sucessful at reducing these long-term commtments (it avoided 13.8 cm (4.5–14.0 cm) of thermosteric rise in GMSL), but continued methane emissions are increasing our commitments. In the case of methane ~70% of its effects on raising GMSL persist for 100yr. after emissions stop, and 40% persists after 500yr. Citation: Zickfield, K., S. Solomon, and D. M. Gilford, 2017: Centuries of Thermal Sea Level Rise Due to Anthropogenic Emissions of Short-Lived Greenhouse Gases. PNAS, 114, 657–662.
20678	113	33	113	44	An interesting study that looks at sea level rise mitigation on multi-centennial timescales using glacial geoengineering is: Wolovick, M. J. and J. C. Moore (2018). Stopping the flood: could we use targeted geoengineering to mitigate sea level rise? The Cryosphere, doi: 10.5194/tc-12-2955-2018. Maybe this study is (will be) mentioned in WGII and/or WGIII. Anyway, it probably deserves a mention in this paragraph. [Gwenaelle GREMION, Canada]	An interesting study that looks at sea level rise mitigation on multi-centennial timescales using glacial geoengineering is: Wolovick, M. J. and J. C. Moore (2018). Stopping the flood: could we use targeted geoengineering to mitigate sea level rise? The Cryosphere, doi: 10.5194/tc-12-2955-2018. Maybe this study is (will be) mentioned in WGII and/or WGIII. Anyway, it probably deserves a mention in this paragraph.
40262	113	47			First it must be said that extremes are local. Second that these are coastal extremes. As in earlier parts citation is very selective. [Michael Tsimplis, China]	First it must be said that extremes are local. Second that these are coastal extremes. As in earlier parts citation is very selective.
38556	113	49	114	14	The section 9.6.4 deals with extreme sea level ESL, the defection of "extreme" should be defined clearly in the beginning of the section. There were several definitions of extremes in the section (annual 99% or 99.9%, 1/10 or 1/100 years level or others). The different sector uses different probability for extreme. Please make it clear and make it consistent for different sea extremes through the section 9.6.4. [Nobuhito Mori, Japan]	The section 9.6.4 deals with extreme sea level ESL, the defection of "extreme" should be defined clearly in the beginning of the section. There were several definitions of extremes in the section (annual 99% or 99.9%, 1/10 or 1/100 years level or others). The different sector uses different probability for extreme. Please make it clear and make it consistent for different sea extremes through the section 9.6.4.
40462	113	49	115	51	This paragraph on past changes would benefit from one or two sections describing longer time scales, which can be often used to gauge possible future changes. A recent PAGES article summarized the main points and data available: http://pastglobalchanges.org/products/pages-magazine/12813 [Alessio Rovere, Germany]	This paragraph on past changes would benefit from one or two sections describing longer time scales, which can be often used to gauge possible future changes. A recent PAGES article summarized the main points and data available: http://pastglobalchanges.org/products/pages-magazine/12813

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24384	113	49			The section makes statement on and compares trends covering very different periods and comprising very different record length. Baseline and periods are generally not provided. I find this very critical as wrong inferences can be made by a reader unaware of this. For example, short-term trends may be part of long-term variability. Please provide baselines and periods for all trend estimations. [Ralf Weisse, Germany]	The section makes statement on and compares trends covering very different periods and comprising very different record length. Baseline and periods are generally not provided. I find this very critical as wrong inferences can be made by a reader unaware of this. For example, short-term trends may be part of long-term variability. Please provide baselines and periods for all trend estimations.
6746	113	51	113	51	the observed signal here may be wave setup, depending on the TG location (though not swash). [Joanne Williams, United Kingdom (of Great Britain and Northern Ireland)]	the observed signal here may be wave setup, depending on the TG location (though not swash).
24382	113	51	114	14	The text attributes observed changes to causes but does not clearly separate between factors and interaction effects. Needs revision. [Ralf Weisse, Germany]	The text attributes observed changes to causes but does not clearly separate between factors and interaction effects. Needs revision.
42646	113	51	115	41	In the executive summary there is comment that extreme sea levels are ‘increasing in frequency’ (line 34, page 9-6). While models may predict an increase in extreme sea levels in the future there is no justification for saying that this is true NOW. It is even stated in line 40 (page 9-6) that extreme sea levels are ‘currently rare’; a sentence that casts doubts on any present ‘increasing frequency’ being actually observed. Given that extreme sea levels are associated with storm surges that occur due to the low-pressure systems of hurricanes or cyclones there cannot have been an increase in extreme sea level events without an historic increase in hurricanes or cyclones. Yet, the number of hurricanes per decade hitting the south-eastern USA has been declining over the past 100 years. And the statement that there may be some ESL increase above the noise by 2030 (page 9-113, line 53-4) is meaningless as this is a statement based on models not from evidence. The decrease in frequency and severity of cyclones in the 20th century is also true for Australian hurricanes hitting its north-eastern coast. [Howard Brady, Australia]	In the executive summary there is comment that extreme sea levels are ‘increasing in frequency’ (line 34, page 9-6). While models may predict an increase in extreme sea levels in the future there is no justification for saying that this is true NOW. It is even stated in line 40 (page 9-6) that extreme sea levels are ‘currently rare’; a sentence that casts doubts on any present ‘increasing frequency’ being actually observed. Given that extreme sea levels are associated with storm surges that occur due to the low-pressure systems of hurricanes or cyclones there cannot have been an increase in extreme sea level events without an historic increase in hurricanes or cyclones. Yet, the number of hurricanes per decade hitting the south-eastern USA has been declining over the past 100 years. And the statement that there may be some ESL increase above the noise by 2030 (page 9-113, line 53-4) is meaningless as this is a statement based on models not from evidence. The decrease in frequency and severity of cyclones in the 20th century is also true for Australian hurricanes hitting its north-eastern coast.
7868	113	55	113	55	I would say that the confidence in that RSL is the major driver of ESL "at most locations" is high instead of medium. Also, Woodworth et al (2016) describes the GESLA-2 data assembling, but does not discuss the impact of RSL on ESL. Marcos and Woodworth (2017) could be added (doi:10.1002/2017JC013065) [Marta Marcos, Spain]	I would say that the confidence in that RSL is the major driver of ESL "at most locations" is high instead of medium. Also, Woodworth et al (2016) describes the GESLA-2 data assembling, but does not discuss the impact of RSL on ESL. Marcos and Woodworth (2017) could be added (doi:10.1002/2017JC013065)

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
12980	114	2	114	2	“increase in the 10-year storm tide return level”. First mention of storm tide and as used here means the same thing as SWL. Also when you say 10 year XXX, no need to spell out return level. [Roshanka Ranasinghe, Netherlands]	“increase in the 10-year storm tide return level”. First mention of storm tide and as used here means the same thing as SWL. Also when you say 10 year XXX, no need to spell out return level.
6748	114	6	114	6	Changes in HW in the German Bight may also be due to increases in tidal range? see recent work by Dangedorf, Arne Arns - not yet published but look out for it soon? [Joanne Williams, United Kingdom (of Great Britain and Northern Ireland)]	Changes in HW in the German Bight may also be due to increases in tidal range? see recent work by Dangedorf, Arne Arns - not yet published but look out for it soon?
24378	114	6	114	7	The statement on surge appears to contradict those made on page 113, lines 51-55 using the same reference among others and needs clarification. [Ralf Weisse, Germany]	The statement on surge appears to contradict those made on page 113, lines 51-55 using the same reference among others and needs clarification.
6750	114	6	114	12	merge lines 6 and 12. [Joanne Williams, United Kingdom (of Great Britain and Northern Ireland)]	merge lines 6 and 12.
7202	114	8	114	8	According to the cited paper, "Europe" is "South Atlantic European coast". Mediterranean and Baltic Sea were excluded from the cited study and this could be confusing since only a small portion of the European coastline evidence such a negative trend [Marco Olivieri, Italy]	According to the cited paper, "Europe" is "South Atlantic European coast". Mediterranean and Baltic Sea were excluded from the cited study and this could be confusing since only a small portion of the European coastline evidence such a negative trend
7870	114	11	114	11	Besides linear trends, ESL also exhibit decadal fluctuations unrelated to RSL of the order of a few tenths of mm per decade (Marcos et al 2015, doi: 10.1002/2015JC011173) [Marta Marcos, Spain]	Besides linear trends, ESL also exhibit decadal fluctuations unrelated to RSL of the order of a few tenths of mm per decade (Marcos et al 2015, doi: 10.1002/2015JC011173)
56012	114	11	114	11	Missing word: “still water LEVEL trends” [Guillaume Dodet, France]	Missing word: “still water LEVEL trends”
24380	114	12	114	13	The sentence is mis-leading and needs re-writing. It implies that changes in the German Bight are caused by interventions such as channel deepening using a reference for Boston harbour. [Ralf Weisse, Germany]	The sentence is mis-leading and needs re-writing. It implies that changes in the German Bight are caused by interventions such as channel deepening using a reference for Boston harbour.
6752	114	14	114	14	This is a misrepresentation of the data shown in Mawdsley et al., 2015, in which the Calais tide gauge has a step change in tidal range during a decade gap in quality measurements. This may be due to highly localised factors and should not be described as a "trend". [Joanne Williams, United Kingdom (of Great Britain and Northern Ireland)]	This is a misrepresentation of the data shown in Mawdsley et al., 2015, in which the Calais tide gauge has a step change in tidal range during a decade gap in quality measurements. This may be due to highly localised factors and should not be described as a "trend".
24386	114	16	114	16	"Longer records" is misleading. Records of similar length were used already in the discussion in the previous paragraph. Please revise. [Ralf Weisse, Germany]	"Longer records" is misleading. Records of similar length were used already in the discussion in the previous paragraph. Please revise.
20680	114	17	114	22	This long run-on sentence affects the clarity of the statements. Split into multiple, clearer sentences. [Gwenaelle GREMION, Canada]	This long run-on sentence affects the clarity of the statements. Split into multiple, clearer sentences.
40264	114	17			Not always. It depends where the tide gauges are located and whether they keep operating when extremes do happen. [Michael Tsimplis, China]	Not always. It depends where the tide gauges are located and whether they keep operating when extremes do happen.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
40266	114	19		21	Even in small and quiet regions like the Mediterranean surge models show significantly different extremes depending on the reanalysis used and their atmospheric resolution It is inappropriate to present very valuable work on understanding extreme formation and efforts to model them as ways of establishing trends in extremes. [Michael Tsimplis, China]	Even in small and quiet regions like the Mediterranean surge models show significantly different extremes depending on the reanalysis used and their atmospheric resolution It is inappropriate to present very valuable work on understanding extreme formation and efforts to model them as ways of establishing trends in extremes.
24388	114	20	114	22	Length of the reanalysis/hindcast data is only one issue. There several other similarly severe that need to mentioned (homogeneity, see Chapters 8, 11) or coastline/bathymetric cahnges or quality of data that probably severly influence trend estimates from such data. [Ralf Weisse, Germany]	Length of the reanalysis/hindcast data is only one issue. There several other similarly severe that need to mentioned (homogeneity, see Chapters 8, 11) or coastline/bathymetric cahnges or quality of data that probably severly influence trend estimates from such data.
20682	114	22	114	22	At the local scale, and for tropical cyclones, which are' -> 'The local scale is' [Gwenaelle GREMION, Canada]	At the local scale, and for tropical cyclones, which are' -> 'The local scale is'
7872	114	22	114	25	"hydrodynamic numerical model simulations forced by observed and synthetic storm data sets allow more robust estimates of changes in the storm surge activity at centennial to millennial time scales"-> also for tropical cyclones, at local to regional and at decadal time scales, hydrodynamic models simulate changes in storm surges: see Muis et al 2019 (doi:10.1038/s41598-019-40157-w) and Vousdoukas et al (2018) (doi: 10.1038/s41467-018-04692-w) [Marta Marcos, Spain]	"hydrodynamic numerical model simulations forced by observed and synthetic storm data sets allow more robust estimates of changes in the storm surge activity at centennial to millennial time scales"-> also for tropical cyclones, at local to regional and at decadal time scales, hydrodynamic models simulate changes in storm surges: see Muis et al 2019 (doi:10.1038/s41598-019-40157-w) and Vousdoukas et al (2018) (doi: 10.1038/s41467-018-04692-w)
40268	114	22		25	I do not follow this at all and I can not see any relevance to what is discussed. [Michael Tsimplis, China]	I do not follow this at all and I can not see any relevance to what is discussed.
37922	114	26			It might be better to use "pre-industrial" rather than "pre-anthropogenic", changing 1800 to 1750. That would be more consistent with terminology used elsewhere in the FOD, and avoids having to keep in mind pre-1750 human changes to land cover/use. [Adrian Simmons, United Kingdom (of Great Britain and Northern Ireland)]	It might be better to use "pre-industrial" rather than "pre-anthropogenic", changing 1800 to 1750. That would be more consistent with terminology used elsewhere in the FOD, and avoids having to keep in mind pre-1750 human changes to land cover/use.
28024	114	27	114	35	Page 114, line 35-27: Very vague, e.g., what is here the difference between 'attributed' and'unattributed'? I do not think that covering attribution here in one sentence is clear [roderik van de wal, Netherlands]	Page 114, line 35-27: Very vague, e.g., what is here the difference between 'attributed' and'unattributed'? I do not think that covering attribution here in one sentence is clear
48980	114	28	114	30	add to end of sentence about paleotempestology: ;however, such records are hampered by... i.e., uncertainties in the fidelity of the geological record, lack of relationship between magnitude and proxy, etc…. To link to next sentence. [Laura Reynolds, United States of America]	add to end of sentence about paleotempestology: ;however, such records are hampered by... i.e., uncertainties in the fidelity of the geological record, lack of relationship between magnitude and proxy, etc…. To link to next sentence.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
44994	114	30	114	31	What is the basis for the assignment of “low confidence” to this statement? More importantly, whether the geological proxies can be directly linked to instrumental records is not as important as the information that geological proxies provide. For example, do they show that warm periods tend to be stormier? Do they show that the instrumental record tends to underestimate the long-term frequency of ESL events? [Darrell Kaufman, United States of America]	What is the basis for the assignment of “low confidence” to this statement? More importantly, whether the geological proxies can be directly linked to instrumental records is not as important as the information that geological proxies provide. For example, do they show that warm periods tend to be stormier? Do they show that the instrumental record tends to underestimate the long-term frequency of ESL events?
40270	114	31			This paragraph is very confusing and unhelpful. The questions are: are extremes changing, are the changes linear? are there accelerations? what are the forcing parameters? Can we model the forcing parameters and the changes observed? if we can what do the projections say for the future. [Michael Tsimplis, China]	This paragraph is very confusing and unhelpful. The questions are: are extremes changing, are the changes linear? are there accelerations? what are the forcing parameters? Can we model the forcing parameters and the changes observed? if we can what do the projections say for the future.
40272	114	33		35	This is confusing. Extremes can have an effect on seasonality and mean level. They are interconnected. ESL will rise if mean sea level rises if everything else stays the same (not fully realistic) so the question is whether they increase faster or slower than RSL. [Michael Tsimplis, China]	This is confusing. Extremes can have an effect on seasonality and mean level. They are interconnected. ESL will rise if mean sea level rises if everything else stays the same (not fully realistic) so the question is whether they increase faster or slower than RSL.
24390	114	41	114	43	Statement needs cross-check with statements in Chapters 8, 11. [Ralf Weisse, Germany]	Statement needs cross-check with statements in Chapters 8, 11.
6493	114	42	114	43	"and in turn higher coastal sea levels" - should this be "and in turn higher extreme coastal sea levels" ? [Tom Howard, United Kingdom (of Great Britain and Northern Ireland)]	"and in turn higher coastal sea levels" - should this be "and in turn higher extreme coastal sea levels" ?
52242	114	43	114	43	This should be "Typhoon Haiyan" [Daniel Gilford, United States of America]	This should be "Typhoon Haiyan"
38558	114	43	114	43	"Cyclone Hayan" should be "Typhoon Haiyan". It was occurred in the WNP. There is typo of name, too. [Nobuhito Mori, Japan]	"Cyclone Hayan" should be "Typhoon Haiyan". It was occurred in the WNP. There is typo of name, too.
16060	114	43	114	43	"Cyclone Hayan" is a typo. Suggest changing it to "Super Typhoon Haiyan in 2013". [SAI MING LEE, China]	"Cyclone Hayan" is a typo. Suggest changing it to "Super Typhoon Haiyan in 2013".

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
38560	114	43	114	44	It is nice to describe already occurred GW effects on storm surge in this paragraph. However the meaning of "20%" increasing intensity of storm surge is difficult to understand for non-experts. It is better show the real surge height of Haiyan before showing GW effects in percentage. The estimated storm surge height in Haiyan is known as 5-6m by several papers. One example of Haiyan paper indicates 5-6m storm surge by 2013 Haiyan and this paper connected to Takayabu et al. (2015) which mainly used in this paragraph. Mori, N., M. Kato, S. Kim, H. Mase, Y. Shibutani, T. Takemi, K. Tsuboki and T. Yasuda (2014) Local amplification of storm surge by Super Typhoon Haiyan in Leyte Gulf, Geophysical Research Letters, American Geophysical Union, Vol.41(14), pp.5106-5113. [Nobuhito Mori, Japan]	It is nice to describe already occurred GW effects on storm surge in this paragraph. However the meaning of "20%" increasing intensity of storm surge is difficult to understand for non-experts. It is better show the real surge height of Haiyan before showing GW effects in percentage. The estimated storm surge height in Haiyan is known as 5-6m by several papers. One example of Haiyan paper indicates 5-6m storm surge by 2013 Haiyan and this paper connected to Takayabu et al. (2015) which mainly used in this paragraph. Mori, N., M. Kato, S. Kim, H. Mase, Y. Shibutani, T. Takemi, K. Tsuboki and T. Yasuda (2014) Local amplification of storm surge by Super Typhoon Haiyan in Leyte Gulf, Geophysical Research Letters, American Geophysical Union, Vol.41(14), pp.5106-5113.
40274	114	43			The IPCC report MUST have a section on this and MUST be linked with this part. This does not look complete or persuasive. [Michael Tsimplis, China]	The IPCC report MUST have a section on this and MUST be linked with this part. This does not look complete or persuasive.
46632	114	48	114	48	Following the IPCC uncertainty guidance, a likelihood should only be provided if confidence is high or very high. [WGI TSU, France]	Following the IPCC uncertainty guidance, a likelihood should only be provided if confidence is high or very high.
24392	114	48	114	48	Please be specific on what is meant by "human activity". Anthropogenic climate change or other issues (waterworks, dredging etc.). [Ralf Weisse, Germany]	Please be specific on what is meant by "human activity". Anthropogenic climate change or other issues (waterworks, dredging etc.).
40276	114	48			With all due respect: if what the referred to studies have shown (as well as many other regional studies have done also) the trend in sea level extremes disappear when the mean sea level is removed from the time series (i.e. they are indistinguishable from the RSL) then it follows that the whatever causes the changes at RSL causes the changes in the extremes aand there is NO NEED for other attribution studies. All the other text can and should be removed. [Michael Tsimplis, China]	With all due respect: if what the referred to studies have shown (as well as many other regional studies have done also) the trend in sea level extremes disappear when the mean sea level is removed from the time series (i.e. they are indistinguishable from the RSL) then it follows that the whatever causes the changes at RSL causes the changes in the extremes aand there is NO NEED for other attribution studies. All the other text can and should be removed.
7874	114	50	115	3	In Marcos and Woodworth (2017) (doi:10.1002/2017JC013065) the authors found small positive trends in the intensity of storm surges around the North Atlantic, unrelated to RSL, using long tide gauge records (centennial time scales), superimposed to multidecadal fluctuations. Given the small trends in comparison to decadal variability I agree with the low confidence in ESL increases. [Marta Marcos, Spain]	In Marcos and Woodworth (2017) (doi:10.1002/2017JC013065) the authors found small positive trends in the intensity of storm surges around the North Atlantic, unrelated to RSL, using long tide gauge records (centennial time scales), superimposed to multidecadal fluctuations. Given the small trends in comparison to decadal variability I agree with the low confidence in ESL increases.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
40278	115	2			There are studies on extremes linked with hurricanes in other parts of the world. But it depends what the term "historical" means. There has been extensive work in the Mediterranean, the Chinese coasts and the Caribbean. So this part is very open to criticism because either it ignores published work OR it wants to say something else and fails to do it properly. [Michael Tsimplis, China]	There are studies on extremes linked with hurricanes in other parts of the world. But it depends what the term "historical" means. There has been extensive work in the Mediterranean, the Chinese coasts and the Caribbean. So this part is very open to criticism because either it ignores published work OR it wants to say something else and fails to do it properly.
40280	115	2			I would argue that there is high confidence that there is no contribution in most parts of the world. [Michael Tsimplis, China]	I would argue that there is high confidence that there is no contribution in most parts of the world.
12982	115	5	115	5	“Surface wind-waves contribute to total ESL at the coast via wave setup and runup processes.”. Runup does not contribute to ESL. It’s a result of ESL. [Roshanka Ranasinghe, Netherlands]	“Surface wind-waves contribute to total ESL at the coast via wave setup and runup processes.”. Runup does not contribute to ESL. It’s a result of ESL.
7876	115	5	115	5	Both wave setup and runup are complex processes highly dependent not only on the incident wind-waves but also on the coastal bathymetry and topography. Perhaps it would be worth to mention that the impact of wind-waves on ESL is hardly assessed at the large scale (e..g continental) due to the limitations in coastal observations, unlike storm surges (possible citation: Stephens S, Coco G, Bryan KR (2011) Numerical simulations of wave setup over barred beach profiles: implications for predictability. J Waterw Port Coast Ocean Eng. https ://doi.org/10.1061/(asce) ww.1943-5460.00000 76) [Marta Marcos, Spain]	Both wave setup and runup are complex processes highly dependent not only on the incident wind-waves but also on the coastal bathymetry and topography. Perhaps it would be worth to mention that the impact of wind-waves on ESL is hardly assessed at the large scale (e..g continental) due to the limitations in coastal observations, unlike storm surges (possible citation: Stephens S, Coco G, Bryan KR (2011) Numerical simulations of wave setup over barred beach profiles: implications for predictability. J Waterw Port Coast Ocean Eng. https ://doi.org/10.1061/(asce) ww.1943-5460.00000 76)
56024	115	5	115	23	I am not sure whether our knowledge on past trends in wave climate is discussed anywhere else in this chapter or report (I haven’t found it) but I think this topic should be fairly extended, with reference to observation-based (e.g Gulev and Grigorieva, 2006; Ruggiero et al. 2010) and model-based studies (e.g. Semedo et al, 2010; Stopa et al. 2016) [Guillaume Dodet, France]	I am not sure whether our knowledge on past trends in wave climate is discussed anywhere else in this chapter or report (I haven’t found it) but I think this topic should be fairly extended, with reference to observation-based (e.g Gulev and Grigorieva, 2006; Ruggiero et al. 2010) and model-based studies (e.g. Semedo et al, 2010; Stopa et al. 2016)
56014	115	8	115	9	Additional references should be provided at the end of this sentence starting with “A number of studies indicate [...]” [Guillaume Dodet, France]	Additional references should be provided at the end of this sentence starting with “A number of studies indicate [...]”
56016	115	10	115	10	The causal relationship (“This has resulted”) does not seem fully appropriate here. There are other reasons to use wave reanalysis and hindcast products rather than buoy platforms in order to investigate change in wind waves, one of them being the poor spatial coverage of buoy platforms. [Guillaume Dodet, France]	The causal relationship (“This has resulted”) does not seem fully appropriate here. There are other reasons to use wave reanalysis and hindcast products rather than buoy platforms in order to investigate change in wind waves, one of them being the poor spatial coverage of buoy platforms.
6754	115	13	115	13	"inhomogeneity"? [Joanne Williams, United Kingdom (of Great Britain and Northern Ireland)]	"inhomogeneity"?

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
40282	115	17			very selective literature [Michael Tsimplis, China]	very selective literature
40284	115	19			Do you mean it has not been done? [Michael Tsimplis, China]	Do you mean it has not been done?
40286	115	22			is this the only study? There have been known and well established changes in waves in different parts of the world (if you consider open ocean). But extremes in the open ocean do not matter (unless freak waves are shown to become more frequent). So one has to be consistent and as with ESL must consider the waves near the coast where there is no evidence of systematic changes (and is very difficult to establish anyway). [Michael Tsimplis, China]	is this the only study? There have been known and well established changes in waves in different parts of the world (if you consider open ocean). But extremes in the open ocean do not matter (unless freak waves are shown to become more frequent). So one has to be consistent and as with ESL must consider the waves near the coast where there is no evidence of systematic changes (and is very difficult to establish anyway).
40288	115	23			For this report the conclusion must be that there is low evidence of any effect of surface wind waves and perhaps everything else should be ommited. [Michael Tsimplis, China]	For this report the conclusion must be that there is low evidence of any effect of surface wind waves and perhaps everything else should be ommited.
6760	115	25	115	41	This paragraph should be merged with that on 9-114 line 11-14 ...and also that from 9-117 line 25-45. [Joanne Williams, United Kingdom (of Great Britain and Northern Ireland)]	This paragraph should be merged with that on 9-114 line 11-14 ...and also that from 9-117 line 25-45.
40290	115	25		28	very selective again in literature and only in the relative past. [Michael Tsimplis, China]	very selective again in literature and only in the relative past.
6756	115	31	115	31	Haigh et al reference incomplete [Joanne Williams, United Kingdom (of Great Britain and Northern Ireland)]	Haigh et al reference incomplete
20684	115	31	115	31	Haigh et al. has no year or "submitted" info. [Gwenaelle GREMION, Canada]	Haigh et al. has no year or "submitted" info.
40292	115	31			this is not new and one does not need an unpublished paper to support. [Michael Tsimplis, China]	this is not new and one does not need an unpublished paper to support.
40294	115	32			as above [Michael Tsimplis, China]	as above
40296	115	34		36	Sea level changing the propagation of the tidal wave was considered from the beginning of understanding sea level variability and was of course observed where ports were dug out for bigger ships to come through. To the extent that tide gauges are used as the basis of such assessments it must be confirmed that the configuration of the port has not changed over the period of observation considerably because if it has then this could change the propagation of the tidal signal. These are difficult issues ti verify and pose uncertainty on the identified changes in the tides- and would potentially hide RSL effects. [Michael Tsimplis, China]	Sea level changing the propagation of the tidal wave was considered from the beginning of understanding sea level variability and was of course observed where ports were dug out for bigger ships to come through. To the extent that tide gauges are used as the basis of such assessments it must be confirmed that the configuration of the port has not changed over the period of observation considerably because if it has then this could change the propagation of the tidal signal. These are difficult issues ti verify and pose uncertainty on the identified changes in the tides- and would potentially hide RSL effects.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
6758	115	36	115	40	There is more recent work on this, which disputes that SLR is a sufficient hypothesis, at least for plausible SLR for the 21st century. Eg Idier 2017 [Déborah Idier, François Paris, Gonéri Le Cozannet, Faiza Boulahya, Franck Dumas, Sea-level rise impacts on the tides of the European Shelf, Continental Shelf Research, Volume 137, 2017, https://doi.org/10.1016/j.csr.2017.01.007] showed in models that the changes in tidal range on the European shelf are generally proportional to SLR, as long as SLR remains smaller than 2 m. Depending on the location, they can account for +/−15% of regional SLR. [Joanne Williams, United Kingdom (of Great Britain and Northern Ireland)]	There is more recent work on this, which disputes that SLR is a sufficient hypothesis, at least for plausible SLR for the 21st century. Eg Idier 2017 [Déborah Idier, François Paris, Gonéri Le Cozannet, Faiza Boulahya, Franck Dumas, Sea-level rise impacts on the tides of the European Shelf, Continental Shelf Research, Volume 137, 2017, https://doi.org/10.1016/j.csr.2017.01.007] showed in models that the changes in tidal range on the European shelf are generally proportional to SLR, as long as SLR remains smaller than 2 m. Depending on the location, they can account for +/?15% of regional SLR.
6762	115	46	115	46	what's a "minor Extreme sea level"? [Joanne Williams, United Kingdom (of Great Britain and Northern Ireland)]	what's a "minor Extreme sea level"?
38552	115	54	118	32	The order of paragraphs in the section 9.6.4.2 is better to rearrange. Although the section title of 9.6.4 is "Extreme sea level: Tides, surge and waves", the paragraph starts from storm surge, following ocean waves and astronomical tides. Especially the paragraph of astronomical tide starts line 45 in page 117 should be located earlier to appropriate order of contents. [Nobuhito Mori, Japan]	The order of paragraphs in the section 9.6.4.2 is better to rearrange. Although the section title of 9.6.4 is "Extreme sea level: Tides, surge and waves", the paragraph starts from storm surge, following ocean waves and astronomical tides. Especially the paragraph of astronomical tide starts line 45 in page 117 should be located earlier to appropriate order of contents.
38554	115	54	118	32	In the some part of section 9.6.4 deals ocean surface waves and denotes as "waves", "surface waves" and etc. It is better to clearly define "ocean surface waves indicating wind waves and swells to avoid confusing heat waves and other waves in the report. I recommend to use of "ocean surface waves" through this section. [Nobuhito Mori, Japan]	In the some part of section 9.6.4 deals ocean surface waves and denotes as "waves", "surface waves" and etc. It is better to clearly define "ocean surface waves indicating wind waves and swells to avoid confusing heat waves and other waves in the report. I recommend to use of "ocean surface waves" through this section.
40298	116	1			If ESL become more common they will not be, by statistical definition, ESL anymore. [Michael Tsimplis, China]	If ESL become more common they will not be, by statistical definition, ESL anymore.
38562	116	5	116	23	The impact of extratropical cyclone and tropical cyclone on extreme sea level has been discussed in different approaches including pseudo-global warming experiments and direct use of GCMs. It should be better mention to several approaches to estimate ESL beside statistical approaches. e.g. Mori, N. and T. Takemi (2016) Impact assessment of coastal hazards due to future changes of tropical cyclones in the North Pacific Ocean, Weather and Climate Extremes (review paper), Vol.11, pp.53-69. [Nobuhito Mori, Japan]	The impact of extratropical cyclone and tropical cyclone on extreme sea level has been discussed in different approaches including pseudo-global warming experiments and direct use of GCMs. It should be better mention to several approaches to estimate ESL beside statistical approaches. e.g. Mori, N. and T. Takemi (2016) Impact assessment of coastal hazards due to future changes of tropical cyclones in the North Pacific Ocean, Weather and Climate Extremes (review paper), Vol.11, pp.53-69.
46634	116	7	116	7	"coastal flood risk" -> "coastal flood hazard" [WGI TSU, France]	"coastal flood risk" -> "coastal flood hazard"

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
12984	116	7	116	7	“future changes in coastal flood risk” Better stay away from using the word risk unless you really mean risk as in hazard probability x damage. [Roshanka Ranasinghe, Netherlands]	“future changes in coastal flood risk” Better stay away from using the word risk unless you really mean risk as in hazard probability x damage.
12986	116	20	116	20	“on average, once or even multiple times per year”. What does on average mean here? 50% exceedance probability? Since the sentence starts with 1% event it would be more consistent if this entire sentence referred to exceedance probabilities (1% become 20%, like that) [Roshanka Ranasinghe, Netherlands]	“on average, once or even multiple times per year”. What does on average mean here? 50% exceedance probability? Since the sentence starts with 1% event it would be more consistent if this entire sentence referred to exceedance probabilities (1% become 20%, like that)
38564	116	25	116	26	The dynamic approach for ESL using climate projections by GCMs and GCM projection periods range from 20 to 30 years generally. The extreme sea level ESL, especially storm surge, occurs in the range from 50 to a few hundred years. Therefore extreme storm surge such as 100-years return level is extrapolation by extreme value analysis. It is necessary to mention about uncertainly based on using limited period of GCMs and extreme value analysis for extreme storm surge. One thing overcome is use of large scale ensemble (over 100 yrs) to estimate 100-years or longer return level. For example, there is study of extreme storm surge projection based on large ensemble recently. Mori, N., T. Shimura, K. Yoshida, R. Mizuta, Y. Okada, M. Fujita, T. Khujanazarov and E. Nakakita (2019) Future changes in extreme storm surges based on mega-ensemble projection using 60-km resolution atmospheric global circulation model, Coastal Engineering Journal, Taylor & Francis, 13p. doi: 10.1080/21664250.2019.1586290 [Nobuhito Mori, Japan]	The dynamic approach for ESL using climate projections by GCMs and GCM projection periods range from 20 to 30 years generally. The extreme sea level ESL, especially storm surge, occurs in the range from 50 to a few hundred years. Therefore extreme storm surge such as 100-years return level is extrapolation by extreme value analysis. It is necessary to mention about uncertainly based on using limited period of GCMs and extreme value analysis for extreme storm surge. One thing overcome is use of large scale ensemble (over 100 yrs) to estimate 100-years or longer return level. For example, there is study of extreme storm surge projection based on large ensemble recently. Mori, N., T. Shimura, K. Yoshida, R. Mizuta, Y. Okada, M. Fujita, T. Khujanazarov and E. Nakakita (2019) Future changes in extreme storm surges based on mega-ensemble projection using 60-km resolution atmospheric global circulation model, Coastal Engineering Journal, Taylor & Francis, 13p. doi: 10.1080/21664250.2019.1586290
24396	116	25	116	27	I don't aggree that this approach has only recently been successfully implemented. [Ralf Weisse, Germany]	I don't aggree that this approach has only recently been successfully implemented.
24394	116	25	116	39	This part ignores the bunch of dynamical studies that already existed or that have been produced recently. It focus on two selected papers only. This does not comprehensivly reflect existing knowledge. Results from cited studies should be brought into perspective with others. [Ralf Weisse, Germany]	This part ignores the bunch of dynamical studies that already existed or that have been produced recently. It focus on two selected papers only. This does not comprehensivly reflect existing knowledge. Results from cited studies should be brought into perspective with others.
20688	116	25	116	39	This paragraph needs IPCC uncertainty language [Gwenaelle GREMION, Canada]	This paragraph needs IPCC uncertainty language
24398	116	28	116	32	Writing suggests that this approach takes interaction and coastal effects into account. To my knowledge this is not the case. Wave-set, for example, was considered with a very crude role of thumb. While this is ok in principle, the writing here biases findings and implies much larger progress than has been made originally. [Ralf Weisse, Germany]	Writing suggests that this approach takes interaction and coastal effects into account. To my knowledge this is not the case. Wave-set, for example, was considered with a very crude role of thumb. While this is ok in principle, the writing here biases findings and implies much larger progress than has been made originally.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
20686	116	30	116	30	Delete 'using' or 'under' [Gwenaelle GREMION, Canada]	Delete 'using' or 'under'
20692	116	32	116	36	A reference is needed. [Gwenaelle GREMION, Canada]	A reference is needed.
40300	116	32			Are the stated numbers in addition of RSL or that due to RSL changes? [Michael Tsimplis, China]	Are the stated numbers in addition of RSL or that due to RSL changes?
12988	116	33	116	36	this analysis found that the current 1% average annual probability extreme water level, will be exceeded, on average, every 2 to 50 years by 2050 for most regions in higher latitudes in both hemispheres, and more often (up to multiple times a year) in the tropics, under both RCP4.5 and 8.5." As above [Roshanka Ranasinghe, Netherlands]	this analysis found that the current 1% average annual probability extreme water level, will be exceeded, on average, every 2 to 50 years by 2050 for most regions in higher latitudes in both hemispheres, and more often (up to multiple times a year) in the tropics, under both RCP4.5 and 8.5." As above
40302	116	34		36	But there is also a reduction so there should be an additional statement covering these too. [Michael Tsimplis, China]	But there is also a reduction so there should be an additional statement covering these too.
24402	116	38	116	38	What exactly is "much larger"? [Ralf Weisse, Germany]	What exactly is "much larger"?
24400	116	38	116	39	How do differences between scenarios compare to differences between models? The latter is missing. [Ralf Weisse, Germany]	How do differences between scenarios compare to differences between models? The latter is missing.
20690	116	41	116	41	I think you should say here that frequency amplification factors increase from RCP2.6 to RCP8.5, and the difference between scenarios is more marked with time (i.e. when comparing 2081-2100 to 2046-2065). Furthermore, this placeholder should be placed after L23. [Gwenaelle GREMION, Canada]	I think you should say here that frequency amplification factors increase from RCP2.6 to RCP8.5, and the difference between scenarios is more marked with time (i.e. when comparing 2081-2100 to 2046-2065). Furthermore, this placeholder should be placed after L23.
38566	116	43	116	48	This paragraph line up regional study of storm surge in NA and SP. There is additional regional study by tropical cyclone effects on storm surge in the WNP. Yasuda, T., S. Nakajo, S. Kim, H. Mase, N. Mori and K. Horsburgh (2014) Evaluation of future storm surge risk in East Asia based on state-of-the-art climate change projection, Coastal Engineering, Elservier, Vol.83, pp.65-71. Yang, J.A, S.Y. Kim, N. Mori, H. Mase (2018) Assessment of long-term impact of storm surges around the Korean Peninsula based on a large ensemble of climate projections, Coastal Engineering, Elsevier, Vol.142, pp.1-8. Mori, N. and T. Takemi (2016) Impact assessment of coastal hazards due to future changes of tropical cyclones in the North Pacific Ocean, Weather and Climate Extremes (review paper), Vol.11, pp.53-69. [Nobuhito Mori, Japan]	This paragraph line up regional study of storm surge in NA and SP. There is additional regional study by tropical cyclone effects on storm surge in the WNP. Yasuda, T., S. Nakajo, S. Kim, H. Mase, N. Mori and K. Horsburgh (2014) Evaluation of future storm surge risk in East Asia based on state-of-the-art climate change projection, Coastal Engineering, Elservier, Vol.83, pp.65-71. Yang, J.A, S.Y. Kim, N. Mori, H. Mase (2018) Assessment of long-term impact of storm surges around the Korean Peninsula based on a large ensemble of climate projections, Coastal Engineering, Elsevier, Vol.142, pp.1-8. Mori, N. and T. Takemi (2016) Impact assessment of coastal hazards due to future changes of tropical cyclones in the North Pacific Ocean, Weather and Climate Extremes (review paper), Vol.11, pp.53-69.
40304	116	45			quantify please what substantial and minima mean, Also this must be linked with the relevant part of the report on tropical cyclones. [Michael Tsimplis, China]	quantify please what substantial and minima mean, Also this must be linked with the relevant part of the report on tropical cyclones.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
16062	116	46	116	48	The statement “There is thus low confidence in projections of changes in ESL driven by changes in tropical cyclone climatology” is very likely based on one single reference by Garner et al., 2017 and may significantly undermine the increasing risk of storm surge due to sea level rise and projected increase in TC intensity in the future (see Chapter 11.7.1.5). This statement also does not align with the findings in page 11-66 (Lines 22-24) which clearly states that “there is high confidence that sea level rise will lead to higher risk due to extreme coastal water levels combined with storm surge due to TCs” and is supported by multiple lines of evidence and study results. Strongly suggest the authors to revise this paragraph to incorporate more findings in Chapter 11.7.1.5 and change the confidence level to “high” accordingly. [SAI MING LEE, China]	The statement “There is thus low confidence in projections of changes in ESL driven by changes in tropical cyclone climatology” is very likely based on one single reference by Garner et al., 2017 and may significantly undermine the increasing risk of storm surge due to sea level rise and projected increase in TC intensity in the future (see Chapter 11.7.1.5). This statement also does not align with the findings in page 11-66 (Lines 22-24) which clearly states that “there is high confidence that sea level rise will lead to higher risk due to extreme coastal water levels combined with storm surge due to TCs” and is supported by multiple lines of evidence and study results. Strongly suggest the authors to revise this paragraph to incorporate more findings in Chapter 11.7.1.5 and change the confidence level to “high” accordingly.
38568	116	50	117	23	The two paragraphs deals ensemble ocean surface wave projection and gives great improvement of future changes in comparison with AR5. However it needs to make clear the definition of wave heights (mean wave heights and extremes) in the section of extreme sea level. Although the main discussion of ocean surface wave are conducted in mean wave heights, it is better to add more projection and knowledge of extreme wave heights such as the annual maximum or 1/10 years return level In the sense of extreme sea level for readers of coastal disaster assessment and adaptation. e.g. Shimura, T., N. Mori and M. A. Hemer (2016) Projection of tropical cyclone-generated extreme wave climate based on CMIP5 multi-model ensemble in the Western North Pacific, Climate Dynamics, Vol.49(4), pp.1449-1462. [Nobuhito Mori, Japan]	The two paragraphs deals ensemble ocean surface wave projection and gives great improvement of future changes in comparison with AR5. However it needs to make clear the definition of wave heights (mean wave heights and extremes) in the section of extreme sea level. Although the main discussion of ocean surface wave are conducted in mean wave heights, it is better to add more projection and knowledge of extreme wave heights such as the annual maximum or 1/10 years return level In the sense of extreme sea level for readers of coastal disaster assessment and adaptation. e.g. Shimura, T., N. Mori and M. A. Hemer (2016) Projection of tropical cyclone-generated extreme wave climate based on CMIP5 multi-model ensemble in the Western North Pacific, Climate Dynamics, Vol.49(4), pp.1449-1462.
56018	116	50	117	23	These paragraphs on the projected changes in ocean waves should be completed with references to other works, in particular for what concerns the Arctic ocean where the most dramatic changes in waves are to be expected (e.g. Casas-Prat, M., Wang, X.L., Swart, N., 2018. CMIP5-based global wave climate projections including the entire Arctic Ocean. Ocean Modelling 123, 66–85). [Guillaume Dodet, France]	These paragraphs on the projected changes in ocean waves should be completed with references to other works, in particular for what concerns the Arctic ocean where the most dramatic changes in waves are to be expected (e.g. Casas-Prat, M., Wang, X.L., Swart, N., 2018. CMIP5-based global wave climate projections including the entire Arctic Ocean. Ocean Modelling 123, 66–85).
12990	116	51	116	51	Section 9.6.5, (Storlazzi et al., 2018) This is a site specific study for one pacific island, if you read it carefully. Cannot substantiate global statements. [Roshanka Ranasinghe, Netherlands]	Section 9.6.5, (Storlazzi et al., 2018) This is a site specific study for one pacific island, if you read it carefully. Cannot substantiate global statements.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
7878	117	2	117	2	wave period is also very relevant for flooding analyses, and it has been largely overlooked as in the case of wave direction. [Marta Marcos, Spain]	wave period is also very relevant for flooding analyses, and it has been largely overlooked as in the case of wave direction.
42640	117	12	117	12	Were the changes of 5-10% positive or negative? [William Gutowski, United States of America]	Were the changes of 5-10% positive or negative?
20696	117	17	117	20	Confusing sentence - split into two. [Gwenaelle GREMION, Canada]	Confusing sentence - split into two.
6495	117	22			"extent of regional studies" - "extent" or "number" ? [Tom Howard, United Kingdom (of Great Britain and Northern Ireland)]	"extent of regional studies" - "extent" or "number" ?
40306	117	23			This statement is troubling. If there is low confidence in wind estimates (in the report) then this statement can be supported. However if there is another level of confidence in wind changes then there must be the same level of confidence on wind wave changes and, where global studies are involved in swell. Indeed there should be low confidence in the estimates concerning their coastal effects. These should be clearly separated, especially because earlier there was discussion of the wave fields in the open ocean which are not really of any consequence. [Michael Tsimplis, China]	This statement is troubling. If there is low confidence in wind estimates (in the report) then this statement can be supported. However if there is another level of confidence in wind changes then there must be the same level of confidence on wind wave changes and, where global studies are involved in swell. Indeed there should be low confidence in the estimates concerning their coastal effects. These should be clearly separated, especially because earlier there was discussion of the wave fields in the open ocean which are not really of any consequence.
40308	117	34		36	It must be stated whether such models were validated at the coasts and what skill they have. Only some of the studies are reliable in this respect. The others at best can be considered as quanlitative assessments or could be ignored. In fact much of this was first assessed by Flather on the basis of 2 d modelling in the Euroepan Continental shelf in the late 1990s. [Michael Tsimplis, China]	It must be stated whether such models were validated at the coasts and what skill they have. Only some of the studies are reliable in this respect. The others at best can be considered as quanlitative assessments or could be ignored. In fact much of this was first assessed by Flather on the basis of 2 d modelling in the Euroepan Continental shelf in the late 1990s.
6497	117	40			"in excess of +/- 10 cm" - surely this should be "+/- 10%" ? [Tom Howard, United Kingdom (of Great Britain and Northern Ireland)]	"in excess of +/- 10 cm" - surely this should be "+/- 10%" ?
40310	117	40			This is for the impacts section of the report. [Michael Tsimplis, China]	This is for the impacts section of the report.
6764	117	41	117	41	how is there "high confidence" that GMSLR will be the primary driver of global tidal amplitude changes in the future, when there is only "medium confidence" (9-115 line 41) that RSL *and* direct anthropogenic factors were the primary drivers in observed changes? It is worth noting that contradictory evidence (eg Idier vs Muller) could arise because of the high sensitivity of tidal models to many factors, such as remote bathymetric changes affecting basin-scale resonance. I do not think the community has "high confidence" in attribution of tidal changes at this stage, although it is the subject of active research. [Joanne Williams, United Kingdom (of Great Britain and Northern Ireland)]	how is there "high confidence" that GMSLR will be the primary driver of global tidal amplitude changes in the future, when there is only "medium confidence" (9-115 line 41) that RSL *and* direct anthropogenic factors were the primary drivers in observed changes? It is worth noting that contradictory evidence (eg Idier vs Muller) could arise because of the high sensitivity of tidal models to many factors, such as remote bathymetric changes affecting basin-scale resonance. I do not think the community has "high confidence" in attribution of tidal changes at this stage, although it is the subject of active research.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
20694	117	47	117	53	It would be appropriate to conclude whether global mean sea-level rise will influence the wave and tidal parameters. [Gwenaelle GREMION, Canada]	It would be appropriate to conclude whether global mean sea-level rise will influence the wave and tidal parameters.
24404	117	48	117	49	To me the separation into sea "level-forced" and "climate forced" is unlucky. Sea-level also includes a climatic component. [Ralf Weisse, Germany]	To me the separation into sea "level-forced" and "climate forced" is unlucky. Sea-level also includes a climatic component.
24406	117	55	118	2	It should be made clear that this only holds when the Wadden Sea is not keeping paces with sea level rise. This is not accounted for in the cited study. [Ralf Weisse, Germany]	It should be made clear that this only holds when the Wadden Sea is not keeping paces with sea level rise. This is not accounted for in the cited study.
32340	118	0	123	0	While it is recognized in the summary that "Changing coastlines are a potentially dominant process in extreme sea levels {high confidence}" the report does not identify the current limited capabilities in accurately model coastal evolution as a key uncertainty and major gap (Section 9.7). The response of various coastal environments (sandy beaches, saltmarshes and tidal flats, estuaries, mangroves, reefs, rocky cliffs) to changing mean and extreme sea levels needs to be better understood to improve confidence and performance of coastal modelling. There are significant environmental, social and economic implications of the current inability to confidently predict coastal change at temporal and spatial scales that are meaningful for climate change adaptation. [Carlos Loureiro, United Kingdom (of Great Britain and Northern Ireland)]	While it is recognized in the summary that "Changing coastlines are a potentially dominant process in extreme sea levels {high confidence}" the report does not identify the current limited capabilities in accurately model coastal evolution as a key uncertainty and major gap (Section 9.7). The response of various coastal environments (sandy beaches, saltmarshes and tidal flats, estuaries, mangroves, reefs, rocky cliffs) to changing mean and extreme sea levels needs to be better understood to improve confidence and performance of coastal modelling. There are significant environmental, social and economic implications of the current inability to confidently predict coastal change at temporal and spatial scales that are meaningful for climate change adaptation.
20698	118	5	118	7	But the relative effects of the different types of coupling need to be quantified. It would be useful to mention this. [Gwenaelle GREMION, Canada]	But the relative effects of the different types of coupling need to be quantified. It would be useful to mention this.
24408	118	6	118	7	The corellation and coupled simulations are only part of the story, but first order coastal processes ignored such as geo-morphological changes may have comparable effects but are usually not considered. A corresponding statement was made later in section 9.6.5.1 (page 118, line 55-page 119, line 1) but is needed here as well. [Ralf Weisse, Germany]	The corellation and coupled simulations are only part of the story, but first order coastal processes ignored such as geo-morphological changes may have comparable effects but are usually not considered. A corresponding statement was made later in section 9.6.5.1 (page 118, line 55-page 119, line 1) but is needed here as well.
40312	118	7			what is this medium confidence about exactly? [Michael Tsimplis, China]	what is this medium confidence about exactly?

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
7880	118	9	118	32	Another type of compound extreme events that may be relevant to discuss is storm surge-waves. The likelihood of joint occurrence of these two phenomena increases the risk of coastal flooding in 55% of the world coastlines, that exhibit dependence between them (Marcos et al 2019, https://doi.org/10.1029/2019GL082599). There has been no attempt to explore how these dependences change under climate change scenarios, though. [Marta Marcos, Spain]	Another type of compound extreme events that may be relevant to discuss is storm surge-waves. The likelihood of joint occurrence of these two phenomena increases the risk of coastal flooding in 55% of the world coastlines, that exhibit dependence between them (Marcos et al 2019, https://doi.org/10.1029/2019GL082599). There has been no attempt to explore how these dependences change under climate change scenarios, though.
46032	118	9	118	32	Should there be discussion of contribution of short-term temperature anomalies to extreme sea levels? For example, studies have shown the San Francisco Bay total water level to increase by one foot during El Nino. [Isaac Pearlman, United States of America]	Should there be discussion of contribution of short-term temperature anomalies to extreme sea levels? For example, studies have shown the San Francisco Bay total water level to increase by one foot during El Nino.
46034	118	9	118	32	In urbanized areas where flood control channels shunt water as fast as possible off streets and into receiving waters, I suspect compound surge/river flow events do matter and can co-occur [Isaac Pearlman, United States of America]	In urbanized areas where flood control channels shunt water as fast as possible off streets and into receiving waters, I suspect compound surge/river flow events do matter and can co-occur
40316	118	9		32	This paragraph does not fit within the scope of this report. [Michael Tsimplis, China]	This paragraph does not fit within the scope of this report.
40314	118	9			This should probably go to regional analysis. It does require an assessment of rain projections. [Michael Tsimplis, China]	This should probably go to regional analysis. It does require an assessment of rain projections.
56020	118	38	118	39	Remove “of this chapter” after “using this chapter’s regional sea-level projections”. [Guillaume Dodet, France]	Remove “of this chapter” after “using this chapter’s regional sea-level projections”.
8096	118	44	121	8	Section 9.6.5.1 discusses sandy shorelines, deltas, marshes, and coral reefs, respectively. The glaring omission here are mangroves. I would argue that they are important enough to justify an additional paragraph. [Torbjorn Tornqvist, United States of America]	Section 9.6.5.1 discusses sandy shorelines, deltas, marshes, and coral reefs, respectively. The glaring omission here are mangroves. I would argue that they are important enough to justify an additional paragraph.
8686	118	44	122	19	This section is a very good synthesis, which is very useful for WG2 where further studies on the detection/attribution of observed impacts can be integrated. This section may also include a quick statement on how morphological changes (above and below sea level) can change flooding hazards. (e.g., see Bilskie, M. V., Hagen, S. C., Medeiros, S. C., & Passeri, D. L. (2014). Dynamics of sea level rise and coastal flooding on a changing landscape. Geophysical Research Letters, 41(3), 927-934) [Goneri Le Cozannet, France]	This section is a very good synthesis, which is very useful for WG2 where further studies on the detectioNot applicablettribution of observed impacts can be integrated. This section may also include a quick statement on how morphological changes (above and below sea level) can change flooding hazards. (e.g., see Bilskie, M. V., Hagen, S. C., Medeiros, S. C., & Passeri, D. L. (2014). Dynamics of sea level rise and coastal flooding on a changing landscape. Geophysical Research Letters, 41(3), 927-934)

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
32346	118	46	121	8	Section 9.6.5.1 does not consider rocky coasts (apart from coral reefs), although these represent approximately 52% of the world's coastlines (Young, A.P., Carilli, J.E., 2019. Global distribution of coastal cliffs. Earth Surface Processes and Landforms, 44 (6), 1309-1316. DOI: 10.1002/esp.4574). While there is high confidence that hard rock cliffs and shore platforms will evolve slowly and perhaps at rates that are too low to be meaningful at a decadal scale, there is also high confidence that erosion of soft rock cliffs will be significantly impacted by higher mean and extreme sea levels, particularly as higher wave setup and runup will contribute to more frequent an energetic wave impacts at the base of soft rock cliffs, triggering mass movements and progressive cliff retreat. Besides the more obvious impacts on soft rock cliffs, regional changes in temperature, humidity and precipitation can also contribute to enhanced physical and chemical weathering of hard rock cliffs, contributing to changes in frequency and intensity of rock falls. [Carlos Loureiro, United Kingdom (of Great Britain and Northern Ireland)]	Section 9.6.5.1 does not consider rocky coasts (apart from coral reefs), although these represent approximately 52% of the world's coastlines (Young, A.P., Carilli, J.E., 2019. Global distribution of coastal cliffs. Earth Surface Processes and Landforms, 44 (6), 1309-1316. DOI: 10.1002/esp.4574). While there is high confidence that hard rock cliffs and shore platforms will evolve slowly and perhaps at rates that are too low to be meaningful at a decadal scale, there is also high confidence that erosion of soft rock cliffs will be significantly impacted by higher mean and extreme sea levels, particularly as higher wave setup and runup will contribute to more frequent an energetic wave impacts at the base of soft rock cliffs, triggering mass movements and progressive cliff retreat. Besides the more obvious impacts on soft rock cliffs, regional changes in temperature, humidity and precipitation can also contribute to enhanced physical and chemical weathering of hard rock cliffs, contributing to changes in frequency and intensity of rock falls.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
32348	118	46	121	8	Section 9.6.5.1 does not consider sandy coasts within rocky environments (embayed, pocket or platform beaches), despite these being ubiquitous and arguably prevalent along the world's coastlines. Sandy beaches backed by rocky cliffs or underlain by shore platforms will respond very differently to exposed sandy beaches to changes in mean and extreme sea levels, as they are constrained vertically and laterally and cannot simply migrate landward with sea level rise. Various conceptual and numerical models have been developed in the past 5 years (e.g. Taborda, R., Ribeiro, M.A., 2015. A simple model to estimate the impact of sea-level rise on platform beaches. Geomorphology, 234, 204-210; Bon de Sousa, L., Loureiro, C., Ferreira, O., 2018. Morphological and economic impacts of rising sea levels on cliff-backed beaches in southern Portugal. Applied Geography, 99, 31-43; Trenhaile, A.S., 2018. Modelling the effect of rising sea-level on beaches with resistant foundations. Marine Geology, 206, 55-72), exploring the potential response of geologically-constrained beaches. The work of Bon de Sousa et al. (2018) demonstrates the potential for beach profile steepening and eventual submergence of these type of sandy coasts under rising sea level, a type of response that is markedly different from exposed/open sandy coasts. While there are no current global scale studies, the response of sandy beaches withing rocky environments should not be discarded. [Carlos Loureiro, United Kingdom (of Great Britain and Northern Ireland)]	Section 9.6.5.1 does not consider sandy coasts within rocky environments (embayed, pocket or platform beaches), despite these being ubiquitous and arguably prevalent along the world's coastlines. Sandy beaches backed by rocky cliffs or underlain by shore platforms will respond very differently to exposed sandy beaches to changes in mean and extreme sea levels, as they are constrained vertically and laterally and cannot simply migrate landward with sea level rise. Various conceptual and numerical models have been developed in the past 5 years (e.g. Taborda, R., Ribeiro, M.A., 2015. A simple model to estimate the impact of sea-level rise on platform beaches. Geomorphology, 234, 204-210; Bon de Sousa, L., Loureiro, C., Ferreira, O., 2018. Morphological and economic impacts of rising sea levels on cliff-backed beaches in southern Portugal. Applied Geography, 99, 31-43; Trenhaile, A.S., 2018. Modelling the effect of rising sea-level on beaches with resistant foundations. Marine Geology, 206, 55-72), exploring the potential response of geologically-constrained beaches. The work of Bon de Sousa et al. (2018) demonstrates the potential for beach profile steepening and eventual submergence of these type of sandy coasts under rising sea level, a type of response that is markedly different from exposed/open sandy coasts. While there are no current global scale studies, the response of sandy
8098	118	48	119	1	It would be beneficial to add one sentence to this introductory paragraph that stresses the fact that the focus here is on low-elevation, depositional coastal zones, as opposed to rocky coastlines with more relief. [Torbjorn Tornqvist, United States of America]	It would be beneficial to add one sentence to this introductory paragraph that stresses the fact that the focus here is on low-elevation, depositional coastal zones, as opposed to rocky coastlines with more relief.
56022	118	48	119	1	I think it is worth stating here that exposed sandy coastline are extremely vulnerable to extreme wave events (a storm or a sequence of storms) which may cause extensive coastal erosion at regional scale (e.g. Masselink, G., Castelle, B., Scott, T., Dodet, G., Suanez, S., Jackson, D., Floc'h, F., 2016. Extreme wave activity during 2013/2014 winter and morphological impacts along the Atlantic coast of Europe. Geophysical Research Letters 2015GL067492). [Guillaume Dodet, France]	I think it is worth stating here that exposed sandy coastline are extremely vulnerable to extreme wave events (a storm or a sequence of storms) which may cause extensive coastal erosion at regional scale (e.g. Masselink, G., Castelle, B., Scott, T., Dodet, G., Suanez, S., Jackson, D., Floc'h, F., 2016. Extreme wave activity during 2013/2014 winter and morphological impacts along the Atlantic coast of Europe. Geophysical Research Letters 2015GL067492).
6768	119	1	119	1	Fig9.1 text unreadable. [Joanne Williams, United Kingdom (of Great Britain and Northern Ireland)]	Fig9.1 text unreadable.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
6770	119	1	119	1	Fig 9.1 I think a bathymetry map would be useful at this stage, to indicate shelf-seas. [Joanne Williams, United Kingdom (of Great Britain and Northern Ireland)]	Fig 9.1 I think a bathymetry map would be useful at this stage, to indicate shelf-seas.
40318	119	1			Indeed and that is why most of the mentioned tidal modelling studies are unreliable. [Michael Tsimplis, China]	Indeed and that is why most of the mentioned tidal modelling studies are unreliable.
48982	119	3	119	28	This paragraph could use an ackowledgement of possible effects of anthropogenic modifications of the coastline that essentially keep barrier islands from rolling back--therefore while sea level rises they get lower in the tidal frame and more prone to flooding, erosion etc. [Laura Reynolds, United States of America]	This paragraph could use an ackowledgement of possible effects of anthropogenic modifications of the coastline that essentially keep barrier islands from rolling back-- therefore while sea level rises they get lower in the tidal frame and more prone to flooding, erosion etc.
32344	119	3	119	28	It should be recognized that the upward and landward displacement of the cross-shore profile with SLR is extremely simplistic (basically the shoreline equivalent to the bathtub inundation model) and that at decadal to centennial scales the evolution of the cross-shore profile may exhibit decoupled linkage between sandy barriers and the shoreface (Cooper, J.A.G., et al., 2018. Geological constraints on mesoscale barrier behaviour. Global and Planetary Change, 168, 15-34). Because the profile of the shoreface can become decoupled from the shoreline, the configuration and bathymetry of the coast can change significantly and strongly modify response to SLR. Since shoreline change is highly localized, it is very unlikely that a meaningful global scale projection of shoreline retreat will ever be accomplished without massive improvements in the geomorphological characterization of coastal areas and their decadal change. [Carlos Loureiro, United Kingdom (of Great Britain and Northern Ireland)]	It should be recognized that the upward and landward displacement of the cross-shore profile with SLR is extremely simplistic (basically the shoreline equivalent to the bathtub inundation model) and that at decadal to centennial scales the evolution of the cross-shore profile may exhibit decoupled linkage between sandy barriers and the shoreface (Cooper, J.A.G., et al., 2018. Geological constraints on mesoscale barrier behaviour. Global and Planetary Change, 168, 15-34). Because the profile of the shoreface can become decoupled from the shoreline, the configuration and bathymetry of the coast can change significantly and strongly modify response to SLR. Since shoreline change is highly localized, it is very unlikely that a meaningful global scale projection of shoreline retreat will ever be accomplished without massive improvements in the geomorphological characterization of coastal areas and their decadal change.
8100	119	3	119	28	I think it would be preferable to open this paragraph with the Bruun Rule and related approaches (but see my concerns about the Bruun Rule elsewhere), before zeroing in on sandy shorelines with tidal inlets. [Torbjorn Tornqvist, United States of America]	I think it would be preferable to open this paragraph with the Bruun Rule and related approaches (but see my concerns about the Bruun Rule elsewhere), before zeroing in on sandy shorelines with tidal inlets.
8102	119	3	119	28	The referencing in this paragraph is very unbalanced, with more than half of the citations to work (co-)authored by Ranasinghe. This should be more even-handed. There are many other relevant recent studies on these topics, such as Lorenzo-Trueba & Ashton (2014, JGR-ES, 119: 779). [Torbjorn Tornqvist, United States of America]	The referencing in this paragraph is very unbalanced, with more than half of the citations to work (co-)authored by Ranasinghe. This should be more even-handed. There are many other relevant recent studies on these topics, such as Lorenzo-Trueba & Ashton (2014, JGR-ES, 119: 779).

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
38570	119	3	119	28	The nation wide projection has conducted targeting to estimate decreasing sandy beaches in Japan. It is nice if the LA can include it to Australia and Vietnam cases. Mori, N., S. Nakajo, S. Iwamura and Y. Shibutani (2018) Projection of decrease in Japanese beaches due to climate change using a geographic database, Coastal Engineering Journal, Taylor & Francis, 8p. doi: 10.1080/21664250.2018.1488513 [Nobuhito Mori, Japan]	The nation wide projection has conducted targeting to estimate decreasing sandy beaches in Japan. It is nice if the LA can include it to Australia and Vietnam cases. Mori, N., S. Nakajo, S. Iwamura and Y. Shibutani (2018) Projection of decrease in Japanese beaches due to climate change using a geographic database, Coastal Engineering Journal, Taylor & Francis, 8p. doi: 10.1080/21664250.2018.1488513
32342	119	8	119	13	Given the overwhelming evidence that the Brunn rule is unsuitable for modelling the effects on SLR on most sandy coasts, with uncertainties so significant that only in uncommon "low-energy gently sloping beaches with little human impacts and small gradients in longshore drift and sheltered from storms" can the Brunn rule be tested (Le Cozannet et al., 2016. Uncertainties in sandy shorelines evolution under the Brunn rule assumption. Frontiers in Marine Science, 3, 49 DOI: 10.3389/fmars.2016.00049), it would be relevant that the AR6 finally makes the paradigm shift in coastal response to SLR and discards the use and mentions to the Brunn rule as a meaningful concept or principle of coastal response to SLR. There is very low confidence in any estimate of SLR induced coastal recession based on the Brunn rule for most sandy coasts, and the continue to highlight an unsuitable concept is only hampering scientific progress in the field. [Carlos Loureiro, United Kingdom (of Great Britain and Northern Ireland)]	Given the overwhelming evidence that the Brunn rule is unsuitable for modelling the effects on SLR on most sandy coasts, with uncertainties so significant that only in uncommon "low-energy gently sloping beaches with little human impacts and small gradients in longshore drift and sheltered from storms" can the Brunn rule be tested (Le Cozannet et al., 2016. Uncertainties in sandy shorelines evolution under the Brunn rule assumption. Frontiers in Marine Science, 3, 49 DOI: 10.3389/fmars.2016.00049), it would be relevant that the AR6 finally makes the paradigm shift in coastal response to SLR and discards the use and mentions to the Brunn rule as a meaningful concept or principle of coastal response to SLR. There is very low confidence in any estimate of SLR induced coastal recession based on the Brunn rule for most sandy coasts, and the continue to highlight an unsuitable concept is only hampering scientific progress in the field.
8688	119	12	199	13	What is the reason for considering that the Bruun rule overstimates impacts of sea-level rise? I agree that alternative models deliver smaller erosion rates, but neither the Bruun rule nor these models are fully validated with the upcoming rates of sea-level rise. I suggest to provide a more neutral statement, saying that two alternative models exists and that the Bruun rule delivers usually more rapid shoreline retreat in response to the same rates of sea-level rise. [Goneri Le Cozannet, France]	What is the reason for considering that the Bruun rule overstimates impacts of sea-level rise? I agree that alternative models deliver smaller erosion rates, but neither the Bruun rule nor these models are fully validated with the upcoming rates of sea-level rise. I suggest to provide a more neutral statement, saying that two alternative models exists and that the Bruun rule delivers usually more rapid shoreline retreat in response to the same rates of sea-level rise.
7882	119	13	119	13	The paper Enríquez et al (2019) also confirms this statement on the Bruun rule (doi: 10.3389/fmars.2019.00004) [Marta Marcos, Spain]	The paper Enríquez et al (2019) also confirms this statement on the Bruun rule (doi: 10.3389/fmars.2019.00004)

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
20700	119	16	119	17	According to idealized hybrid model simulations by Sampath and Boski, (2016), coastal systems such as estuarine systems with salt-marsh habitats in the intertidal zone deepen due to the increase of erosion with mean sea-level rise in a context of reduced fluvial sediment supply.during the 21st century. There would socio-economic losses including the habitat losses and conversion of salt-marsh habitats to mud flats where the biodiversity is low compared to the orginal habitat distribution. Sampath, D.M.R., Boski, T., 2016. Morphological response of the saltmarsh habitats of the Guadiana estuary due to flow regulation and sea-level rise, Estuarine, Coastal and Shelf Science. 183 (2016) 314 -326. http://dx.doi.org/10.1016/j.ecss.2016.07.009 [Gwenaelle GREMION, Canada]	According to idealized hybrid model simulations by Sampath and Boski, (2016), coastal systems such as estuarine systems with salt-marsh habitats in the intertidal zone deepen due to the increase of erosion with mean sea-level rise in a context of reduced fluvial sediment supply.during the 21st century. There would socio-economic losses including the habitat losses and conversion of salt-marsh habitats to mud flats where the biodiversity is low compared to the orginal habitat distribution. Sampath, D.M.R., Boski, T., 2016. Morphological response of the saltmarsh habitats of the Guadiana estuary due to flow regulation and sea-level rise, Estuarine, Coastal and Shelf Science. 183 (2016) 314 -326. http://dx.doi.org/10.1016/j.ecss.2016.07.009
8690	119	26	119	28	This statement is very good. [Goneri Le Cozannet, France]	This statement is very good.
40320	119	26		28	I would say there is certainty that there will be coastal land loss - assuming no changes in coastal protection but low confidence of net loss (is this what you are trying to say). [Michael Tsimplis, China]	I would say there is certainty that there will be coastal land loss - assuming no changes in coastal protection but low confidence of net loss (is this what you are trying to say).
32350	119	27	119	28	The low confidence in quantitative global projections of land loss along sandy coasts is not only due to the limited number of global scale studies, but also due to the high uncertainties in model results for decadal scale coastal evolution. [Carlos Loureiro, United Kingdom (of Great Britain and Northern Ireland)]	The low confidence in quantitative global projections of land loss along sandy coasts is not only due to the limited number of global scale studies, but also due to the high uncertainties in model results for decadal scale coastal evolution.
48984	119	30	119	49	It would be useful to differentiate between compaction and subsidence-- or specify the relationship early in this paragraph. Or simply use one term or the other for clarity. [Laura Reynolds, United States of America]	It would be useful to differentiate between compaction and subsidence-- or specify the relationship early in this paragraph. Or simply use one term or the other for clarity.
40322	119	30		49	Should this be part of land movements -earlier in the chapter? [Michael Tsimplis, China]	Should this be part of land movements -earlier in the chapter?
8104	119	32	119	32	Please use quantitative information wherever possible. Rather than "Late Holocene" (which nowadays generally refers to the past 4200 years), I would suggest something like "about 7000 years ago". This falls within the range reported by Stanley & Warne (1994). Not coincidentally, this corresponds to the final demise of the Laurentide Ice Sheet, as mentioned elsewhere in this chapter (page 93, lines 45-46). [Torbjorn Tornqvist, United States of America]	Please use quantitative information wherever possible. Rather than "Late Holocene" (which nowadays generally refers to the past 4200 years), I would suggest something like "about 7000 years ago". This falls within the range reported by Stanley & Warne (1994). Not coincidentally, this corresponds to the final demise of the Laurentide Ice Sheet, as mentioned elsewhere in this chapter (page 93, lines 45-46).
8106	119	33	119	39	I suggest tidal range is mentioned here as well; it is a key factor that contributes to determining elevation capital on delta plains. [Torbjorn Tornqvist, United States of America]	I suggest tidal range is mentioned here as well; it is a key factor that contributes to determining elevation capital on delta plains.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
8108	119	39	119	40	Again, numbers are preferable to qualitiative descriptions. In this case, reference could be made to Allison et al. (2016, Eos, 97(19): 22) who present relevant quantitative data in their Fig. 1. [Torbjorn Tornqvist, United States of America]	Again, numbers are preferable to qualitiative descriptions. In this case, reference could be made to Allison et al. (2016, Eos, 97(19): 22) who present relevant quantitative data in their Fig. 1.
8110	119	46	119	46	The best reference here would be Syvitski et al. (2005, Science, 308:376). [Torbjorn Tornqvist, United States of America]	The best reference here would be Syvitski et al. (2005, Science, 308:376).
40324	120	5			Same as Haigh earlier: Bad and opaque practice citing papers not yet publsihed. The reviewers may have a say on the fate of the paper AND on the exact detail. [Michael Tsimplis, China]	Same as Haigh earlier: Bad and opaque practice citing papers not yet publsihed. The reviewers may have a say on the fate of the paper AND on the exact detail.
48986	120	14	120	33	If space allows, a sentence or two could be added about expected changes to marsh type, not just overall marsh survival, has implications for the ecological impacts of RSL-induced marsh change. [Laura Reynolds, United States of America]	If space allows, a sentence or two could be added about expected changes to marsh type, not just overall marsh survival, has implications for the ecological impacts of RSL-induced marsh change.
48988	120	23	120	23	Ganju et al., 2018 for microtidal system vulnerability [Laura Reynolds, United States of America]	Ganju et al., 2018 for microtidal system vulnerability
48990	120	28	120	28	Gedan and Kirwan, 2019 for ghost forests/marsh migration [Laura Reynolds, United States of America]	Gedan and Kirwan, 2019 for ghost forests/marsh migration
8692	120	32	120	32	I suppose that the "medium confidence" comes here from lack of evidences, but I would say the agreement is very high. May be the high agreement could be mentionned, since this is a very useful policy relevant statement (allocate space for wetlands to migrate inlands allows for wetland preservation). [Goneri Le Cozannet, France]	I suppose that the "medium confidence" comes here from lack of evidences, but I would say the agreement is very high. May be the high agreement could be mentionned, since this is a very useful policy relevant statement (allocate space for wetlands to migrate inlands allows for wetland preservation).
8112	120	32	120	33	The Schuerch et al. (2018) paper that has highlighted the ability of coastal wetlands to potentially expand by migrating landward is very contentious. Therefore, I would argue that "medium confidence" is vastly overstated. At best, I would have low confidence in what is said here. [Torbjorn Tornqvist, United States of America]	The Schuerch et al. (2018) paper that has highlighted the ability of coastal wetlands to potentially expand by migrating landward is very contentious. Therefore, I would argue that "medium confidence" is vastly overstated. At best, I would have low confidence in what is said here.
8694	120	35	121	8	May be this paragraph could benefit from a link with the SR15 report, which states that: "Reaching 2°C will increase the frequency of mass coral bleaching and mortality to a point at which it will result in the total loss of coral reefs from the world's tropical and subtropical regions." and "Restricting overall warming to 1.5°C will still see a downward trend in average coral cover (70–90% decline by midcentury) but will prevent the total loss of coral reefs projected with warming of 2°C". These statements mean that at the time when sea-level rise will allocate space for corals (L1-3 p120), there will be no more corals in tropical areas. [Goneri Le Cozannet, France]	May be this paragraph could benefit from a link with the SR15 report, which states that: "Reaching 2°C will increase the frequency of mass coral bleaching and mortality to a point at which it will result in the total loss of coral reefs from the world's tropical and subtropical regions." and "Restricting overall warming to 1.5°C will still see a downward trend in average coral cover (70–90% decline by midcentury) but will prevent the total loss of coral reefs projected with warming of 2°C". These statements mean that at the time when sea-level rise will allocate space for corals (L1-3 p120), there will be no more corals in tropical areas.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
56284	120		121		Need to mention coastal areas where isostatic rebound has uplifted coastal regions in the past, offsetting SLR impacts. These areas are coming out of this uplift phase and will see rapid SLR impact cpmapred to recent static impacts. This needs mentioned for all coastal environments [Derek Jackson, United Kingdom (of Great Britain and Northern Ireland)]	Need to mention coastal areas where isostatic rebound has uplifted coastal regions in the past, offsetting SLR impacts. These areas are coming out of this uplift phase and will see rapid SLR impact cpmapred to recent static impacts. This needs mentioned for all coastal environments
41288	121	3	121	3	Define in greater detail the anthropogenic pressures affecting reefs that may limit their growth in climate change context. [Marcelino Hernández González, Cuba]	Define in greater detail the anthropogenic pressures affecting reefs that may limit their growth in climate change context.
40326	121	8			Many of the previous sections are not about ocean and sea level change but on coastal processes and the sea level impacts. Are they needed and even if they are do they have to be this long? [Michael Tsimplis, China]	Many of the previous sections are not about ocean and sea level change but on coastal processes and the sea level impacts. Are they needed and even if they are do they have to be this long?
46292	121	41	121	41	propose to add "for example,Increasing seawater levels can cause seawater to migrate into coastal aquifers. For example, on moving eastwards along the Iranian south coast, the impacts of climate change on average sea level change decreases. The average sea level rise at the region is about 0.33 m and 0.59 m under climate change scenarios of A1b and A2 respectively. Considerable expanses of flat coastal areas will be inundated as a result of sea level increase. This range of sea level change would result in substantial changes in coastal ecosystems and would give rise to significant economic problems. (Goharnejad, H., Shamsai, A., Hosseini, S. A., 2013)" Reference: Vulnerability assessment of southern coastal areas of Iran to sea level rise: evaluation of climate change impact, OCEANOLOGIA, 55 (3), 2013, pp. 611–637, doi:10.5697/oc.55-3.611. [sadegh zeyaeyan, Iran]	propose to add "for example,Increasing seawater levels can cause seawater to migrate into coastal aquifers. For example, on moving eastwards along the Iranian south coast, the impacts of climate change on average sea level change decreases. The average sea level rise at the region is about 0.33 m and 0.59 m under climate change scenarios of A1b and A2 respectively. Considerable expanses of flat coastal areas will be inundated as a result of sea level increase. This range of sea level change would result in substantial changes in coastal ecosystems and would give rise to significant economic problems. (Goharnejad, H., Shamsai, A., Hosseini, S. A., 2013)" Reference: Vulnerability assessment of southern coastal areas of Iran to sea level rise: evaluation of climate change impact, OCEANOLOGIA, 55 (3), 2013, pp. 611–637, doi:10.5697/oc.55-3.611.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
57568	121	41	121	41	propose to add "for example,Increasing seawater levels can cause seawater to migrate into coastal aquifers. For example, on moving eastwards along the Iranian south coast, the impacts of climate change on average sea level change decreases. The average sea level rise at the region is about 0.33 m and 0.59 m under climate change scenarios of A1b and A2 respectively. Considerable expanses of flat coastal areas will be inundated as a result of sea level increase. This range of sea level change would result in substantial changes in coastal ecosystems and would give rise to significant economic problems. (Goharnejad, H., Shamsai, A., Hosseini, S. A., 2013)" Reference: Vulnerability assessment of southern coastal areas of Iran to sea level rise: evaluation of climate change impact, OCEANOLOGIA, 55 (3), 2013, pp. 611–637, doi:10.5697/oc.55-3.611. [Sahar Tajbakhsh Mosalman, Iran]	propose to add "for example,Increasing seawater levels can cause seawater to migrate into coastal aquifers. For example, on moving eastwards along the Iranian south coast, the impacts of climate change on average sea level change decreases. The average sea level rise at the region is about 0.33 m and 0.59 m under climate change scenarios of A1b and A2 respectively. Considerable expanses of flat coastal areas will be inundated as a result of sea level increase. This range of sea level change would result in substantial changes in coastal ecosystems and would give rise to significant economic problems. (Goharnejad, H., Shamsai, A., Hosseini, S. A., 2013)" Reference: Vulnerability assessment of southern coastal areas of Iran to sea level rise: evaluation of climate change impact, OCEANOLOGIA, 55 (3), 2013, pp. 611–637, doi:10.5697/oc.55-3.611.
41292	122	22	122	30	It would be recommendable to assess as one of the largest key uncertainties the adaptation capacity of oceanic and coastal ecosystems to GrISs and AISs changes, considering the current and future anthropogenic pressures. It should be taken into account that, before the development of human civilizations, intense mean sea level changes took place to which these ecosystems were able to adapt. [Marcelino Hernández González, Cuba]	It would be recommendable to assess as one of the largest key uncertainties the adaptation capacity of oceanic and coastal ecosystems to GrISs and AISs changes, considering the current and future anthropogenic pressures. It should be taken into account that, before the development of human civilizations, intense mean sea level changes took place to which these ecosystems were able to adapt.
8114	122	22	123	15	I believe it would be appropriate to add one key uncertainty with respect to coastal responses here. One overarching element that stands out is the lack of understanding about the dynamic response of coastal environments to sea-level rise (as stated in the final sentence of the first paragraph of section 9.6.5.1). For predictions to become more useful on the regional to local scale, we must move beyond the "bathtub" approach that has to date often been followed, by accounting for morphodynamic changes that will result from sea-level rise. [Torbjorn Tornqvist, United States of America]	I believe it would be appropriate to add one key uncertainty with respect to coastal responses here. One overarching element that stands out is the lack of understanding about the dynamic response of coastal environments to sea-level rise (as stated in the final sentence of the first paragraph of section 9.6.5.1). For predictions to become more useful on the regional to local scale, we must move beyond the "bathtub" approach that has to date often been followed, by accounting for morphodynamic changes that will result from sea-level rise.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
30148	122	22	123	15	In my opinion, this section 9.7 is very short and weak. I agree that uncertainties are associated to knowledge gaps in reconstructions, observations, models and process understanding (p122, lines 24-26). In this section, there is a list of gaps related to these issues listed above, but there are many other processes, or observations, not listed in this section, which are important knowledge gaps. For instance, considering glacier evolution, the main gaps to assess the future glacier evolution concern glacier volume, flow processes (such as friction, and interactions with englacial hydrology, as well as bed lithology), surface processes such as the spatio-temporal variability of accumulation...), forcing data (i.e. precipitation (solid or liquid) in mountainous regions...) And I am mentioning here only a non exhaustive list of gaps related to glacier evolution. There are likely more gaps not mentionned related to other fields of research i.e. snow, permafrost... more generally I am wondering whether listing the main gaps in research is a relevant topic for AR6. If yes, this section should be completed [patrick Wagnon, France]	In my opinion, this section 9.7 is very short and weak. I agree that uncertainties are associated to knowledge gaps in reconstructions, observations, models and process understanding (p122, lines 24-26). In this section, there is a list of gaps related to these issues listed above, but there are many other processes, or observations, not listed in this section, which are important knowledge gaps. For instance, considering glacier evolution, the main gaps to assess the future glacier evolution concern glacier volume, flow processes (such as friction, and interactions with englacial hydrology, as well as bed lithology), surface processes such as the spatio-temporal variability of accumulation...), forcing data (i.e. precipitation (solid or liquid) in mountainous regions...) And I am mentioning here only a non exhaustive list of gaps related to glacier evolution. There are likely more gaps not mentionned related to other fields of research i.e. snow, permafrost... more generally I am wondering whether listing the main gaps in research is a relevant topic for AR6. If yes, this section should be completed
24410	122	22			I missed a statement on unaccounted effects in ESL changes discussed in section 9.6.4 and 9.6.5 [Ralf Weisse, Germany]	I missed a statement on unaccounted effects in ESL changes discussed in section 9.6.4 and 9.6.5
20702	122	28	122	28	There is only one GrIS and AIS -> remove s. Also in line 40 [Gwenaelle GREMION, Canada]	There is only one GrIS and AIS -> remove s. Also in line 40
20714	122	28	122	28	I would add something like: 'Beside the uncertainty linked to the RCP scenario, the largest uncertainties in this chapter…' Indeed, the scenario uncertainty is probably as large as the model process uncertainty and needs not to be forgotten (Fig. 9.37). [Gwenaelle GREMION, Canada]	I would add something like: 'Beside the uncertainty linked to the RCP scenario, the largest uncertainties in this chapter…' Indeed, the scenario uncertainty is probably as large as the model process uncertainty and needs not to be forgotten (Fig. 9.37).
40330	122	28			why not deep uncertainty? [Michael Tsimplis, China]	why not deep uncertainty?
20712	122	29	122	29	Change 'inadequate models' into 'model uncertainties'. Models are not inadequate but suffer from uncertainties: they need to be improved. [Gwenaelle GREMION, Canada]	Change 'inadequate models' into 'model uncertainties'. Models are not inadequate but suffer from uncertainties: they need to be improved.
20710	122	30	122	30	highly uncertain': convert to IPCC uncertainty language and itzlicize [Gwenaelle GREMION, Canada]	highly uncertain': convert to IPCC uncertainty language and itzlicize
20704	122	31	122	35	Internal preocesses should also be mentioned because they influence the adjustment time of the ice sheets, which also causes large uncertainties. [Gwenaelle GREMION, Canada]	Internal preocesses should also be mentioned because they influence the adjustment time of the ice sheets, which also causes large uncertainties.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
20716	122	36	122	37	I would add something like: 'Beside the uncertainty linked to the RCP scenario, the uncertainty in ice sheet projections...' Indeed, the scenario uncertainty is probably as large as the 'ice sheet uncertainty' (Fig. 9.37). [Gwenaelle GREMION, Canada]	I would add something like: 'Beside the uncertainty linked to the RCP scenario, the uncertainty in ice sheet projections...' Indeed, the scenario uncertainty is probably as large as the 'ice sheet uncertainty' (Fig. 9.37).
20706	122	39	122	46	Unclear and poorly structured paragraph: Would be better to separate between the uncertainties and the importance of the Southern Ocean. Processes that need to be better understood: impact of shelf regions on the future of the AIS, the impact of ocean and atmosphere on heat and carbon uptake and sea ice, attribution of sea ice change to anthropogenic forcing, and representation of upwelling regions an katabatic winds. [Gwenaelle GREMION, Canada]	Unclear and poorly structured paragraph: Would be better to separate between the uncertainties and the importance of the Southern Ocean. Processes that need to be better understood: impact of shelf regions on the future of the AIS, the impact of ocean and atmosphere on heat and carbon uptake and sea ice, attribution of sea ice change to anthropogenic forcing, and representation of upwelling regions an katabatic winds.
20718	122	39	122	47	You are probably missing the observational uncertainty in the Southern Ocean, which is quite important. I think this should appear here. [Gwenaelle GREMION, Canada]	You are probably missing the observational uncertainty in the Southern Ocean, which is quite important. I think this should appear here.
20708	122	46	122	47	ellaborate: strong effects on regional climate through sea ice formation, change in stratification etc and global climate through modification in ocean currents. [Gwenaelle GREMION, Canada]	ellaborate: strong effects on regional climate through sea ice formation, change in stratification etc and global climate through modification in ocean currents.
20720	122	51	122	51	MISI (marine ice sheet instability) should also be mentioned, as this is a source of large uncertainty. [Gwenaelle GREMION, Canada]	MISI (marine ice sheet instability) should also be mentioned, as this is a source of large uncertainty.
6325	122	52	122	53	Uncertainty in the AMOC should be made more prominent. Past rapid climate change is often thought to involve rapid, non-linear changes in the AMOC. However, climate models have great difficulties to realistically simulate such events, thus questioning the AMOC sensitivity and stability in models (as discussed in this chapter), certainly for past climates, but potentially also for present and future climates. Moreover, past large-scale rapid AMOC changes could be key in understanding past ice sheet changes since the AMOC redistributes heat between the different ocean basins and could therewith induce important changes in sub-ice-shelf melt rates. [Pepijn Bakker, Netherlands]	Uncertainty in the AMOC should be made more prominent. Past rapid climate change is often thought to involve rapid, non-linear changes in the AMOC. However, climate models have great difficulties to realistically simulate such events, thus questioning the AMOC sensitivity and stability in models (as discussed in this chapter), certainly for past climates, but potentially also for present and future climates. Moreover, past large-scale rapid AMOC changes could be key in understanding past ice sheet changes since the AMOC redistributes heat between the different ocean basins and could therewith induce important changes in sub-ice-shelf melt rates.
40328	122				Previous section - another impacts section without any new research reported. [Michael Tsimplis, China]	Previous section - another impacts section without any new research reported.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
40332	122				On the final section - This report is for policy makers. What is needed is a better assessment for what has happened and what will happen assuming continuing increase in GHG concentrations. Indeed we have many uncertainties in understanding the marine environment and the ocean climate interaction. However only some of them are important in terms of what is to come. For example, closing the 20th budget will have a minimal effect while understanding ice sheet behaviour could double the future projections. Complaining about lack of past observations is not at all helpful - except in very rare cases the dtaset will not be improved although it may be re-interpreted. However if the spatial distribution of a monitoring system is inadequate to detect future changes early or validate models etc this is important to state and indicate which way this should be dealt with. Therefore I would suggest that the last section is reconsidered so that it is not a bucket list. [Michael Tsimplis, China]	On the final section - This report is for policy makers. What is needed is a better assessment for what has happened and what will happen assuming continuing increase in GHG concentrations. Indeed we have many uncertainties in understanding the marine environment and the ocean climate interaction. However only some of them are important in terms of what is to come. For example, closing the 20th budget will have a minimal effect while understanding ice sheet behaviour could double the future projections. Complaining about lack of past observations is not at all helpful - except in very rare cases the dtaset will not be improved although it may be re-interpreted. However if the spatial distribution of a monitoring system is inadequate to detect future changes early or validate models etc this is important to state and indicate which way this should be dealt with. Therefore I would suggest that the last section is reconsidered so that it is not a bucket list.
20722	123	1	122	2	Ellaborate more on 'ocean metrics' [Gwenaelle GREMION, Canada]	Ellaborate more on 'ocean metrics'
20728	123	1	123	1	Instead of saying that the uncertainty across the ensemble is anticipated to increase with higher resolution, I would say that the representation of fine-scale processes is anticipated to be improved. Some preliminary HighResMIP model results show improved SST bias in the North Atlantic for example, which could lead to improvements in GMSL rise projections. [Gwenaelle GREMION, Canada]	Instead of saying that the uncertainty across the ensemble is anticipated to increase with higher resolution, I would say that the representation of fine-scale processes is anticipated to be improved. Some preliminary HighResMIP model results show improved SST bias in the North Atlantic for example, which could lead to improvements in GMSL rise projections.
20724	123	6	123	6	remove 'and allow their impact on climate to be understood'; doesn't fit in this sentence. [Gwenaelle GREMION, Canada]	remove 'and allow their impact on climate to be understood'; doesn't fit in this sentence.
48212	123	8	123	15	Gaps in sea ice observations especially for winter are also an imortant point in this context. I suggest considering mentioning this. See for example discussions in Gerland et al. (2019): Essential gaps and uncertainties in the understanding of the roles and functions of Arctic sea ice. Environmental Research Letters, 14, 043002. https://iopscience.iop.org/article/10.1088/1748-9326/ab09b3. [Sebastian Gerland, Norway]	Gaps in sea ice observations especially for winter are also an imortant point in this context. I suggest considering mentioning this. See for example discussions in Gerland et al. (2019): Essential gaps and uncertainties in the understanding of the roles and functions of Arctic sea ice. Environmental Research Letters, 14, 043002. https://iopscience.iop.org/article/10.1088/1748-9326/ab09b3.
20730	123	8	123	15	OK. But in which way are such uncertainties accounted? Or, are they already and it is just a discussion on the sources of uncertainty? [Gwenaelle GREMION, Canada]	OK. But in which way are such uncertainties accounted? Or, are they already and it is just a discussion on the sources of uncertainty?
20726	123	13	123	13	what are 'more recent periods'? [Gwenaelle GREMION, Canada]	what are 'more recent periods'?

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
20742	124	1	124	55	FAQ 9.1: I think a conclusion is missing for this FAQ. What does all this mean in terms of reversibility of the climate system? [Gwenaelle GREMION, Canada]	FAQ 9.1: I think a conclusion is missing for this FAQ. What does all this mean in terms of reversibility of the climate system?
9432	124	1	128		A few remarks: The FAQ for chapter 9 are very relevant and this justifies to have more FAQ for chapter 9 compared to other chapters. However, they might induce the thinking: thanks to anthropogenic climate change we enhance the understanding of our world considerable. Let us continue with this fascinating experiment. I feel that such unintended notion should be avoided, e.g. by explaining qualitatively the significant impacts that might be associated with those changes as well as the long period of time which we are going to impact so signifcantly - which is in contradiction with the sustainable development goals. It would be important to put these potential effects into a broader context - even if not yet fully exploited by scientific literature, and based primarily on expert judgement. [Klaus Radunsky Radunsky, Austria]	A few remarks: The FAQ for chapter 9 are very relevant and this justifies to have more FAQ for chapter 9 compared to other chapters. However, they might induce the thinking: thanks to anthropogenic climate change we enhance the understanding of our world considerable. Let us continue with this fascinating experiment. I feel that such unintended notion should be avoided, e.g. by explaining qualitatively the significant impacts that might be associated with those changes as well as the long period of time which we are going to impact so signifcantly - which is in contradiction with the sustainable development goals. It would be important to put these potential effects into a broader context - even if not yet fully exploited by scientific literature, and based primarily on expert judgement.
20744	124	3	124	3	I would add 'cryospheric' between 'long-term' and 'effects of climate change': 'Can the long-term cryospheric effects of climate change be reversed?' [Gwenaelle GREMION, Canada]	I would add 'cryospheric' between 'long-term' and 'effects of climate change': 'Can the long-term cryospheric effects of climate change be reversed?'
20734	124	3	124	3	Reformulate the question: Is it still possible to reverse long-term effects of current climate change? (important here to specify that the current climate change is meant. [Gwenaelle GREMION, Canada]	Reformulate the question: Is it still possible to reverse long-term effects of current climate change? (important here to specify that the current climate change is meant.
44204	124	3	124	4	The question is quite difficult to me, because the response is talking about how long the process need be reversed and the question is "can be reversed". In my opinion the question should be “how long it will take to be reversed”?. If the question is “can be reversed”, the response must be yes, it can be, but curiously the message it gives, is that despite what we do there is no possibility of changing it because it take so long. For me it would be more sensible to say, that it cannot be changed in the short time, but that every improvement that is made in reducing greenhouse gases, will have a positive long-term impact in the recovery process [angelica CASANOVA-KATNY, Chile]	The question is quite difficult to me, because the response is talking about how long the process need be reversed and the question is "can be reversed". In my opinion the question should be “how long it will take to be reversed”?. If the question is “can be reversed”, the response must be yes, it can be, but curiously the message it gives, is that despite what we do there is no possibility of changing it because it take so long. For me it would be more sensible to say, that it cannot be changed in the short time, but that every improvement that is made in reducing greenhouse gases, will have a positive long-term impact in the recovery process

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
20740	124	3	124	47	The reply to this question is confusing. A better reply would be to explain that building up a 'healthy' climate system takes long time (e.g. growing ice sheets, carbon uptake in permafrost or release from the ocean, build up corals and organisms with shells etc) – more time than human timescales in many cases - , whereas it is a much faster process to melt ice, emit CO2, destroy corals by acidification etc. [Gwenaelle GREMION, Canada]	The reply to this question is confusing. A better reply would be to explain that building up a 'healthy' climate system takes long time (e.g. growing ice sheets, carbon uptake in permafrost or release from the ocean, build up corals and organisms with shells etc) – more time than human timescales in many cases - , whereas it is a much faster process to melt ice, emit CO2, destroy corals by acidification etc.
48546	124	3	124	55	The FAQ title says "can the long term effects of climate changes be reversed?", but given the topic discussed perhaps it would be better framed as "can climate-driven changes in the ocean be reversed?" or something like that. Also, perhaps a key point to make is that ocean warming and sea level rise will continue even if global temperatures are stabilized. [Kyle Armour, United States of America]	The FAQ title says "can the long term effects of climate changes be reversed?", but given the topic discussed perhaps it would be better framed as "can climate-driven changes in the ocean be reversed?" or something like that. Also, perhaps a key point to make is that ocean warming and sea level rise will continue even if global temperatures are stabilized.
9796	124	5	124	5	The FAQ being addressed here is, "Can the long-term effects of climate change be reversed?" The first sentence in the italicized response to this question simply says, "Some impacts of current climate change will take hundreds to thousands of years." My interpretation of what is meant here, based on the rest of the italicized response, is that this is saying it could take hundreds to thousands of years for these impacts to reach their full extent. However, because this sentence immediately follows the question, "Can the long-term effects of climate change be reversed?" there is some potential ambiguity here related to the first italicized sentence--it could read as meaning that some impacts would take "hundreds of thousands of years" to be reversed. To avoid that ambiguity, I would add a phrase to the first italicized sentence, so that it reads, "Some impacts of current climate change will take hundreds of thousands of years to be fully realized." [Andra Garner, United States of America]	The FAQ being addressed here is, "Can the long-term effects of climate change be reversed?" The first sentence in the italicized response to this question simply says, "Some impacts of current climate change will take hundreds to thousands of years." My interpretation of what is meant here, based on the rest of the italicized response, is that this is saying it could take hundreds to thousands of years for these impacts to reach their full extent. However, because this sentence immediately follows the question, "Can the long-term effects of climate change be reversed?" there is some potential ambiguity here related to the first italicized sentence--it could read as meaning that some impacts would take "hundreds of thousands of years" to be reversed. To avoid that ambiguity, I would add a phrase to the first italicized sentence, so that it reads, "Some impacts of current climate change will take hundreds of thousands of years to be fully realized."
20752	124	5	124	7	FAQ 9.1. The use of the word "take" is a bit vague. The first two intro sentences are confusing. I would suggest rewording them to something like "Some impacts of current climate change will only begin occurring in hundreds to thousands of years. Evidence from past climates shows that if greenhouse gas levels in the atmosphere were reduced, many of these impacts would in addition take a similarly long time to reverse." [Gwenaelle GREMION, Canada]	FAQ 9.1. The use of the word "take" is a bit vague. The first two intro sentences are confusing. I would suggest rewording them to something like "Some impacts of current climate change will only begin occurring in hundreds to thousands of years. Evidence from past climates shows that if greenhouse gas levels in the atmosphere were reduced, many of these impacts would in addition take a similarly long time to reverse."

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
20736	124	5	124	8	Paragraph difficult to understand: First sentence rather: Current climate change has impacts on a time scale of hundreds to thousands of years. Also: what is meant with 'would take similar lenghts of time' (l. 7)? similar to what? [Gwenaelle GREMION, Canada]	Paragraph difficult to understand: First sentence rather: Current climate change has impacts on a time scale of hundreds to thousands of years. Also: what is meant with 'would take similar lenghts of time' (l. 7)? similar to what?
20738	124	14	124	22	Paragraph basically says that warm temperatures over a long time period cause the ice sheets to melt. This is not the answer to the questions. Remove whole paragraph and focus more on the long response/ adjustment time of the ice sheets to warming. [Gwenaelle GREMION, Canada]	Paragraph basically says that warm temperatures over a long time period cause the ice sheets to melt. This is not the answer to the questions. Remove whole paragraph and focus more on the long response/ adjustment time of the ice sheets to warming.
20746	124	14	124	22	This paragraph does not seem necessary and is a bit out of scope. The focus of this FAQ should be the three impacts mentioned in the first paragraph, i.e. sea level rise, release of carbon stores and ocean pH changes. [Gwenaelle GREMION, Canada]	This paragraph does not seem necessary and is a bit out of scope. The focus of this FAQ should be the three impacts mentioned in the first paragraph, i.e. sea level rise, release of carbon stores and ocean pH changes.
9430	124	16	124	16	Insert "and" after "thousands of years". [Klaus Radunsky Radunsky, Austria]	Insert "and" after "thousands of years".
20754	124	17	124	17	FAQ 9.1. Change West AIS to WAIS (and line 26), and East AIS to EAIS. [Gwenaelle GREMION, Canada]	FAQ 9.1. Change West AIS to WAIS (and line 26), and East AIS to EAIS.
20732	124	17			Write out the word AIS -> Antarctic Ice Sheet. Not everyone reading the FAQ might know what this is. Same for GrIS. [Gwenaelle GREMION, Canada]	Write out the word AIS -> Antarctic Ice Sheet. Not everyone reading the FAQ might know what this is. Same for GrIS.
20748	124	25	124	25	Add ', leading to changes in sea level' after 'waned in volume'. [Gwenaelle GREMION, Canada]	Add ', leading to changes in sea level' after 'waned in volume'.
20750	124	28	124	28	Human timescales' does not mean anything. Replace by 'decadal timescales'. [Gwenaelle GREMION, Canada]	Human timescales' does not mean anything. Replace by 'decadal timescales'.
25442	124	33	124	41	Are you repeating chapter 5 material here? Some things like gas hydrates were not discussed in Ch 9 [Sharon Smith, Canada]	Are you repeating chapter 5 material here? Some things like gas hydrates were not discussed in Ch 9
20756	124	34	124	38	FAQ 9.1. Parallelize the sentence structure for ease of reading: "[...] scientists estimate the warming was accelerated by the release of carbon dioxide or methane into the atmosphere from the thawing of perennially frozen ground (permafrost) in the Arctic and mountains (FAQ 5.2) and/or from the release of methane from frozen crystals ('hydrates') in the deep ocean. [Gwenaelle GREMION, Canada]	FAQ 9.1. Parallelize the sentence structure for ease of reading: "[...] scientists estimate the warming was accelerated by the release of carbon dioxide or methane into the atmosphere from the thawing of perennially frozen ground (permafrost) in the Arctic and mountains (FAQ 5.2) and/or from the release of methane from frozen crystals ('hydrates') in the deep ocean.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
20758	124	40	124	41	FAQ 9.1. I think this sentence can be misleading. Indeed, the release of hydrates IS occuring at the moment (in the Arctic, the Gulf of Mexico), studies have shown it. But what is important to tell the readers is two-fold: (1) the annual emissions of methane to the ocean from gas hydrates is far smaller than greenhouse gas emissions to the atmosphere from human activities, (2) most of the methane released by gas hydrates never reaches the atmosphere due to getting locked in undersea sediments, dissolving in the ocean or getting converted to carbon dioxide by microbes on the way up. There was a good review on this published recently: C.D. Ruppel & J.D. Kesslerm The interaction of climate change and methane hydrates, Reviews of Geophysics, 2016, https://doi.org/10.1002/2016RG000534. So I would suggest changing that last sentences to “However, the release of hydrates as a source of carbon is predicted to be insignificant at the moment, as it is dwarfed by human-induced CO2 emissions and most of the methane that does get released is trapped in the sediments, the ocean water or transformed by microbes at the ocean bottom.” [Gwenaelle GREMION, Canada]	FAQ 9.1. I think this sentence can be misleading. Indeed, the release of hydrates IS occuring at the moment (in the Arctic, the Gulf of Mexico), studies have shown it. But what is important to tell the readers is two-fold: (1) the annual emissions of methane to the ocean from gas hydrates is far smaller than greenhouse gas emissions to the atmosphere from human activities, (2) most of the methane released by gas hydrates never reaches the atmosphere due to getting locked in undersea sediments, dissolving in the ocean or getting converted to carbon dioxide by microbes on the way up. There was a good review on this published recently: C.D. Ruppel & J.D. Kesslerm The interaction of climate change and methane hydrates, Reviews of Geophysics, 2016, https://doi.org/10.1002/2016RG000534. So I would suggest changing that last sentences to “However, the release of hydrates as a source of carbon is predicted to be insignificant at the moment, as it is dwarfed by human-induced CO2 emissions and most of the methane that does get released is trapped in the sediments, the ocean water or transformed by microbes at the ocean bottom.”
52244	124	43	124	47	This section should also briefly note that even short-term climate pollutants can lead to ~irreversible thermosteric sea level rise on century timescales (Zickfeld et al. 2017), because of the long time scales of ocean heat uptake and release. The impacts of these pollutants on ice-sheet processes are not well known. [Daniel Gilford, United States of America]	This section should also briefly note that even short-term climate pollutants can lead to ~irreversible thermosteric sea level rise on century timescales (Zickfeld et al. 2017), because of the long time scales of ocean heat uptake and release. The impacts of these pollutants on ice-sheet processes are not well known.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
29142	124	43	124	47	refers to comment that "the oceans acidification' makes it more difficult for marine life to grow, such as corals…". I don't agree with this statement for corals since latest research shows that acidification is currently not affecting corals, at least not tropical corals. Tropical corals can regulate the internal pH beyond 21st century projections, so it is unlikely that corals will be affected this century, at least not as much as SST warming and bleaching. Also not all calcifiers are affected. Upregulation of pH is common to symbiotic marine life. It is therefore not correct in my view to repeat this statement again and again. Sheel forming organisms such as Pteropods are much more lilely to suffer from OA and those in colder waters due to larger CO2 uptake in colder oceans. Papers: McCulloch et al., 2012 Nature Climate Change; D'Olivo & McCulloch, 2017 and many more [Jens Zinke, United Kingdom (of Great Britain and Northern Ireland)]	refers to comment that "the oceans acidification' makes it more difficult for marine life to grow, such as corals…". I don't agree with this statement for corals since latest research shows that acidification is currently not affecting corals, at least not tropical corals. Tropical corals can regulate the internal pH beyond 21st century projections, so it is unlikely that corals will be affected this century, at least not as much as SST warming and bleaching. Also not all calcifiers are affected. Upregulation of pH is common to symbiotic marine life. It is therefore not correct in my view to repeat this statement again and again. Sheel forming organisms such as Pteropods are much more lilely to suffer from OA and those in colder waters due to larger CO2 uptake in colder oceans. Papers: McCulloch et al., 2012 Nature Climate Change; D'Olivo & McCulloch, 2017 and many more
25444	124				Sorry - I made an error an can't delete the row. [Sharon Smith, Canada]	Sorry - I made an error an can't delete the row.
56168	125	3		55	[pt 1 of 5] The FAQ 9.2 text reads, "Scientists estimate that global average sea level – in 2015 already about 20 cm higher than in 1900 and 5 cm higher than in 2000 – will rise by a further 7–43 cm by 2050. ... The rate of global mean sea level change has increased from an average of 1.4 ± 0.1 millimetres per year over the 20th century to 3.1 ± 0.3 millimetres per year from 1993 to 2017..." This FAQ is wrong. It should be rewritten to read something like the following: [cont'd] [David Burton, United States of America]	[pt 1 of 5] The FAQ 9.2 text reads, "Scientists estimate that global average sea level – in 2015 already about 20 cm higher than in 1900 and 5 cm higher than in 2000 – will rise by a further 7–43 cm by 2050. ... The rate of global mean sea level change has increased from an average of 1.4 ± 0.1 millimetres per year over the 20th century to 3.1 ± 0.3 millimetres per year from 1993 to 2017..." This FAQ is wrong. It should be rewritten to read something like the following: [cont'd]
56170	125	3		55	[pt 2 of 5] The global average rate of coastal sea level rise has been approximately 1.5 mm/year, with some decadal variations, but no sustained acceleration since the late 1920s. In 2015, globally averaged sea-level was about 17 cm higher than 1900, and 2 cm higher than 2000. [cont'd] [David Burton, United States of America]	[pt 2 of 5] The global average rate of coastal sea level rise has been approximately 1.5 mm/year, with some decadal variations, but no sustained acceleration since the late 1920s. In 2015, globally averaged sea-level was about 17 cm higher than 1900, and 2 cm higher than 2000. [cont'd]

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
56172	125	3		55	[pt 3 of 5] The rate is so small that in many places it is exceeded by local factors, either positive or negative, like post-glacial vertical land motion, sedimentation, erosion, or subsidence due to various local factors. That causes local sea-level trends to negative in some places (i.e., sea-level is falling), and much larger than the global average in other places. Because of that, calculating "global average" trends is tricky, and depends on the choice of sites used in the calculation. If the mix of sites included in the index varies over time, the result can be a spirious acceleration or deceleration apparent in the "average," which is not present at any of the individual sites. [cont'd] [David Burton, United States of America]	[pt 3 of 5] The rate is so small that in many places it is exceeded by local factors, either positive or negative, like post-glacial vertical land motion, sedimentation, erosion, or subsidence due to various local factors. That causes local sea-level trends to negative in some places (i.e., sea-level is falling), and much larger than the global average in other places. Because of that, calculating "global average" trends is tricky, and depends on the choice of sites used in the calculation. If the mix of sites included in the index varies over time, the result can be a spirious acceleration or deceleration apparent in the "average," which is not present at any of the individual sites. [cont'd]
56174	125	3		55	[pt 4 of 5] Satellite altimetry cannot measure sea-level at or near the coasts, so it is not useful for coastal planning. Most of the satellite altimetry measurements are finding rates of sea-level rise which are substantially larger than those measured by the best tide gauges. Combining the two types of measurements can create the illusion of acceleration, seen as a step-increase in rate at about 1993 (when the satelltie measurements began). You can see the effect in this graph, from Hansen & Sato; fortunately, they use contrasting colors, so the cause for the "acceleration" is obvious: https://sealevel.info/SL.1900-2018b.png [cont'd] [David Burton, United States of America]	[pt 4 of 5] Satellite altimetry cannot measure sea-level at or near the coasts, so it is not useful for coastal planning. Most of the satellite altimetry measurements are finding rates of sea-level rise which are substantially larger than those measured by the best tide gauges. Combining the two types of measurements can create the illusion of acceleration, seen as a step-increase in rate at about 1993 (when the satelltie measurements began). You can see the effect in this graph, from Hansen & Sato; fortunately, they use contrasting colors, so the cause for the "acceleration" is obvious: https://sealevel.info/SL.1900-2018b.png [cont'd]
56176	125	3		55	[pt 5 of 5] Thus far there is no sign that manmade climate change is affecting sea-level. Since the rate of sea level rise has not increased significantly in response to the last 3/4 century of CO2 emissions, there is no reason to expect that it will do so in response to the next 3/4 century of CO2 emissions. The best prediction for sea level in the future is simply a linear projection of the history of sea level at the same location in the past. ### [David Burton, United States of America]	[pt 5 of 5] Thus far there is no sign that manmade climate change is affecting sea-level. Since the rate of sea level rise has not increased significantly in response to the last 3/4 century of CO2 emissions, there is no reason to expect that it will do so in response to the next 3/4 century of CO2 emissions. The best prediction for sea level in the future is simply a linear projection of the history of sea level at the same location in the past. ###
20760	125	6	125	6	'Local sea level change will be higher or lower than the global average in many locations' sounds as if we don't know whether it gets higher or lower. Should be reformulated as: Sea level change has large local variations and can be both higher or lower than th global average, with the lowest rates ... (same in line 30) [Gwenaelle GREMION, Canada]	Local sea level change will be higher or lower than the global average in many locations' sounds as if we don't know whether it gets higher or lower. Should be reformulated as: Sea level change has large local variations and can be both higher or lower than th global average, with the lowest rates ... (same in line 30)
20768	125	6	125	7	FAQ 9.2. Add "of rise" after "lowest rates" for parallelism. [Gwenaelle GREMION, Canada]	FAQ 9.2. Add "of rise" after "lowest rates" for parallelism.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
20764	125	16	125	19	Shouldn't you say that the first contributor to sea level rise is land ice melting with 44% (glaciers and ice caps 21%, GrIS 15%, AIS 8%) and the second contributor is thermal expansion with 42%? [Gwenaelle GREMION, Canada]	Shouldn't you say that the first contributor to sea level rise is land ice melting with 44% (glaciers and ice caps 21%, GrIS 15%, AIS 8%) and the second contributor is thermal expansion with 42%?
20770	125	19	125	20	FAQ 9.2. The sentence “Another source is changes in land water storage, such as groundwater extraction.” is too vague. Are the authors pointing to depleted water tables, which means water tables are drying up, while runoff is increased and a lot of it eventually ends up in the oceans? I think expanding a little this sentence to explain the process would be helpful. [Gwenaelle GREMION, Canada]	FAQ 9.2. The sentence “Another source is changes in land water storage, such as groundwater extraction.” is too vague. Are the authors pointing to depleted water tables, which means water tables are drying up, while runoff is increased and a lot of it eventually ends up in the oceans? I think expanding a little this sentence to explain the process would be helpful.
20762	125	22	125	25	It sounds as if green house gass emissions had no impact on global sea level rise, which is contradictive to line 13-14. [Gwenaelle GREMION, Canada]	It sounds as if green house gass emissions had no impact on global sea level rise, which is contradictive to line 13-14.
50630	125	23	125	24	respond on slow time scales' now sounds somewhat different than response time, but still I would not write it this way. Their geometric adjustment is slow i.e. it will take some time (decades and maybe even centuries) before their geometry is again in balance with (a previous) climate. This is most important to consider when arguing about obviously smaller glaciers 2000 years ago: their states are not yet comparable. I think what it is important to stress here is that glaciers are integrators of climatic fluctuations, the larger ones do not care what happens with climate on a decadal time scale (this is why their fluctuations are indicators of climate change). But their contribution to sea level is an immediate one and not related to their response time. I suggest making these differences clearer. [Frank Paul, Switzerland]	respond on slow time scales' now sounds somewhat different than response time, but still I would not write it this way. Their geometric adjustment is slow i.e. it will take some time (decades and maybe even centuries) before their geometry is again in balance with (a previous) climate. This is most important to consider when arguing about obviously smaller glaciers 2000 years ago: their states are not yet comparable. I think what it is important to stress here is that glaciers are integrators of climatic fluctuations, the larger ones do not care what happens with climate on a decadal time scale (this is why their fluctuations are indicators of climate change). But their contribution to sea level is an immediate one and not related to their response time. I suggest making these differences clearer.
20766	125	25	125	27	I think a sentence should be added related to the 2000-2100 projection, where the effect of the scenario starts to play. [Gwenaelle GREMION, Canada]	I think a sentence should be added related to the 2000-2100 projection, where the effect of the scenario starts to play.
40642	125	32	125	33	"In regions where large ice sheets covered the land during the last ice age, such as Scandinavia and Siberia". As far as I know in the past ca 60 ka the Siberia was not covered with the ice sheet (Svendsen et al. / Quaternary Science Reviews 23 (2004) 1229–1271). [Olga Solomina, Russian Federation]	"In regions where large ice sheets covered the land during the last ice age, such as Scandinavia and Siberia". As far as I know in the past ca 60 ka the Siberia was not covered with the ice sheet (Svendsen et al. / Quaternary Science Reviews 23 (2004) 1229–1271).
20772	125	34	125	35	FAQ 9.2. I would reword this sentence to be more explicit about “near”. Is that kilometers, 10s km? [Gwenaelle GREMION, Canada]	FAQ 9.2. I would reword this sentence to be more explicit about “near”. Is that kilometers, 10s km?

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
20774	125	35	125	38	FAQ 9.2. I would reword this sentence as such (in bold): “In many cities within low-lying delta regions, the land is rapidly subsiding, because of human activities such as groundwater or fossil fuel extraction. In some cases, this happens at a rate of tens of millimetres per year, so this is amplifying sea level rise.” [Gwenaelle GREMION, Canada]	FAQ 9.2. I would reword this sentence as such (in bold): “In many cities within low-lying delta regions, the land is rapidly subsiding, because of human activities such as groundwater or fossil fuel extraction. In some cases, this happens at a rate of tens of millimetres per year, so this is amplifying sea level rise.”
46038	125	48	125	48	Saying sea level rise beyond 2050 could be misleading, as it could be read to mean that sea level may not rise beyond 2050. Saying that how much sea level will rise beyond 2050 could help make the point that there is no doubt that sea levels will rise beyond 2050, what is uncertain is by how much and when. [Isaac Pearlman, United States of America]	Saying sea level rise beyond 2050 could be misleading, as it could be read to mean that sea level may not rise beyond 2050. Saying that how much sea level will rise beyond 2050 could help make the point that there is no doubt that sea levels will rise beyond 2050, what is uncertain is by how much and when.
52246	125	48	125	50	It should perhaps be noted that because of non-linearities in the system's response (primarily from ice-sheet contributions), recently observed and near-term sea level trends are not necessarily indicative of absoluate sea level changes (see Kopp et al. 2017, Figure 5) [Daniel Gilford, United States of America]	It should perhaps be noted that because of non-linearities in the system's response (primarily from ice-sheet contributions), recently observed and near-term sea level trends are not necessarily indicative of absoluate sea level changes (see Kopp et al. 2017, Figure 5)
16064	125	48	125	50	The statement says, "Beyond 2050, sea level rise is much more uncertain. This is not only because it will depend on greenhouse gas emissions but also because it is difficult to predict how the AIS will respond to large temperature changes". Suggest to add that AIS could potentially become a big contributor to SLR in the latter half of the 21st century and beyond. [SAI MING LEE, China]	The statement says, "Beyond 2050, sea level rise is much more uncertain. This is not only because it will depend on greenhouse gas emissions but also because it is difficult to predict how the AIS will respond to large temperature changes". Suggest to add that AIS could potentially become a big contributor to SLR in the latter half of the 21st century and beyond.
16352	125	49	125	49	It might be helpful to define 'AIS' [Renee van Diemen, United Kingdom (of Great Britain and Northern Ireland)]	It might be helpful to define 'AIS'
46040	126	1	126	1	Is it worth mentioning that the melting and eventual collapse of the Earth’s ice sheets could impact the Earth’s orbit and tilt? [Isaac Pearlman, United States of America]	Is it worth mentioning that the melting and eventual collapse of the Earth’s ice sheets could impact the Earth’s orbit and tilt?
20776	126	1	126	17	This is not complete. Just a list of questions that are not answered yet. [Gwenaelle GREMION, Canada]	This is not complete. Just a list of questions that are not answered yet.
20778	126	5	126	17	Some of the questions haven't been answered yet. [Gwenaelle GREMION, Canada]	Some of the questions haven't been answered yet.
31632	126		126		FAQ 9.3: text seems to be missing. [Pierre Mathiot, United Kingdom (of Great Britain and Northern Ireland)]	FAQ 9.3: text seems to be missing.
39200	127	1	127	1	I find the wording shuts down too strong. Slows down is already a lot. [Pascale Braconnot, France]	I find the wording shuts down too strong. Slows down is already a lot.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
20796	127	1	127	55	FAQ 9.4: I guess care needs to be taken when talking about 'Gulf Stream shutdown'. Observations show a slowdown and not a shutdown. If you still want to keep 'shutdown' in the title, I think you need to add a paragraph about consequences of such a shutdown, which is not the case at the moment (you explain impacts of a slowdown). Otherwise, consider replacing 'shutdown' by 'slowdown'. [Gwenaelle GREMION, Canada]	FAQ 9.4: I guess care needs to be taken when talking about 'Gulf Stream shutdown'. Observations show a slowdown and not a shutdown. If you still want to keep 'shutdown' in the title, I think you need to add a paragraph about consequences of such a shutdown, which is not the case at the moment (you explain impacts of a slowdown). Otherwise, consider replacing 'shutdown' by 'slowdown'.
48548	127	1	127	55	I found this FAQ confusing. Shouldn't key points be that AMOC is unlikely to collapse, but even if it does slow down it will have some pretty minor impacts. This is because much heat transport is associated with western boundary currents, which are driven by winds that don't change much. A slowdown of AMOC could lead to local cooling in the subpolar gyre, slower overall warming in the northern high latitudes, and increased sea level rise along the US East Coast, but little else. As written, it makes the AMOC slowdown seem more likely and more dramatic. [Kyle Armour, United States of America]	I found this FAQ confusing. Shouldn't key points be that AMOC is unlikely to collapse, but even if it does slow down it will have some pretty minor impacts. This is because much heat transport is associated with western boundary currents, which are driven by winds that don't change much. A slowdown of AMOC could lead to local cooling in the subpolar gyre, slower overall warming in the northern high latitudes, and increased sea level rise along the US East Coast, but little else. As written, it makes the AMOC slowdown seem more likely and more dramatic.
7962	127	1	128	1	This has a lot of background and very little detail on impacts (which is what I expect is wanted). Also the question is on shutdown rather than a gradual weakening (though the latter should also be mentioned). There is a thorough overview of impacts of a shutdown in the SROCC [Laura Jackson, United Kingdom (of Great Britain and Northern Ireland)]	This has a lot of background and very little detail on impacts (which is what I expect is wanted). Also the question is on shutdown rather than a gradual weakening (though the latter should also be mentioned). There is a thorough overview of impacts of a shutdown in the SROCC
20782	127	3	127	3	I suggest to add one small sentence explaining what is the AMOC in the first paragraph. [Gwenaelle GREMION, Canada]	I suggest to add one small sentence explaining what is the AMOC in the first paragraph.
20784	127	4	127	5	The Gulf Stream is a warm current and affects…' (it's not because the Gulf Stream is a warm current that it affects the weather). [Gwenaelle GREMION, Canada]	The Gulf Stream is a warm current and affects…' (it's not because the Gulf Stream is a warm current that it affects the weather).
20786	127	5	127	6	"If it slows down, for example following large inputs of freshwater coming from ice melting, North America…" I think this is important to precise an example of how the Gulf Stream could shut/slow down. [Gwenaelle GREMION, Canada]	"If it slows down, for example following large inputs of freshwater coming from ice melting, North America…" I think this is important to precise an example of how the Gulf Stream could shut/slow down.
49324	127	6	127	6	FAQ 9.4 line 6: should "cooling" instead be expressed here as "less warming" or "slower warming" to maintain consistency with later statements in this section? [Yarrow Axford, United States of America]	FAQ 9.4 line 6: should "cooling" instead be expressed here as "less warming" or "slower warming" to maintain consistency with later statements in this section?
37924	127	17	127	21	A sentence explaining why the strong boundary currents are western ones not eastern ones would not go amiss. [Adrian Simmons, United Kingdom (of Great Britain and Northern Ireland)]	A sentence explaining why the strong boundary currents are western ones not eastern ones would not go amiss.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
20780	127	33	127	37	This paragraph sounds speculative. Is there any evidence of the changes in wind circulation not playing a nimportant role? [Gwenaelle GREMION, Canada]	This paragraph sounds speculative. Is there any evidence of the changes in wind circulation not playing a nimportant role?
50430	127	33	127	37	This statement seems oversimplistic and unsupported. It ignores feedbacks between the ocean and atmosphere, for example. [Chris Wilson, United Kingdom (of Great Britain and Northern Ireland)]	This statement seems oversimplistic and unsupported. It ignores feedbacks between the ocean and atmosphere, for example.
20788	127	39	127	40	"Thus, the overturning flow coming from the Gulf Stream is expected to slow down." [Gwenaelle GREMION, Canada]	"Thus, the overturning flow coming from the Gulf Stream is expected to slow down."
20794	127	39	127	47	No cause of the AMOC slowdown is given here, while it would be important to mention it. For example, there is evidence that Arctic sea ice contributed to it. Reference: Sévellec, F., A. V. Federov, W. Lu (2017). Arctic sea-ice decline weakens the Atlantic Meridional Overturning Circulation. Nature Climate Change, doi: 10.1038/NCLIMATE3353. [Gwenaelle GREMION, Canada]	No cause of the AMOC slowdown is given here, while it would be important to mention it. For example, there is evidence that Arctic sea ice contributed to it. Reference: Sévellec, F., A. V. Federov, W. Lu (2017). Arctic sea-ice decline weakens the Atlantic Meridional Overturning Circulation. Nature Climate Change, doi: 10.1038/NCLIMATE3353.
20790	127	49	127	49	I suggest to add the process by which Europe gets colder following the overturning slowdown. [Gwenaelle GREMION, Canada]	I suggest to add the process by which Europe gets colder following the overturning slowdown.
20792	127	49	127	55	There is no mention of North America here, while you mention it in the introduction of this FAQ. Why is that the case? [Gwenaelle GREMION, Canada]	There is no mention of North America here, while you mention it in the introduction of this FAQ. Why is that the case?
49326	127	52	127	55	Consider adding more specificity to FAQ 9.4 regarding the hydroclimate changes that accompany past and modeled AMOC shutdown/slowdown. Presumably hydroclimate changes would cause some of the major societal impacts of such an event, but the current text does not describe what that might look like. Eg drier or wetter, drier in any areas where reduced precip represents a major societal vulnerability? etc. [Yarrow Axford, United States of America]	Consider adding more specificity to FAQ 9.4 regarding the hydroclimate changes that accompany past and modeled AMOC shutdown/slowdown. Presumably hydroclimate changes would cause some of the major societal impacts of such an event, but the current text does not describe what that might look like. Eg drier or wetter, drier in any areas where reduced precip represents a major societal vulnerability? etc.
50432	127	55	128	1	This statement seems oversimplistic and unsupported. It ignores feedbacks between the ocean and atmosphere, for example. [Chris Wilson, United Kingdom (of Great Britain and Northern Ireland)]	This statement seems oversimplistic and unsupported. It ignores feedbacks between the ocean and atmosphere, for example.
41274	129	42	129	42	insert in line 42: "Araujo, M., Dartus, D., Maurel, P., and Masbernat, L. (2001). Langmuir circulations and enhanced turbulence beneath wind-waves. Ocean Modelling 3, 109-126. doi: 10.1016/S1463-5003(01)00004-X". [Moacyr Araujo, Brazil]	insert in line 42: "Araujo, M., Dartus, D., Maurel, P., and Masbernat, L. (2001). Langmuir circulations and enhanced turbulence beneath wind-waves. Ocean Modelling 3, 109-126. doi: 10.1016/S1463-5003(01)00004-X".
43202	136	52	136	54	Author list for paper doi:10.1175/JCLI-D-16-0439.1 needs to be corrected [Ian Simmonds, Australia]	Author list for paper doi:10.1175/JCLI-D-16-0439.1 needs to be corrected
41276	141	27	141	27	insert in line 27: "Dengler, M., Schott, F. A., Eden, C., Brandt, P., Fischer, J., and Zantopp, R.J. (2004). Break-up of the Atlantic deep western boundary current into eddies at 8 degrees S. Nature, 432(7020), 1018–1020. doi: 10.1038/nature03134". [Moacyr Araujo, Brazil]	insert in line 27: "Dengler, M., Schott, F. A., Eden, C., Brandt, P., Fischer, J., and Zantopp, R.J. (2004). Break-up of the Atlantic deep western boundary current into eddies at 8 degrees S. Nature, 432(7020), 1018–1020. doi: 10.1038/nature03134".
20798	151	14	151	14	Haigh et al. citation needs journal and year [Gwenaelle GREMION, Canada]	Haigh et al. citation needs journal and year

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
41278	155	5	155	5	insert in line 5: "Hummels, R., Brandt, P., Dengler, M., Fischer, J., Araujo, M., Veleda, D., and Durgadoo, J.V.and Zantopp, R.J. (2015). Interannual to decadal changes in the western boundary circulation in the Atlantic at 11°S, Geophys. Res. Lett., 42, 7615–7622. doi: 10.1002/2015GL065254". [Moacyr Araujo, Brazil]	insert in line 5: "Hummels, R., Brandt, P., Dengler, M., Fischer, J., Araujo, M., Veleda, D., and Durgadoo, J.V.and Zantopp, R.J. (2015). Interannual to decadal changes in the western boundary circulation in the Atlantic at 11°S, Geophys. Res. Lett., 42, 7615–7622. doi: 10.1002/2015GL065254".
26294	161	44	161	45	Lamont T., García-Reyes M., Bograd S.J., van der Lingen C.D., Sydeman W.J. Upwelling indices for comparative ecosystem studies: Variability in the Benguela Upwelling System. // Journal of Marine Systems. 2018. 188 3-16 [Alexander Polonsky, Russian Federation]	Lamont T., García-Reyes M., Bograd S.J., van der Lingen C.D., Sydeman W.J. Upwelling indices for comparative ecosystem studies: Variability in the Benguela Upwelling System. // Journal of Marine Systems. 2018. 188 3-16
9936	163	38	163	39	Please, update the reference. It has been published now. [Kevin Bulthuis, Belgium]	Please, update the reference. It has been published now.
40412	171	35	171	35	reference should probably be Morrison A. K. and Hogg, A. M. [Nicolas Jourdain, France]	reference should probably be Morrison A. K. and Hogg, A. M.
41280	182	52	182	52	insert in line 52: "Schott, F. A., Dengler, M., Zantopp, R., Stramma, L., Fischer, J. and P. Brandt (2005). The shallow and deep western boundary circulation of the South Atlantic at 5 degrees–11 degrees S. J. Phys. Oceanogr. 35(11), 2031–2053. doi: 10.1175/JPO2813.1". [Moacyr Araujo, Brazil]	insert in line 52: "Schott, F. A., Dengler, M., Zantopp, R., Stramma, L., Fischer, J. and P. Brandt (2005). The shallow and deep western boundary circulation of the South Atlantic at 5 degrees–11 degrees S. J. Phys. Oceanogr. 35(11), 2031–2053. doi: 10.1175/JPO2813.1".
26296	190	29	190	31	Tim N., Zorita E. and Hünicke B. Decadal variability and trends of the Benguela Upwelling System as simulated in a high ocean-only simulation. // Ocean Sci. 2015. 11: P. 483–502. doi:10.5194/os-11-483-2015. [Alexander Polonsky, Russian Federation]	Tim N., Zorita E. and Hünicke B. Decadal variability and trends of the Benguela Upwelling System as simulated in a high ocean-only simulation. // Ocean Sci. 2015. 11: P. 483–502. doi:10.5194/os-11-483-2015.
39202	199	1	199	1	Sorry I am late with the IPCC review and do not take the time to really think about it. But since there are several places in the text where the paleo information is key and also provide a nice background for the discussion on projections It would be very interesting to see several figures sea-ice, ice-sheet, sea level, conbining the different paleo/present/future time scales to provide well integrated messages. It is more difficult to do than to say, but it seems that you are very close to being able to do it. [Pascale Braconnot, France]	Sorry I am late with the IPCC review and do not take the time to really think about it. But since there are several places in the text where the paleo information is key and also provide a nice background for the discussion on projections It would be very interesting to see several figures sea-ice, ice-sheet, sea level, conbining the different paleo/present/future time scales to provide well integrated messages. It is more difficult to do than to say, but it seems that you are very close to being able to do it.
52916	199	4	199	4	Figure 9.1 (a): Test is too small on figure, especially light blue box on top left corner. [Abigail Bodner, United States of America]	Figure 9.1 (a): Test is too small on figure, especially light blue box on top left corner.
57194	199	4	199	10	I suggest deleting “of NADW” in panel b in the Southern Hemisphere, since it is not only NADW being upwelled in the Southern Ocean but also Pacific and Indian Deep Waters. [F. Alexander Haumann, Germany]	I suggest deleting “of NADW” in panel b in the Southern Hemisphere, since it is not only NADW being upwelled in the Southern Ocean but also Pacific and Indian Deep Waters.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
20800	199	4	246	5	Figures 9.1 - 42. Low resolution, the text inside the figures is illegible. Arrows does not correspond to the information. Change for a vector plot. Increase font size. in the figures, it's hard to distinguish caption info. Panels confusing. It would be helpful to always also refer to the exact subfigure as a lot of the figures have subfigures which are not relevant at the place of citation [Gwenaelle GREMION, Canada]	Figures 9.1 - 42. Low resolution, the text inside the figures is illegible. Arrows does not correspond to the information. Change for a vector plot. Increase font size. in the figures, it's hard to distinguish caption info. Panels confusing. It would be helpful to always also refer to the exact subfigure as a lot of the figures have subfigures which are not relevant at the place of citation
24954	199	7	199	7	add that the western boundary currents are denoted by bold red arrows in the figure caption [Adrian New, United Kingdom (of Great Britain and Northern Ireland)]	add that the western boundary currents are denoted by bold red arrows in the figure caption
45896	199		199		Picture quality is not good. Clarity is compromised [Shikha Singh, India]	Picture quality is not good. Clarity is compromised
26434	200	0	200	0	In either panel (b) or (c), it will be more informative if the process of dense-shelf water production in coastal/open polynyas is included. I believe this is still one of the bottlenecks in modern simulations despite its role in climate and physics of the ocean (sec 9.2.2.4 & 9.2.4.2). [Katsuro Katsumata, Japan]	In either panel (b) or (c), it will be more informative if the process of dense-shelf water production in coastal/open polynyas is included. I believe this is still one of the bottlenecks in modern simulations despite its role in climate and physics of the ocean (sec 9.2.2.4 & 9.2.4.2).
56166	200	1	200	1	In panel c, the word below "River" does not show up. Please also note the font color to the lower left of the panel. [Ning Zhao, Germany]	In panel c, the word below "River" does not show up. Please also note the font color to the lower left of the panel.
52918	200	1	200	1	Figure 9.2 (a): Axes, colorbar and title are too light and hard to read. [Abigail Bodner, United States of America]	Figure 9.2 (a): Axes, colorbar and title are too light and hard to read.
52920	200	1	200	1	Figure 9.2 (c): consider coloring the water area in clue like in figure 9.2 (b), alternitavely, change the text color of "boundayr transport" from white to black. [Abigail Bodner, United States of America]	Figure 9.2 (c): consider coloring the water area in clue like in figure 9.2 (b), alternitavely, change the text color of "boundayr transport" from white to black.
52922	200	1	200	1	Figure 9.2 (c): fix text below the word "river" [Abigail Bodner, United States of America]	Figure 9.2 (c): fix text below the word "river"
49460	200	1	200	9	Figure 9.2 should also include dense overflows, another poorly represented process on Antarctic shelves [Sonya Legg, United States of America]	Figure 9.2 should also include dense overflows, another poorly represented process on Antarctic shelves
24958	200	1	200	9	in fig 9.2(c) there is some white lettering which is partly invisible (it is against a white background) [Adrian New, United Kingdom (of Great Britain and Northern Ireland)]	in fig 9.2(c) there is some white lettering which is partly invisible (it is against a white background)
20802	200	3	200	4	I think the sentence that includes "roughly the scale at which a model grid is high-resolution enough to represent internal variability", could be clearer using "roughly the scale at which a model grid is of a sufficient resolution to represent internal variability" instead. [Gwenaelle GREMION, Canada]	I think the sentence that includes "roughly the scale at which a model grid is high-resolution enough to represent internal variability", could be clearer using "roughly the scale at which a model grid is of a sufficient resolution to represent internal variability" instead.
24956	200	6	200	6	I think the definitions of the dot and cross symbols are the wrong way round ie the cross should show flow away from the reader (i.e. into the page). This may also mean that the cross symbols in fig 9.2(b) should be changed to dots, indicating westerly winds in the southern ocean [Adrian New, United Kingdom (of Great Britain and Northern Ireland)]	I think the definitions of the dot and cross symbols are the wrong way round ie the cross should show flow away from the reader (i.e. into the page). This may also mean that the cross symbols in fig 9.2(b) should be changed to dots, indicating westerly winds in the southern ocean

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
45270	200	6	200	6	two dots at the end of the caption [Alessandro Silvano, Australia]	two dots at the end of the caption
39246	200		200		Figure 9.2 c: white font is unreadable on white area: "… (?) transport" [Dmitry Kovalevsky, Germany]	Figure 9.2 c: white font is unreadable on white area: "… (?) transport"
56158	201	1	201	1	In panel a, I think it makes more sense and provides better context to plot the temperature estimates for time intervals with relatively stable climate conditions in the past, such as the Last Interglciation (LIG) and the mid-Pliocene, rather than average very wide intervals that cover very different climate states. [Ning Zhao, Germany]	In panel a, I think it makes more sense and provides better context to plot the temperature estimates for time intervals with relatively stable climate conditions in the past, such as the Last Interglciation (LIG) and the mid-Pliocene, rather than average very wide intervals that cover very different climate states.
52926	201	2	201	8	Figure 9.3 (a) is confusing. What do the vertical lines represent? Where is the shading? Why doesn't the historical record match the model? What is the calibration time? [Abigail Bodner, United States of America]	Figure 9.3 (a) is confusing. What do the vertical lines represent? Where is the shading? Why doesn't the historical record match the model? What is the calibration time?
39248	201	3	201	3	Proposed addition in figure caption: "(a) Timeseries of SST anomaly..." -> "(a) Timeseries of global mean SST anomaly..." [Dmitry Kovalevsky, Germany]	Proposed addition in figure caption: "(a) Timeseries of SST anomaly..." -> "(a) Timeseries of global mean SST anomaly..."
24960	201	3	201	3	State that this is Global SST anomaly [Adrian New, United Kingdom (of Great Britain and Northern Ireland)]	State that this is Global SST anomaly
24964	201	3	201	4	Please explain what is the difference between the "historical" and HadISST" curves in fig 9.3(a) [Adrian New, United Kingdom (of Great Britain and Northern Ireland)]	Please explain what is the difference between the "historical" and HadISST" curves in fig 9.3(a)
24962	201	4	201	4	There is no shading apparent in fig 9.3(a) as indicated by the caption. [Adrian New, United Kingdom (of Great Britain and Northern Ireland)]	There is no shading apparent in fig 9.3(a) as indicated by the caption.
24966	202	1	202	6	It would be better if the Box 9.1, Fig 1 (a) coiuld be a fullt global plot - currently there is part of the ocean off SE Africa (etc) which is not shown (near 30-40°E) [Adrian New, United Kingdom (of Great Britain and Northern Ireland)]	It would be better if the Box 9.1, Fig 1 (a) coiuld be a fullt global plot - currently there is part of the ocean off SE Africa (etc) which is not shown (near 30-40°E)
39250	202	6	202	6	Incorrect reference to the panel in the caption, should be: "And similarly (d) under SSP8.5 in 2100." [Dmitry Kovalevsky, Germany]	Incorrect reference to the panel in the caption, should be: "And similarly (d) under SSP8.5 in 2100."
45898	202		202		The caption of Figure 'a' is trend from 2 batches of years(1925-1954, 1987-2016), but the figure title suggests one long period(1925-2016). This is inconsistent. This can be presented as either a figure from complete data, or two spearate figures or just one firgure for the recent data (1987-2016). [Shikha Singh, India]	The caption of Figure 'a' is trend from 2 batches of years(1925-1954, 1987-2016), but the figure title suggests one long period(1925-2016). This is inconsistent. This can be presented as either a figure from complete data, or two spearate figures or just one firgure for the recent data (1987-2016).
46996	203	1	203	1	The labeling of the middle row of Figure 9-4 a "warming" will be confusing to some readers, for whom warming will be interpreted as an increase in temperature, especially since other sections of this report do describe trends in ocean heat content with the same units of W/m2. Describing this field as an "Air-Sea Heat Flux" instead of "Ocean Warming" would add just 4 characters and would be much less likely to be misunderstood. [Robert Hallberg, United States of America]	The labeling of the middle row of Figure 9-4 a "warming" will be confusing to some readers, for whom warming will be interpreted as an increase in temperature, especially since other sections of this report do describe trends in ocean heat content with the same units of W/m2. Describing this field as an "Air-Sea Heat Flux" instead of "Ocean Warming" would add just 4 characters and would be much less likely to be misunderstood.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
44404	203	4	203	4	Figure 9.4 middle row, right column. It appears that the trend of the net surface heat flux into the ocean is either negligible or negative. Is this correct? If it is the uncertainties in this estimate need to be clarified. [Michael Bell, United Kingdom (of Great Britain and Northern Ireland)]	Figure 9.4 middle row, right column. It appears that the trend of the net surface heat flux into the ocean is either negligible or negative. Is this correct? If it is the uncertainties in this estimate need to be clarified.
45280	203	5	203	5	specify wind acceleration [Alessandro Silvano, Australia]	specify wind acceleration
49462	205	1	205	11	Use a different color scale (e.g. not rainbow) for the top four panels. [Sonya Legg, United States of America]	Use a different color scale (e.g. not rainbow) for the top four panels.
45902	205		205		Picture quality is not good. Clarity is compromised [Shikha Singh, India]	Picture quality is not good. Clarity is compromised
46998	206	1	206	1	In Figure 9-7, the use of the word "bias" could be misleading. As I understand it, panels (c) and (f) are the difference between a multi-model mean (which will tend to suppress internally generated variability) and observations (which do not). These quantities are not expected to be the same. However the word "bias" will be interpreted by some as an indication of model failings. This issue could be addressed by using not just the multi-model mean in these two panels, but also stippling to indicate where the observed trends are very likely to be inconsistent with the model simulations based on the 5th and 95th percentile trends of individual model realizations. Doing so would also help in generating and supporting confidence language statements about these trends. [Robert Hallberg, United States of America]	In Figure 9-7, the use of the word "bias" could be misleading. As I understand it, panels (c) and (f) are the difference between a multi-model mean (which will tend to suppress internally generated variability) and observations (which do not). These quantities are not expected to be the same. However the word "bias" will be interpreted by some as an indication of model failings. This issue could be addressed by using not just the multi-model mean in these two panels, but also stippling to indicate where the observed trends are very likely to be inconsistent with the model simulations based on the 5th and 95th percentile trends of individual model realizations. Doing so would also help in generating and supporting confidence language statements about these trends.
47000	206	1	206	1	The chosen units for figure 9-7, PJ m-2 decade-1, are proportional to the W m-2 used elsewhere in this and other IPCC reports. It might be worth considering using these more conventional units to facilitate cross-comparison between figures from various parts of the report. Alternately, I think that some context needs to be given to allow a policy maker to put PJ m-2 decade-1 into context, such as the rates of warming this would lead to were it to be applied over a couple of vertical extents of the ocean; a footnote in SROCC Chapter 5 deals with something analogous to this to help interpret ocean heat content changes in ZJ, by stating that "ZJ is Zettajoule and is equal to 10^21 Joules. Warming the entire ocean by 1℃ requires about 5500 ZJ; 144 ZJ would warm the top 100 m by about 1℃." A similar approach could be taken here if these units are retained. [Robert Hallberg, United States of America]	The chosen units for figure 9-7, PJ m-2 decade-1, are proportional to the W m-2 used elsewhere in this and other IPCC reports. It might be worth considering using these more conventional units to facilitate cross-comparison between figures from various parts of the report. Alternately, I think that some context needs to be given to allow a policy maker to put PJ m-2 decade-1 into context, such as the rates of warming this would lead to were it to be applied over a couple of vertical extents of the ocean; a footnote in SROCC Chapter 5 deals with something analogous to this to help interpret ocean heat content changes in ZJ, by stating that "ZJ is Zettajoule and is equal to 10^21 Joules. Warming the entire ocean by 1? requires about 5500 ZJ; 144 ZJ would warm the top 100 m by about 1?." A similar approach could be taken here if these units are retained.
52936	206	1	206	1	Impossible to read anything from figure 9.7 (a) [Abigail Bodner, United States of America]	Impossible to read anything from figure 9.7 (a)

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
24984	206	2	206	4	Surely fig 9.7 (a) cannot show both the 0-700 and the 0-2000m curves ie there seems to be only a single set of curves. [Adrian New, United Kingdom (of Great Britain and Northern Ireland)]	Surely fig 9.7 (a) cannot show both the 0-700 and the 0-2000m curves ie there seems to be only a single set of curves.
24986	206	2	206	4	In fig 9.7(a) the legend and axes cannot be read [Adrian New, United Kingdom (of Great Britain and Northern Ireland)]	In fig 9.7(a) the legend and axes cannot be read
44406	206	6	206	7	Figure 9.7: Are the figures e) and f) calculated for 700-2000 metres rather than 0-700 metres. c) and f) imply that 700-2000 metre OHC changes are negative (because these changes are vertical integrals not vertical means). [Michael Bell, United Kingdom (of Great Britain and Northern Ireland)]	Figure 9.7: Are the figures e) and f) calculated for 700-2000 metres rather than 0-700 metres. c) and f) imply that 700-2000 metre OHC changes are negative (because these changes are vertical integrals not vertical means).
52938	207	1	207	1	Figure 9.8: why are contours showing salinity rather than the more standard density? [Abigail Bodner, United States of America]	Figure 9.8: why are contours showing salinity rather than the more standard density?
57196	207	1	207	16	- What product is being used for the observational figure? Is there any dependence of the observed change on the chosen time period and data product? One issue seems that the observed change does not show the surface cooling trend in the high-latitude Southern Ocean that is reported several times throughout chapter 9. This inconsistency need to be resolved. A more sensitive approach might be to take the pentadal or annual temperature and salinity anomalies for the global ocean heat and salt content data product and calculate trends including the entire period and not leaving out the 1980s, 1990s, and early 2000s. This would also account more accurately for strong decadal changes that have been reported for the Southern Ocean. [F. Alexander Haumann, Germany]	- What product is being used for the observational figure? Is there any dependence of the observed change on the chosen time period and data product? One issue seems that the observed change does not show the surface cooling trend in the high-latitude Southern Ocean that is reported several times throughout chapter 9. This inconsistency need to be resolved. A more sensitive approach might be to take the pentadal or annual temperature and salinity anomalies for the global ocean heat and salt content data product and calculate trends including the entire period and not leaving out the 1980s, 1990s, and early 2000s. This would also account more accurately for strong decadal changes that have been reported for the Southern Ocean.
57198	207	1	207	16	- When extending the figure to lower latitudes, I would also suggest extending it to higher latitudes to cover the entire Southern Ocean. [F. Alexander Haumann, Germany]	- When extending the figure to lower latitudes, I would also suggest extending it to higher latitudes to cover the entire Southern Ocean.
24968	207	8	207	8	Please say what the black contours are in the temperature figure panels on the left hand side - we are only told about the black contours in the salinity figures. [Adrian New, United Kingdom (of Great Britain and Northern Ireland)]	Please say what the black contours are in the temperature figure panels on the left hand side - we are only told about the black contours in the salinity figures.
40402	207	8	207	11	The end of the caption of Fig. 9.8 (about contours and fingerprints) only refers to salinity while the left column represents temperature. [Nicolas Jourdain, France]	The end of the caption of Fig. 9.8 (about contours and fingerprints) only refers to salinity while the left column represents temperature.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
47002	209	1	209	1	I think that Figure 9-10 does a very nice job of synthesizing the transports and changes in transports of various ocean currents from many different models. If possible, the addition to the top panel of observational estimates of these transports the real world with 5%-95% error bars would be helpful. If there is space, adding the acroynms for the currents to the caption would help this figure to stand alone. [Robert Hallberg, United States of America]	I think that Figure 9-10 does a very nice job of synthesizing the transports and changes in transports of various ocean currents from many different models. If possible, the addition to the top panel of observational estimates of these transports the real world with 5%-95% error bars would be helpful. If there is space, adding the acroynms for the currents to the caption would help this figure to stand alone.
49464	210	1	210	6	Use a different color scale (e.g. not rainbow) for the top panel. [Sonya Legg, United States of America]	Use a different color scale (e.g. not rainbow) for the top panel.
52940	211	1	211	1	It would be helpdul to color the boxes in the map of figure 9.12 that correspond to the locations of the line plots. Also, make map larger. [Abigail Bodner, United States of America]	It would be helpdul to color the boxes in the map of figure 9.12 that correspond to the locations of the line plots. Also, make map larger.
52942	212	1	212	1	Figure 9.13: titles are not consistent with capital letters. [Abigail Bodner, United States of America]	Figure 9.13: titles are not consistent with capital letters.
49466	212	1	212	7	Use a different color scale (e.g. not rainbow) for these panels [Sonya Legg, United States of America]	Use a different color scale (e.g. not rainbow) for these panels
6671	213	1	213	17	A suggestion to change “Version 450” with “OSI-450” and “Version 430b” with “OSI-430-b” for easier reference. This yields all sea-ice figures for Chapter 9. [Thomas Lavergne, Norway]	A suggestion to change “Version 450” with “OSI-450” and “Version 430b” with “OSI-430-b” for easier reference. This yields all sea-ice figures for Chapter 9.
20804	213	2	213	6	Add in the caption what positive (blue) and negative (red) means: Red (blue) is more (less) sea ice. [Gwenaelle GREMION, Canada]	Add in the caption what positive (blue) and negative (red) means: Red (blue) is more (less) sea ice.
6673	214	1	214	11	Further clarification is required for the last column of Fig 9.15: does the map correspond to the standard deviation of an a n=3 esemble (OSISAF/CCI, Bootstrap, NasaTeam) to show the inter-observation variability? Also, it is not clear what the “blue” and “red” colormaps represents. This comment yields also for Fig 9.18. [Thomas Lavergne, Norway]	Further clarification is required for the last column of Fig 9.15: does the map correspond to the standard deviation of an a n=3 esemble (OSISAF/CCI, Bootstrap, NasaTeam) to show the inter-observation variability? Also, it is not clear what the “blue” and “red” colormaps represents. This comment yields also for Fig 9.18.
20806	214	2	214	9	Add either in the figure title of column 3 what difference is calculated: (2008-2017) – (1979-1988) or the other way round? [Gwenaelle GREMION, Canada]	Add either in the figure title of column 3 what difference is calculated: (2008-2017) – (1979-1988) or the other way round?
20808	214	2	214	9	Mention that shown are the months of minimum and maximum sea ice extent (September and March) [Gwenaelle GREMION, Canada]	Mention that shown are the months of minimum and maximum sea ice extent (September and March)
20810	215	1	215	1	Why is there a line-plot in Figure (b) and a scatter plot in Figure (a)? Makes more sense with a scatter plot in both. [Gwenaelle GREMION, Canada]	Why is there a line-plot in Figure (b) and a scatter plot in Figure (a)? Makes more sense with a scatter plot in both.
20812	216	2	216	7	Add in the caption what positive (blue) and negative (red) means: Red (blue) is more (less) sea ice. [Gwenaelle GREMION, Canada]	Add in the caption what positive (blue) and negative (red) means: Red (blue) is more (less) sea ice.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
20814	217	2	217	8	Add either in the figure title of column 3 what difference is calculated: (2008-2017) – (1979-1988) or the other way round? [Gwenaelle GREMION, Canada]	Add either in the figure title of column 3 what difference is calculated: (2008-2017) – (1979-1988) or the other way round?
20816	217	2	217	8	Mention that shown are the months of minimum and maximum sea ice extent (February and September) [Gwenaelle GREMION, Canada]	Mention that shown are the months of minimum and maximum sea ice extent (February and September)
57952	218	1	218	1	I don' see (all) the references that are mentioned in Figure 9.19e,f,g (e.g. Dolan et al. (P3, 2011); De Boer et al. (GRL, 2017)) in the reference list at the end of the chapter. Also panel labels are missing. Lines in panels e,f,g could be a bit thicker, and perhaps use different colours when refering to either model or data estimates. [Bas de Boer, Netherlands]	I don' see (all) the references that are mentioned in Figure 9.19e,f,g (e.g. Dolan et al. (P3, 2011); De Boer et al. (GRL, 2017)) in the reference list at the end of the chapter. Also panel labels are missing. Lines in panels e,f,g could be a bit thicker, and perhaps use different colours when refering to either model or data estimates.
9748	218	1	218	10	More explanation and finessing is needed for parts e), f), and g) of the figure. What do the horizontal dashes on the figures represent? Presumably the vertical lines are showing the SLE volume estimates from the various studies, but what range? Is this a full range from the study, or are these specific quantiles? [Andra Garner, United States of America]	More explanation and finessing is needed for parts e), f), and g) of the figure. What do the horizontal dashes on the figures represent? Presumably the vertical lines are showing the SLE volume estimates from the various studies, but what range? Is this a full range from the study, or are these specific quantiles?
9750	218	1	218	10	Lines would benefit from being thicker, making the figure easier to read at a glance. [Andra Garner, United States of America]	Lines would benefit from being thicker, making the figure easier to read at a glance.
20818	218	1	218	10	Figure 9.19. I find the wording “pale lines show zero contour of topography” obscure. Would it be better to replace it by “Grey line outlines present-day coastlines” ? [Gwenaelle GREMION, Canada]	Figure 9.19. I find the wording “pale lines show zero contour of topography” obscure. Would it be better to replace it by “Grey line outlines present-day coastlines” ?
41460	218	1	218	10	Make sure to assign a), b), etc on each panel of the figure. [Charalampos Charalampidis, Germany]	Make sure to assign a), b), etc on each panel of the figure.
9938	218	3	218	8	Letters a) to g) should be added on the figures to increase the comprehension. [Kevin Bulthuis, Belgium]	Letters a) to g) should be added on the figures to increase the comprehension.
9940	218	3	218	8	For figures e), f) and g). What does the length of the lines for the volume estimate represent? (min-max values?, uncertainty ranges?), please clarify. [Kevin Bulthuis, Belgium]	For figures e), f) and g). What does the length of the lines for the volume estimate represent? (min-max values?, uncertainty ranges?), please clarify.
9942	218	3	218	8	Maybe add that sea level is compared to present-day value (it is actually more ΔSLE than an absolute sea level equivalent. [Kevin Bulthuis, Belgium]	Maybe add that sea level is compared to present-day value (it is actually more ΔSLE than an absolute sea level equivalent.
9944	218	3	218	8	In the legend of figures e), f) and g). Replace etal. By et al. [Kevin Bulthuis, Belgium]	In the legend of figures e), f) and g). Replace etal. By et al.
9746	218	7	218	8	I don't think that it's necessary to explain that "Pale lines show zero contour of topography". This seems very obvious, and by including it in the caption was more confusing than if it had been omitted. [Andra Garner, United States of America]	I don't think that it's necessary to explain that "Pale lines show zero contour of topography". This seems very obvious, and by including it in the caption was more confusing than if it had been omitted.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
31274	219	1	219	1	Figure 9.20: Label a, b are missing. Graph b should include data from Mouginot et al. 2019 between 1972 and 2018. Figure c with GRACE results would be an interessting addition. [Jeremie Mouginot, France]	Figure 9.20: Label a, b are missing. Graph b should include data from Mouginot et al. 2019 between 1972 and 2018. Figure c with GRACE results would be an interessting addition.
9754	220	1	220	6	Explain what the horizontal dashes represent. Also, add an explanation of what the ranges shown by the vertical lines represent--if they are the same as Table 9.2, note this in the caption. [Andra Garner, United States of America]	Explain what the horizontal dashes represent. Also, add an explanation of what the ranges shown by the vertical lines represent--if they are the same as Table 9.2, note this in the caption.
9756	220	1	220	6	Remove the zero line from these plots--since none of the ranges cross this line, and the range of the y-axis starts at 0 on all plots, this line does not add any clarification to the plots, but may risk crowding them. [Andra Garner, United States of America]	Remove the zero line from these plots--since none of the ranges cross this line, and the range of the y-axis starts at 0 on all plots, this line does not add any clarification to the plots, but may risk crowding them.
9758	220	1	220	6	Make the lines a bit thicker, and consider using separate colors for each study, to make the figure easier to read at a glance. [Andra Garner, United States of America]	Make the lines a bit thicker, and consider using separate colors for each study, to make the figure easier to read at a glance.
20820	220	1	220	6	Figure 9.21. It is should mention what the error bar represents. 1 sigma error? [Gwenaelle GREMION, Canada]	Figure 9.21. It is should mention what the error bar represents. 1 sigma error?
9946	220	2	220	3	Maybe add some explanations about what the length of the lines means (min-maxvalues, probability intervals, ...)? [Kevin Bulthuis, Belgium]	Maybe add some explanations about what the length of the lines means (min-maxvalues, probability intervals, ...)?
57956	221	1	221	1	Similar to above mentioned figures, are the references (some of the same) added to the refernce list? Lines could be thicker and/or coloured [Bas de Boer, Netherlands]	Similar to above mentioned figures, are the references (some of the same) added to the refernce list? Lines could be thicker and/or coloured
9760	221	1	221	11	Explain what the horizontal dashes on figures e), f), and g) represent. Also, add an explanation of how the ranges shown by the vertical lines in the figure are defined (i.e., what quantiles are shown by these ranges?). [Andra Garner, United States of America]	Explain what the horizontal dashes on figures e), f), and g) represent. Also, add an explanation of how the ranges shown by the vertical lines in the figure are defined (i.e., what quantiles are shown by these ranges?).
9762	221	1	221	11	I suggest adding some color to the figure to represent different studies--such a visual cue would greatly aid with understanding and reading the figure. [Andra Garner, United States of America]	I suggest adding some color to the figure to represent different studies--such a visual cue would greatly aid with understanding and reading the figure.
20822	221	1	221	11	Figure 9.22. (Same as for 9.19) I find the wording “pale lines show zero contour of topography” obscure. Would it be better to replace it by “Grey line outlines present-day coastlines” ? [Gwenaelle GREMION, Canada]	Figure 9.22. (Same as for 9.19) I find the wording “pale lines show zero contour of topography” obscure. Would it be better to replace it by “Grey line outlines present-day coastlines” ?
9948	221	3	221	8	Letters a) to g) should be added on the figures to increase the comprehension. [Kevin Bulthuis, Belgium]	Letters a) to g) should be added on the figures to increase the comprehension.
9950	221	3	221	8	For figures e), f) and g). What does the length of the lines for the volume estimate represent? (min-max values?, uncertainty ranges?), please clarify. [Kevin Bulthuis, Belgium]	For figures e), f) and g). What does the length of the lines for the volume estimate represent? (min-max values?, uncertainty ranges?), please clarify.
9952	221	3	221	8	Maybe add that sea level is compared to present-day value (it is actually more ΔSLE than an absolute sea level equivalent. [Kevin Bulthuis, Belgium]	Maybe add that sea level is compared to present-day value (it is actually more ΔSLE than an absolute sea level equivalent.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
9954	221	3	221	8	In the legend of figures e), f) and g). Replace etal. By et al. [Kevin Bulthuis, Belgium]	In the legend of figures e), f) and g). Replace etal. By et al.
52944	222	1	222	1	Figre too small, also cannot read text on figure. [Abigail Bodner, United States of America]	Figre too small, also cannot read text on figure.
20824	222	1	222	3	Box 9.1 Figure 1. My first comment is that the resolution of the figure is very poor. It is difficult to see the processes, or read the text at all. But this might be because this is a draft version. Secondly, would it be easier to show MISI as two stage diagrams and the same for MICI ? A good graph for MISI is for example Figure 3 in Hanna et al., 2013 paper (doi:10.1038/nature12238). Something similar could be created for MICI? [Gwenaelle GREMION, Canada]	Box 9.1 Figure 1. My first comment is that the resolution of the figure is very poor. It is difficult to see the processes, or read the text at all. But this might be because this is a draft version. Secondly, would it be easier to show MISI as two stage diagrams and the same for MICI ? A good graph for MISI is for example Figure 3 in Hanna et al., 2013 paper (doi:10.1038/nature12238). Something similar could be created for MICI?
31276	223	1	223	2	Figure 9.23: Time series on the left should also include Schroder et al. 2019. Figure c with GRACE results would be an interessting addition. [Jeremie Mouginot, France]	Figure 9.23: Time series on the left should also include Schroder et al. 2019. Figure c with GRACE results would be an interessting addition.
39272	223	1	223	3	Figure 9.23a shows three time series of mass loss since 1992. However, only the uncertainty from the Bamber et al (2018) assessment is included in the figure. For clarity, the 1 standard deviation uncertainty (as a minimum) should be plotted for the Shepherd et al (2018) (black line) and Rignot et al (2019) (orange line) [Stephen Chuter, United Kingdom (of Great Britain and Northern Ireland)]	Figure 9.23a shows three time series of mass loss since 1992. However, only the uncertainty from the Bamber et al (2018) assessment is included in the figure. For clarity, the 1 standard deviation uncertainty (as a minimum) should be plotted for the Shepherd et al (2018) (black line) and Rignot et al (2019) (orange line)
39274	223	1	223	3	The uncertainty bars would be easier to read if plotted as translucent ribbons around the mass loss lines (as opposed to vertical lines at each year). This would imporve clarity particulalry when uncertainties for all three estimates are inlcuded on the plot (see substance comment 9) [Stephen Chuter, United Kingdom (of Great Britain and Northern Ireland)]	The uncertainty bars would be easier to read if plotted as translucent ribbons around the mass loss lines (as opposed to vertical lines at each year). This would imporve clarity particulalry when uncertainties for all three estimates are inlcuded on the plot (see substance comment 9)
20826	223	1	223	12	Figure 9.23. the two curves (red and orange) are very different since 2005. However, this is not discussed in the relevant paragraph page 56. It would be worth mentioning why the two curves differ so much in the text discussion. [Gwenaelle GREMION, Canada]	Figure 9.23. the two curves (red and orange) are very different since 2005. However, this is not discussed in the relevant paragraph page 56. It would be worth mentioning why the two curves differ so much in the text discussion.
31648	223	4	223	4	There is no Gray line in my pdf version but a black line. [Pierre Mathiot, United Kingdom (of Great Britain and Northern Ireland)]	There is no Gray line in my pdf version but a black line.
9956	223	4	223	4	The line seems more black than grey. Maybe change grey by black. [Kevin Bulthuis, Belgium]	The line seems more black than grey. Maybe change grey by black.
45304	223	4	223	4	The line seems black and not gray [Alessandro Silvano, Australia]	The line seems black and not gray
9958	223	5	223	5	Maybe clarify what the length of the red lines is (min-max values, uncertainty range) and what the red dots are (mean or median values?) [Kevin Bulthuis, Belgium]	Maybe clarify what the length of the red lines is (min-max values, uncertainty range) and what the red dots are (mean or median values?)
9768	224	1	224	14	Explain what the horizontal dashes represent. Also, add an explanation of what the ranges shown by the vertical lines represent--if they are the same as Table 9.3, note this in the caption. [Andra Garner, United States of America]	Explain what the horizontal dashes represent. Also, add an explanation of what the ranges shown by the vertical lines represent--if they are the same as Table 9.3, note this in the caption.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
9770	224	1	224	14	Make the lines a bit thicker, and consider using separate colors for each study, to make the figure easier to read at a glance. [Andra Garner, United States of America]	Make the lines a bit thicker, and consider using separate colors for each study, to make the figure easier to read at a glance.
20828	224	1	224	14	Figure 9.24. It is should mention what the error bar represents. 1 sigma error? [Gwenaelle GREMION, Canada]	Figure 9.24. It is should mention what the error bar represents. 1 sigma error?
6772	224	2	224	2	Note in legend that this is based on tide gauge records [Joanne Williams, United Kingdom (of Great Britain and Northern Ireland)]	Note in legend that this is based on tide gauge records
9960	224	3	224	4	Maybe explain what the bar represent in term of uncertainty (5-95% probability intervals?). [Kevin Bulthuis, Belgium]	Maybe explain what the bar represent in term of uncertainty (5-95% probability intervals?).
9962	225	1	225	1	I do not find the colormap very optimal. Maybe a colormap from blue to red would be clearer and more relevant. [Kevin Bulthuis, Belgium]	I do not find the colormap very optimal. Maybe a colormap from blue to red would be clearer and more relevant.
31278	225	1	225	6	Figure 9.25: Figure is hardly readable. Bernales et al. 2017 is a model tuned to reproduce Rignot et al. 2013, therefore it would make sense to show direct measurements from Rignot et al. [Jeremie Mouginot, France]	Figure 9.25: Figure is hardly readable. Bernales et al. 2017 is a model tuned to reproduce Rignot et al. 2013, therefore it would make sense to show direct measurements from Rignot et al.
20830	225	1	225	16	Figure 9.25. It would be good to label the ice shelves with their names as they are referred to a lot in the text. [Gwenaelle GREMION, Canada]	Figure 9.25. It would be good to label the ice shelves with their names as they are referred to a lot in the text.
20832	226	1	229	1	Poor visual quality of figure with parts borderline illegible [Gwenaelle GREMION, Canada]	Poor visual quality of figure with parts borderline illegible
42524	226	3	226	3	A busy figure that requires some thought about what authors are trying to show. The area altitude graphs are too small and cluttered for a reader to grasp any similarities between mountain regions. A better illustration of these data might be how the elevation of the isotherm (0C) is projected to change in these regions under climate scenarios. [Brian Menounos, Canada]	A busy figure that requires some thought about what authors are trying to show. The area altitude graphs are too small and cluttered for a reader to grasp any similarities between mountain regions. A better illustration of these data might be how the elevation of the isotherm (0C) is projected to change in these regions under climate scenarios.
29888	226	3	226	3	I don't see any information about snow in this figure. [Christoph Marty, Switzerland]	I don't see any information about snow in this figure.
20834	227	1	227	1	Poor visual quality of figure with parts borderline illegible. Plots should have point markers on lines showing where observations are [Gwenaelle GREMION, Canada]	Poor visual quality of figure with parts borderline illegible. Plots should have point markers on lines showing where observations are

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
42526	227	3	227	3	Figure could be improved. Also, some of these length changes from western Canada are based on Orlemans Science paper which I contacted him about (Wedgemount and Sentinel length records of RGI-02). There is no dating for these earliest records (they were based on assummed positions from what I can tell). The earliest photographic evidence we have Sentinel comes from photos around 1912 and even from those one can't really tell what length of the record is. The figure should have time axis on top of graph (and higher frequency tick marks) to make it easier for reader to evaluate. Finally, scale these length records to 0-1 (divide by earliest length) so one can compare. Othewise 10 km of retreat sounds like alot but it might simply be a 100 km-long glacier. [Brian Menounos, Canada]	Figure could be improved. Also, some of these length changes from western Canada are based on Orlemans Science paper which I contacted him about (Wedgemount and Sentinel length records of RGI-02). There is no dating for these earliest records (they were based on assummed positions from what I can tell). The earliest photographic evidence we have Sentinel comes from photos around 1912 and even from those one can't really tell what length of the record is. The figure should have time axis on top of graph (and higher frequency tick marks) to make it easier for reader to evaluate. Finally, scale these length records to 0-1 (divide by earliest length) so one can compare. Othewise 10 km of retreat sounds like alot but it might simply be a 100 km-long glacier.
26068	227	4	227	4	Figure 9.27: for me theses length change figure are not very appropriate to indicate ongoing glacier changes. In think a figure like Figure3 in Zemp et al 2019 (nature), which indicates overall and specific mass changes is much more illustrative. Two more comments: there appears a Tyndall Glacier in the RGI16 plot. There is also a Tyndall Glacier on the Southern Patagonia Icefield belonging to RGI17. Please check that! And: the caption says: " Different regions were grouped due to similar climate settings." This is definitely not true for RGI17: Southern Andes. We know that there is an extreme climate contrast between Northern Chile (one of the driest places on the planet) to Southern Patagonia (on of the wettest places on earth). So you should better say: "Different regions were grouped due to geographical aspects and climate settings." [Marius Schaefer, Chile]	Figure 9.27: for me theses length change figure are not very appropriate to indicate ongoing glacier changes. In think a figure like Figure3 in Zemp et al 2019 (nature), which indicates overall and specific mass changes is much more illustrative. Two more comments: there appears a Tyndall Glacier in the RGI16 plot. There is also a Tyndall Glacier on the Southern Patagonia Icefield belonging to RGI17. Please check that! And: the caption says: " Different regions were grouped due to similar climate settings." This is definitely not true for RGI17: Southern Andes. We know that there is an extreme climate contrast between Northern Chile (one of the driest places on the planet) to Southern Patagonia (on of the wettest places on earth). So you should better say: "Different regions were grouped due to geographical aspects and climate settings."
20836	228	1	228	1	Poor visual quality of figure with parts borderline illegible [Gwenaelle GREMION, Canada]	Poor visual quality of figure with parts borderline illegible
39276	228	1	228	3	Whilst I recognise this is a placeholder figure, when the updated figure is included, it should avoid the use of red and green colours on the same plot for legibility of readers with colour blindness [Stephen Chuter, United Kingdom (of Great Britain and Northern Ireland)]	Whilst I recognise this is a placeholder figure, when the updated figure is included, it should avoid the use of red and green colours on the same plot for legibility of readers with colour blindness
20838	231	2	231	8	Add a legend describing the two different lines and what they represent. [Gwenaelle GREMION, Canada]	Add a legend describing the two different lines and what they represent.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
55988	232	2	232	3	Should the caption of Figure 9.32 specify that the snow cover change is computed with respect to an average over a specific period? Is the choice of this period affect the fact that colors move from green to brown in 1980? The different panels could be quoted in the caption using letter or bottom/top location. [Martin Ménégoz, France]	Should the caption of Figure 9.32 specify that the snow cover change is computed with respect to an average over a specific period? Is the choice of this period affect the fact that colors move from green to brown in 1980? The different panels could be quoted in the caption using letter or bottom/top location.
9778	235	1	235	7	Box 9.2, Fig. 1--In the inset for Extreme sea level, should "Mean sea level" be "Mean relative sea level"? [Andra Garner, United States of America]	Box 9.2, Fig. 1--In the inset for Extreme sea level, should "Mean sea level" be "Mean relative sea level"?
9780	235	1	235	7	Box 9.2, Fig. 1--Are the structures on the left of the figure intended to show buildings? If so, could they be replaced with a more recognizable cartoon of a city? The structures there now are a bit confusing. [Andra Garner, United States of America]	Box 9.2, Fig. 1--Are the structures on the left of the figure intended to show buildings? If so, could they be replaced with a more recognizable cartoon of a city? The structures there now are a bit confusing.
9782	235	1	235	7	Box 9.2, Fig. 1--Should "Gravitational Pull" have an arrow (or arrows) associated with it to indicate a direction? [Andra Garner, United States of America]	Box 9.2, Fig. 1--Should "Gravitational Pull" have an arrow (or arrows) associated with it to indicate a direction?
9784	235	1	235	7	Box 9.2, Fig. 1--Should "vertical land motion" have an arrow going both ways, similar to GIA? [Andra Garner, United States of America]	Box 9.2, Fig. 1--Should "vertical land motion" have an arrow going both ways, similar to GIA?
42522	235	5	235	5	This figure could be improved. Show topography with alpine glaciers (right now simply shows an ice sheet), also include agricultural areas so reader can link changes in groundwater storage to humans (agriculture, urbanization, etc. [Brian Menounos, Canada]	This figure could be improved. Show topography with alpine glaciers (right now simply shows an ice sheet), also include agricultural areas so reader can link changes in groundwater storage to humans (agriculture, urbanization, etc.
15710	238	1			The annual results from Zemp et al. (2019, Nature) from 1961 to 2016 are available from the zenodo repository: https://zenodo.org/record/1492141 [Michael Zemp, Switzerland]	The annual results from Zemp et al. (2019, Nature) from 1961 to 2016 are available from the zenodo repository: https://zenodo.org/record/1492141
9790	239	1	239	7	This figure is very useful and well explained in the caption and the text of the chapter. However, I think that the current combinations of color scheme and line widths makes it very difficult to distinguish certain line colors, especially with the gray shading added to the figure. In particular, Bakker et al., 2017, Jevrejeva et al., 2014, Kopp et al., 2014, and Kopp et al., 2016 are all quite difficult to distinguish from one another, as are Kopp et al., 2017 and Wong et al., 2017 from one another. I suggest that one way to address this would be to use lighter/brighter colors. For example, the colors for Grinsted et al. 2015 and Jackson and Jevrejeva 2016 are relatively easy to pick out on the figure. Some similarly light/bright colors in yellows, greens, or purples would likely be useful. Thicker lines may also help, but I imagine that this would also risk crowding the plot. [Andra Garner, United States of America]	This figure is very useful and well explained in the caption and the text of the chapter. However, I think that the current combinations of color scheme and line widths makes it very difficult to distinguish certain line colors, especially with the gray shading added to the figure. In particular, Bakker et al., 2017, Jevrejeva et al., 2014, Kopp et al., 2014, and Kopp et al., 2016 are all quite difficult to distinguish from one another, as are Kopp et al., 2017 and Wong et al., 2017 from one another. I suggest that one way to address this would be to use lighter/brighter colors. For example, the colors for Grinsted et al. 2015 and Jackson and Jevrejeva 2016 are relatively easy to pick out on the figure. Some similarly light/bright colors in yellows, greens, or purples would likely be useful. Thicker lines may also help, but I imagine that this would also risk crowding the plot.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
20840	239				Figure 9.37: Where are the thick grey lines outlining the p boxes? You should highlight them (e.g. by making them thicker). [Gwenaelle GREMION, Canada]	Figure 9.37: Where are the thick grey lines outlining the p boxes? You should highlight them (e.g. by making them thicker).
20842	239				Figure 9.37: In order to improve the understanding of this figure, I would add the text in P104 L9-11 ('For each study, the values along the x-axis…') in the caption. [Gwenaelle GREMION, Canada]	Figure 9.37: In order to improve the understanding of this figure, I would add the text in P104 L9-11 ('For each study, the values along the x-axis…') in the caption.
20844	239				Figure 9.37: I would add the full definition of the acronym of CDF in the caption not to have to come back to the text. [Gwenaelle GREMION, Canada]	Figure 9.37: I would add the full definition of the acronym of CDF in the caption not to have to come back to the text.
20846	239				Figure 9.37: I find it strange that the dark grey and light grey shadings abruptly stop in the top and bottom of each panel (e.g. for probabilities of 0.95 and 0.05). Shouldn't the shading be continuous? [Gwenaelle GREMION, Canada]	Figure 9.37: I find it strange that the dark grey and light grey shadings abruptly stop in the top and bottom of each panel (e.g. for probabilities of 0.95 and 0.05). Shouldn't the shading be continuous?
44996	242	50			Fig caption 9.40: I suggest replacing “Holocene thermal maximum” with “mid-Holocene”, otherwise, the GMSL elevation needs to span everything from 11 ka (HTM in central Beringia), when sea level was considerably lower, to 5 ka (HTM in Greenland). [Darrell Kaufman, United States of America]	Fig caption 9.40: I suggest replacing “Holocene thermal maximum” with “mid-Holocene”, otherwise, the GMSL elevation needs to span everything from 11 ka (HTM in central Beringia), when sea level was considerably lower, to 5 ka (HTM in Greenland).
56026	244	1	244	1	The label of the color scale is missing [Guillaume Dodet, France]	The label of the color scale is missing
20848	244				Figure 9.42: Consider changing the color bar to see more clearly the differences between different scenarios and time periods. There are differences but they are not clearly identifiable, partly due to the color bar. [Gwenaelle GREMION, Canada]	Figure 9.42: Consider changing the color bar to see more clearly the differences between different scenarios and time periods. There are differences but they are not clearly identifiable, partly due to the color bar.
7326	11933	8			Figure 9.10 caption: RCP85->RCP8.5 [LU AN, United States of America]	Figure 9.10 caption: RCP85->RCP8.5
7328	11933	34		35	This sentence is incomplete."…, hence the richness and productivity of EBUS". [LU AN, United States of America]	This sentence is incomplete."…, hence the richness and productivity of EBUS".
7330	12298	14			lack of a comma: "…(…;Sylla et al., 2019), however,…" [LU AN, United States of America]	lack of a comma: "…(…;Sylla et al., 2019), however,…"
7332	12298	31			…are beyond 2040-2050, so… [LU AN, United States of America]	…are beyond 2040-2050, so…
7308	43720	12			the caption should be clear, whether it marks flow in or out of the page. [LU AN, United States of America]	the caption should be clear, whether it marks flow in or out of the page.
7310	43726	30			the font size is different within word "biases". [LU AN, United States of America]	the font size is different within word "biases".
7312	43731	20			remove 'however' [LU AN, United States of America]	remove 'however'
7314	43732	3			no hyphen is needed between "time scale" [LU AN, United States of America]	no hyphen is needed between "time scale"
7316	43732	6		11	the expression of "21st century" in differenct format, should be consistant. Same for all the others, e.g. 20 th, 19th century.. [LU AN, United States of America]	the expression of "21st century" in differenct format, should be consistant. Same for all the others, e.g. 20 th, 19th century..
7318	43732	49			a global mean trend of 0.53 m°C year^-1"-> delete "m" [LU AN, United States of America]	a global mean trend of 0.53 m°C year^-1"-> delete "m"
7320	43733	3			0.19°C ±0.07°C -> 0.19± 0.07°C [LU AN, United States of America]	0.19°C ±0.07°C -> 0.19± 0.07°C
7322	43733	42			26.5N->26.5°N [LU AN, United States of America]	26.5N->26.5°N
7324	43735	15			"however" is not used in this way. [LU AN, United States of America]	"however" is not used in this way.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
44376	17`	17	17	17	it is not clear what "the observed strengthening" refers to (the ITF, SSTs or winds) [Michael Bell, United Kingdom (of Great Britain and Northern Ireland)]	it is not clear what "the observed strengthening" refers to (the ITF, SSTs or winds)
6361	entire				The entire chapter-I would suggest the authors to compare (along the whole chapter) between the open ocean and the semi-enclosed basins, including marginal seas (e.g., Gulf of Suez, Mediterranean, Labrador, Weddell...). Climate change impacts may differentiate significantly between both 'oceanic' types. [Baruch Rinkevich, Israel]	The entire chapter-I would suggest the authors to compare (along the whole chapter) between the open ocean and the semi-enclosed basins, including marginal seas (e.g., Gulf of Suez, Mediterranean, Labrador, Weddell...). Climate change impacts may differentiate significantly between both 'oceanic' types.
6363	entire				The entire chapter- much of the text is written as a text book, with established old outcomes. While I can see some background information to be cited, there is lack of specified new outcomes and modeling (last 5 years) and the gaps of knowledge. Suggest to concentrate on data gathered Since the AR5. Further, the chapter is wording and can be cut (I estimate) by at least one third, without missing the essence. [Baruch Rinkevich, Israel]	The entire chapter- much of the text is written as a text book, with established old outcomes. While I can see some background information to be cited, there is lack of specified new outcomes and modeling (last 5 years) and the gaps of knowledge. Suggest to concentrate on data gathered Since the AR5. Further, the chapter is wording and can be cut (I estimate) by at least one third, without missing the essence.
6367	entire				Very little is provided on future projections (e.g., 9.4.2.4) . Suggest tofocus in each subchapter on this issue [Baruch Rinkevich, Israel]	Very little is provided on future projections (e.g., 9.4.2.4) . Suggest tofocus in each subchapter on this issue
57088					Figure 9.10: short indicative titles could be added in each panel for clarity at first glance: (a) historical transport, (b) projected transport [WGI TSU, France]	Figure 9.10: short indicative titles could be added in each panel for clarity at first glance: (a) historical transport, (b) projected transport
57090					Figure 9.11: SF should be spelled out in the figure // units should be added in the figure next to the color bar [WGI TSU, France]	Figure 9.11: SF should be spelled out in the figure // units should be added in the figure next to the color bar
26628					There is considerable discussion of past changes to the ice sheet. To a large extent this is a replication, although not always consistent, of 2.4.3.1 and should be removed from Ch 9. [Jeff Ridley, United Kingdom (of Great Britain and Northern Ireland)]	There is considerable discussion of past changes to the ice sheet. To a large extent this is a replication, although not always consistent, of 2.4.3.1 and should be removed from Ch 9.
57092					Figure 9.12: this color palette (left) is not suitable for data visualisation and should be replace. The Visual Style guide propose color schemes, or contact TSU graphics officer // red-green is not suitable for colorblind vision, red could be replaced by blue [WGI TSU, France]	Figure 9.12: this color palette (left) is not suitable for data visualisation and should be replace. The Visual Style guide propose color schemes, or contact TSU graphics officer // red-green is not suitable for colorblind vision, red could be replaced by blue
57094					Figure 9.14: unit should be placed next to the color bar [WGI TSU, France]	Figure 9.14: unit should be placed next to the color bar
57096					Figure 9.15: following elements should be added in the figure: units of color bars, title "sea ice coverage in arctic" on top of the maps. [WGI TSU, France]	Figure 9.15: following elements should be added in the figure: units of color bars, title "sea ice coverage in arctic" on top of the maps.
57098					Figure 9.16: For consistancy with other figures/chapters, Kelvin should be replaced with Celcius (°C) [WGI TSU, France]	Figure 9.16: For consistancy with other figures/chapters, Kelvin should be replaced with Celcius (°C)

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57100					Figure 9.17: unit should be placed next to the color bar [WGI TSU, France]	Figure 9.17: unit should be placed next to the color bar
57102					Figure 9.15: following elements should be added in the figure: units of color bars, title "sea ice coverage in antarctic" on top of the maps. [WGI TSU, France]	Figure 9.15: following elements should be added in the figure: units of color bars, title "sea ice coverage in antarctic" on top of the maps.
46608					The chapter is well-structured and easy to follow. Unsurprisingly, the chapter currently has difficulties in adding to SROCC, however the detailed section on extreme se level is a nice complement to SROCC and goes beyond Ch4. [WGI TSU, France]	The chapter is well-structured and easy to follow. Unsurprisingly, the chapter currently has difficulties in adding to SROCC, however the detailed section on extreme se level is a nice complement to SROCC and goes beyond Ch4.
57104					Figure 9.19: mPWP, LIG, LGM should be spelled out in the respective plots or acronyms should be added in brackets next to the corresponding period, right above greenland map // a short title above the figure could be added for clarity "Greenland Ice Sheet extent " [WGI TSU, France]	Figure 9.19: mPWP, LIG, LGM should be spelled out in the respective plots or acronyms should be added in brackets next to the corresponding period, right above greenland map // a short title above the figure could be added for clarity "Greenland Ice Sheet extent "
46610					Note that in terms of consistency in section structure, there are no seprate model evaluation sections for the ocean - only for the cyrosphere [WGI TSU, France]	Note that in terms of consistency in section structure, there are no seprate model evaluation sections for the ocean - only for the cyrosphere
57106					Figure 9.21: RCP colors as presented in the Visual Style Guide (p. 8) could be used for each panel. [WGI TSU, France]	Figure 9.21: RCP colors as presented in the Visual Style Guide (p. 8) could be used for each panel.
57108					Figure 9.22: mPWP, LIG, LGM should be spelled out in the respective plots or acronyms should be added in brackets next to the corresponding period, right above antarctic map // a short title above the figure could be added for clarity "Antarctic Ice Sheet extent " [WGI TSU, France]	Figure 9.22: mPWP, LIG, LGM should be spelled out in the respective plots or acronyms should be added in brackets next to the corresponding period, right above antarctic map // a short title above the figure could be added for clarity "Antarctic Ice Sheet extent "
57110					box 9.1 fig 1: For clarity, it is better to use the full title instead of acronyms (MICI and MISI) [WGI TSU, France]	box 9.1 fig 1: For clarity, it is better to use the full title instead of acronyms (MICI and MISI)
57112					Figure 9.23: for clarity, (b) should be renamed "surface height change" // color legend should be added in (a) - instead of having it only in the caption // Ideally, same color palette as in 9.20 (a) should be used for (b). // units should be placed next to the color bar in (b) [WGI TSU, France]	Figure 9.23: for clarity, (b) should be renamed "surface height change" // color legend should be added in (a) - instead of having it only in the caption // Ideally, same color palette as in 9.20 (a) should be used for (b). // units should be placed next to the color bar in (b)
57114					Figure 9.24: RCP colors as presented in the Visual Style Guide (p. 8) could be used for each panel. [WGI TSU, France]	Figure 9.24: RCP colors as presented in the Visual Style Guide (p. 8) could be used for each panel.
57116					Figure 9.26: for guidance for information design is needed, it is possible to contact the TSU graphics officer [WGI TSU, France]	Figure 9.26: for guidance for information design is needed, it is possible to contact the TSU graphics officer
57118					Figure 9.27: RGI should be spelled out in the caption at least // for clarity at a first glance, a title could be added to the figure (e.g." long-term Glacier length change") [WGI TSU, France]	Figure 9.27: RGI should be spelled out in the caption at least // for clarity at a first glance, a title could be added to the figure (e.g." long-term Glacier length change")

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57120					Figure 9.28: it would be good to have a visual geographical reference for each plot - would it be possible to add a map in the design? further discussion could be taken with the TSU graphics officer // the colors for RCP lines should be the ones mentioned for RCP in the Visual Style Guide (see page 8) // for clarity at a first glance, a title could be added to the figure (e.g."projected glacier mass loss evolution 2015-2100") [WGI TSU, France]	Figure 9.28: it would be good to have a visual geographical reference for each plot - would it be possible to add a map in the design? further discussion could be taken with the TSU graphics officer // the colors for RCP lines should be the ones mentioned for RCP in the Visual Style Guide (see page 8) // for clarity at a first glance, a title could be added to the figure (e.g."projected glacier mass loss evolution 2015-2100")
57122					Figure 9.29: for clarity at first glance, a title could be added to the figure (e.g."Arctic permafrost temperature change ") // red-green not distinguishible for colorblind. Red could be replaces by orange [WGI TSU, France]	Figure 9.29: for clarity at first glance, a title could be added to the figure (e.g."Arctic permafrost temperature change ") // red-green not distinguishible for colorblind. Red could be replaces by orange
57124					Figure 9.30: the color palette is not consistent: it should go from brown (at 0%) to light brown at 50% and light blue (50%) to blue 100% // what are non-hatched regions ? [WGI TSU, France]	Figure 9.30: the color palette is not consistent: it should go from brown (at 0%) to light brown at 50% and light blue (50%) to blue 100% // what are non-hatched regions ?
57126					Figure 9.31: GMAT should be spelled out [WGI TSU, France]	Figure 9.31: GMAT should be spelled out
57128					Figure 9.32: it is more intuitive to read months from January (top) to December (bottom) - like done in figure 9.20 and 9.22 // months should be written in full // [WGI TSU, France]	Figure 9.32: it is more intuitive to read months from January (top) to December (bottom) - like done in figure 9.20 and 9.22 // months should be written in full //
57130					Figure 9.34: the color palette is not consistent: it should be a single hue sequential scheme (see IPCC visual style guide p. 10) //it is more intuitive to read months from January (top) to December (bottom) - like done in figure 9.20 and 9.22 // months should be written in full // For consistancy with other figures/chapters, Kelvin should be replaced with Celcius (°C) //GMAT should be spelled out [WGI TSU, France]	Figure 9.34: the color palette is not consistent: it should be a single hue sequential scheme (see IPCC visual style guide p. 10) //it is more intuitive to read months from January (top) to December (bottom) - like done in figure 9.20 and 9.22 // months should be written in full // For consistancy with other figures/chapters, Kelvin should be replaced with Celcius (°C) //GMAT should be spelled out
57132					Box 9.2, Figure 1: the schematic shows key processes, but the processes per se are not mentioned in the figure (e.g. "glacier and ice sheet", etc.), the figure would benefit from some short explenation about the way "hydrological cycle" contributes to sea level change, for example. for more guidance, please contact TSU graphics officer // GIA should be spelled out // the schematic on "extreme sea level" is confusing: the levels indicated are still below the water surface. [WGI TSU, France]	Box 9.2, Figure 1: the schematic shows key processes, but the processes per se are not mentioned in the figure (e.g. "glacier and ice sheet", etc.), the figure would benefit from some short explenation about the way "hydrological cycle" contributes to sea level change, for example. for more guidance, please contact TSU graphics officer // GIA should be spelled out // the schematic on "extreme sea level" is confusing: the levels indicated are still below the water surface.
57134					Figure 9.35: GMSL should be spelled out in caption // specifying (CE) in the x axis does not seem necessary and could be removed. [WGI TSU, France]	Figure 9.35: GMSL should be spelled out in caption // specifying (CE) in the x axis does not seem necessary and could be removed.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
57136					Figure 9.36: acronyms should be spelled out in caption. // longitudinal numbers should be removed to avoid confusion with color bar // color palette should be divergent with 2 sequential hue on each side - more information to come towards SOD for sea-level change color palette [WGI TSU, France]	Figure 9.36: acronyms should be spelled out in caption. // longitudinal numbers should be removed to avoid confusion with color bar // color palette should be divergent with 2 sequential hue on each side - more information to come towards SOD for sea-level change color palette
49218					There is nothing obvious about ocean heat and freshwater transports in the chapter, the focus is on heat and freshwater storage and AMOC transports. Perhaps this is covered in another chapter, or is this an oversight. Given the typical biases in ocean heat transports (and whether these are compensated by the atmospheric transports), how these might change in future may well be different in such biased models? [Malcolm Roberts, United Kingdom (of Great Britain and Northern Ireland)]	There is nothing obvious about ocean heat and freshwater transports in the chapter, the focus is on heat and freshwater storage and AMOC transports. Perhaps this is covered in another chapter, or is this an oversight. Given the typical biases in ocean heat transports (and whether these are compensated by the atmospheric transports), how these might change in future may well be different in such biased models?
45900					A recent paper suggested that subsurface temperature in CMIP5 was higher than the observations in all the models. This feature may also be studied for CMIP6 and reported. The reference is 'Subsurface ocean biases in climate models and its implications in the simulated interannual variability: A case study for Indian Ocean', Shikha and Valsala, 2018, Dynamics of Atmospheres and Oceans. [Shikha Singh, India]	A recent paper suggested that subsurface temperature in CMIP5 was higher than the observations in all the models. This feature may also be studied for CMIP6 and reported. The reference is 'Subsurface ocean biases in climate models and its implications in the simulated interannual variability: A case study for Indian Ocean', Shikha and Valsala, 2018, Dynamics of Atmospheres and Oceans.
38482					Overall, this chapter is already well developed and it is very interesting to read. [Iskhaq Iskandar, Indonesia]	Overall, this chapter is already well developed and it is very interesting to read.
46690					Assessment on modes of variability occurs in Section 1.3.3; Section 2.4; Section 3.7; Section 4.4.3, 4.5.3; Section 6.2.2.5.1; Section 7.1.1/2 ; Section 8.3.1.3.2, 8.3.2.2, 8.3.2.4.1, 8.3.2.9.1, 8.4.2.5,8.5.2.2.1, 8.3.2.9.2, 8.4.2.5, 8.3.2.9.3, 8.4.2.5, 8.3.2.9.4, 8.4.2.5, Figure 8.43, 8.5.2.2.1, 8.5.2.2.1; Section 9.2.2.1, 9.2.2.3, Section 9.4.3.2, BOX 9.2, 9.2.3.1, Table 9.1, Section 9.2.1, Cross-Chapter Box 9.1, BOX 9.2, 9.6.2.1.1, 9.6.2.1.2, 9.5.4.7, 9.2.5; Section 10.1.4.2, 10.4.2.2, 10.6.3.3; Section 11.3.1, 11.7.1.1, 11.6.2, 11.1.5,11.4.1, 11.6.1, Table 11.4; Section 12.4.1, 12.4.4.3, 12.5.2.3; Section Atlas.5.2.1.2, Atlas.5.3.1.1, Atlas.5.3.2.1, Atlas.5.5.1.1, Atlas.5.5.2.1, Atlas.5.6.2.1, Atlas.5.6.3.1, Atlas.5.10.2.1, Atlas.5.10.2.2. This topic is addressed in ES of Chapter 2, 3, 4, 7, 11, addressed in box in chapter 9, and broadly addressed in above-mentioned subsections in chapter 1, 2, 3, 4, 6, 7, 8, 9, 10, 11, 12. [WGI TSU, France]	Assessment on modes of variability occurs in Section 1.3.3; Section 2.4; Section 3.7; Section 4.4.3, 4.5.3; Section 6.2.2.5.1; Section 7.1.1/2 ; Section 8.3.1.3.2, 8.3.2.2, 8.3.2.4.1, 8.3.2.9.1, 8.4.2.5,8.5.2.2.1, 8.3.2.9.2, 8.4.2.5, 8.3.2.9.3, 8.4.2.5, 8.3.2.9.4, 8.4.2.5, Figure 8.43, 8.5.2.2.1, 8.5.2.2.1; Section 9.2.2.1, 9.2.2.3, Section 9.4.3.2, BOX 9.2, 9.2.3.1, Table 9.1, Section 9.2.1, Cross-Chapter Box 9.1, BOX 9.2, 9.6.2.1.1, 9.6.2.1.2, 9.5.4.7, 9.2.5; Section 10.1.4.2, 10.4.2.2, 10.6.3.3; Section 11.3.1, 11.7.1.1, 11.6.2, 11.1.5,11.4.1, 11.6.1, Table 11.4; Section 12.4.1, 12.4.4.3, 12.5.2.3; Section Atlas.5.2.1.2, Atlas.5.3.1.1, Atlas.5.3.2.1, Atlas.5.5.1.1, Atlas.5.5.2.1, Atlas.5.6.2.1, Atlas.5.6.3.1, Atlas.5.10.2.1, Atlas.5.10.2.2. This topic is addressed in ES of Chapter 2, 3, 4, 7, 11, addressed in box in chapter 9, and broadly addressed in above-mentioned subsections in chapter 1, 2, 3, 4, 6, 7, 8, 9, 10, 11, 12.

Comment ID	From Page	From Line	To Page	To Line	Comment	Response
46710					Moonsoon is assessed in section 3.3.3.2; Section 4.4.1.4, 4.5.1.5; 8.2.1.3, 8.3.1.3.2, 8.3.2.2, 8.3.2.4 , 8.4.2.3, 8.3.2.1.1 , 8.4.2.7, 8.5.1.1.2; Section 9.5.4.7; Section 10.4.2.2.1, 10.4.2.2.2, 10.4.3.2.1, 10.4.3.2.2, 10.6.3; Section 11.1.5, 11.4.1, 11.4.4, 11.4.5, 11.7.1, 11.9.5, 11.10.2, Cross-Chapter-box-11.1.1, Section 12.4.1.3, 12.4.2.3, 12.4.2.4, 12.4.2.6, Cross-chapter box 12.1; Atlas.2.2, Atlas.2.3, Atlas.5.2.2, Atlas.5.3.1, Atlas.5.3.1, Atlas.5.3.1, Atlas.5.3.2, Atlas.5.3.3, Atlas.5.3.3, Atlas.5.5.1, Atlas.5.5.2.2, Atlas.5.11.1.3, in the form of ES in chapter 3,4,8,11, box in chapter 8 and above-mentioned subsections [WGI TSU, France]	Moonsoon is assessed in section 3.3.3.2; Section 4.4.1.4, 4.5.1.5; 8.2.1.3, 8.3.1.3.2, 8.3.2.2, 8.3.2.4 , 8.4.2.3, 8.3.2.1.1 , 8.4.2.7, 8.5.1.1.2; Section 9.5.4.7; Section 10.4.2.2.1, 10.4.2.2.2, 10.4.3.2.1, 10.4.3.2.2, 10.6.3; Section 11.1.5, 11.4.1, 11.4.4, 11.4.5, 11.7.1, 11.9.5, 11.10.2, Cross-Chapter-box-11.1.1, Section 12.4.1.3, 12.4.2.3, 12.4.2.4, 12.4.2.6, Cross-chapter box 12.1; Atlas.2.2, Atlas.2.3, Atlas.5.2.2, Atlas.5.3.1, Atlas.5.3.1, Atlas.5.3.1, Atlas.5.3.2, Atlas.5.3.3, Atlas.5.3.3, Atlas.5.5.1, Atlas.5.5.2.2, Atlas.5.11.1.3, in the form of ES in chapter 3,4,8,11, box in chapter 8 and above-mentioned subsections
11646					While there is extensive discussion of sea ice areal extent and change over time in the WG1 report, there is no quantification of seasonal start of spring melt and the start of the fall freeze up. This weblog post is the only work I am aware of on this subject. Temporal Trends In Arctic and Antarctic Sea Ice Maximum and Minimum Areal Extentshttps://pielkeclimatesci.wordpress.com/2009/09/09/temporal-trends-in-arctic-and-antarctic-sea-ice-maximum-and-minimum-areal-extents/ The conclusion was (up to 2007) The time of occurrence of the maximum and minimum sea ice coverage in the Arctic showed slight trends towards occurring earlier in the year, although not significant. In the Southern Hemisphere, the trends were smaller and also not significant, but the time of ice maximum was becoming later, contrary to the other three trends. This analysis should be extended up to the present. [Roger Pielke Sr, United States of America]	While there is extensive discussion of sea ice areal extent and change over time in the WG1 report, there is no quantification of seasonal start of spring melt and the start of the fall freeze up. This weblog post is the only work I am aware of on this subject. Temporal Trends In Arctic and Antarctic Sea Ice Maximum and Minimum Areal Extentshttps://pielkeclimatesci.wordpress.com/2009/09/09/temporal-trends-in-arctic-and-antarctic-sea-ice-maximum-and-minimum-areal-extents/ The conclusion was (up to 2007) The time of occurrence of the maximum and minimum sea ice coverage in the Arctic showed slight trends towards occurring earlier in the year, although not significant. In the Southern Hemisphere, the trends were smaller and also not significant, but the time of ice maximum was becoming later, contrary to the other three trends. This analysis should be extended up to the present.

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11648					In assessing ocean heat content changes, in addition to presenting as zetajoules, it should be shown in terms of rate of heating (i.e.,. in Watts per meter squared). As I discussed in Ellis et al. 1978: The annual variation in the global heat balance of the Earth. J. Geophys. Res., 83, 1958-1962 Pielke Sr., R.A., 2003: Heat storage within the Earth system. Bull. Amer. Meteor. Soc., 84, 331-335. This flux can be used to estimate the top of the atmosphere radiative imbalance. In addition to presenting the observed data, the model predictions of this flux of heat into the ocean should be presented. Comment on land portion of surface temperature data While the ocean heat change should be the primary metric to assess climate system heat changes (global warming and cooling), to the extent that the global average surface temperature is used, there needs to be a more thorough discussion of uncertainties which include 1.Height of the temperature data from the observing sites. In light winds at night, trends vary depending on height in the surface layer [Lin, X., R.A. Pielke Sr., R. Mahmood, C.A. Fiebrich, and R. Aiken, 2015: Observational evidence of temperature trends at two levels in the surface layer. Atmos. Chem. Phys. Discuss., 15, 24695–24726,www.atmos-chem-phys-discuss.net/15/24695/2015/doi:10.5194/acpd-15-24695-2015.] 2.Concurrent trends in absolute humidity can affect the dry bulb temperature trend. The dry bulb is only part of the heat per unit volume (of kg) in the surface air, as discussed in Pielke Sr., R.A., C. Davey, and J. Morgan, 2004: Assessing "global warming" with surface heat content. Eos, 85, No. 21, 210-211. A concurrent long term drying trend, for example, such as from land use change can result in elevated dry bulb temperatures even though the actual heat in the air has not changed or even fallen. A trend of increasing absolute moisture in the air (such as due to irrigation) can increase	In assessing ocean heat content changes, in addition to presenting as zetajoules, it should be shown in terms of rate of heating (i.e.,. in Watts per meter squared). As I discussed in Ellis et al. 1978: The annual variation in the global heat balance of the Earth. J. Geophys. Res., 83, 1958-1962 Pielke Sr., R.A., 2003: Heat storage within the Earth system. Bull. Amer. Meteor. Soc., 84, 331-335. This flux can be used to estimate the top of the atmosphere radiative imbalance. In addition to presenting the observed data, the model predictions of this flux of heat into the ocean should be presented. Comment on land portion of surface temperature data While the ocean heat change should be the primary metric to assess climate system heat changes (global warming and cooling), to the extent that the global average surface temperature is used, there needs to be a more thorough discussion of uncertainties which include 1.Height of the temperature data from the observing sites. In light winds at night, trends vary depending on height in the surface layer [Lin, X., R.A. Pielke Sr., R. Mahmood, C.A. Fiebrich, and R. Aiken, 2015: Observational evidence of temperature trends at two levels in the surface layer. Atmos. Chem. Phys.
32398					I find Figures 9.15 and 9.18 to be a little cramped. The panels are quite small and the use of a textured land mask doesn't help. [Ed Blockley, United Kingdom (of Great Britain and Northern Ireland)]	I find Figures 9.15 and 9.18 to be a little cramped. The panels are quite small and the use of a textured land mask doesn't help.

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32400					Table 9.1. I like the idea of having a table such as this to point the reader to the relevant sections/chapters and allow them to see what timescales might be of interest. However I'm left with a lot of questions after looking at the table. For example are we talking about observed/past changes or future changes (or both)? What do the colours mean or do they just correspond to the column that the coloured box is in (to be catchy)? I suspect that this could be improved considerably with a better caption and more careful column headers. However it might be that inclusion of more information would help. At present the attribution column seems a little bit disjointed because I'm left wondering what the human impact is. Perhaps an additional column coud be included to state - very simply - how things are changing. For example statements like: "decreasing", "regional changes", "more intense extremes" or something? [Ed Blockley, United Kingdom (of Great Britain and Northern Ireland)]	Table 9.1. I like the idea of having a table such as this to point the reader to the relevant sections/chapters and allow them to see what timescales might be of interest. However I'm left with a lot of questions after looking at the table. For example are we talking about observed/past changes or future changes (or both)? What do the colours mean or do they just correspond to the column that the coloured box is in (to be catchy)? I suspect that this could be improved considerably with a better caption and more careful column headers. However it might be that inclusion of more information would help. At present the attribution column seems a little bit disjointed because I'm left wondering what the human impact is. Perhaps an additional column coud be included to state - very simply - how things are changing. For example statements like: "decreasing", "regional changes", "more intense extremes" or something?

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58018					Chapter 9: Ocean, cryosphere, and sea level change, “Detection and attribution” and “Past global and regional sea level changes” is biased, negating the stable pattern evidenced at the world long-term-trend tide gauges, while supporting mostly computational products engineered to give the false impression of sea levels rising following the carbon dioxide emission. By looking at the long-term-trend tide gauges of the world, they are all acceleration free, showing oscillations about different longer-term-trends, of rise or fall, resulting from the different sea and land contributions to the tide gauge signal, and no acceleration linked to the carbon dioxide emission. The lack of acceleration in the long-term-trend tide gauges is acknowledged by many, for example [1] to [50] just to name a few. This pattern suggests a minimal thermosteric component, compatible with a gentle temperature recovery from the last little ice age, and often significant subsidence effects, for example from groundwater withdrawal, that strongly affect the trend. The stable pattern is easily detectable by anyone having the willingness to understand, from a simple analysis of tide gauge data. By considering the best long term trends tide gauges proposed by www.psmsl.org, that is already a biased view of the world tide gauges (tide gauges such as Oshoro, Wajima, Hosojima or Hamada only partially accounted for, tide gauges such as Aden, Mumbai or Karachi originating from subjective composition of tide gauges segments), the average rate of rise is +0.34 mm/yr., maximum +6.66 mm/yr., minimum -7.90 mm/yr., subjected to an acceleration of +0.007 mm/yr2. Below are three examples, of the many, of monthly average mean sea levels (MSL) measured by long-term-trend tide gauges. The three tide gauges are Honolulu+I15, The Battery (New York) and Trois Riviere. Images and analyses are from sealevel.info, data are from www.psmsl.org. From GPS domes nearby the tide gauges, data and analyses are from geodesy.unr.edu, The Battery is very likely subjected to high subsidence, -2.15 mm/yr., Honolulu is very likely also subjected to subsidence but less, -0.70 mm/yr., Trois Riviere is very likely subjected to a small uplift of about 0.80 mm/yr.	Chapter 9: Ocean, cryosphere, and sea level change, “Detection and attribution” and “Past global and regional sea level changes” is biased, negating the stable pattern evidenced at the world long-term-trend tide gauges, while supporting mostly computational products engineered to give the false impression of sea levels rising following the carbon dioxide emission. By looking at the long-term-trend tide gauges of the world, they are all acceleration free, showing oscillations about different longer-term-trends, of rise or fall, resulting from the different sea and land contributions to the tide gauge signal, and no acceleration linked to the carbon dioxide emission. The lack of acceleration in the long-term-trend tide gauges is acknowledged by many, for example [1] to [50] just to name a few. This pattern suggests a minimal thermosteric component, compatible with a gentle temperature recovery from the last little ice age, and often significant subsidence effects, for example from groundwater withdrawal, that strongly affect the trend. The stable pattern is easily detectable by anyone having the willingness to understand, from a simple analysis of tide gauge data. By considering the best long term trends tide gauges proposed by www.psmsl.org, that is already a biased view of the world tide gauges (tide gauges such as Oshoro,
12992					The IPCC uncertainity language (likely, very likely) has here been used in relation to the p-boxes. I feel it will be very confusing for the average govt employee who looks for practical SLR info to grasp this way of presenting the projections. As done in other chapters, I think people would expect the hazard level (in this case SLR amount) to increase with decreasing likelihood (i.e. a 0.5 m SLR by 2100 is very likely but a 1m SLR by 2100 is likely). But when you assign the whole range between 5th and 95th percentile as very likely (which is statistically correct of course), then if someone just looks at 95th percentile values of the likely and very likely bands, it would appear to the non-mathematically inclined reader that the upper bound of the very likely range is higher than that of the likely range, which is counter-intuitive. [Roshanka Ranasinghe, Netherlands]	The IPCC uncertainity language (likely, very likely) has here been used in relation to the p-boxes. I feel it will be very confusing for the average govt employee who looks for practical SLR info to grasp this way of presenting the projections. As done in other chapters, I think people would expect the hazard level (in this case SLR amount) to increase with decreasing likelihood (i.e. a 0.5 m SLR by 2100 is very likely but a 1m SLR by 2100 is likely). But when you assign the whole range between 5th and 95th percentile as very likely (which is statistically correct of course), then if someone just looks at 95th percentile values of the likely and very likely bands, it would appear to the non-mathematically inclined reader that the upper bound of the very likely range is higher than that of the likely range, which is counter-intuitive.

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46036					There doesn't appear to be any discuss about how changes in oceanic currents and circulation systems could potentially impact regional sea levels? Also seismic as a potentially large local factor. [Isaac Pearlman, United States of America]	There doesn't appear to be any discuss about how changes in oceanic currents and circulation systems could potentially impact regional sea levels? Also seismic as a potentially large local factor.
57072					Figure general comments Chapter 9: ideally, figures should be a bit more independent from the caption => Titles can be added to the figure to enhance the understanding at first glance //Figures and caption should be more independent from the main text => spell out acronyms in figure and/or caption wherever possible // Ideally, temperature unit should be °C and not Kelvin, for consistency accross the chapter // units have to be in ( ) and not in [ ] and font is Arial // For more information about Visual guidelines, please refer to the IPCC visual style guide (https://www.ipcc.ch/site/assets/uploads/2019/04/IPCC-visual-style-guide.pdf) [WGI TSU, France]	Figure general comments Chapter 9: ideally, figures should be a bit more independent from the caption => Titles can be added to the figure to enhance the understanding at first glance //Figures and caption should be more independent from the main text => spell out acronyms in figure and/or caption wherever possible // Ideally, temperature unit should be °C and not Kelvin, for consistency accross the chapter // units have to be in ( ) and not in [ ] and font is Arial // For more information about Visual guidelines, please refer to the IPCC visual style guide (https://www.ipcc.ch/site/assets/uploads/2019/04/IPCC-visual-style-guide.pdf)
57074					Figure 9.1: short indicative titles could be added next to schematic label (e.g. (a) large scale, (b) Atlantic) [WGI TSU, France]	Figure 9.1: short indicative titles could be added next to schematic label (e.g. (a) large scale, (b) Atlantic)
29428					General comment about the mid-Miocene climate and the ocean (and sea ice) is that sea ice seem to desappear also in parts of East Antarctica under oligotrophic and warm water conditions, very different from today. The structure of the ocean and its fronts seems to have changed dramatically across the Southern Ocean during warm climate optimum and vegetation was growing. Much info on the potentailly marine-based ice sheet at that time can be found in Sangiorgi et al. (2018) NATCOMMS on Wilkes Land comparison with other Antartcic sites [Francesca Sangiorgi, Netherlands]	General comment about the mid-Miocene climate and the ocean (and sea ice) is that sea ice seem to desappear also in parts of East Antarctica under oligotrophic and warm water conditions, very different from today. The structure of the ocean and its fronts seems to have changed dramatically across the Southern Ocean during warm climate optimum and vegetation was growing. Much info on the potentailly marine-based ice sheet at that time can be found in Sangiorgi et al. (2018) NATCOMMS on Wilkes Land comparison with other Antartcic sites
57076					Figure 9.2: short indicative titles could be added next to schematic label (e.g. (a)internal variability // missing processes (b) antarctic ice shelves, © costal ocean) [WGI TSU, France]	Figure 9.2: short indicative titles could be added next to schematic label (e.g. (a)internal variability // missing processes (b) antarctic ice shelves, © costal ocean)
29430					§ 9.4.3 Antarctica (page 9-53): warm Pliocene evidence of EAIS also retreating (e.g. Cook et al., 2013 NATGEO) [Francesca Sangiorgi, Netherlands]	§ 9.4.3 Antarctica (page 9-53): warm Pliocene evidence of EAIS also retreating (e.g. Cook et al., 2013 NATGEO)

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57078					CC box 9.1 figure 1: is there 'no data' region in white too (e.g. labrador sea) or is white color only representing trends ≤ 0? If white also means "no data", trends ≤ 0 should be changed into light blue. Mention the "no data" = white in the caption. // 60N tick mark is missing in the Y axes [WGI TSU, France]	CC box 9.1 figure 1: is there 'no data' region in white too (e.g. labrador sea) or is white color only representing trends ? 0? If white also means "no data", trends ? 0 should be changed into light blue. Mention the "no data" = white in the caption. // 60N tick mark is missing in the Y axes
29432					page 9-64: there are evidence for melting of the Wilkes land, Miles, B. W. J., Stokes, C. R. & Jamieson, S. S. R. Pan–ice-sheet glacier terminus change in East Antarctica reveals sensitivity of Wilkes Land to sea-ice changes.Sci. Adv. 2, e1501350 (2016 [Francesca Sangiorgi, Netherlands]	page 9-64: there are evidence for melting of the Wilkes land, Miles, B. W. J., Stokes, C. R. & Jamieson, S. S. R. Pan–ice-sheet glacier terminus change in East Antarctica reveals sensitivity of Wilkes Land to sea-ice changes.Sci. Adv. 2, e1501350 (2016
57080					Figure 9.4: is it possible to have the same type of map projection than figure 9.3 or 9.5 (for consistency)? [WGI TSU, France]	Figure 9.4: is it possible to have the same type of map projection than figure 9.3 or 9.5 (for consistency)?
57082					Figure 9.5: units should be added in the figure next to the color bar [WGI TSU, France]	Figure 9.5: units should be added in the figure next to the color bar
57084					Figure 9.6: units should be added in the figure next to the color bar [WGI TSU, France]	Figure 9.6: units should be added in the figure next to the color bar
57086					Figure 9.8: short indicative titles could be added in the figure for clarity at first glance: temperature, salinity, observations, GHG, ozone… // an annotation "climatological salinities" explaining the black lines could be added [WGI TSU, France]	Figure 9.8: short indicative titles could be added in the figure for clarity at first glance: temperature, salinity, observations, GHG, ozone… // an annotation "climatological salinities" explaining the black lines could be added