

SROCC Second Order Draft Government and Expert Review Compiled Comments - Chapter 5							
Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
1517	5	0	0	0	0	General: Well written and thorough chapter and well supported with literature [Chandani APPADOO, Mauritius]	Thank you for this comment.
10257	5	0	0	0	0	references are to be fully provided; currently there are many 'et al.'s. For example, 'Aanesen, M. et al., 2015' [Jinsoon Park, Republic of Korea]	References are now formatted
10261	5	0	0	0	0	the fonts of figure lables are all different for now, and better be unified. [Jinsoon Park, Republic of Korea]	The TSU will be redressing this for all figures.
20221	5	0	0	0	0	Overall, we believe that the chapter reflects the outline, especially in terms of determining the changes in climate-related processes and variables and their impacts on the ecosystems services. However, we believe that some topics are covered more thoroughly than others, probably as a result of the amount of information available on the different subjects. To this respect, boxes are very helpful in highlighting important aspects [APECS Group Review, Germany]	Taken into consideration
20223	5	0	0	0	0	Some processes that are relevant to the Earth System, such as chemical pollution, stratospheric ozone depletion, atmospheric aerosol loading, etc., were not clearly stated. Also, 'engineered' solutions to the problem of climate change, such as iron fertilization, received minimal concern. Indeed, these engineered solutions should point to the uncertainties associated with them. Noteworthy, towards the end of the chapter, there are tables that provided a short overview of what the chapter talks about, which could be of help between chapters [APECS Group Review, Germany]	Taken into consideration. The chapter also included in the FD a synthesis figure.
20225	5	0	0	0	0	The writing is relatively homogeneous throughout the chapter. Despite having been written by different authors, the treatment of the content and the style do not seem to differ significantly. However, subsection 5.2 appears to be less structured, showing some duplications and overlaps, making it more challenging to understand [APECS Group Review, Germany]	Taken into account. Section structure of 5.2 is revised to improve readability
20227	5	0	0	0	0	Definitely, we have learned new concepts, including in our own fields. Overall, there was no need to consult any outside sources to understand the material. The new knowledge acquired has allowed us to gain relevant ideas regarding avenues to focus our future research on [APECS Group Review, Germany]	Thank you
20229	5	0	0	0	0	Due to the difficulty to evaluate this lengthy report as a whole, it helped to have this broken up into areas of expertise to think about how it should all come together as a whole document. Overall, many of us learned new things through curiosity within our areas of research [APECS Group Review, Germany]	Taken into consideration

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21689	5	0	0	0	0	references are to be fully provided; currently there are many 'et al.'s. For example, 'Aanesen, M. et al., 2015' [Government of Republic of Korea, Republic of Korea]	The reference has been edited.
21691	5	0	0	0	0	the fonts of figure labes are all different for now, and better be unified. [Government of Republic of Korea, Republic of Korea]	Style of the figures has been revised.
32077	5	0	0	0	0	The chapter has much improved since the first order draft. Most importantly, some of the egregious statements have been eliminated. However, the chapter is still imbalanced with regard to the emphasis and allocation to the different topics. Some truly important topics are discussed in a relatively short way, others in great detail despite not being that important. I thus urge the author team to take the text and based on a thorough review allocate a maximum number of words to each section and subsection. [Nicolas Gruber, Switzerland]	accepted
32079	5	0	0	0	0	The quality of the assessment still varies substantially across the chapter. While some sections are almost ready, others read much more like a summary instead of an assessment. The chapter should also make an effort to clearly separate new assessments based on new data from simply restating conclusions drawn from previous assessments. [Nicolas Gruber, Switzerland]	accepted
32081	5	0	0	0	0	In terms of weighing the different topics of this chapter: The big storyline - in my opinion - is that the ocean is (i) the most crucial sink for heat, (ii) the most important and persistent sink for the anthropogenic CO2 that we emit into the atmosphere, and (iii) a very important source of food. Looking at the chapter with these eyes, I find about 10 pages on ocean heat uptake, about 4 pages on ocean carbon uptake, and roughly 20 pages or so on the provision of food (from NPP to ecosystem structure) - not counting the many pages that merely describe different ecosystems. This distribution does not reflect well this overarching storyline. [Nicolas Gruber, Switzerland]	The big-picture storyline in this comment is well articulated, and the committee generally agrees with it. (Although we would argue that ocean ecosystems also have intrinsic value beyond just their role in provisioning for humans, and other aspects of changes in the ocean, such as regional changes, are also important even though they do not contribute to the global budgets of heat, carbon, and food.) However, we feel that this story emerges not just from the SROCC but also from the complementary AR5 and AR6. The relative weights of the various topics within this chapter also needs to reflect how thoroughly they have been and are expected to be covered in the other IPCC reports. Because the carbon uptake is relatively well covered by the other reports, the committee is comfortable with a less intensive treatment of the ocean carbon cycle, as is also reflected in this chapter's agreed outline.

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32083	5	0	0	0	0	I am concerned about overconfidence creeping in. When reading the sections about ecosystem changes and their attribution to climate change, I get the impression that (i) many long-term changes have been observed, and (ii) that many of these changes can be clearly associated with anthropogenic climate change. When I started to read some of the underlying literature, I discovered that (i) many timeseries are rather short (no surprise there), (ii) most of the papers are much more careful about stating the cause of the change compared to the text here, and (iii) almost none undertook a formal attribution test or something similar. Given that I strongly urge the authors to be much more careful about their conclusions and to be more conservative. We need to acknowledge that the data are scarce, the timeseries short, and our fundamental understanding of the way climate change impacts marine ecosystems relatively poorly developed. We have some important exceptions, and those can and should be explicitly mentioned. But they should be used very cautiously to extrapolate to other groups of species. [Nicolas Gruber, Switzerland]	Taken into account - traceability of the evidence and of the level of agreement has been improved and confidence levels adjusted up or down as required.
480	5	0	0	0		I propose that a likelihood statement should not be given as part of a sentence (e. g. "it is very likely that.."). It is much easier to see what the statement actually implies if you add the likelihood statement in parenthesis at the end (as one more commonly does with the confidence statements). [Cecilie Mauritzen, Norway]	Taken into account - statement adjusted in final draft
10693	5	0	0	0		There are several citations of IPCC reports. I would suggest to cite the relevant products of the report (chapters, SPM, cross-chapter boxes) rather than the full reports which are hundreds or thousands of pages, which makes it impossible for the reader to find the relevant text. [Jean-Pierre Gattuso, France]	Accepted - text revised and reports referred to at the section level.
10717	5	0	0	0		throughout the chapter, there must be a non-breakable space between a number and its unit (150 m). [Jean-Pierre Gattuso, France]	Accepted - text adjusted
10859	5	0	0	0		General comment on Chapter 5: It is appreciated that the authors have addressed comments provided in the first round of review about the impact of climate change on phytoplankton productivity. The text and statements on this topic have gained clarity and strength. [Marie-Fanny Racault, United Kingdom (of Great Britain and Northern Ireland)]	Thank you for this comment.

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11907	5	0	0	0		Please express the word "in situ" in the text in a uniform style. For example, some are expressed in italic style, some has dash bar. Check whether it is italic or not. [Jun Sun, China]	In situ is borrowed from Latin, and therefore it should be italicized throughout.
11909	5	0	0	0		<p>While reading I felt this report already gone to many scientists before come to us because I felt each and every sentence has a lot of meaning (at least one sentence is having one complete published manuscript information, while in some cases one sentence consisted over 3-5 papers information) therefore I felt not to have any big suggestion that I can give. Further, while reading again and again I felt this report having both advantages and disadvantages. For example, as a disadvantage, this report talks about climate change regulation to the ecosystem at a glance view. Perhaps in the last report of IPCC half of these things were there.</p> <p>Compare to in the earlier IPCC report in recent year many of technical breakthrough developed, resulting numerous molecular level reports have been published on marine organisms to the changing environment, but I haven't seen much of the citations to molecular level to know the exact underpinning changes of organisms to the changing environment that would be more interesting to know the next level of organism's response to the climate change from current understanding. (I felt this is a gap)</p> <p>I would suggest one small title from the molecular response of an organism to the changing environment would be an excellent report.</p> <p>And as an advantage, this report covers all the fundamental information to the till data in a glance view in a simple language where a normal people can easily understand the whole process of the ocean if they read (MOLECULAR STUDIES WILL BE UNDERSTAND ONLY BY PEOPLE WHO ALREADY KNOWS). [Jun Sun, China]</p>	Rejected - the suggestion of molecular work was outside of the original scoping document.

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11911	5	0	0	0		Another big contrary I felt is in this report are given primary importance to the Arctic, Southern Ocean, Atlantic Ocean, and the Eastern Pacific Ocean changes, while in the many of the subtopic the Indian Ocean and western Pacific Ocean area are generally described as the tropical ocean. I felt Indian ocean and Western Pacific has a dynamic role in changing global climate, therefore it is much needed to give to explain more and more about the Indian Ocean and the western Pacific Ocean worth to mention alone as Arctic and Atlantic and the Southern Ocean. There are numerous reports are already available about this geographic area on the internet. I felt this is a big gap to fill. [Jun Sun, China]	Taken into account - this is an interesting and thoughtful comment about the composition of the report in its second draft. It was taken into account and there are a range of maps that cover the tropical regions of the ocean. It is difficult in a report of fit all the regions in with complete coverage.
12983	5	0	0	0		General comment: the chapter is quite long and too extensive to be easily readable for non-scientists. Having the proposed number of pages (~65) for chapter 5 in mind, the provided chapter exceeds this limit largely. Please consider further streamlining/shortening the chapter text. [Government of Germany, Germany]	Taken into account - this draft is now just 80 pages inclusive of figures compared with 157 with figures.
12985	5	0	0	0		General comment: Due to long sentences, it is sometimes difficult to follow the thought of the sentence. Short sentences with clear messages should be the goal of all chapters. [Government of Germany, Germany]	Taken into account - the chapter was largely redrafted with strong reductions in length and much stronger assessments of the underlying science.
12987	5	0	0	0		The FAQ format is very helpful, also for policy-makers, to retrieve information at first sight. Please ensure full consistency and robustness of the FAQs in the light of the chapters' findings. [Government of Germany, Germany]	Accepted - FAQ was checked for consistency with the chapter science, while being accessible and brief.

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12989	5	0	0	0		<p>The shifts of fish distribution due to climate change discussed in this report focus only on pelagic fish and global ocean (Sections 5.2.3 and 5.4.1 for instance). Is there is a reason not to mention studies showing shifts of other types of fish (for instance demersal) and on smaller scales or regions? I know well the case of North Sea cod (<i>Gadus Morhua</i>), which is completely absent in this report. North Sea cod is a well studied commercial fish species having commercial and survey data spanning various decades. At least three studies have shown that the geographical distribution of North Sea cod has changed from the shallow south-western to deeper, north-eastern parts of the North Sea in the last decades: 1) Hedger et al 2004. Analysis of the spatial distributions of mature cod (<i>Gadus morhua</i>) and haddock (<i>Melanogrammus aeglefinus</i>) abundance in the North Sea (1980–1999) using generalized additive models. Fisheries Research 70 17-25; 2) Engelhard et al 2014. Climate change and fishing: a century of shifting distribution in North Sea cod. Global Change Biology 20 8, 2473-2483; 3) Nicolas et al 2014. Spatio-Temporal Variability of the North Sea Cod Recruitment in Relation to Temperature and Zooplankton. PLOS ONE 9 2. There is a general agreement that temperature rise is responsible for the northward shift, with Engelhard et al 2014 stating additionally that the eastward shift could have been related to fishery. Perhaps a paragraph about this geographical shift can be inserted in Section 5.3 (Section 5.3.3 near the 2nd paragraph), because North Sea cod lives mostly in waters shallower than 200 m depth and is thus considered “coastal” in this report (“coastal seas extend from the coastline towards the 200 m depth)”. Alternatively, Section 5.4.1.1.1 near the last paragraph? [Government of Germany, Germany]</p>	<p>Taken into account - we now provide some nice figures of global distribution of fish catches. The polar chapter, chapter 3 also covers demersal fisheries in more detail than this chapter. There is a report that has just come out from the FAO, which also covers demersal fisheries, and this report has taken an ecosystems approach and so sought to be more complementary.</p>
16423	5	0	0	0		<p>Congratulations to the authors on a much improved SOD! The approved outline of the report calls on Chapter 5 to provide information on limits to adaptation, which is now comprehensively done under Section 5.5.2.5. Given the importance of this topic, the authors should now also elevate key findings to the ES. [Alexander Nauels, Germany]</p>	<p>Taken into account - Thans for the positive remarks and we have elevated some new results on limits of adaptpation to the ES.</p>
17355	5	0	0	0		<p>Text should be thoroughly checked for contradicting statements. This is always a challenge when a group of authors write different parts of a review, since topics might be differently interpreted. I have pointed out some below, but I would assume that I have not caught all of them. [Svein Sundby, Norway]</p>	<p>Taken into account - we have spent a considerable amount of time making the section consistent and linked.</p>

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17357	5	0	0	0		I find that lower-latitude ecosystem dynamics is overemphasized compared to higher latitudes and that generalisations are derived from lower-latitude ecosystems that are not necessarily applicable for higher-latitude ecosystems. [Svein Sundby, Norway]	Taken into account - much of the text has been rewritten, and we agree that the chapter has a mid-latitude and tropical bias because we are very conscious of the polar chapter 3.
17359	5	0	0	0		I find that the tropic levels of zooplankton and fish are not proportionally covered compared to the other level and parts of the marine ecosystem. [Svein Sundby, Norway]	Taken into account - while also shortening the available text by about 40%
20675	5	0	0	0		General comments on section: The final part of the section (pages 82-96 + Box 5.2) read very well and was well referenced - I have very few suggestions here. In contrast, the beginning part of the section (pages 75-82) does, however, need considerable work, both from general flow and content perspectives. While I understand that a lack of references in some cases may be due to a paucity of research being conducted in open ocean environments, there were many outright errors in referencing (perhaps due to the use of a referencing software), which need to be addressed. [APECS Group Review, Germany]	Taken into account - we have worked to reduce the length, improve the coherence of this section, and make clear its key messages
20677	5	0	0	0		General comments on section: Given that this is a report on the cryosphere and the oceans, it feels like there is missing some link to this within this specific section. Having read through the preceding sections of the chapter, this link seems to be more clear and the examples used are more "global" in their breadth. For example, inclusion of indigenous uses/values of marine resources in polar regions in relation to sea ice extent, etc. would be a worthwhile addition and would round out the intended "global" nature of the assessment. [APECS Group Review, Germany]	Taken into account - Chapter 3 covers the polar regions, including the issues raised by this comment.
21423	5	0	0	0		Should include more information about microbial and their ecological and biogeochemical significance. [Rui Zhang, Canada]	Taken into account - this is an example of a process that is very relevant to the climate but which we found very difficult to assess comprehensively.
21425	5	0	0	0		Should introduce more information about marine organic carbon cycling. [Rui Zhang, Canada]	Taken into account - marine organic carbon cycling is another area to complete an assessment of their role in climate change, or as a sink or source of carbon storage in the ocean
22559	5	0	0	0		Suggested reference: Bonebrake, T. C., C. J. Brown, J. Bell, J. Blanchard et al., 2017: Managing consequences of climate-driven species redistribution requires integration of ecology, conservation and social science. Biological Reviews, 93, 284-305, doi:10.1111/brv.12344. [Government of Australia, Australia]	Taken into account - we didn't find a suitable place for this reference in this assessment

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22561	5	0	0	0		Suggested reference: Champion, C., A. J. Hobday, G. T. Pecl, S. Tracey and X. Zhang, 2018: Changing windows of opportunity: Past and future climate-driven shifts in temporal persistence of kingfish <i>Seriola lalandi</i> oceanographic habitat within southeast Australian bioregions. Marine and Freshwater Research, doi.org/10.1071/MF17387. [Government of Australia, Australia]	Taken into account - we didn't find a suitable place for this reference in this assessment
22563	5	0	0	0		Suggested reference: Pecl, G. T., M. B. Araújo, J. D. Bell, J. Blanchard et al., 2017: The universal impacts of species on the move. Science, 355 (6332), doi: 10.1126/science.aai9214. [Government of Australia, Australia]	Taken into account - now referred to
22565	5	0	0	0		Suggest including an explicit cross reference to Chapter 6 regarding how climate change will influence extreme events and climate modes (ENSO, PDO etc). For example, p27 line 20 mentions ENSO variability impacts - and this could include a link to Chapter 6 here. [Government of Australia, Australia]	taken into account -There are links to specific sections in Chapter 6.
23369	5	0	0	0		I congratulate the authors for the second order draft. I have provided comments to the SPM that are relevant for executive summaries of all chapters. The use of the IPCC calibrated language is still missing in the expression of key findings at the end of sections (in summary, ...). The conclusions (ES) do not enough highlight what is new since AR5, and this is also missing in several sections. Links with SD/SDGs could be highlighted more explicitly in the outline (where to find it) and text. Several aspects go beyond the mandate of the chapter (ocean mitigation). Please check the captions of figures, traceability to the assessed literature reporting methods etc to be ensured. [Valerie Masson-Delmotte, France]	Accepted - the chapter has reduced in size and a lot of effort has been made to make the text linked and consistent and we now have a figure around SDG's
23371	5	0	0	0		There is a need to check the consistency between elements of the ES and the underlying chapter. It seems to me that the ES reports on the uptake of CO2 in the last 2 decades but I found the total uptake since pre industrial in chapter. [Valerie Masson-Delmotte, France]	Accepted - the chapter has reduced in size and a lot of effort has been made to make the text linked and consistent on carbon uptake, by key ecosystems
23375	5	0	0	0		Consider providing inputs on time of emergence for SPM (incl. Visual representation). [Valerie Masson-Delmotte, France]	Accepted - Time of emergence features in some bullets.
23377	5	0	0	0		Too many subsections on gaps / summaries. I suggest to have a summary of key finding at the end of each subsection and treat gaps altogether in the final section (to be structured by theme). Sections need to provide a clearer understanding of the links between projected risks with the level of global warming, the scenario, the time horizon (at the moment often missing). [Valerie Masson-Delmotte, France]	Taken into account - key uncertainties and gaps are collected in the last section

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28479	5	0	0	0		The executive summary is missing important findings on the impacts for coastal and island communities as well as on the impacts at 1.5°C and beyond. This crucial information needs to be added. [Government of Saint Lucia, Saint Lucia]	Taken into account - SIDS are mentioned and assessed in some sections. The CCBox on low lying islands also covers some of this type of material.
31751	5	0	0	0		When referring to something discussed/assessed in other chapter, please specify the section in that chapter instead of only referring to "Chapter xy" [Hans-Otto Poertner and WGII TSU, Germany]	References to other chapters have been made more specific.
31753	5	0	0	0		be consistent in the use of full terms vs acronyms and introduce acronyms at first mention (please check SROCC styleguide and author instructions). At the moment this is not consistent (see e.g. AMOC in 5.2.2.2) [Hans-Otto Poertner and WGII TSU, Germany]	Taken into account - accepted and through the text
31755	5	0	0	0		Cross referencing to other chapters (e.g. Chapter 3) needs to be improved. When referring to information in other chapters, please indicate sections. [Hans-Otto Poertner and WGII TSU, Germany]	Taken into account -References to other chapters have been made more specific.
31757	5	0	0	0		Acronyms: there are many redundant acronyms in this chapter. Please carefully check which acronyms are really necessary and where full term can be provided only. [Hans-Otto Poertner and WGII TSU, Germany]	Several of the unnecessary acronyms have been eliminated.
31759	5	0	0	0		The entire chapter needs to be significantly shortened (it is exceeding the approved target page length by almost 60%). Reduction of details and restructuring might help to reduce repetition across sections and shorten. Many parts are rather text-book style with a lot of "old" (pre-AR5) information given in detail. I suggest focussing on new information since AR5 [Hans-Otto Poertner and WGII TSU, Germany]	Taken into account - the text is now 40% shorter and just 80 pages long compared with the second order draft of 154
31761	5	0	0	0		Please clearly indicate what's new since AR5 [Hans-Otto Poertner and WGII TSU, Germany]	Results from AR5 are now clearly indicated.
31763	5	0	0	0		Please carefully check and consider results from SR15 [Hans-Otto Poertner and WGII TSU, Germany]	SR15 is now referenced in several prominent and appropriate places.
31765	5	0	0	0		The current structure with section 5.2 (open) ocean and 5.3 coastal seas does not work very well. There is a lot of repetition and overlap (e.g. tides and impacts on coasts are discussed in 5.2). Moreover, many/most of the physical and biogeochemical changes described for the open ocean in 5.2 also apply to coastal seas (according to your definition up to 200m water depth) in 5.3. I strongly suggest to restructure and not to try to completely separate open ocean and coastal seas, that does not make sense. This may also help to reduce repetition and to shorten the text. [Hans-Otto Poertner and WGII TSU, Germany]	Section 5.2 covers all large-scale physical and biogeochemical changes, and the section heading has been changed accordingly

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31919	5	0	0	0		Please respect the original page allocations in the government approved outline. In the text please focus on the policy relevant issues and those aspects that help developing a clear, coherent and comprehensive picture, and condense textbook like or review elements simply describing the system under study. [Hans-Otto Poertner and WGII TSU, Germany]	Many of these elements have been substantially reduced, with greater focus on issues that are directly policy relevant or are the primary drivers for the changes discussed in later sections.
20673	5	0	0	0		In general, I tried to avoid commenting too much on mistakes in sentence structure, spelling and grammar. The flow and readability of this section can be improved upon, and an experienced copy editor will need to work on this further as far as language errors. It is obvious in some places that a different author has stepped in, as there are noticeable differences in the text. [APECS Group Review, Germany]	Coauthors of all of the subsections, including native English speakers, have now reread and edited the text throughout the entire document to improve the grammar and syntax.
4879	5	0	0	0		Figure 5.9 Consider including in the legend something like this: "Bars show total estimated range shift (or total phenology shift) sorted from highest to lowest, for N studies. Blue means the shift is in the opposite direction than expected." Rotate d. graphs so that they match the orientation as in c. graphs (vertical bars). Please give an indication in a. and b. as to the numbers in each category, eg [N=34 ***]. - what does 'inconclusive' mean in this context? No significant change detected? - "[-] antagonistic" is mentioned in legend, but doesn't seem to appear in the figure. - Move last sentence in legend ("T – temperature, OA - ocean acidification...") to definition of panel a. "organism's body size" - is that larger or smaller or both/either? [Debra Roberts and Durban Team, South Africa]	Taken into account: figure has been simplified and legend included and now easier to read
5189	5	0	0	0		Use of the ecosystems framework has helped create a much more integrated chapter - but the excessive chapter length makes it difficult to read so this value is lost [Debra Roberts and Durban Team, South Africa]	Accepted - text revised and changes made to material to make a greater fraction assessment and less review
5191	5	0	0	0		ES is light on figures re: impacts, responses and related costs [Debra Roberts and Durban Team, South Africa]	Taken into account - the ES now sports a range of assessments that are specific, particularly in the physical bio geochemical and fisher disciplines
5193	5	0	0	0		No reference to SDGs in the ES [Debra Roberts and Durban Team, South Africa]	Taken into account - no specific and strong assessment came forward from the underlying text about the SDG's.
10727	5	0	0	0		I am not sure why 5.3.3.10 and 5.3.4 were split. I would suggest to merge them. [Jean-Pierre Gattuso, France]	Taken into account - we kept the two sections separate in the end
25477	5	0	0	0		FIGURE 5.2 IS DIFFICULT TO INTERPRET. ADDITIONAL EXPLANATIONS MIGHT BE USEFUL [Christophe Deissenberg, Luxembourg]	This figure has been reorganized to clearly separate observed and projected changes, and different color bars will be used for temperature, salinity, and density changes. Also, the revised section structure, which combines the projected and observed trends should help make the discussion and figure easier to follow.

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31979	5	0	0	0		There may still be some confusion between proper relations between review (out of scientific interest) and assessment with relevant background information as well as a lack of focus on policy-relevant storylines. Sorting this out will be very helpful in the much needed but painful shortening exercise. [Hans-Otto Poertner and WGII TSU, Germany]	This separation of assessment and review and policy questions is the path to a more concise chapter.
32007	5	0	0	0		There may still be some confusion between proper relations between review (out of scientific interest) and assessment with relevant background information as well as a lack of focus on policy-relevant storylines. Much of the undoubtedly interesting background information could be shortened or moved to OSM if truly needed as background information for the assessment. [Hans-Otto Poertner and WGII TSU, Germany]	See above
32009	5	0	0	0		The treatment according to habitats or biomes open ocean, deep sea , coast etc comes with high risk of redundancy and overlap on principles. This emphasizes the suggestion made earlier to address the principles first and then compare the systems with respect to climate drivers, impacts and adaptation in a concise way. The same approach may work for ecosystem services p. 75 onward. [Hans-Otto Poertner and WGII TSU, Germany]	Taken into account - we also consider the "principles" but wanted to alsoe differentiate from the AR5 approach
34025	5	0	0	0		There seems to be lack of discussion on the impact of rate of change that can often be as big a factor as total change. [Government of United States of America, United States of America]	This critical point is now explicitly highlighted in several areas, such as the response of coastal ecosystems to sea-level rise.
34027	5	0	0	0		The connection between OA and anthropogenic CO2 uptake is not clearly defined. [Government of United States of America, United States of America]	Taken into account - we have sharpened up the ocean acidification section, including pH
34029	5	0	0	0		The connection between increasing CO2 and decreasing pH is not always well articulated. [Government of United States of America, United States of America]	Taken into account - we have sharpened up the ocean acidification section, including pH
34031	5	0	0	0		When possible, use ocean temperature change rather than ocean heat content (or relate the two better). [Government of United States of America, United States of America]	This needs some discussion withn the chapter team. Temperature is certainly meaningful in terms of the physiological responses. Heat content is almost linearly related to the vertically integrated temperature change.
34033	5	0	0	0		With respect to ocean acidification, it should be noted that an important aspect of an acidification event occurs when the rate of CO2 increase exceeds the rate at which rock weathering can provide an adquate alkalinity supply to compensate. Thus, there have been historical periods of much higher CO2 (and even lower pH) but saturation states remained suitably high to maintain calcification rates in the oceans. Acidification events are thus distinguished not by ocean pH but rather by the rate of CO2 change in the ocean relative to supplied buffering from continental weathering. [Government of United States of America, United States of America]	rejected - while relevant it is out of scope for this climate change report in the oceans that has a pretty narrow time frame from pre-industrial to 2100.

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34035	5	0	0	0		The chapter needs a good copyedit to catch issues related to singular/plural, inclusion of articles, and other issues of English language use. [Government of United States of America, United States of America]	Agree, can we get help here
34037	5	0	0	0		This document would benefit from a heavy and comprehensive edit to make it more cohesive and streamlined. The text wanders in some places and is highly repetitive. There are also contradictions between sections in summary statements that need to be reconciled. [Government of United States of America, United States of America]	accepted - and taken into account. Coauthors of all of the subsections, including native English speakers, have now reread and edited the text throughout the entire document to improve the grammar and syntax. Contradictions between sections have been addressed.
34039	5	0	0	0		Chapter 5 is an excellent synthesis of a broad body of science concerning changing oceans, marine ecosystems, and dependent communities. It provides a well-written review of the state of knowledge in this area based on extensive literature. The findings are well-documented and clearly presented with information on the level of confidence following the IPCC standards. The chapter clearly identifies the scope, scale, and direction of changing ocean systems and the impacts and implications for the systems and dependent human communities. [Government of United States of America, United States of America]	Thank you for this comment.
2613	5	1	0	224		In general the chapter is very nicely written and no more changes needed now. [Pushp Raj Tiwari, United Kingdom (of Great Britain and Northern Ireland)]	Thank you for this comment.
14051	5	1	0	224		It is not clear to the reader exactly what the remit of this chapter is. There is a partial and incomplete discussion of past and projected changes in physical variables such as temperature and salinity (but not circulation, which is dismissed fairly lightly and/or referred to other chapters, especially in the ES). This is followed by a quite wide-ranging discussion of impacts on biogeochemistry, ecosystems and other areas. However the discussion of these areas is not firmly linked to the driving physics. Hence the potential value of the chapter in providing an integrated discussion from physical climate change through to marine impacts is not realised. While it may be too late to restructure the chapter, it would be very helpful (and probably feasible) to include a more explicit discussion, when discussing downstream changes in biogeochemistry and ecosystems, of the key physical changes that drive each change. This should include any areas where confident attribution to climate change is (or isn't) possible. [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	In revising the chapter, we have attempted to achieve a tighter integration across the chapter, and there are references throughout the chapter to the other relevant subsections.

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14053	5	1	0	224		<p>A specific area of omission is discussion of physical changes in the shelf seas environment. There is little if any mention (e.g. in Section 5.3.2) of studies that have focused on this by downscaling global climate models. While Section 5.3.2 discusses some generic points, assessment of actual impacts requires specific regional projections and this does not come through. For shelf regions one does not expect global models to provide good state estimates, e.g. due to poor representation of shelf break exchange and tidal mixing. For North-west Europe, for example, such downscaled projections are available. It seems important that the chapter discusses such downscaled projections and their role in assessing future marine impacts of climate change. (See following references below): References on downscaled projections for NW European shelf (re previous comment):</p> <p>Uncertainty in climate projections for the 21st century northwest European shelf seas. Tinker, Jonathan et al.. PROGRESS IN OCEANOGRAPHY 148, 56-73 (2016)</p> <p>Validation of an ensemble modelling system for climate projections for the northwest European shelf seas. Tinker, Jonathan et al. PROGRESS IN OCEANOGRAPHY 138,211-237 (2015)</p> <p>The potential impacts of climate change on the hydrography of the northwest European continental shelf. Holt, Jason et al.PROGRESS IN OCEANOGRAPHY 86, 361-379 (2010)</p> <p>These projections have been used for specific studies of downstream impacts, e.g. Future fish distributions constrained by depth in warming seas. By: Rutterford, Louise A.; Simpson, Stephen D.; Jennings, Simon; et al. NATURE CLIMATE CHANGE Volume: 5 Issue: 6 Pages: 569-+ Published: JUN 2015 [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]</p>	<p>A discussion of the challenges of projections of changes in the coastal environment and the use of downscaled regional models to do this has been added to section 5.2.2.2.3, including a citation of the suggested Tinker et al., 2016 paper. (Thank you for that suggestion.)</p>
14055	5	1	0	224		<p>An example of the imbalance between physical and impacts discussion is that there is not even any discussion of basin scale physical changes. This seems to be insufficient to understand anything beyond the global mean picture, despite the chapter's aspiration to consider both global and regional scales (page 7 line 56). [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]</p>	<p>This has been at least partially addressed by restructuring section 5.2.2 to bring observed and projected changes together, avoiding repetition and offering a more coherent description of climate-related changes, and to highlight the challenge regional manifestations of anthropogenic climate change in the presence of substantial natural variability.</p>
14059	5	1	0	224		<p>Consider making the key points for policy makers in this chapter more accessible by summarising them in the Executive Summary or Introduction. [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]</p>	<p>Taken in account - more specific ES bullets were created for the policy makers, greater attention to RCP2.6 and RCP 8.5</p>

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15793	5	1	1	21	41	General comment: the report considers the role of coastal and blue carbon ecosystems for climate mitigation and adaptation. But it would be helpful to look at and analyse potential of ocean seaweed farming, marine permaculture, development of microalgae farming (e.g. coccolithophores) and their potential impact on climate mitigation [EUCE, Belgium]	Taken into account - blue carbon in the coastal environment was considered along with seaweed as these were the main policy relevant stores .
14049	5	1	1	224	1	A general feeling that the figures do not match the text well. IT is clear that the figures have been taken from other publications as they are often not referred to in the text or only part of the figure is relevant to the text. Many of the figures are difficult to interpret, even for specialists. They would all benefit from being edited by a designer for consistency and to improve interpretation. [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	Taken into account - we have simplified figures, we have matched the text to the figures and the TSU has helped with graphics designers
9923	5	1	1	224	19	General comments. The text gives a very detailed and scientific supported knowledge about the physical, biological and chemical processes and the interaction of the land-produced anthropogenic impacts, the GHG emissions and the impacts in the ocean and its inhabitants. The text is still missing a systemic integration between the natural and the human-induced factors. The gender theme should be transversal and is only marginally mentioned in one subchapter. However, especially women are open to changes and collaborate actively in adaptation and restoration activities at local and national level. They can empower and the methodology of education by Paolo Freire has helped in Latin America to involve actively communities, indigenous and peasants to increase their resilience. Fishermen are highly exposed to extreme hazards, when early warning is missing, thus the chapter requires a transversal gender revision, gender understood as socio-cultural representation of masculinity and femininity. There is also too much emphasis on French Polynesia when speaking about indigenous communities. In Africa, Asia and Latin America exist multiple experiences from bottom-up to deal with climate-induced changes in coastal areas. This is also reflected in a primary occidental reference analysis. [Úrsula Oswald Spring, Mexico]	Taken into account - we now have two sentences on gender in the context of SDG's

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14047	5	1	1	224	20	This chapter is too long and tries to cover too much - this generates inconsistency and confusion. It could be covered over four 30 page chapters - Changing Ocean, Changing coastal seas, Changing marine ecosystems and Impacts on people? Many sections of the text read like a listing of results, with the structure of the argument unclear. The chapter sets out to answer some focused questions (page 7 lines 51-56), but this structure is not always clear in the way the sections are written. The text could be made both shorter and clearer by structuring the sections clearly around the questions. [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	Taken into account - the reeport is much shorter, more tightly integrated and much more assessment material
25311	5	1	1	300	70	This chapter is simply overwhelming. It is very broad in scope and contains great detail; together it is nearly impossible to get an overall takeaway of ocean implications. That this is the special report on oceans and cryosphere and just one chapter focuses primarily on changing oceans seems insufficient, and has resulted in this beast of a chapter. I strongly urge the lead authors to take a firm hand in helping streamline the chapter so that the same level of detail appears in all the sections, and similar/parallel information is offered to allow elements of the ocean system and issues related to it to be intercompared. Ideally, the chapter could be split somehow, but I realize that may not be possible given the editorial schedule of this report. [Sarah Cooley, United States of America]	Taken into account - we have shortened the chapter by 40% and have distilled out a lot of material while fitting into the scope of the chapter outline.
12093	5	1	27	1	27	"Taiwan" is changed to "Taiwan Province of China". [Government of China, China]	Taken into account -
14057	5	1	33	1	36	The ocean absorbs carbon dioxide which is acidifying and is a direct impact of emissions rather than a climate-related impact. Suggested editing as follows: "Increased emissions of greenhouse gases and other human activities are causing clear and, in some cases, irreversible changes in the ocean and cryosphere, altering living conditions for ecosystems and people." [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	Taken into account - the text has some bullets like this and also in the syntehsis section
27771	5	2	1	6	39	The executive summary discusses uses RCPs 2.6 and 8.5 throughout implcitly assuming the reader to know their significance within the range of AR5 scenaraios. Maybe their role as the extreme ends in this range should be indicated more explicitly at this level. [Momme Butenschön, Italy]	This point is now made explicitly in the introduction and in many places in the text where language identifies RCP2.6 as a low-emissions scenario and RCP8.5 as a high-emissions scenario.
27769	5	2	4	2	4	"key services like climate regulation": might be worthwhile to extend a little beyond climate regulation adding other equally important processes such as food provision [Momme Butenschön, Italy]	Taken into account - we discuss ecosystes services

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1579	5	2	8	2	19	I wonder if this opening statement can be made more quantitatively? Obviously zettajoules is a difficult unit for a policy maker (and perhaps even for a scientist) but figure 5.1 does give some estimates in Wm-2 which could, for example be compared with the radiative forcing. I presume this (or the time integrals of it) is used to get the more user-friendly '90% of excess heat from global warming goes into the ocean'. [Matthew Collins, United Kingdom (of Great Britain and Northern Ireland)]	We have added text to the footnote introducing Zetta Joules indicating that 5500 ZJ could warm the entire ocean by 1 C, while 144 ZJ would warm just the top 100 m by 1 C.
1581	5	2	8	2	19	Surprised not to find any mention of the 'hiatus' here [Matthew Collins, United Kingdom (of Great Britain and Northern Ireland)]	Accepted - we link to chapter 6 sections 6.6.1 ?
14063	5	3	22	3	22	Explain what 'lighter' means in this context [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	Here we meant less dense, and this sentence has been revised accordingly.
1583	5	2	33	3	33	The 25+/-5% figure could arguably go in the bold text at the beginning of this statement. [Matthew Collins, United Kingdom (of Great Britain and Northern Ireland)]	Accepted - also we need to make sure this figure is consistent with SR15 and AR4. I have the number 29% in mind.
1585	5	2	40	2	40	0.02 pH units sounds very small. This could be one place where it would be useful to join up the statement about physical changes with the impacts on ecosystems. Just how damaging is a 0.02 pH change? Also, perhaps include some information about attribution and projections? [Matthew Collins, United Kingdom (of Great Britain and Northern Ireland)]	Accepted - text revised
15795	5	3	0	3	0	The summary is comprehensive, but it would benefit from the following: (i) inclusion of a preceeding list of key summary points (e.g. ocean is stratifying, ocean sinks continue to strengthen, etc.) to allow for a busy reader to get a quicker overview of what is covered; (ii) linking some of conclusions of the report (notably in terms of physical changes to the oceans) to their associated ecological and environmental consequences, in order for the reader to be able to easily comprehend the magnitude of impacts and their translation in terms of follow-up impacts; (iii) a clear list of recommendations, including research gaps and action points on solutions (those with high confidence) - these are "softly" noted through the chapters, but might be easily missed for those looking for a quick overview of the possible solutions (notably policy makers) [EUCE, Belgium]	Accepted - summary changed. The question on gaps is rejected and including in the section at the end of the chapter
15257	5	3	0	0		The current executive summary stays largely silent on the vulnerabilities and exposure on coastal communities. Please provide quantitative information in a SDG relevant framework including on economic and employment impacts. [Government of Gambia, Gambia]	Taken into account -

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15259	5	3	0	0		Information on limits to adaptation and loss and damage is absent from the executive summary. However, it is available in the underlying chapter (5.4.2.2.1, 5.5.2.5). Please provide information in the summary as well. [Government of Gambia, Gambia]	Taken into account - loss of damage is missing because it is very hard to make a good assessment, however we have brought forward limits of adaptation from parts of Section 5.5.2.
14071	5	3	0	6		The language in the Executive Summary is complex and concepts such as radiative forcing and the RCPs are lacking proper explanation. The style of writing is often difficult to digest, with long and complex sentences that are not appropriate for a non-technical reader. Please consider revising language and clarifying technical terms here. [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	Accepted - Executive Summary has been revised to simplify and shorten sentences, and links to chapters sections to ensure the traceability of the executive summary is maintained
14075	5	3	0	7		The Executive Summary seems unbalanced. There are a couple of paragraphs about physical changes (incomplete and lacking even basin-scale detail and then a huge amount about the impacts on biogeochemistry and ecosystems. The link between physical changes and consequential changes in biogeochemistry and ecosystems needs to be made clear in the later paragraphs of the ES. [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	The link of the physical changes to the later paragraphs has been made explicit, but this imbalance emphasizing ecological changes largely reflects the Agreed Outline that was given to this chapter, with only 1 bullet point of 8 in its mandate partly covering physical changes. <<<Question for the committee, should we add a bullet on changing tidal patterns to address this point?>>>
14077	5	3	0	7		A specific omission in the ES is discussion of changes in (basin scale) circulation (including AMOC). It's unhelpful to the reader to have discussion of large scale changes dotted about the chapters without an obvious rationale. It may be too late to change the overall distribution of material between chapters but there should be somewhere where a reader can pick up an integrated view of changes in the large-scale ocean. This could be achieved by adding a paragraph to the Executive Summary of Chapter 5 on ocean circulation, and specifically the North Atlantic – obviously this would need to be consistent with the conclusions of Chapter 6. Is the North Atlantic the only basin where circulation variability and change are important? Probably not, e.g. what about changes in ventilation rates of mode waters? [Government of United Kingdom (of Great Britain and Northern Ireland),]	Rejected - link to AMOC discussion in Chapter 6 (Section 6.7.1.1) and avoid inconsistency.

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31921	5	3	1	0		The executive summary gives a nice general, mostly qualitative overview but would be more punchy if key findings could be detailed (specified and quantified), also and especially with respect to solution options by adaptation and mitigation efforts. This would also help the development of the SPM as a stand-alone document. I have indicated where such question marks come up when reading the present ES. If quantitative statements are not possible for global scale they may still be possible for key regional examples (case studies). Providing semi-quantitative estimates or orders of magnitude would also help to understand better and e.g. differentiate between whether projected mean global or regional changes are by e.g. 5 or 95 %. [Hans-Otto Poertner and WGII TSU, Germany]	Accepted - more quantitative estimates have been added to the ES from the underlying text.
31923	5	3	1	0		Differentiation between scenarios is needed in many ES statements, also including the 1.5 report as a starting point. [Hans-Otto Poertner and WGII TSU, Germany]	Accepted - differentiation between the two scenarios RCP 2.6 and RCP 8.5 is now uniformly applied to the ES statements where appropriate
4427	5	3	1	3	1	The first sentence is quite generic and could be deleted. [The UBern Team Group Review, Switzerland]	Accepted - the first paragraph has been extensively revised.
24693	5	3	1	3	1	general overall comment. The content of chapter 5 requires more work to clarify and correct the content. Whereas chapter 1's content appears much more well developed and only appears to require relatively minor work. It might be prudent to focus some of the effort from Chapter 1 lead authors to help fill holes in expertise and knowledge that seem to exist in the authors writing chapter 5. [Shutler Jamie, United Kingdom (of Great Britain and Northern Ireland)]	Accepted - The CA list already includes Chapter 1 lead authors, but was expanded in this round.
24707	5	3	1	3	1	general overall comment. This chapter appears to completely miss out the role of the continental shelf seas for absorbing carbon and later exporting it to the open ocean (the continental shelf pump). the air-sea CO2 sink is covered for the open ocean (depth >200m) and is discussed for rivers, beaches, inter-tidal zone, (blue carbon bit) but the section in between (i.e. water that is <200m, but not coastal) is omitted from all sections. this has links with temperature as these shelf seas are warming faster than the open ocean and changes in circulation and exchange with the open ocean could have profound impacts on the carbonate system (pH) in these shelf seas. there is some work on this that lead author Phil Williamson will know about, but more is needed to allow robust monitoring of the health of this system. [Shutler Jamie, United Kingdom (of Great Britain and Northern Ireland)]	Phil Williamson, issues will be warming faster, but more variable ... PW: Info on shelf seas has been included, but included as part of 'coastal'. It would help if that were made more explicit, using phrase 'coastal and shelf seas' except where coastal = inshore

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14069	5	3	1	6	39	The Exec Summary points are very different in style and content. The bold text need to be specific and clear, with concise and focused supporting text in the subsequent paragraph. [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	Accepted - have been homogenised in this round
30437	5	3	1	6	41	The ES statement does not contain any statement regarding projected changes in upwelling systems, despite these systems being critical in terms of projectivity. Even if no statements can be made with confidence, that needs to be reflected in the ES. [Francois Engelbrecht, South Africa]	How to include changes in EBUS and other systems, even where there is no robust and clear knowledge?
29745	5	3	2	6	39	I was surprised not to see more indication/findings of what the consequences are likely to be to low lying islands and what their option are for responding, and how long such approaches might work and be effective. In my view, the increasing indications of loss of mass from the Greenland and Antarctic ice sheets are making them more and more vulnerable to early inundation, and starting to raise questions about where they can relocate to needs to begin. Not even the last finding included a discussion of small island complications, etc. [Michael MacCracken, United States of America]	Section 5.5 team.... also links to Chapter 4.
31925	5	3	3	0	6	This is a textbook like introductory text which can be dropped. [Hans-Otto Poertner and WGII TSU, Germany]	Rejected - The line numbering is incorrect and not sure what text this is referring too
4429	5	3	3	3	3	Should be 'Earth' [The UBern Team Group Review, Switzerland]	Earth has been capitalized.
21907	5	3	3	3	3	is the ocean really essential for ALL aspects of human wellbeing? I'm not so sure. Perhaps tone down? [David Schoeman, Australia]	This sentence was removed during a larger-scale revision of the Executive Summary.
29725	5	3	3	3	3	Apologies for a grammatical comment, but please capitalize "Earth" when referring to the planet. [Michael MacCracken, United States of America]	Earth has been capitalized.
11467	5	3	3	3	4	I think that saying the ocan is *essential* for *ALL* aspects of human well-being and livelihood is a bit too bold of a statement. [Anson Cheung, United States of America]	This sentence was removed during a larger-scale revision of the Executive Summary.
22897	5	3	3	3	4	These two first statements: "Ocean and cryosphere are important components of the earth system. The ocean is essential for all aspects of human well-being and livelihood." are understatements, and need to be rewritten. Here is a suggestion for an improved statement: "Ocean and Cryosphere covers more than 80% of the total surface of Earth. Therefore they represent important components of the Earth system. Obviously, they are essential for all aspects of human well-being and livelyhood." [Martin Hovland, Norway]	Accepted - response was toned down
26581	5	3	3	3	4	Interestingly, the use of the term "dependent communities" seems to refer more to non-human communities than to human communities who are the ones creating the anthropogenic changes and challenges. [Florence Poulain, Italy]	Taken into account: section 5.4 and 5.5 does cover the human side services and adaptation. These sections are quite extensive

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598	5	3	3	3	6	This paragraph could be reworded. The intentions of the chapter aren't completely clear here, in particular the relationship between climate and biodiversity. [Jenna Pearson, United States of America]	This paragraph was removed during a larger-scale revision of the Executive Summary.
20845	5	3	3	3	6	The ocean provides other key services for human-well being like food as well. [APECS Group Review, Germany]	This paragraph was removed during a larger-scale revision of the Executive Summary, while food provisioning is explicitly mentioned in the first paragraph of the introduction..
21037	5	3	3	3	6	Consider putting the cryosphere into the same context as the ocean here: what is it and why is it important/linked to the ocean [APECS Group Review, Germany]	This suggestion would be more appropriate for Chapter 1, and it goes beyond what could be accommodated in the space available in this chapter.
22815	5	3	3	3	6	This is overly general as an introductory section. Would be better to explain what THIS chapter is contributing. Suggest deleting the first two sentences and start with the third sentence, then perhaps expand a bit on marine ecosystems and communities. [Raphael Kudela, United States of America]	This paragraph was removed during a larger-scale revision of the Executive Summary.
26395	5	3	3	3	6	This paragraph should be more specific. As it is, it gives no meaningful information, and is too broad to serve as a roadmap for the rest of the chapter. [Ethan Pierce, United States of America]	This paragraph was removed during a larger-scale revision of the Executive Summary.
16855	5	3	3	6	41	The ES is missing information on limits to adaptation and Loss and Damage. However, there is ample evidence in the chapter for such limits and associated losses such as loss of coral reefs, substantial reductions in tropical marine productivity, and deoxygenation. Please add and lift respective information to the SPM. [Government of Grenada, Grenada]	Taken into account - We looked at loss and damage, but the assessments of the literature did not permit a strong assessment
28481	5	3	3	6	41	The ES is missing information on limits to adaptation and Loss and Damage. However, there is ample evidence in the chapter for such limits and associated losses such as loss of coral reefs, substantial reductions in tropical marine productivity, and deoxygenation. Please add and lift respective information to the SPM. [Government of Saint Lucia, Saint Lucia]	Taken into account - We looked at loss and damage, but the assessments of the literature did not permit a strong assessment
33529	5	3	4	3	4	Maybe should be "key roles" instead of "key services". [Government of United States of America, United States of America]	This paragraph was removed during a larger-scale revision of the Executive Summary.
16571	5	3	4	3	5	key ecosystem services that ocean could provide also include providing us sea food, and recreational with tourism [Liu Jie, Norway]	accepted - and indeed they do
33531	5	3	4	3	5	This sentence needs to be edited: "It provides key services, like climate regulation, through the energy budget, carbon cycle, and nutrient cycle." [Government of United States of America, United States of America]	This paragraph was removed during a larger-scale revision of the Executive Summary.
4431	5	3	5	3	6	Microbes and marine mammals are not examples for biodiversity [The UBern Team Group Review, Switzerland]	Accepted - we have been more rigorous in the final draft
26583	5	3	5	3	6	The limitation of the range of biodiversity from microbes to marine mammals ignores the vast diversity of fisheries species that contribute more to human nutrition than the others. [Florence Poulain, Italy]	This paragraph was removed during a larger-scale revision of the Executive Summary.

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4433	5	3	6	3	6	maybe delete word 'open' [The UBern Team Group Review, Switzerland]	This paragraph was removed during a larger-scale revision of the Executive Summary.
14065	5	3	6	3	6	I would say the term "pelagic" is redundant [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	This paragraph was removed during a larger-scale revision of the Executive Summary.
21909	5	3	6	3	6	The reader hasn't yet seen the definitions of pelagic and coastal ocean. I was left wondering "where is the benthos?". Perhaps consider rewording? [David Schoeman, Australia]	This paragraph was removed during a larger-scale revision of the Executive Summary.
3885	5	3	8	3	10	These statements strongly imply that over the past several decades the ocean warming occurred everywhere and from the [Zhaomin Wang, China]	Section 5.2.2 has now been extensively revised to discuss the differences between internally generated variations and the anthropogenic long-term trend. This statement about the vertical extent of the long-term warming trend is not contradicted by the specific examples of regional interannual variations.
3887	5	3	8	3	10	surface to bottom. This is not true. At least, between the 1970s and 2010s, there was no obvious surface warming as [Zhaomin Wang, China]	Section 5.2.2 has now been extensively revised to discuss the differences between internally generated variations and the anthropogenic long-term trend. This statement about the vertical extent of the long-term warming trend is not contradicted by the specific examples of regional interannual variations.
3889	5	3	8	3	10	indicated by changes in average SST over the Southern Hemisphere(Fig. 5 of Gille, S. Decadal-scale temperature trends in [Zhaomin Wang, China]	Section 5.2.2 has now been extensively revised to discuss the differences between internally generated variations and the anthropogenic long-term trend. This statement about the vertical extent of the long-term warming trend is not contradicted by the specific examples of regional interannual variations.
3891	5	3	8	3	10	the Southern Hemisphere Ocean. J. Climate 21, 4749-4765 (2008)), and there was even a cooling trend at southern high [Zhaomin Wang, China]	Section 5.2.2 has now been extensively revised to discuss the differences between internally generated variations and the anthropogenic long-term trend. This statement about the vertical extent of the long-term warming trend is not contradicted by the specific examples of regional interannual variations.
3893	5	3	8	3	10	latitudes (Zhaomin Wang, Xiangdong Zhang, Zhaoyong Guan, Bo Sun, Xin Yang & Chengyan Liu An atmospheric origin of [Zhaomin Wang, China]	Section 5.2.2 has now been extensively revised to discuss the differences between internally generated variations and the anthropogenic long-term trend. This statement about the vertical extent of the long-term warming trend is not contradicted by the specific examples of regional interannual variations.
3895	5	3	8	3	10	the multi-decadal bipolar seesaw. Scientific Reports 5, 8909; DOI:10.1038/srep08909 (2015)). [Zhaomin Wang, China]	Rejected - This paper is more relevant to Chapter 3 and the cross chapter box on the Southern Ocean. However the general point on climate variations is now made much more explicitly in section 5.2.2.2.3 than it was previously.
15797	5	3	8	3	12	Good overview, but lacks quantification (e.g. how much have the oceans warmed up?) even if only added as ranges as provided ahead in the chapter; it also misses contextualisation in terms of associated impacts (e.g. movements of biological resources), which could be briefly added by listing a couple of these consequences as examples. [EUCE, Belgium]	Accepted - the question here is about the policy side of the physical changes on biological systems. I feel this link needs to be strengthened and made more clear.
4435	5	3	8	3	19	Maybe good to quantify also changes in SST (not only heat content), given that this is one of the best observed quantity in the ocean. [The UBern Team Group Review, Switzerland]	Accepted - additional statement about temperature changes and perhaps including surface temperature changes.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
15697	5	3	8	3	19	What about the challenges of attributing observed changes to climate change rather than natural variability? This statement should summarise the chapter's findings on this (e.g. from 5.2.2.2.2), which seem to be that there are more lines of evidence since AR5, enabling to be more confident in attributing changes to global climate change, despite challenges of natural and local variability. [EUCE, Belgium]	Accepted - there is more evidence since AR5 but we have kept ocean attribution of climate change very modest because there are very few regional studies.
23655	5	3	8	3	19	The paragraph refers to many different time spans (since 2004, AR5, 2004-2016, "continues to warm", since 1970, "since the start of the 20th Century"). It would be useful, if some redrafting could be done (of course respecting possible data limitations). For example, the "warmed unabated since 2004" does not reconcile with the last statement about the oceans warming up since more than 100 years ago. Did AR5 estimate only until 2004? "continues to warm" is unclear. Etc. [Government of Sweden, Sweden]	Accepted - text refined in ES
14079	5	3	8	3	25	A specific omission from the ES (and the chapter) is discussion of downscaled projections of physical changes in shelf seas - reading off changes on shelf seas from global model projections is not always reliable. [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	A discussion of the use of high-resolution regional downscaled models and the challenges of making projections in the shelf seas has been added to section 5.2.2.3. Should it also be added in the ES?
9697	5	3	8	3	9	The ocean has warmed (use the singular as in the next paragraph). [Government of France, France]	Accepted - corrected as suggested.
9699	5	3	9	3	10	Use a stronger formulation than "dominate" since the ocean stores 93% of the heat energy surplus. [Government of France, France]	Rejected - This is a direct quote from AR5. Also, "dominate" is already a strong formulation.
11543	5	3	9	3	12	"Ocean warming ... pervades the ocean from surface to bottom." The statement from "pervades ..." needs to be clarified or it may be read as the *whole* ocean from top to bottom. The blanket statement "pervades the ocean from top to bottom" seems to be contradicted by Figure 5.3 which shows cooling in the abyssal ocean in the Southeast Atlantic, the North Atlantic, and the western Indian Oceans. Figure 5.1 and 5.2 only show temperature change to 2000 meters. Given the paucity of measurements from many parts of the deepest basins, and the fact that the statement seems to reserve "high confidence" for the Southern Hemisphere, this statement should be modified. Either provide a depth limit over which the statement does apply with high confidence throughout the ocean, or a caveat such as 'large areas of the ocean.' [William Howard, Australia]	Taken into account - the assessment of is more qualified to the Southern Ocean. It is pervasive though, upper ocean 700-2000 metre layer have all warmed plus the Southern ocean...

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
22531	5	3	9	3	12	<p>Suggest clarifying use of the term 'pervades' since it may be read as referring to the *whole* ocean from top to bottom.</p> <p>In addition, the statement "pervades the ocean from top to bottom" seems to be contradicted by Figure 5.3 which shows cooling in the abyssal ocean in the Southeast Atlantic, the North Atlantic, and the western Indian Oceans. Figure 5.1 and 5.2 only show temperature change to 2000 meters. Given the paucity of measurements from many parts of the deepest basins, and the fact that the statement seems to reserve "high confidence" for the Southern Hemisphere, this statement should be modified to provide either a depth limit over which the statement does apply with high confidence throughout the ocean, or a caveat such as 'large areas of the ocean.' [Government of Australia, Australia]</p>	Taken into account - we have a more caveated statement, but the evidence of warming is pervasive with southern ocean abyss
29205	5	3	9	3	12	<p>The upper ocean (0–700 m) and 700–2000 m layers have both warmed from 2004 to 2016 (virtually certain¹) and the abyssal ocean (below 4000 m) continues to warm in the Southern Hemisphere..¹ This statement needs an explanation related to the ocean uptake of heat and overturning circulation and stratification. (same comment at page 54 lines 46-48.) [Patrizia Ziveri, Spain]</p>	Taken into account - the text describes part of the overturning circulation and the abyssal warming changes
476	5	3	10	3	11	<p>I am surprised of this choice of key message: you are virtually certain the upper 2000 meters have warmed from 2004 to 2016. Why not something like: the ocean warmed by X+-Y amount from 2014 to 2016? Or: the rate of warming in the 21st century has been as large/large/s smaller than the one from 1960-2000. More interesting, I should think? [Cecilie Mauritzen, Norway]</p>	Accepted - The text on the observed warming of the ocean now describes it quantitatively using syntax similar to what was suggested.
24651	5	3	10	3	11	<p>inconsistent definition of the upper ocean. Chapter 1 already holds 2 different definitions of the upper ocean and both of these are different to this definition. [Shutler Jamie, United Kingdom (of Great Britain and Northern Ireland)]</p>	Accept - change was made to the text but we have homogenised the terms in Chapter 5, Chapter 1 and Chapter 3. Note Chapter one refers to the chapter 5 use of deep ocean. "The distinction between the upper ocean and deep ocean depends on the processes being considered. From a biological perspective, the deep ocean is below 200 m (Chapter 5); from a physical perspective, the deep ocean is below 1000 m depth (Chapter 3)." Last bit needs to be fixed, with Chapter 1 and Chapter 3.
4437	5	3	10	3	12	<p>Why not quantify changes in OHC? [The UBern Team Group Review, Switzerland]</p>	Accepted - The text on the observed warming of the ocean now describes it quantitatively.
10637	5	3	11	0		<p>The bold sentence mentions AR5 (published in 2013) but the statement includes 2014-16 [Jean-Pierre Gattuso, France]</p>	Accepted - The text on the observed warming of the ocean now describes it quantitatively using a number of more recent references.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
31927	5	3	11	0	19	This text can likely be shortened. In the AR5 the key message from observations relevant for policy was that the oceans had warmed by about 0.3°C on average. An update of this finding would come across as a much clearer message than presenting the heat uptake in Joules.... especially since impacts on ecosystems and marine natural resources would be related to the temperature change. A link to such impacts similar to the link made in the bullet for oxygen would make this bullet more comprehensive. [Hans-Otto Poertner and WGII TSU, Germany]	A note quantitatively relating ocean heat uptake to temperature changes has been added to the footnote defining the Zetta Joule.
4935	5	3	11	3	11	Add "intermediate ocean" before "700–2000" [Debra Roberts and Durban Team, South Africa]	Considered - The revised sentence seems clear enough without this specific addition.
600	5	3	12	3	12	What is happening from 2000m-4000m? [Jenna Pearson, United States of America]	Considered - the warming signals in this depth range are mostly small and not well characterized observationally, so there was nothing to elevate to the ES.
4439	5	3	12	3	12	It is interesting that there is 'high confidence' for warming below 4000m in the Southern Hemisphere given the sparse dataset available. This assessment is not clear to me. In contrast only medium confidence has been assigned to O2 changes in the North Pacific, where we have many more data available (and also the signal is quite clear) than for temperature in Southern Ocean below 4000m. [The UBern Team Group Review, Switzerland]	Taken into account - this is a discussion of signal to noise ratio, and how the signal stands out more strongly in the Southern Ocean for temperature compared with the Oxygen in North Pacific.
478	5	3	12	3	14	This is a very vague sentence. "Substantial" can mean almost anything. When you in addition give this statement a likelihood evaluation (very likely) the sentence becomes almost absurd. [Cecilie Mauritzen, Norway]	Reject - this type of sentence was used in AR5. We have however taken the comment into account and rephrased the text.
7001	5	3	12	3	14	Sentence not clear. Perhaps insert "had" after "have"? [Nina Hunter, South Africa]	This paragraph has been extensively revised and the sentence in question has been rewritten.
29727	5	3	12	3	14	What is it in this sentence that limits the likelihood of a substantial human contribution to less than certain? If it is the 1970 date, then just leave that off--you already have "substantial" as a qualifier. This is just a far too qualified a statement--there is no question of a substantial contribution since preindustrial, to this statement seems to put into question something on which there is no question (and the rest of the finding makes clear this is the case). Also, you can change "or" to "and" [Michael MacCracken, United States of America]	Reject - while the ocean temperatures have changed since 1970 (the beginning of viable ocean temperature observations) the ocean temperature measurements are combination of the different external forcing (eg greenhouse gases) and also internal variability and natural forcings. So the additional step is to "prove" that human activity is actually the cause of the change oceans state, a much larger question than whether the ocean is warmer... we have revised the text to make clear.
4441	5	3	14	3	14	increased agreement' : relative to what? [The UBern Team Group Review, Switzerland]	Accept - relative to observations and simulations as explained in the ES text referred to here. The statement has been revised in new draft to clarify.
21693	5	3	14	3	14	"since 1970 " may need to be "since 1970s". Please check. [Government of Republic of Korea, Republic of Korea]	Considered - 1970 is the exact start of some of the periods in the assessment, and the updated paragraph is correct as written.

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482	5	3	14	3	15	Two issues in this sentence: 1) why a confidence statement? Either there is more agreement or there isn't. And 2) What are you comparing to? Increased agreement compared to what? [Cecilie Mauritzen, Norway]	Taken into account - (not sure why this sentence is mis interpreted, but clearly needs to change)
7003	5	3	17	0		Suggest insert "RCP" before "8.5" [Nina Hunter, South Africa]	Accept - RCP is used in all instances to describe RCP8.5 and RCP2.6.
484	5	3	17	3	19	I believe this is an erroneous way to use likelihood language. Your statement is, roughly: "Under the RCP2.6 scenario the ocean will take up 3 times what it already has taken up; Under RCP 8.5 it will take up six times" To use likelihood language probably should include an error bar (a likely/very likely range), and you should also add some confidence statement due to the fact that the climate models do not agree, even under a given scenario, on the amount of heat uptake. [Cecilie Mauritzen, Norway]	Accept - See comment 158, and accept the suggestion of giving confidence intervals and for RCP2.6 and 8.5. Now provided this way
14067	5	3	17	3	19	Rephrase sentence for ease of understanding - "Under the RCP2.6 and 8.5 scenarios, by 2100 the ocean is likely to take up about 3 and 6 times, respectively, the roughly 500 × 10 ²¹ J that the oceans have already taken up since the start of the 20th century. {5.2.2.2}" to "The Oceans have taken up 500x10 ²¹ J since the start of the 20th Century, by 2100 they are likely to take up about 3 or 6 times this amount by 2100 under RCP2.6 and 8.5 respectively" [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	Considered - This paragraph has been extensively revised for clarity and updated scientific content in a way that should address the reviewer's concern.
15799	5	3	17	3	19	The use of Joules as a unit in here (though it provides comparability to other earth systems) is not useful for a non-expert reader - this could be presented also in temperature for simplicity and relatability (this especially applies to SPM-10, rows 8-9). There are some issues with the clarity of the phrasing too, which could be easily addressed (e.g. The ocean is projected to uptake x and y, under w and z scenarios. This constitutes a proportional increase/decrease(?) of x, in comparison to what has been observed in the past 20 years" [EUCE, Belgium]	Taken into account. Also a note quantitatively relating ocean heat uptake to temperature changes has been added to the footnote defining the Zetta Joule.
20847	5	3	17	3	19	J should be put in context, even a two word qualifier would help [APECS Group Review, Germany]	Taken into account -
24623	5	3	17	3	19	The sentence appears to be missing some words. Suggest to rephrase to increase clarity [frigstad helene, Norway]	This paragraph has been extensively revised and the sentence in question has been rewritten.
28281	5	3	18	0		Change "500 × 10 ²¹ J" to "500 ZJ" [Nsikak Benson, Nigeria]	Corrected
28283	5	3	18	0		I suggest that "roughly" should be replaced with "approximately". [Nsikak Benson, Nigeria]	The word "roughly" no longer appears in the Executive Summary.
29011	5	3	18	3	18	10 ²¹ should be changed in 10 to the power 21. [Government of Netherlands, Netherlands]	Corrected

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
33533	5	3	18	3	18	Something seems missing with 500 x 1021 J. Do you mean 500^1021 J? [Government of United States of America, United States of America]	Corrected
14087	5	3	20	3	23	Text notes 'Marine, coastal, high mountain and Arctic systems are expected to be at high to very high risk of dangerous impacts'. To reflect the urgency noted in lines 20-21 could this be changes to 'Marine, coastal, high mountain and Arctic systems are at high to very high risk of dangerous impacts'. [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	Reject - this text is not here, maybe from SPM?
27861	5	3	21	0	22	It took me three reads to understand this sentence, especially what we meant by "making the surface ocean lighter at a faster rate than deeper in the ocean." Please revisit [Ko Barrett, United States of America]	Taken into account -
29729	5	3	21	3	21	Given key findings are pulled out and published in articles, etc., I think it might help to define "stratifying" right up front, so take the first four words and make that into a sentence that defines stratifying in more common words, and may be even include mention that it results in fewer nutrients being brought to the surface instead of having the key point later in the finding. And then the rest can be a second sentence. [Michael MacCracken, United States of America]	Taken into account -
486	5	3	21	3	22	Since when? And where? (not so obvious in the Atlantic Ocean (your figure 5.2)). [Cecilie Mauritzen, Norway]	Taken into account - the column on density change is blue even for Atlantic which is a lighter. Just need to clarify for the reader.
14081	5	3	21	3	22	The phrases "surface intensified trends" and "making the surface ocean lighter" are somewhat confusing. The headline statement could be rephrased for clarity - i.e. "The ocean is stratifying; observed warming and high latitude freshening are both trends that show higher intensity at the ocean surface, making the surface ocean less dense at a faster rate than deeper in the ocean (high confidence)." [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	Taken into account -
24625	5	3	21	3	22	The sentence does not read well, suggest to rephrase to: "... freshening are both intensified in the surface, ..." [frigstad helene, Norway]	Accepted - this sentence has been revised for clarity.
33535	5	3	21	3	22	This is rather poorly worded especially the use of the word "lighter" is very imprecise. [Government of United States of America, United States of America]	"Lighter" has been revised to "less dense" to avoid confusion.
602	5	3	21	3	25	Is it possible to list the rates of the upper and deep ocean respectively, or at least give one quantitative measure to judge the difference? How do evaporation and atmospheric circulation factor into this? [Jenna Pearson, United States of America]	Considered - Observed and projected changes in stratification are now described quantitatively.
734	5	3	21	3	25	In addition to the stratification, I think there can be a brief quantified description of the salinity change in the executive summary. [Mengxi Wu, United States of America]	Considered - Salinity changes were discussed extensively in AR5, and this assessment is not finding any major changes from what was assessed there.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
1689	5	3	21	3	25	What is driving increased freshening? Should changes in precipitation and evaporation be included and how they could influence stratification? [Nora Richter, United States of America]	Considered - This level of supporting detail is discussed extensively within the chapter itself, but does not warrant promotion to the Executive Summary.
1691	5	3	21	3	25	Are there implications for changes in ocean circulation? Do we have paleoclimate evidence available that can help us inform how this is likely to change? [Nora Richter, United States of America]	Rejected - Paleoclimate changes are outside of the mandate of this chapter, as described in the agreed-upon outline.
24653	5	3	21	3	25	need to explicitly state that this is de-oxygenating the water (as stated in chapter 1) making it more difficult for life and the ecosystem services on which we rely. This will make it more 'real' to reader. [Shutler Jamie, United Kingdom (of Great Britain and Northern Ireland)]	Taken into account -oxygen is being given greater prominence in the assessment, we have included a new tables that assesses the oxygen change atlases
28285	5	3	22	0		Replace "... surface ocean ... than deeper in the ocean..." with "...surface mixed layer depth ... than deep ocean depth..." [Nsikak Benson, Nigeria]	Considered - this paragraph has been extensively revised.
31929	5	3	22	0	25	As presented this is textbook and AR5 knowledge. A quantification of the respective magnitudes of change would be very useful if then linked to the respective impacts. A link to impacts as made in the bullet for oxygen would make this bullet more comprehensive. [Hans-Otto Poertner and WGII TSU, Germany]	AR5 WGI actually only considered "thermal stratificaion", which omits salinity effects, not stratification due in part to limations with the global-scale interior ocean salnity data available in the pre-Argo era, and did not discuss projected ocean stratification changes. Average observed and projected changes in upper-ocean stratification are now described quantitatively.
26585	5	3	22	3	28	Again, the text perpetuates the implicit notion that the oceans consist of organisms and mammals. Fish usually are not popularly thought of as animals (although they are), yet they are the fundamental component of the oceans for oceans-dependent communities of people. [Florence Poulain, Italy]	This comment does not appear to be relevant to the cited page and line numbers. Perhaps it was a comment on p. 4, line 22?
488	5	3	23	3	24	I believe this is an erroneous way to use likelihood language. Your statement is, roughly: Stratification will increase significantly in the 21st century" . To use likelihood language probably should include an an amount and an error bar (a likely/very likely range), you should mention that the statement depends on the scenario used (if it does), and you should also add some confidence statement due to the fact that the climate models do not agree, even under a given scenario, on the amount of stratification change. [Cecilie Mauritzen, Norway]	Considered - Observed and projected changes in stratificaion are now described quantitatively for different scenarios with error bars.
20403	5	3	24	0		C1: First time deep sea is mentioned but range not specified [APECS Group Review, Germany]	Taken into account - more accurate use of deep sea. Deep sea also has multiple meaning across disciplines.
15801	5	3	24	3	25	The sentence, would benefit from any specific examples of the consequences of affecting these cycles. [EUCE, Belgium]	Taken into account: - stratification now more completely explained, and now assessed with CMIP5 prohections as well as observations. Very clear sigal, but consequences could be stonger.
33537	5	3	25	3	25	Do authors mean "reoxxygenation of THE ocean"? [Government of United States of America, United States of America]	accepted

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28287	5	3	27	0	28	In the sentence "...oceanic sink for atmospheric CO2 has continued to strengthen..." I think that the word "strengthen" is ambiguous in this context, as it neither specifies if the sink capacity of the ocean is increasing or decreasing. Is it referring to a net sink increase? This should be clearly stated. [Nsikak Benson, Nigeria]	accepted
31931	5	3	27	0	37	This reads a bit convoluted and could be much shortened around the confirmation of the 25% uptake. The temporal and spatial variability could possibly be indicated in regional numbers? [Hans-Otto Poertner and WGII TSU, Germany]	Accepted
30435	5	3	27	3	27	The sentence needs to be rephrased - in its current form it may be incorrectly interpreted that the ocean's ability to absorb carbon has increased (i.e. it has become a stronger sink). [Francois Engelbrecht, South Africa]	accepted
11993	5	3	27	3	28	The wording that 'the oceanic sink for atmospheric CO2 has continued to strengthen in the recent two decades in response to the growing burden of CO2 in the atmosphere' is a little misleading. The sink has continued to increase, with a continuing accumulation of CO2 in the surface and deep ocean due to the rising atmospheric pCO2 and the continued action of the ocean's physical carbon pump. However, I'm not aware that the mechanism of uptake has itself strengthened as it is most expected that the efficiency of ocean uptake will decrease due to lower gas solubility in a warmer ocean, reduced chemical buffering capacity by the seawater carbonate system and weakening of the physical pump linked to slowdown of the MOC. I would suggest change the word 'strengthen' to 'increase'. [Nicholas Hardman-Mountford, United Kingdom (of Great Britain and Northern Ireland)]	accepted
14085	5	3	27	3	28	'...continued to strengthen..' - this could be made clearer, 'continued to increase its capacity'? [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	accepted
15803	5	3	27	3	28	It might be worth framing why has the ocean sink continued to strengthen, as per chapter ahead. [EUCE, Belgium]	accepted
23657	5	3	27	3	28	It is not clear what the strengthening of the ocean sink means. That the fraction of emissions taken up by oceans has increased That the amount of carbon going into the ocean is larger (as would be expected from Henry's law). The former would seem to imply a stronger sink (strength), the latter unchanged sink. [Government of Sweden, Sweden]	accepted

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490	5	3	27	3	29	What is virtually certain? That the oceanic sink has strengthened? (and what does that even mean?) Or that it is due to the growing burden of CO2 in the atmosphere? Please make the sentence simpler, preferably split into several sentences, and use the appropriate likelihood/confidence language for each. [Cecilie Mauritzen, Norway]	accepted
11545	5	3	27	3	29	"... the oceanic sink for atmospheric CO2 has continued to strengthen in the recent two decades in response to the growing burden of CO2 in the atmosphere (virtually certain), while an important degree of temporal variability has emerged" Should clarify by saying "sink for atmospheric CO2 has continued to strengthen in absolute terms in the last two decades" (otherwise it might be clear which recent two decades are meant). "... important degree of temporal variability has emerged" is vague. Does this mean temporal variability has increased? Clarify "temporal" by specifying a timescale, "interannual and decadal", as on Page 22 [William Howard, Australia]	accepted
22533	5	3	27	3	29	Suggest clarifying the statement by noting that the "sink for atmospheric CO2 has continued to strengthen in absolute terms in the last two decades" - not "two recent decades". Suggest clarifying the use of the term 'temporal' by specifying a timescale, such as "interannual and decadal", as on Page 22. [Government of Australia, Australia]	accepted
25469	5	3	27	3	29	THE SENTENCE IS DIFFICULT TO UNDERSTAND FOR A LAYMAN. HOW CAN A SINK "STRENGTHEN"? WHAT DOES CO2 "BURDEN" MEAN? WHAT DOES "an important degree of temporal variability has emerged" MEAN EXACTLY? TEMPORAL VARIABILITY OF WHAT? A DEGREE CANNOT EMERGE ...MY UNDERSTANDING: Multiple datasets and models indicate that the oceans have continued to capture atmospheric CO2 in response to the growing concentration of CO2 in the atmosphere (virtually certain), although with an important degree of temporal variability. [Christophe Deissenberg, Luxembourg]	accepted

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
29731	5	3	27	3	37	It needs to be explained how this finding is consistent with the prior one that the ocean is stratifying. If the ocean is stratifying, then fewer nutrients are making it to the surface, so the biological pump is presumably weaker (and there are indications that phytoplankton is way down) and if the overturning circulation is slowing, then that transfer is also weaker, so the answer needs to be provided. I'm guessing that it is either that the water that is still descending in high latitudes has higher CO2 loading due to the higher CO2 concentration or that the carbon is mixing downward along isopycnals so the additional CO2 is going down somewhat but not to the bottom-. These are only guesses, but it needs to be clarified how these two findings are compatible. [Michael MacCracken, United States of America]	The mechanisms are discussed in the chapter text. However, for the executive summary, only key findings are presented. Readers are referred to the chapter text for details.
32511	5	3	27	3	37	Perhaps to remain consistent with the ocean warming, oxygen, and productivity summary paragraphs, this carbon uptake summary should also briefly state future carbon uptake estimates from CMIP5 models, and the uncertainties associated with future uptake (e.g. due to changes in climate, circulation and/or biogeochemical cycling). [Yassir Eddebbar, United States of America]	Carbon up-take projection is out-of-scope for this assessment
4401	5	3	29	3	29	Emerged from what? From the scientific literature? Maybe just say that the growing oceanic C sink is superimposed on relatively large interannual-to-decadal scale variability. [The UBern Team Group Review, Switzerland]	accepted
33539	5	3	29	3	29	The adoption of 'virtually certain' appears suspect with regards to the strengthening of the oceanic sink for carbon. There is some evidence that the oceanic sink may actually be weakening. This should be confirmed. [Government of United States of America, United States of America]	This is based on standardized IPCC uncertainty language with the associated probability estimates
33541	5	3	29	3	29	Change this to very likely (90-100%). From a physical perspective, the ocean sink must increase with increasing atm. CO2, but this can be violated by increasing feedbacks. However, the feedbacks are unlikely to be greater than the forcing (increasing delta pCO2). [Government of United States of America, United States of America]	This is based on standardized IPCC uncertainty language with the associated probability estimates
16969	5	3	29	3	32	I think there is something wrong with the last part of this sentence: "... as well as ocean models that ocean carbon uptake has continued to increase commensurate with the atmospheric carbon dioxide growth rate". Please rephrase. [Hege Gundersen, Norway]	Taken into consideration in the revision

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
33543	5	3	30	3	37	Need to confirm that the 25% figure refers to all anthropogenic emissions (e.g., fossil fuel, cement, land use change, etc.). Also, while the amount of carbon being taken up each year has increased, the relative fraction of total emission may, in fact, be declining. Need to confirm this through the Global Carbon Cycle Project. [Government of United States of America, United States of America]	This is based on assessment on recent literature.
33545	5	3	30	3	37	The numbers in the global carbon cycle section are not consistent. Using the recent GCP report (Le Quere et al. 2018 supplementary spreadsheet Global_Carbon_budget 2018v1.0 tab Global Carbon budget 1998-2017), the ocean uptake is 27% of ff emission and 23% if it is total (ff and land use change). So here 25 +- 5% seems OK. [Government of United States of America, United States of America]	This is based on assessment on recent literature.
492	5	3	32	3	32	It is advisable, for scientific clarity, to take the "very likely" statement out of the sentence and enter it in a parenthesis at the end. [Cecilie Mauritzen, Norway]	Taken into account
10639	5	3	33	0		See later comment [Jean-Pierre Gattuso, France]	OK
12991	5	3	33	3	33	Pls. substitute: ...in the recent two decades..., by...in the recent three decades...Because at p:5-22 l:3 is noted: ...since the mid 1980s.... [Government of Germany, Germany]	Text is rewritten and consistent is checked
12993	5	3	33	3	33	Please revise "ocean has taken up about ~ 25±5% of total anthropogenic emissions in the recent two decades"; to read "of the recent two decades". Else the reader could understand that the ocean takes up 25% of all (historic) anthropogenic CO2 in the last 20 years. [Government of Germany, Germany]	Text re-written
24655	5	3	33	3	33	is the 25% value consistent with the value of 30% stated in chapter 1? Need to ensure consistency. The same value of 25% is used on page 22, line 3 of chapter 5 and then 29% seems be shown on line 49 of page 22. [Shutler Jamie, United Kingdom (of Great Britain and Northern Ireland)]	We have a new assessment based on more recent literature.
26397	5	3	33	3	34	The estimate for oceanic uptake of anthropogenic emissions is a lot lower than in AR5 (almost outside the uncertainty bounds). What changed? [Ethan Pierce, United States of America]	We have a new assessment based on more recent literature.
33547	5	3	36	3	37	Mechanisms of uptake are well understood. The uncertainty emerges from the fact that the flux measurements remain limited in spatial and temporal coverage so the mechanisms (which are well known) may not be suitably quantified. That's different from an uncertainty in the mechanisms. It should read 'quantification of the mechanisms'. [Government of United States of America, United States of America]	Taken into consideration in the rewriting of the text
31933	5	3	39	0	44	Some of this is identical to AR5 as formulated without updating on specifics. Suggest tightening up and merging with bullet on carbon uptake by oceans. [Hans-Otto Poertner and WGII TSU, Germany]	Taken into consideration and revised.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
494	5	3	39	3	40	I believe this statement is too strong. We do not have enough data to say that the ocean pH is declining by (exactly) 0.2 units per decade. Please add a +/- errorbar (a likely/very likely range) and take the likelihood statement out of the sentence itself, reduce it to something more sensible and add it in a parenthesis. [Cecilie Mauritzen, Norway]	Taken into consideration.
10641	5	3	39	3	40	It is not "virtually certain that open ocean pH is declining by ~0.02 pH units per decade". The (incomplete appendix 5A table 1 shows a range of 0.016 to 0.026 pH units [Jean-Pierre Gattuso, France]	Accepted - table revised and assessment constrained more tightly
14073	5	3	39	3	40	Change to : 'Where time series exist, it is virtually certain..', to make this sentence clearer [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	accepted
604	5	3	39	3	45	What control does biology have compared to the air-sea exchange? [Jenna Pearson, United States of America]	Not a message that is suitable to be highlighted in the ES
1693	5	3	39	3	45	Put this into context: how has ocean pH changed in the past (i.e., past warm periods in the paleo record) in response to higher CO2 levels? [Nora Richter, United States of America]	Rejected. Paleo-record is not assessed
14083	5	3	39	3	45	"ocean pH is declining" - please specify the time period over which this has been declining. The IPCC 1.5C Special Report states "The ocean has absorbed about 30% of the anthropogenic carbon dioxide, resulting in ocean acidification and changes to carbonate chemistry that are unprecedented in 65 million years at least" - please highlight here that the current rate of pH change is unprecedented over this timescale. [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	Text re-written and clarified.
15683	5	3	39	3	45	The future expected evolution of oceanic pH should be mentioned in this paragraph, given its importance and potential impacts, and this should in turn appear in section B3 of the summary for policy makers. The statement on future pH changes is only about the most important control being emissions, but there is no mention of the expected range of change. According to 5.2.2.3 "there is high confidence that future ocean will experience pH drops of between 0.1 or 0.3 pH units by 2100, depending on whether we follow the RCP2.6 or RCP8.5 emissions scenario" [EUCE, Belgium]	rejected, stated later in ES
23741	5	3	39	3	45	There is high confidence that ocean acidification will be exacerbated in polar regions, especially the Arctic. It should be mentioned in the executive summary. [Government of Sweden, Sweden]	rejected, part of chapter 3
24041	5	3	39	3	45	There is high confidence that ocean acidification will be exacerbated in polar regions, especially the Arctic. It should be mentioned in the executive summary that OA is very much an Arctic problem. [Peter Thor, Sweden]	rejected, part of chapter 3

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
33549	5	3	39	3	45	As worded, this is generally correct; however, there are important caveats depending upon what one considers surface open ocean. While the statement mentions the importance of ocean circulation of deep ocean acidification rates, this can be equally true for some surface (or mid-level) waters. For example, the rate of acidification of the western Arctic waters is notably faster due to the increased supply of Pacific Winter Water transport (Chen et al., 2017 Nature Climate Change). Also, it's important to note that the shelf and coastal waters where many living marine resources reside can also be considerably more complex. [Government of United States of America, United States of America]	accepted
4443	5	3	40	3	40	Clarify over which timeperiod the -0.02 ph units per decade decrease applies [The UBern Team Group Review, Switzerland]	accepted
22817	5	3	40	3	40	Over what decades? The rate of change is useful but please provide the time interval. [Raphael Kudela, United States of America]	accepted
33551	5	3	40	3	40	Need to stress that 0.02 decrease in pH per decade is in surface water only. Also, there is no such thing as a "pH unit". [Government of United States of America, United States of America]	accepted
12995	5	3	40	3	43	What exactly is meant by "emissions scenarios are the most important control...." - is this an attribution statement? If yes, then please say so directly. If not, please revise the text so it offers an interpretation that is accessible to non-experts. [Government of Germany, Germany]	accepted
32469	5	3	40	3	43	The phrase starting with "The anthropogenic ...(virtually certain)." is too long and complex to read; shhould be cut into 2 phrases and if possible more explicit. [Jacques Beall, France]	Taken into consideratin and sentence clarified.
4937	5	3	42	3	42	Scenarios seems vague. Consider "emission reduction" or "emission reduction scenarios" [Debra Roberts and Durban Team, South Africa]	Taken into consideration.
496	5	3	42	3	43	In this part of the sentence you essentially state :” emission scenarios are controlling open ocean PH for most of the 21st century (Virtually certain)”. First of all, a scenario cannot control anything. I presume you mean something like: “in the future projections, PH changes due to Co2 emissions are larger than those due to internal variability, regardless of scenario”. If so, write that. But that statement doesn't require a likelihood statement. These are model results. So either they are (larger) or they aren't. [Cecilie Mauritzen, Norway]	Text edited and clarified.

SROCC Second Order Draft Government and Expert Review Compiled Comments - Chapter 5							
Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
23659	5	3	42	3	43	What does "most of the 21st century" refer to? Except the early part of the Century? Except the end of the century under high mitigation scenario? Except some outlier result? Also, suggest changing to, for example, "Across all emission scenarios, future CO2 emissions constitute a more important driver of changes to the open ocean surface pH than natural variability [over ...time period] at both global and local scale...", or suchlike. [Government of Sweden, Sweden]	Text edited and clarified.
24037	5	3	42	3	43	"and emission scenarios are the most important control of surface open ocean pH relative to internal variability for most of the 21st century at both global and local scale (virtually certain)". Sentence difficult to read. Suggest changing to "Across all emission scenarios, future CO2 emissions constitute a more important driver of changes to the open ocean surface pH than natural variability for most of the 21st century at both global and local scale (virtually certain)" [Peter Thor, Sweden]	Taken into consideration. Text rewritten
31917	5	3	42	3	43	Does this refer to actual processes, happening or projected to happen in the ocean or to modelled scenarios? The very technical language makes it difficult for non-expert readers to extract a clear message from this sentence. As a consequence, ocean acidification might be overlooked in this Executive Summary. [Hans-Otto Poertner and WGII TSU, Germany]	Text re-written and clarified.
11547	5	3	43	3	44	"Changes to the deep ocean are more complex as they are controlled by parallel changes to ocean circulation" Not clear what is meant by 'parallel'. I think this may mean that changes to the residence times of deep water masses may increase their respiratory-contributed dissolved inorganic carbon and thus shift their carbonate chemistry towards lower carbonate ion concentration? But in any case the authors should clarify what "parallel" means [William Howard, Australia]	Revise to "changes in deep and abyssal water formation rates and properties"?
22535	5	3	43	3	44	Suggest clarifying what is meant by 'parallel' in the statement "Changes to the deep ocean are more complex as they are controlled by parallel changes to ocean circulation". [Government of Australia, Australia]	Text rewritten
23813	5	3	43	3	44	If the "parallel changes to ocean circulation" are also due to (anthropogenic) climate change, it would be good to clarify further here, so as not to risk interpretations of natural factors in play. [Government of Sweden, Sweden]	Text rewritten

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Comment id	Chapter	From page	From line	To page	To line	Comment	
15805	5	3	43	3	45	The objective of this sentence is unclear, as the degree of complexity in the deep ocean is obvious. If the meaning in here is that we are lacking data and understanding of these systems before conclusions can be drawn, this should be clearly stated. [EUCE, Belgium]	Text rewritten
22819	5	4	1	4	1	Is the phrase "is observed" being used to separate this statement from statements based on models? The previous summary point says the ocean is acidifying. It seems odd that one is qualified (is observed) and the other is not. [Raphael Kudela, United States of America]	Text rewritten
1695	5	4	1	4	10	There is no mention of changes in ocean circulation and/or natural oceanic variability (i.e., AMO and PDO). There is also no mention of how changes in precipitation-evaporation will lead to changes in the surface ocean. [Nora Richter, United States of America]	Text rewritten
21109	5	4	1	4	2	Says: (declined by about 2% (...)) declined about 2% since when? [APECS Group Review, Germany]	Text rewritten
25471	5	4	1	4	2	Overall, OVER THE PERIODE XXXX?. the oxygen content [Christophe Deissenberg, Luxembourg]	Text rewritten
498	5	4	1	4	3	Since when? Please clarify [Cecilie Mauritzen, Norway]	Text rewritten
9701	5	4	1	4	3	The statement needs a reference period. [Government of France, France]	Text rewritten
32513	5	4	1	4	3	Should add the period (i.e. "since 1960"). [Yassir Eddebbar, United States of America]	Text rewritten
10023	5	4	1	4	6	The value used for the predicted O2 decline is unclear - is O2 going to decline by an additional 3.5% for a total of 5.5%? Or will the total decline by 3.5%. Also, over what time period had the 2% decline occurred? It would also be good to provide some estimates on the current status of hypoxic/dead zones and how much they are expected to expand by. [Tommy Moore, United States of America]	Text rewritten
31935	5	4	2	0		Time window of decline by 2% is missing? The recent literature has postulated that the rate of oxygen loss has been underestimated by the AR5. If assessed and confirmed such would be an important message. [Hans-Otto Poertner and WGII TSU, Germany]	Text rewritten
4445	5	4	2	4	2	Type: 'response' [The UBern Team Group Review, Switzerland]	Text rewritten
14089	5	4	2	4	2	"declined by about 2%" - please specify the time period over which this has happened. [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	Text rewritten

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
14101	5	4	2	4	2	There is no discussion here or elsewhere in the ES of the underlying physical drivers. E.g. heat waves and storms are mentioned but what is the evidence that these are changing in response to climate variability or change? This (and elsewhere in the chapter) is a missed opportunity for the chapter to perform a clear integration across WGs to show the full evidence chain – what steps are known, what is sensible assumption based on limited evidence and what is more speculative? [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	This is now stated upfront in the ES
21911	5	4	2	4	2	Over what timescale has this decline happened? [David Schoeman, Australia]	Clarified
23661	5	4	2	4	3	It would be good to clarify that/whether the changes in ocean circulation and respiratory demand are due to climate forcing. [Government of Sweden, Sweden]	Text re-written
26763	5	4	2	5	2	"declined by about 2%" since when / relative to what baseline? [Marco Andrello, Canada]	Text re-written
27773	5	4	3	4	3	Semantics: consumption rather than demand [Momme Butenschön, Italy]	Text re-written
11913	5	4	4	4	5	<p>"There low confidence for changing in the tropical ocean due to the natural variability and limited agreement" The author mention the oxygen reduction in the tropical ocean is limited agreement of studies and haven't cite any references to support this sentence, but there are many studies have been published related to this and available in online</p> <p>For example,</p> <p>Duteil, Olaf, Andreas Oschlies, and Claus W. Böning. "Pacific Decadal Oscillation and recent oxygen decline in the eastern tropical Pacific Ocean." Biogeosciences Discussions (2018): 1-30.</p> <p>University of California - San Diego. "Oxygen Depletion Zones In Tropical Oceans Expanding, Maybe Due To Global Warming." ScienceDaily. ScienceDaily, 2 May 2008</p> <p>Are the oceans running out of oxygen? Fish could 'choke' as climate change causes a dramatic drop in the gas being dissolved</p> <p>We could suggest to avoid such a contradict sentence. [Jun Sun, China]</p>	Taken into consideration
14103	5	4	5	4	5	The non tropical oceans are listed, but the tropical options are not. Please add for completeness. [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	Text re-written
11927	5	4	6	0		add comma after "Over the next century" [Wolfgang Kiessling, Germany]	Text re-written
31937	5	4	6	0		Isn't the postulated decline by 3.5% dependent on the climate scenario? [Hans-Otto Poertner and WGII TSU, Germany]	Text re-written. No longer relevant.
4447	5	4	6	4	6	Maybe rewrite to: 'By 2100, CMIP5 models project a decline of 3.5%' [The UBern Team Group Review, Switzerland]	Taken into consideration

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
4449	5	4	6	4	6	Please assign uncertainty estimates for the O2 decline [The UBern Team Group Review, Switzerland]	Uncertainty languages are added.
29733	5	4	6	4	6	"predicted" needs to be replaced by "projected"--these changes are conditional on choices made by society, so need to be considered projections. [Michael MacCracken, United States of America]	Text edited and clarified.
32515	5	4	6	4	6	under what RCP? Perhaps either add range from different models or range from different RCPs. [Yassir Eddebbbar, United States of America]	Text edited and clarified.
500	5	4	6	4	7	Doesn't this statement depend on which scenario is used? Please clarify [Cecilie Mauritzen, Norway]	Text edited and clarified.
11549	5	4	6	4	8	"Over the next century oxygen declines of 3.5% by 2100 are predicted by CMIP5 models globally (medium confidence), with low confidence at regional scales, especially in the tropics. The largest changes in the deep sea will occur after 2100." Need to indicate the model outputs are *projections* not predictions; i.e. are scenario-dependent. So need to clarify what scenario is being referred to (RCP 8.5?). Also need to change *will* to *is likely to* since we are not in a position to know what *will* happen [William Howard, Australia]	Text edited and clarified.
22539	5	4	6	4	8	Suggest clarifying that the model outputs are *projections* not predictions; i.e. are scenario-dependent. So need to clarify what scenario is being referred to (RCP 8.5?). Suggest avoiding the term *will* and instead suggest *is likely to* since we are not in a position to know what *will* happen. [Government of Australia, Australia]	Text edited and clarified.
32085	5	4	6	6	4	"declines by 3.5%": First, there is a considerable amount of uncertainty around this number. Please state it. Second, the exact values depends on the scenario. This needs to be stated explicitly. Perhaps more important, in my opinion, is the question how to deal with information that is neither new, nor newly assessed in this report. The 3.5% number comes from Bopp et al. (2013), which provided the background for what was actually plotted in AR5 (pages 532ff, chapter 6, WGI). Thus, we should be open and clear that this is simply a restatement from AR5 without new assessment [Nicolas Gruber, Switzerland]	Text re-written. No longer relevant.
23663	5	4	7	4	7	The meaning of "largest" is unclear. Perhaps, "Changes will increase further in the deep sea after 2100." [Government of Sweden, Sweden]	Text edited.
29735	5	4	7	4	8	I think it would be appropriate to add here that this happening is a reason that the changes made will be so long-lasting--just as it is taking a long time to warm the deep ocean, it will take a very long time to reverse the change (which is what will ultimately be needed to have a climate that fully meets the 1992 UNFCCC objective. [Michael MacCracken, United States of America]	Taken into consideration

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31939	5	4	8	0	9	This link to impacts has been made in this bullet for oxygen which is nice. Wouldn't it make sense to do this for temperatura and CO2 as well? Giving at least an indication of the magnitude of change and impact would be even more informative and relevant. [Hans-Otto Poertner and WGII TSU, Germany]	Taken into consideraton.
502	5	4	8	4	10	Perhaps add a confidence statement here? [Cecilie Mauritzen, Norway]	Text edited. Confidence statement is added when appropriate.
21913	5	4	8	4	10	Does this sentence need a confidence assessment? [David Schoeman, Australia]	Text edited. Confidence statement is added when appropriate.
15699	5	4	8	4	20	Projections of changes in pp have medium low confidence. Due partly to limitations of satellite data. It should also be mentioned that satellites only estimate directly pp of the surface layer and cannot estimate reliably pp of subsurface layers in stratified seas. Therefore, other or additional observational platforms for ocean interior measurements are necessary. [EUCE, Belgium]	Uncertainties associated with observed primary production is now reflected in the executive summary statement and the main text.
24657	5	4	9	4	9	Suggest: nutrient cycling, and ecosystem productivity and services. [Shutler Jamie, United Kingdom (of Great Britain and Northern Ireland)]	Taken into consideration. These are mentioned in separate statements
27857	5	4	12	0	13	Only projected to show? Do we not have observations of current change? [Ko Barrett, United States of America]	Statement about observation is now provided
4451	5	4	12	4	12	Maybe rewrite to: 'to show regional heterogenic changes in response' [The UBern Team Group Review, Switzerland]	Taken into consideration
15807	5	4	12	4	15	This sentence lacks clarity (or at least commas), given how long it is. Please consider rephrasing. [EUCE, Belgium]	Text edited
784	5	4	12	4	20	I think this paragraph should also mention the big model uncertainty and the long time or emergence of nitrate and primary production. [Mengxi Wu, United States of America]	These are referred to the main text for further details.
15809	5	4	12	4	20	Primary productivity is a key point for regulating ocean ecosystems and cycles - this currently does not come across. Understandably, there are significant data gaps and questionable confidence in these assessments, but the point that any changes to this factor will lead to significant changes to ocean functioning should be made clear. This is allured to ahead in the chapter and could be easily mentioned here. [EUCE, Belgium]	The role of primary productivity in affecting the open ocean ecosystems are now more prominently reflected in the executive summary
31941	5	4	13	0		One wonders whether the link of PP to nutrients only should not be complemented by statements on the impacts of warming and ocean acidification [Hans-Otto Poertner and WGII TSU, Germany]	Accepted. Other factors are now mentioned
4453	5	4	13	4	15	Not only in response to nutrient supply but also in response to warming, light availability, etc [The UBern Team Group Review, Switzerland]	Accepted. Other factors are now mentioned
10643	5	4	15	0		As well as the decline in ice cover in polar regions [Jean-Pierre Gattuso, France]	The details about the polar regions are discussed in Ch 3 and relevant sections in this chapter.
31943	5	4	15	0		Differentiation between scenarios is needed, considering the 1.5 report as a starting point. [Hans-Otto Poertner and WGII TSU, Germany]	Contrastin scenarios are provided
14105	5	4	15	4	15	...ratio of nutrient supply' - this term is not clear to policy makers, please clarify or unpack what this means. [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	Text edited

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
29737	5	4	15	4	17	It would be useful to explain the mechanism here. If the ocean is stratifying, how are there going to be enough nutrients to provide for an increase in productivity in high latitudes-- where is the supply coming from? Is it up along isopycnals for lower depths in low latitudes to shallower depths in middle and high latitudes? Is it faster cycling so that there is also faster death of species? It would be useful to be explaining why on the various findings. [Michael MacCracken, United States of America]	For detailed mechanism, readers are referred to the main text that provide a comprehensive explanation.
7005	5	4	17	0		Suggest change "changes" to "changing" [Nina Hunter, South Africa]	Text edited
4455	5	4	17	4	17	change to 'to changes in ocean nutrient supply' [The UBern Team Group Review, Switzerland]	Text edited
32517	5	4	17	4	17	" changes in ocean .. " [Yassir Eddebbar, United States of America]	Text edited
33553	5	4	17	4	17	changes [in] nutrient supply [Government of United States of America, United States of America]	Text edited
10861	5	4	17	4	20	<p>The sentence is not clear. Please consider rephrasing as follows: 'There is currently low confidence in appraising past open ocean productivity trends due to newly identified region-specific drivers, which are generating regional trends that are larger than the global trend, and the lack of in situ time series datasets corroborating evidence made by satellites.'</p> <p>The above suggestion for rephrasing is based on the following lines of evidence: [1] In SROCC chapter 5, page 30 lines 49-51, it is stated that "at present, satellite records are not yet long enough to unambiguously isolate long term climate related trends from natural variability (Beaulieu et al., 2013)."; and [2] The last decade has seen substantial effort to generate climate-quality controlled satellite observations, which include error characterisation and bias correction. These satellite observations show robust evidence that regional trends in phytoplankton are larger than the global trend (Mélin et al., 2017; von Schuckmann et al., 2018). These observations hold for decadal (~10 years) trends based on single satellite sensor, as well as multi-decadal (20 years) trends based on merged satellite observation products.</p> <p>References: Mélin, F., V. Vantrepotte, A. Chuprin, M. Grant, T. Jackson, and S. Sathyendranath. "Assessing the Fitness-for-Purpose of Satellite Multi-Mission Ocean Color Climate Data Records: A Protocol Applied to OC-CCI Chlorophyll-a Data." (2017) Remote Sensing of Environment, Earth Observation of Essential Climate Variables, 203: 139–51. https://doi.org/10.1016/j.rse.2017.03.039.</p> <p>von Schuckmann, K. et al. The Copernicus Marine Environment Monitoring Service Ocean State Report – issue #2, Chapter 1.8 Ocean Colour, p 45-50, eds. K. von Schuckmann and P.-Y. Le Traon (2018), Journal of Oceanography, doi:10.1080/1755876X.2018.1489208. https://doi.org/10.1080/1755876X.2018.1489208 [Marie-Fanny Racault, United Kingdom (of Great Britain and Northern Ireland)]</p>	Taken into consideration

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24659	5	4	17	4	20	The sentence about satellites needs revising based on my next comment. [Shutler Jamie, United Kingdom (of Great Britain and Northern Ireland)]	Taken into consideration
21695	5	4	19	0		Needed to change in situ with in-situ or in situ. It should be consistent throughout this chapter. E.g., 5-13, 5-16, 5-117, 5-133, 5-139 [Government of Republic of Korea, Republic of Korea]	Accepted.
28289	5	4	19	0		The word "in situ" should be in italics. [Nsikak Benson, Nigeria]	Accepted
4299	5	4	19	4	19	Executive Summary: Ocean primary productivity is projected to show regional variability in response to climate driven 12 changes in nutrient supply with implications for pelagic and seafloor ecosystems [TAOFIKAT ADESALU, Nigeria]	Taken into account
31945	5	4	22	0	23	This formulation excludes any specific treatment of drivers and their specific effects as well as their interactions, in the sense of detection and attribution to temperature, CO2, oxygen. By adding such information to the bullet points above, this would prepare for an integrated view in this one but then the current knowledge and extensive literature on driver interactions needs to be reflected, with a perspective on what this means for biogeography, species interactions etc. [Hans-Otto Poertner and WGII TSU, Germany]	The observed shifts are mainly attributed to warming. The impacts of multiple climatic drivers are discussed in different statements.
15701	5	4	22	4	23	These changes will also lead to major impacts on species interactions and trophic flows in food webs, affecting also ecosystem services. These should be mentioned here, or in a separate paragraph, given their importance to ecosystems and humanity. For reference, see a recent paper on the topic by van Denderen, P., Lindegren, M., MacKenzie, B. R., Watson, R. A., Andersen, K. H. 2018. Global patterns in marine predatory fish. Nature Ecology and Evolution 2: 65-70. https://doi.org/10.1038/s41559-017-0388-z [EUCE, Belgium]	Taken into consideration.
14107	5	4	22	4	27	Please clarify if the projected changes in lines 22-27 are for the same time period, i.e. 2100 and under all emission scenarios? [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	Text edited to clarify
14095	5	4	22	4	32	The section gives std dev with percentages, whereas others do not. Please be consistent, are std devs necessary in an exec summary and, if so, why don't all the other statements have them? [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	Accepted. Text edited.
15811	5	4	22	4	32	Please give example of repercussions (e.g. fisheries, biodiversity/extinctions, shock transfer through food chain) or at least mention that this is explored ahead. [EUCE, Belgium]	Accepted. Implications for human societies are discussed in separate statements.

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32087	5	4	22	4	32	This summary statement is not tenable in my opinion, as there is not enough evidence and independent lines of evidence to support it. First, no evidence is given in the text to support the statement about "emergence of novel ocean conditions". This implies the appearance of conditions that are outside the observed range. What we see is primarily a shift in the oceanic conditions that result in novel conditions at a certain location. But this does not mean that "novel" conditions have really appeared, with the exception, perhaps of the parameters associated with ocean acidification. Second, I don't see how the available literature supports the the high and very high confidence statements associated with "earlier timing" and "overall shift in biomass and species composition". Most of these statements rely on a single meta analysis of the available literature, but when I began to open the pandora box of the individual studies, many questions arose, e.g. associated with the length of the records, the highly skewed distribution of the observations, and most importantly the quasi attribution that is being done here. Take the fact, for example, that a good fraction of the trends stem from the North Atlantic, i.e., one of the regions that has been cooling during the last decades (see e.g., Figure 5.1b). Thus any trends seen in this region need to be assessed very differently from those in other regions. As far as I can tell, this has not been done. Instead, all trends have been analyzed together and then put into the context of the world-wide warming of the ocean. This is problematic, especially when a statement of the kind "consistent with expected responses to climate change" is then made. I thus urge the authors to take a much more cautionary approach to the assessment of the trends, and particularly be much more cautious about making any pseudo-attribution statement. Being on the cautionary side of things has been one of IPCC's key strength. The authors should heed IPCC's time-tested principles. [Nicolas Gruber, Switzerland]	Accepted. This is now re-written.
9703	5	4	25	4	25	"Seasonal biological events" would be more appropriate. [Government of France, France]	Taken into consideration
14109	5	4	25	4	25	...overall shift' - please specify what this means as shift implies a directional change. [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	Direction of shifts are specified now
14097	5	4	27	4	30	The sentence starting 'Changes in Biogeography' is too long and too complex for an executive summary. [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	Text rewritten
10645	5	4	28	0		I believe that this point mostly refers to fish biomass rather than "global animal biomass" [Jean-Pierre Gattuso, France]	This refers to animal biomass, not only fish biomass
10647	5	4	28	0		I would not use technical terms such as s.d. in an executive summary. [Jean-Pierre Gattuso, France]	Text edited

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31947	5	4	28	0	30	This is fine but would benefit from mentioning the drivers and their contributions and magnitudes of impacts in relation to scenarios and degree of environmental change. [Hans-Otto Poertner and WGII TSU, Germany]	Accepted
4459	5	4	28	4	28	should be 'aquatic animal biomass' [The UBern Team Group Review, Switzerland]	Text edited
33555	5	4	28	4	28	Referring to "...global marine animal biomass..."? [Government of United States of America, United States of America]	Text edited
7007	5	4	29	0		Suggest insert "RCP" before "8.5" [Nina Hunter, South Africa]	Accepted
33557	5	4	29	4	29	Double check predicted change percentages. [Government of United States of America, United States of America]	Percentages are checked
33559	5	4	29	4	29	Round the decreases and uncertainty to full percentages. [Government of United States of America, United States of America]	Taken into consideration. One decimal places of percentages are provided.
26443	5	4	29	4	30	Given that there are published estimates of fisheries catch potential change available it seems surprising that the figures in this executive figure (for total biomass in the ocean) are from a paper that is in review [Florence Poulain, Italy]	Both catch potential and animal biomass are now reported in the executive summary. The paper that the animal biomass figures are based on is published in peer-review literature.
33561	5	4	30	4	30	Change "Scope for adaptation for many organisms to cope with..." to "The ability of many organisms to adapt to..." [Government of United States of America, United States of America]	Text-rewritten
4457	5	4	30	4	31	Rewrite sentence [The UBern Team Group Review, Switzerland]	Text- rewritten
33563	5	4	30	4	33	Provide more justification for the statements here. [Government of United States of America, United States of America]	The statement is rewritten. Further details are given in separate statements.
23665	5	4	32	4	32	"Greenhouse gas emission" may be clearer than "carbon emissions": [Government of Sweden, Sweden]	The guideline in the chapter writing is to use greenhouse gas emission.
26769	5	4	32	4	32	For many organismal groups, the ability to respond to novel conditions depends on the current variability of the environmental stressor, e.g., temperature, with organisms from environments with low and high variability being more limited in their responses than organisms currently occupying environments with medium variability (high confidence). [Lars Tomanek, United States of America]	Text rewritten. Comment no-long relevant.
33565	5	4	34	4	34	"under stress" needs to be defined. [Government of United States of America, United States of America]	Text re-written. Under stress is not mentioned.
606	5	4	34	4	43	This is an excellent highlighted topic to have. [Jenna Pearson, United States of America]	Thank you.
1697	5	4	34	4	43	What about heat waves and other extreme events in the open ocean? How will these influence marine ecosystems or are they not as relevant and/or addressed in the next chapter? [Nora Richter, United States of America]	Our assessment of observed impacts of heatwaves on ecosystems mainly focus on coastal ecosystems
24663	5	4	34	4	43	This paragraph needs to list examples of all human activities (but does state 'human activity' the bold. human activity isn't just emission based). E.g. what about human encroachment and continued expansion into coastal areas and increasing population induced stresses on the coastal environment.? [Shutler Jamie, United Kingdom (of Great Britain and Northern Ireland)]	The text has highlighted non-climatic pressures from human activities

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9705	5	4	35	4	37	Add water warming among the listed stressors. [Government of France, France]	Accepted. Warming is considered.
29825	5	4	35	4	43	I suggest specifying latitudinal range differences, taking into account range expansion of species (and habitats, e.g. benthic primary producers) in high latitude vs retreat at low latitudes [Dorte Krause-Jensen, Denmark]	The main focus is the multiple stressors and risks and impacts across ecosystems. Latitudinal patterns are not highlighted here.
4461	5	4	36	4	36	should be 'to a loss of' [The UBern Team Group Review, Switzerland]	Text edited
14091	5	4	36	4	36	"more severe storms" - does this mean a change in the frequency or intensity, or both? Please clarify this here. The language used to discuss changes in storms in Chapter 4 is very clear - please ensure consistency in Chapter 5 too. [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	Text edited. No longer relevant.
11551	5	4	37	4	39	"Extreme events such as heat waves and storms are exacerbating the rate of ecosystem changes, such as those observed in kelp forest and seagrass meadow." Clarify and fix grammar: "Extreme events such as marine heat waves and storms are exacerbating the rate of ecosystem changes, such as those observed in kelp forests and seagrass meadows" [William Howard, Australia]	Text edited to clarify the statement.
22541	5	4	37	4	39	Suggest clarifying this statement to "Extreme events such as marine heat waves and storms are exacerbating the rate of ecosystem changes, such as those observed in kelp forests and seagrass meadows". [Government of Australia, Australia]	Text edited to clarify the statement.
4463	5	4	38	4	39	rewrite to'such as marine heatwaves' [The UBern Team Group Review, Switzerland]	Accepted
33567	5	4	38	4	39	Shouldn't it be "kelp forestS" and "meadowS" in the plural? [Government of United States of America, United States of America]	Accepted
14111	5	4	39	4	39	herbivory intensified by warming' - please unpack this statement. Not immediately obvious to a policy maker what the link between these two things is. [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	Text is now re-written. No longer relevant.
31949	5	4	41	0	42	Such aspect is missing from the ocean bullet (the one before). Once again, mentioning the magnitude of impacts would increase relevance. [Hans-Otto Poertner and WGII TSU, Germany]	Taken into consideration. Magnitude of impacts (quantified or quality) are provided when informaiton is available..
12671	5	4	41	4	41	- deoxygenation....why not hypoxia? Deoxygenation might refer to a mechanical removal of oxygen, while hypoxia often refers to oxygen decrease caused by a natural process... [Noureddine Benkeblia, Jamaica]	Deoxygenation and loss of oxygen in the ocean are used interchangeably in the literature, and thus in our chapter.
14093	5	4	41	4	41	The Exec Summary has combined coastal and open ocean conclusions. However the chapter is fairly clear that the evidence on some of the effects is much stonger in the open ocean, compared to coastal/shelf environments. Please amend text to clarify which environments the confidence statements correspond to, or create separate statements for the coastal and open ocean. [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	Coastal and open ocean assessments are now reported in separate executive summary statements.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
12673	5	4	41	4	46	- Acidification or Eutrophication? The second term is more recommended no? [Noureddine Benkeblia, Jamaica]	Text is rewritten
10659	5	4	44	5	47	Stating that carbon storage is high and that maintaining and promoting it could assist countries to reach targets of the Pais Agreement is misleading. As the next item of the ES says: "maximum global mitigation benefits of cost-effective coastal wetland restoration is unlikely to be more than 2% of current total emissions from all sources". Perhaps the two items could be merged in order to highlight the small global contribution while highlighting the multiple benefits. [Jean-Pierre Gattuso, France]	COMMENT OUT OF SEQUENCE - relates to p 5, lines 44-47. Text to be amended to take into account. But note that there are two processes at play, and these occur at two scales, national and global. Thus GHG emissions arising from BC habitat loss can be prevented by "successful implementation of measures to maintain and promote carbon storage..", relating to national-level NDCs for intact ecosystems and covered in first BC para. However, the global-scale benefits of BC habitat restoration, covered in 2nd BC para, are not that great (c 2%) in context of increasing uptake, to offset emissions elsewhere.
11553	5	4	45	4	45	Fix grammar: "Almost all major coral reef systems (shallow and deep) are vulnerable to climate change" [William Howard, Australia]	Text revised
9707	5	4	45	4	48	Rising sea level is not known to affect coral reef system. [Government of France, France]	The argument is refuted by the literature. Examples from different disciplines: (1) Storlazzi, C. D., Elias, E., Field, M. E., & Presto, M. K. (2011). Numerical modeling of the impact of sea-level rise on fringing coral reef hydrodynamics and sediment transport. Coral Reefs, 30(1), 83-96; (2) Bellwood, D. R., & Fulton, C. J. (2008). Sediment-mediated suppression of herbivory on coral reefs: Decreasing resilience to rising sea-levels and climate change?. Limnology and Oceanography, 53(6), 2695-2701; (3) Camoin, G. F. et al. (2012). Reef response to sea-level and environmental changes during the last deglaciation: Integrated Ocean Drilling Program Expedition 310, Tahiti Sea Level. Geology, 40(7), 643-646; (4) Perry, C. T. et al. Nature 558, 396–400 (2018); (5) Perry, C. T., et al. (2018). Loss of coral reef growth capacity to track future increases in sea level. Nature, 558(7710), 396; (6) van Woesik, R., & Cacciapaglia, C. W. (2018). Keeping up with sea-level rise: Carbonate production rates in Palau and Yap, western Pacific Ocean. PloS one, 13(5), e0197077. Screen reader support enabled.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
9211	5	4	45	4	52	The catastrophic mass coral mortality and bleaching affecting the Great Barrier Reef (and other world regions) during unprecedented marine heat waves in 2016 and 2017 should be adequately covered in the Executive Summary. For details, see the related comment on Section 5.3.3.6. [Hans-Martin Füssel, Denmark]	The argument is refuted by the literature. Examples from different disciplines: (1) Storlazzi, C. D., Elias, E., Field, M. E., & Presto, M. K. (2011). Numerical modeling of the impact of sea-level rise on fringing coral reef hydrodynamics and sediment transport. Coral Reefs, 30(1), 83-96; (2) Bellwood, D. R., & Fulton, C. J. (2008). Sediment-mediated suppression of herbivory on coral reefs: Decreasing resilience to rising sea-levels and climate change?. Limnology and Oceanography, 53(6), 2695-2701; (3) Camoin, G. F. et al. (2012). Reef response to sea-level and environmental changes during the last deglaciation: Integrated Ocean Drilling Program Expedition 310, Tahiti Sea Level. Geology, 40(7), 643-646; (4) Perry, C. T. et al. Nature 558, 396–400 (2018); (5) Perry, C. T., et al. (2018). Loss of coral reef growth capacity to track future increases in sea level. Nature, 558(7710), 396; (6) van Woessik, R., & Cacciapaglia, C. W. (2018). Keeping up with sea-level rise: Carbonate production rates in Palau and Yap, western Pacific Ocean. PloS one, 13(5), e0197077.
23667	5	4	45	4	52	For consistency with the SR1.5, some statements on projected losses of corals could be included here. [Government of Sweden, Sweden]	Screen reader support enabled.
29739	5	4	45	4	52	There are some suggestions for possibly geoengineering reef systems, seeking to limit impacts from warming and/or acidification. Are any of these considered? Should they be? [Michael MacCracken, United States of America]	Out-of-scope
31951	5	4	46	0		It is not clear whether this means a difference in sensitivity due to genetic differences between corals or due to regional differences in climate changes. [Hans-Otto Poertner and WGII TSU, Germany]	Clarified
14113	5	4	48	4	48	Please make clear if 'other impacts' are human caused and state here if so. [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	Text re-written and clarified.
1829	5	4	48	4	50	Same as comment #2 for SPM: use of refuge is unclear, since shallow coral reefs protected from direct human impacts such as trawling and nutrient enrichment would still be subject to global change (temperature, acidification, sea level rise), these reefs are not climate change refugia. It is unclear what is meant here. Is the point that local damages should be reduced? [Lydia Kapsenberg, Spain]	Text re-written. The discussion about refugia now removed.
9709	5	4	48	4	50	This sentence can be constructed differently to emphasis the necessity to reduce anthropogenic impacts : "Limiting overfishing and reducing impact of sewage, nutrient and coastal development will be essential to mitigate future impact of climate change and will give time to coral reefs to adapt." [Government of France, France]	Text revised. Discussion related to the scope for adaptation for coral is now discussed separately.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
10649	5	4	48	4	50	Perhaps better to write "Shallow coral reefs that are not degraded by overfishing and nutrient enrichment could constitute an important refuge from which reefs degraded by climate change could be recolonized." [Jean-Pierre Gattuso, France]	Text re-written now
7009	5	4	49	0		Is "for" meant instead of "to"? [Nina Hunter, South Africa]	Text edited
504	5	4	50	4	50	This statement depends on scenario chosen, I believe. Please modify. And: "Virtually certain" seems too strong, given the differences between climate models, even under the same scenario. Perhaps use a confidence level instead? [Cecilie Mauritzen, Norway]	Accepted. The confidence statement is re-calibrated.
14117	5	4	50	4	51	Please make clear if the projection statement here refers to all or specific emission scenarios. [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	It refers to RCP8.5 and is now specified.
33569	5	4	50	4	52	Major reservations with respect to the virtually certain loss of deep-water coral reef habitat under projected ocean acidification. It remains rather poorly understood what the vulnerability of these systems are to OA. There are deep-water reefs that currently persist below the ASH. Rather, increases in bio-erosion are likely an equal (if not greater) challenge for shallow water reef systems under OA. Do not overstate current understanding of the vulnerability of deep-sea coral reef habitats to OA. [Government of United States of America, United States of America]	Accepted. The confidence statement is re-calibrated.
33571	5	4	50	4	52	This statement is not supported by 5.3.3.6, which does not include a discussion of deep-water coral reef habitat. Either strike this sentence or expand 5.3.3.6 to support it. [Government of United States of America, United States of America]	A box that specifically discuss about the cold-water coral reef is now included in the chapter.
14115	5	4	51	4	52	This last sentence includes technical terms that will be unfamiliar to a policy audience - please define 'dissolution' and 'bioerosion of the non-living matrix' or use simpler term to refer to these, e.g. change 'non living matrix' to skeleton or hard structure or calcified structure to make clearer for non-specialists. [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	Non-living matrix is now change to component. The text is now revised to improve clarity.
9711	5	4	52	4	52	Add "Corals have the ability to regulate pH as a result of calcification (Rodolpho et al, 2015 ; Gori et al., 2016)" [Government of France, France]	Take into account, but this is not reported specifically in the executive summary.
10653	5	4	54	4	55	"Benthic communities in deep-sea habitats will experience structural and functional changes that affect the carbon cycle in this century under all emission scenarios" Is there evidence for that? I could not find it in the text which addresses how deep communities will be affected by changes in the carbon cycle. [Jean-Pierre Gattuso, France]	Text rewritten and clarified that this is about the impacts of carbon flux which are assessed in the chapter.

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Comment id	Chapter	From page	From line	To page	To line	Comment	
14099	5	4	54	4	55	Change to 'Under all emissions scenarios, benthic communities....' to make clearer [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	Text rewritten to specific emission scenarios.
29827	5	4	54	4	55	Please take latitudinal differences into account including potential contribution from kelp ecosystems [Dorte Krause-Jensen, Denmark]	Taken into consideration.
15703	5	4	54	5	4	Agreed. See also van Denderen et al 2018 Global patterns in marine predatory fish. Nature Ecology and Evolution 2: 65-70. https://doi.org/10.1038/s41559-017-0388-z for how changes in C flux will affect fish community functional composition in pelagic and demersal foodwebs. [EUCE, Belgium]	Taken into consideration.
29741	5	4	54	5	4	Might it be possible to add a sentence about why this matters for either society and/or the productivity of the overall ocean ecosystem? [Michael MacCracken, United States of America]	This is now discussed in a separate key message.
32089	5	4	54	5	4	"affect the carbon cycle in this century". I suggest to delete this addition. There is no statement in what way and also not that what degree. Also the text does not provide further information on this beyond such a general statement. Of course, this statement is factually correct, but meaningless without quantification. [Nicolas Gruber, Switzerland]	Accepted and revised.
31953	5	4	55	0	57	Can any information be provided about the magnitude of changes in relation to climate scenarios? [Hans-Otto Poertner and WGII TSU, Germany]	Quantitative projections are now provided.
22821	5	4	55	4	55	I'm not an expert on the confidence language but it's an odd juxtaposition having "medium confidence" next to "suggested". I would perhaps use the word "supported" instead [Raphael Kudela, United States of America]	Text rewritten
15261	5	5	0	0		This is a very strong finding of key relevance to coastal LDCs that would be most affected. Please consider lifting it up to the SPM. [Government of Gambia, Gambia]	Taken into consideration.
12683	5	5	0	18		- Section 5.2.2.2: This section is not well structured. Same topic is scattered, and should be under the same paragraph. [Noureddine Benkeblia, Jamaica]	Section revised to improve clarity
16577	5	5	0	5		Subfigure 5.1 a has no legend. The model estimates (blue and red) seem to overestimate the increasing heat content compared to the measured data (green), but in the text is written "good agreement" (page 5-16, lines 19-20), please check for consistency. Subfigures b-g: units of the scale are not visible [Jens Rassmann, Belgium]	Figure revised and quality improved.
23225	5	5	0	5		The text on lines 6 to 29 looks at risks but does not show any hint for risk reduction / risk management. [Valerie Masson-Delmotte, France]	Risk reduction approaches are now comprehensively covered in Section C of executive summary.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
23227	5	5	0	5		Inconsistency in the two paragraphs on blue carbon, the first one suggesting it "should significantly assist countries in reaching net zero of Paris Agreement" (which seems quite prescriptive in the way it is written) and the next one saying that the full potential is really small. [Valerie Masson-Delmotte, France]	COMMENT OUT OF SEQUENCE. Text to be amended to take into account. But note that there are two processes at play, and these occur at two scales, national and global. Thus GHG emissions arising from BC habitat loss can be prevented by "successful implementation of measures to maintain and promote carbon storage..", relating to national-level NDCs for intact ecosystems and covered in first BC para. However, the global-scale benefits of BC habitat restoration, covered in 2nd BC para, are not that great (c 2%) in context of increasing uptake, to offset emissions elsewhere.
31955	5	5	1	0	5	Can any information be provided about the magnitude of changes in relation to climate scenarios? [Hans-Otto Poertner and WGII TSU, Germany]	Quantitative projections are now provided.
14133	5	5	2	5	2	Please specify the change to carbon burial rates - i.e. will this increase and decrease in different regions/environments? [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	Text rewritten. Comment no longer relevant.
4939	5	5	2	5	4	Consider comparing this with RCP2.6 [Debra Roberts and Durban Team, South Africa]	Contrast between RCP2.6 and RCP8.5 is now provided
31957	5	5	6	0	18	Can any information be provided about the magnitude of changes in relation to climate scenarios? [Hans-Otto Poertner and WGII TSU, Germany]	Quantitative projections or risk levels are now provided when such assessment is available in the chapter.
12997	5	5	6	5	18	Does the headline statement refer to the past, present or future? Please specify clearly. Also, the last sentence is a factual statement (...will experience), but it is based on projections. Please revise to ensure that causality and confidence are not mixed between projections, predictions and assumptions/expectations based on theory. [Government of Germany, Germany]	Text rewritten to clearly state whether the statement is about observed impacts or future risks.
14119	5	5	6	5	18	A real mix of information in here, some with limited evidence that highlights threats but no opportunities- is this a fair representation of understanding? [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	Text rewritten to improve clarity.
15705	5	5	6	5	18	The future expected declines will not happen everywhere, as suggested by this text. There will be some regional increases, as indicated by various models and already by some observations. The text should state more clearly that there will be losses and gains in different areas, i.e., there are regional differences, so the storyline presented in this text is a misleading global view. The effect of regional differences should be stated at line 14 and elsewhere. Also, lines 17-18 will not apply in all regional contexts and this must be indicated more clearly in the text. [EUC, Belgium]	It is clearly stated that there are regional differences. The treatment of changes in the polar regions are discussed in Chapter 3. The statement highlighted the global average trends.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
22727	5	5	6	5	18	The paragraph could reflect the studies that show the relationship between climate change and fisheries "Globally, the potential fisheries catch in the open pelagic oceans is projected to decrease by 2100 relative to the 2000s under RCP8.5, RCP4.5, and RCP2.6 scenarios with regional differences (Cheung et al., 2016a; Blanchard et al., 2017). Based on projections from an ensemble of three CMIP5 earth system models and a fisheries impact model, there is a projected significant (more than -10% by 2050 relative to present day) decrease in catch potential under both RCP4.5 and RCP8.5 forcing (Cheung et al., 2016a)." [Greenpeace Group Review, Republic of Korea]	Accepted. Projections of catch potential are presented.
26587	5	5	6	5	18	Revenue from the fisheries sector in its entirety is quite distinct from revenue from particular fisheries -- and the models have failed to make this distinction or include the impacts of scarcity on pricing and changing dietary preferences. Additionally, although farmed species in one location may be more exposed to increased risks, it doesn't not mean that the locations of farms could not change to adjust to such changes. Of course, those people dependent in one location will be at risk, but those in other locations will have potential new opportunities. [Florence Poulain, Italy]	The text is rewritten. Comment no longer relevant.
29829	5	5	6	5	18	Please consider mentioning the potential for macroalgal aquaculture [Dorte Krause-Jensen, Denmark]	This is not assessed in the chapter
22729	5	5	6	5	9	The headline statement is clear on the social and economical security but needs to have clearer suggestions [Greenpeace Group Review, Republic of Korea]	Text edited
11929	5	5	8	0		what are "vulnerable people". Sounds odd. [Wolfgang Kiessling, Germany]	Text edited
4555	5	5	8	5	8	different' instead of across. You cannot 'cover .. across' [The UBern Team Group Review, Switzerland]	Text edited
22731	5	5	8	5	9	Add "low- and middle- income coastal communities around the equator in particular {5.4.2.2.2}" after "...and food security of vulnerable people". In general it is not emphasized enough throughout the chapter that those in the areas where catches are expected to decline more, communities are more dependent on fish, even if it is mentioned. [Greenpeace Group Review, Republic of Korea]	Text is now re-written. Comment no long relevant.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
12999	5	5	9	5	19	This paragraph carries a very important message with regard to the necessary yet not sufficient improvement of resilience through better management of non-climatic stressors. But it is not really clear what is meant by "given strong mitigation..." - is this statement based on modelling experiments with low emission scenarios, showing the cost effectiveness, or is the intention simply to stress that those measures can not substitute for mitigation, and will only work for moderate raises in T and acidification? Please revise the first sentence to make this more clear. [Government of Germany, Germany]	In the FD, it is specifically addressed in the section on human responses.
1831	5	5	11	5	11	Same as comment #3 for SPM: Shellfish aquaculture is also sensitive to warming. Mediterranean sea aquacultures have shifted harvesting dates to avoid mass mortalities that occur during warm temperatures in August (e.g., aquaculture in the Ebro river delta in Spain) [Lydia Kapsenberg, Spain]	Taken into consideration.
5459	5	5	11	5	11	Extreme climatic events resulting from climate change, such as hurricanes, floods and droughts can transport invasive alien species to new areas and decrease the resistance of habitats to invasions. Climate change is also opening up new pathways of introduction of IAS. Biological invasions are a major threat to global food security, fisheries and livelihoods ((IUCN, 2017 (Issues Brief, Invasive Alien Species and Climate Change)), [IRFAN UYSAL, Turkey]	Taken into consideration.
15815	5	5	11	5	11	The meaning of this sentence is unclear and this is a key point for aquaculture, as an essential blue growth sector. It is recommended adding ", notably through increased shell decalcification and interference with life cycle" or something of this sort, taking into consideration the data from your analysis. The same type of information should be reflected in the summary for policy makers. [EUCE, Belgium]	The text is rewritten. The impacts of ocean acidification on shellfish aquaculture is comprehensively assessed in AR5 and SR1.5. Therefore, the assessment refers to these earlier assessments for their conclusions.
15813	5	5	11	5	12	The report indicates that shellfish aquaculture is sensitive to ocean acidification and points to section 5.4.2.2.1 However there is nothing in the chapter about the impact. Which species are affected? Is there a tipping point? What is the impact of removing the shells from the ocean? [EUCE, Belgium]	The impacts of ocean acidification on shellfish aquaculture is comprehensively assessed in AR5 and SR1.5. Therefore, the assessment refers to these earlier assessments for their conclusions.
23669	5	5	12	5	12	What does "by multiple models" emphasise here, in particular with respect to the included confidence level statement? [Government of Sweden, Sweden]	Text is now rewritten to clarify meaning.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
26445	5	5	12	5	13	Following on the above, when statement on fish potential catch are provided, no figures are mentioned. In Cheung et al (2018, FAO report) the catch potential change is 2.8-5.3% under rcp2.6 and 7.0-12.1% under rcp8.5 by 2050, based on two models. Results are consistent with other papers (Cheung, Blanchard, etc.) and thus worth mentioning. [Florence Poulain, Italy]	Quantified projectons are now provided.
4465	5	5	13	5	13	replace 'CO2 emissions' with 'global warming', as fish react to warming not to the C emissions [The UBern Team Group Review, Switzerland]	Accepted.
26447	5	5	14	5	14	"realized catch" will depend strongly on FISHERIES MANAGEMENT strategies and decisions (fishing intensity is the consequence of the management policy). As discussed in Cheung et al (2018, op.cit.) a decline in potential catch does not have to mean a decrease in realised catch if rebuilding policies are implemented. This should be mentioned. [Florence Poulain, Italy]	This is discussed in the chapter text. But the executive summary focuses on the added risk from climate change, thus we use catch potential as an indicator.
23671	5	5	14	5	15	It is difficult to catch the meaning as one region is singled out with "among the largest regional declines": For example, it is not clear which the other regions are, how much larger changes and how much/less important these may be. [Government of Sweden, Sweden]	This is now re-written to clarify the meaning.
15817	5	5	16	5	16	The mention of the confidence level is missing. The same happens in pg. 6 ln.4, ln.7., ln. 34 [EUCE, Belgium]	Text is now rewritten and confidence level is given in relation to aquaculture.
22823	5	5	16	5	16	Two comments regarding HABs. First, it's not listed in the referenced section (I think all the HAB information was moved to Box 5.3). Second, the implication is that expanding HABs only impact farmed species, but there is plenty of evidence that increasing prevalence of HABs will also impact wild-caught fisheries. This is well documented for Ciguatera Fish Poisoning (numerous references after 2015) which is primarily artisinal or wild-caught fisheries, while the McCabe 2016 paper cited in Box 5.3 highlights the impact to commercial (non-farmed) species on the US west coast in a bloom attributed to climate change. [Raphael Kudela, United States of America]	It is assessed mainly in Box 5.4. The broader impacts and risk of HABs on ecosystem and human communitiies are assessed and reported.
14121	5	5	17	5	17	This suggests that all people reliant on fisheries and related sectors "will experience substantial decline" - Would this be better phrased as "most people"or "many people" as some areas will see few impacts or be able to adapt or in some areas there might be opportunities? [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	Text rewritten to improve clarity.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
22733	5	5	19	5	19	Add new paragraph: "Overall, climate change will impact the chance of achieving the Sustainable Development Goals and sustaining their benefits (medium confidence). Particularly, climate change will have direct consequences for the goals that consider sustainable oceans (SDG 14) (high confidence), achieving food security (SDG 2) (medium confidence), achieving good health and wellbeing (SDG 3) (low confidence) as well as all other SDGs indirectly (low confidence) {5.4.2.4}." [Greenpeace Group Review, Republic of Korea]	This is not selected to be highlighted in the executive summary.
10025	5	5	20	4	29	The use of "Climate regulation" in the opening statement here is misleading. The text focuses on ecosystem services - it would be better to replace this with "carbon storage" or something similar. [Tommy Moore, United States of America]	Text rewritten. The comment is no long relevant.
506	5	5	20	5	22	What does this mean? That ocean ecosystems' role are threatened by climate change? Please make the sentence simpler and tell us what is happening to the ecosystem services. [Cecilie Mauritzen, Norway]	Text rewritten.
14135	5	5	20	5	22	Suggest that lines 20 -22 could be rephrased for clarity to: 'Ocean ecosystems' role in climate regulation, and their intrinsic values that support human wellbeing via culture and recreation are being threatened by climate change because of the loss and degradation of biodiversity and ecosystems functions' [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	Text rewritten.
14123	5	5	20	5	23	This bold text is too general and to give this generality high confidence when the evidence is localised and case-specific is probably a further generalisation [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	Text is now re-written to make it more specific.'
13001	5	5	20	5	29	This paragraph is convoluted, and mixes several very different impacts. The examples listed appear somewhat random and it is not clear how they were chosen. "loss of educational opportunities" is an unexpected item in this list, is this really the most relevant impact to be prioritized in the ES/SPM? On the other hand "the relationship with indigenous knowledge and culture" is very vague and it is not clear whether this is a stand alone item or linked to the education issue. Please rephrase and consider to prioritize the most relevant examples (highlighting those are examples and not an exhaustive list). [Government of Germany, Germany]	Agreed. Text is now rewritten for clarity.
15707	5	5	20	5	29	Management, overexploitation from tourism,...are also impacting ecosystems, including coral reefs, whose resilience may be affected both ways (from overexploitation and from climate change stressors). This is an important aspect that also needs to be recognised. [EUCE, Belgium]	Text rewritten. The comment is no long relevant.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
29831	5	5	20	5	29	Add latitudinal aspect.. Consider linking/referring more directly to the section on Blue Carbon.. Add potential for Blue Carbon strategies - e.g. Nelleman et al 2009, Duarte et al 2013 (The role of coastal plant communities for climate change mitigation and adaptation. Nature Climate Change). Add Gattuso et al. 2018.. [Dorte Krause-Jensen, Denmark]	Noted. But not clear what "latitudinal aspects" needs to be added, and there is linkage to subsequent BC paragraphs by mention of "carbon stock and sequestration"
32091	5	5	20	5	29	The headline statement of this paragraph implies more substance than is actually provided in the more detailed statements. For example, the reduction in the nutrient cycling in the deep sea floor ecosystems cannot really qualify as a contribution to the ocean ecosystem's role in climate regulation, etc. I suggest to reformulate this and make it less general and more precise. [Nicolas Gruber, Switzerland]	Text rewritten. The comment is no long relevant.
33573	5	5	20	5	29	It doesn't seem logically consistent that when referencing an "intrinsic" value one can exhibit high confidence about any aspect of it provided that, by definition, such values are largely subjective. Furthermore, most of the examples listed are extrinsic values and are themselves of medium confidence. Advise adopting a medium confidence for the bolded statement ending on line 22. [Government of United States of America, United States of America]	Text rewritten. The comment is no long relevant.
33575	5	5	20	5	29	The sentences in this section are very dense and should be simplified for clarity and impact. [Government of United States of America, United States of America]	Text rewritten
17145	5	5	22	5	22	Replacing of word "evidenced" with "evident" for sentence correction. [Shalini Singh, Fiji]	Text rewritten
4469	5	5	22	5	29	Very long sentence, maybe split into two [The UBern Team Group Review, Switzerland]	Text rewritten
31959	5	5	23	0	24	Is this statement focused on Deep sea floor meant to be the key support for the first sentence? The following sentence structure appears incomplete? May be the sequence in the intended list (?) can be changed? Can any information be provided about the magnitude of changes in relation to climate scenarios? [Hans-Otto Poertner and WGII TSU, Germany]	Text rewritten
4467	5	5	25	5	25	Maybe rewrite to 'attractions such as coral reefs are degraded by warming' [The UBern Team Group Review, Switzerland]	Text rewritten - comment no long relevant
25763	5	5	26	5	27	It is not clear "...sequestration in salt marshes through reduced habitat availability for fauna requiring open vegetation structure as a result of sealevel rise"; how the fauna is playing role in sequestration of reduced salt marsh habitats [Government of India, India]	Text edited to clarify the meaning
25765	5	5	26	5	27	Not only saltmarshes for reduction in carbon stock and sequestraon but also mangroves and seagrasses. [Government of India, India]	Text edited to clarify the meaning

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
25793	5	5	26	5	27	It is not clear "...sequestration in salt marshes through reduced habitat availability for fauna requiring open vegetation structure as a result of sealevel rise"; how the fauna is playing role in sequestration of reduced salt marsh habitats. [Government of India, India]	Text edited to clarify the meaning
7011	5	5	31	0		Change "is" to "are" [Nina Hunter, South Africa]	Text edited
31961	5	5	31	0		Can any information be provided about the magnitude of changes and risk thresholds in relation to climate scenarios? This concerns various items in this bullet point. [Hans-Otto Poertner and WGII TSU, Germany]	Taken into consideration
4471	5	5	31	5	31	Change to 'on the ocean are' [The UBern Team Group Review, Switzerland]	Text edited
11555	5	5	31	5	31	fix grammar and frame in probabilistic terms: "Climate change impacts on the ocean are likely to substantially increase the risks on human health" [William Howard, Australia]	Probably statement cannot be assigned. Instead confidence language is used based on evidence and agreement in the literature.
22543	5	5	31	5	31	Suggest clarifying this statement and framing in probabilistic terms to "Climate change impacts on the ocean are likely to substantially increase the risks on human health". [Government of Australia, Australia]	Probably statement cannot be assigned. Instead confidence language is used based on evidence and agreement in the literature.
508	5	5	31	5	32	Here there are two key messages compressed into one (risks to human health AND risk of conflict), resulting in an unclear sentence. Suggest to keep the two messages separate, each with their own paragraph, so that you know the reader will get both points. [Cecilie Mauritzen, Norway]	Points now separated
14125	5	5	31	5	32	Suggest to separate the point about human health from the one about political disagreement - not sure why you would want to put these together? [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	Agreed. Text edited.
33577	5	5	31	5	32	The word "substantially" appears to be hyperbole and would advise striking it. Replace the term "conflict" (which seems to specifically denote violent confrontation) with "competing interest" perhaps. The historical trends in violent conflict have, by-and-large, shown considerable declines in recent decades suggesting that while competing interest remain, and may in fact increase under a changing world, that does not necessitate open conflict. [Government of United States of America, United States of America]	Accepted. The term conflict has been used in a more specific context on fisheries.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
17421	5	5	31	5	35	The meaning of this paragraph is ambiguous – can the authors provide a deep edit in order to clarify the meaning? I was not certain if you meant that “we must conjecture from biophysical principles” to understand the impact of climate change on those deep ocean ecosystems in their own right. Or whether “we must conjecture from biophysical principles” to understand the impact of climate change on deep ocean ecosystems’ changes and the consequent impacts on human society? It is not currently clear whether this entire paragraph is about impacts on ecosystems, impacts on human society, or both. [Mairi Dupar, United Kingdom (of Great Britain and Northern Ireland)]	The text around this message has been largely rewritten
13003	5	5	31	5	40	Similar to the paragraph above, this statement is made hard to digest by mixing different impacts and implying causal relationships by listing effects that have some interlinkage, but without providing an assessment of the strength of those linkages. As health impacts, food security, and increased competition for resources are very important topics, space should be reserved to highlight all robust relationships, however a clear assessment needs to be provided. [Government of Germany, Germany]	The text around this message has been largely rewritten
28891	5	5	31	5	40	Replace with: "Climate change impacts on the Ocean is expected to substantially increase the risks on human health (medium confidence). Elevated risks of water-borne disease, food poisoning and pollutant contamination on human health are directly related to climate change through increase prevalence of pathogens and harmful algal bloom, and increased contaminant bioaccumulation under warming and high CO2 conditions (high confidence). {Box 36 5.3, 5.4.2.1.1} The projected decline in fish supply and key fish micronutrients threaten food security of coastal communities that are strongly dependent on seafood, such as coastal Indigenous people and many 38 tropical countries. {5.4.2.1.2} Redistribution of fish stocks under climate change increases the risk of dispute over ocean resources (high confidence) while reduced food security and livelihood of socially marginalized human populations exacerbates inequality and social unrest (medium confidence). {5.4.2.1.3} [Government of Brazil, Brazil]	The text around this message has been largely rewritten
28291	5	5	33	0		I suggest that the word “pollutant” should be replaced with “pollutants” [Nsikak Benson, Nigeria]	Text edited.
7013	5	5	34	0		Change "increase" to "increased" [Nina Hunter, South Africa]	Text edited.
4551	5	5	34	5	34	change to 'an increasing prevalence' [The UBern Team Group Review, Switzerland]	Text edited.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
33579	5	5	34	5	34	Change to "increasing prevalence of pathogens and harmful algal blooms, and..." [Government of United States of America, United States of America]	Text edited.
10655	5	5	35	0		Is high confidence really justified? I would think that evidence is rather limited. [Jean-Pierre Gattuso, France]	High agreement, medium evidence is concluded here. It is based on multiple lines of evidence from experiments, models and in situ observations.
28293	5	5	36	0	38	The sentence "The projected ... tropical countries." appears to be incomplete. I suggest the introduction of either "could likely" or "may likely" after the word micronutrients. [Nsikak Benson, Nigeria]	Rejected. This is not a probability statement so in IPCC terminology, "likely" cannot be used here. Instead confidence language is used.
26589	5	5	36	5	37	lized declines will have local (up to regional) impacts, but the total fish supply may not change. [Florence Poulain, Italy]	Taken into account. Text edited.
4553	5	5	38	5	38	such as .. Countries': Countries can not be an example for a coastal community. Rephrase [The UBern Team Group Review, Switzerland]	Text edited.
1833	5	5	42	5	43	Blue carbon as a worthy solution is in direct conflict with the previous information detailing the harmful effects of climate change on such ecosystems (e.g., seagrasses and mangroves on pg. 4 line 34-43). It would be VERY beneficial to mitigation efforts to have a clear explanation of the cost-benefit of investing in blue carbon when these ecosystem are at risk in and of themselves (and potentially large sources of CO2 when they degrade). I do not feel like this report clearly outlines this issue with Blue Carbon. Instead, it presents a conflict (blue carbon is worth the investment, but blue carbon is not a good and reliable solution). [Lydia Kapsenberg, Spain]	Noted. But the cost-benefit nformation requested does not currently exist in the literature: there are too many uncertainties.
10657	5	5	42	5	43	Solution to what? I would suggest to write something like "nature-based solutions to reduce the impacts of climate change" [Jean-Pierre Gattuso, France]	Accepted. Change to be made: "... can help reduce the risks and impacts of climate change, with multiple co-benefits"
33581	5	5	42	5	43	The term "solution" should be replaced with "contributing option" or perhaps "assist" provided that Blue carbon ecosystems are not sufficient to serve as a complete solution. This is well expressed in the following bullet starting on line 55. [Government of United States of America, United States of America]	Accepted. To be changed as above
11227	5	5	42	5	53	Blue carbon ecosystems also contain seaweed systems -->see Krause-Jensen and Duarte 2016. Nature Geoscience: DOI: 10.1038/NGEO2790 [Inka Bartsch, Germany]	Noted. Seaweeds are mentioned at the end of the para. The initial wording does not exclude them ("such as..")
31963	5	5	42	6	1	As an example, this section has the minimum level of quantitative information that is needed to complement statements on climate induced change, impacts and in this case mitigation capacity and thereby put this information into a wider context. [Hans-Otto Poertner and WGII TSU, Germany]	Noted. Not apparently requiring action.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
28895	5	5	42	6	2	Delete all references to "blue carbon". There is no agreed definition for this term; its use interchangeably with "coastal ecosystems", mangroves, salt marshes, seagrasses and wetlands reduces the accuracy of the report. [Government of Brazil, Brazil]	Reject. The term 'blue carbon' is relatively new, and it is recognised that there may be some disagreements regarding its definition. Nevertheless: i) there is wider scientific consensus regarding its usage and meaning; ii) a carefully-considered definition (based on that consensus and SROCC usage) is provided in the SROCC Glossary; iii) blue carbon was specifically mentioned in the governmentally-approved SROCC report outline; and iv) it would not be either feasible or helpful to replace the term blue carbon with alternative wording within Chapter 5 of the SROCC report.
4473	5	5	42	6	7	Maybe merge the two paragraphs about blue carbon ecosystems into one to add equal weight to the different topics addressed in the chapter. For example I also miss a paragraph about changes in ocean circulation in the executive summary [The UBern Team Group Review, Switzerland]	Rejected. The two paragraphs cover different issues, and their merger is not considered helpful.
14129	5	5	42	6	7	There is an imbalance here in the discussion of 'blue carbon' methods to remove atmospheric CO2, vs other methods such as macro- and micro-nutrient fertilisation and liming/enhanced weathering. The text (in the ES and in the chapter section 5.5.1) gives a lot of prominence to the former and little to the latter. The impression given is that the authors chose not to give as much attention to the latter methods as the former. Since all these methods gain interest in the policy world and public media from time to time it would be preferable to have a careful, specific assessment of each. If the evidence is limited, so be it, but it would be better to show that each idea has been considered carefully. [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	Noted. The apparent imbalance directly results from the governmentally-approved scoping guidance, requesting focus on; "Blue carbon, mangrove restoration, and other nature-based solutions, and ocean implications of different mitigation measures" and WG III request/advice that SROCC should not cover the full range of mitigation measures (e.g. marine renewable energy).
14131	5	5	43	5	43	a 'nature based solution' to what? Please define or give examples. [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	Accepted. Change to be made: "... can help reduce the risks and impacts of climate change, with multiple co-benefits"
15709	5	5	44	5	45	Carbon storage efficiency of marine ecosystems could be quantified here, e.g. 5 times more efficient at storing carbon. Perhaps reference to the speed at which they sink carbon could also be brought to this paragraph? [EUCE, Belgium]	Noted. But it is not yet possible to make the general statement on 'carbon storage efficiency' that is requested, since too many variables. Speed of sinking carbon is only one of many factors; return rate to atmosphere is much more important.
15819	5	5	44	5	45	This should be substantiated by quantifiable data. Please add the range of carbon storage per unit, for recognised blue carbon ecosystems (mangroves, salt marshes, seagrass). The point should also be made that there is a need to address the lack of data on other (less researched) blue carbon ecosystems, as their current contribution to mitigation might be overseen, and on the data gaps on "traditional" blue carbon ecosystems (as noted in section 5.5.1). [EUCE, Belgium]	To be taken into account. Carbon storage values for different ecosystems is quantified in text, but giving per unit area values in the Executive Summary could be misleading (since areal extent values are not very well known, and are needed to estimate national and global values)

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17423	5	5	44	5	46	There are references in Chapter 5 regarding the role of over-exploitation of fisheries in creating pressure on fishing stocks (e.g. page 5-77, lines 44-46) but you could also add a reference in the same section to other relevant, recently published literature about the combined pressure of over fishing and climate change such as 'Delivering sustainable fisheries through adoption of a risk-based framework as part of an ecosystem approach to fisheries management' in Marine Policy (July 2018) https://www.sciencedirect.com/science/article/pii/S0308597X16306856?via%3Dihub [Mairi Dupar, United Kingdom (of Great Britain and Northern Ireland)]	THIS COMMENT SEEMS TO RELATE TO TEXT ELSEWHERE. Not applicable to line numbers 44-46 (paragraph on blue carbon).
23673	5	5	45	5	45	The relation of "can be" and "high confidence" is very unclear, and thus the substance-statement. (uncertain? Very variable across habitats?) [Government of Sweden, Sweden]	Accepted; edits made to clarify
3741	5	5	45	5	46	The statement that vegetated marine habitats store more carbon per unit area is not accurate. In the top 1 m of soil, tropical forests and boreal forests store 242 Mg C ha ⁻¹ and 239 Mg C ha ⁻¹ , respectively (Pan et al. 2011). As a result, carbon stocks per unit area for forests are higher than salt marsh (140 Mg C ha ⁻¹), similar to seagrass (240 Mg C ha ⁻¹) and slightly below mangroves (280 Mg C ha ⁻¹). This statement is also not accurate from a total carbon storage point of view, as forests alone store a total 383 GtC in the top 1 meter compared to 5-6Gt C in vegetated coastal ecosystems. Vegetated coastal ecosystems do, however, have substantially greater (nearly an order of magnitude greater) mean long-term rates of C sequestration per unit area compared to terrestrial forests, making them comparable to terrestrial forests in terms of their contribution to long-term C sequestration (McLeod et al. 2011) Pan et al. 2011. Science DOI:10.1126/science.1201609 McLeod et al. 2011. Frontiers in Ecology and the Environment. doi:10.1890/110004 [Trisha Atwood, United States of America]	Accepted; edits made to clarify. But note that i) the data quoted by Pan et al (2011) is for both above and below ground carbon, not just "top 1m of soil". Hence including short-term storage (wood) as well as longer term storage (soil/sediment); and ii) recent values for mean C storage in mangrove sediment are higher than 280 Mg C ha ⁻¹ (from Pendleton, 2012), typically around 1000 Mg C ha ⁻¹ .
32093	5	5	46	5	47	"should significantly assist several countries in reaching net zero emissions" What is the basis for this statement? I don't see the evidence. [Nicolas Gruber, Switzerland]	Noted/accepted. Supporting reference will be added to text and reference list: Taillardat, P., D.A. Friess and M. Lupascu, 2018: Mangrove blue carbonstrategies for climate change mitigation are most effective at the national scale. Biol. Lett. 14: 20180251, doi 10.1098/rsbl.2018.0251

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
23947	5	5	46	5	48	"reaching the net zero emissions target" is not appropriate because such text is not included in the Paris Agreement. We would suggest modifying it to "achieving a balance between anthropogenic emissions by sources and removals by sinks". [Government of Japan, Japan]	Accepted - whilst noting that 'achieving a balance between emissions and removals' does mean the same as 'net zero emissions'.
28897	5	5	46	5	48	Delete " Successful implementation of measures to maintain and promote carbon storage in coastal ecosystems could significantly assist some countries in reaching national net zero emissions targets (high confidence)." This sentence leads to promoting carbon storage in coastal ecosystems as offsets to fossil fuel emissions — a challenge to environmental integrity of any mitigation strategy. [Government of Brazil, Brazil]	Taken into account; edits made - including deletion of mention of Paris Agreement. However, the original wording did not (and was not intended to) directly promote blue carbon storage as an offset to fossil fuel emissions.
23675	5	5	47	5	47	This would seem to make/be based on assumptions which credits mechanisms, MRV, accounting is agreed under the Paris Agreement, including definition of anthropogenic sinks and sources. Especially with respect to "maintain". [Government of Sweden, Sweden]	Accepted; edits made.
13005	5	5	47	5	48	Please revise the phrase "should significantly assist", as it is not at all clear what is meant here. Also, this paragraph should be better aligned with the following para that clearly spells out the overall very limited mitigation potential of blue carbon, e.g. by adding "..., albeit total area is small" to the end of ln 46. Currently, it is hard to figure out what the message of the two combined paragraphs is. If it is that blue carbon approaches provide no-regret options with multiple co-benefits, yet are limited in total mitigation potential, maybe some of the detail of the first paragraph can be omitted? [Government of Germany, Germany]	Accepted; edits made.
22547	5	5	48	5	50	Suggest clarifying this section. Currently the wording suggests sites that have effective management of these impacts will be immune and important refuge to the impacts listed, which is not correct. Suggest changing to "Shallow coral reefs with effective management of localised impacts remain vulnerable to climate change. Shallow coral reefs that are not degraded by other impacts such as overfishing and nutrient enrichment are likely to have greater resilience to climate change impacts. However degradation of these more resilient refuge reefs will occur over time....". [Government of Australia, Australia]	COMMENT OUT OF SEQUENCE. Relates to penultimate para on p 4, re coral reef systems

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
29833	5	5	48	5	51	In addition to climate change mitigation, conservation of these habitats would also sustain the wide range of additional ecosystem services, including improving critical habitats for biodiversity and nursery, thereby enhancing local fisheries production. Moreover, these habitats support climate adaptation by high sedimentation rates buffering coastal communities against sea level rise, wave attenuation providing protection from extreme weather events and productivity hotspots resulting in elevated pH, locally buffering ocean acidification. [Dorte Krause-Jensen, Denmark]	Noted. Covered by existing text - except for local buffering of OA
4933	5	5	50	4	52	Consider adding if the loss will be different under low and high RCP scenarios [Debra Roberts and Durban Team, South Africa]	COMMENT OUT OF SEQUENCE? 'loss' is referred to on p 4 in context of deep water coral reef habitats; doesn't seem to match line-numbering on p 5
1835	5	5	50	5	51	Marine heat waves are a clear threat to blue carbon ecosystems. If heat waves are included under "extreme weather events" the sentence no longer makes sense. It's not clear how conservation actions would protect blue carbon ecosystems from heat waves. [Lydia Kapsenberg, Spain]	Accepted. "Extreme weather events" changed to "storm events"
16973	5	5	51	5	53	Macroalgae, such as kelp, is increasingly acknowledged as major carbon sinks (Krause-Jensen and Duarte 2016). This is acknowledged in Chapter 5.3.3.8. The Executive Summary should also reflect this. [Hege Gundersen, Norway]	Noted, with changes made to text mentioning macro-algae/seaweed. However, the global scale of the longterm sink is very uncertain. In particular, the cited reference considers 'sequestration' to be the same as productivity, yet if removal is only short-term, there is little, if any, climate mitigation.
21111	5	5	51	5	53	After checking traceability, the use of the words "Low feasibility" suggests reduced literature on this subject and this is true for non-biological marine CO2 removal but not much for seaweeds. As mentioned, the body of evidence has been rapidly increasing the last couple of years. I would make the point that seaweed ecosystem studies have been increasing rapidly and maybe a new alternative as blue carbon ecosystem in the future but further studies are needed. Reference: Raven, J. (2018). Blue carbon: past, present and future, with emphasis on macroalgae. Biology letters, 14(10), 20180336. [APECS Group Review, Germany]	Taken into account. Raven reference to be added to main text. "Low feasibility" changed to "currently have high associated uncertainties. Seaweed aquaculture warrants further research attention"

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
24627	5	5	51	5	53	The effectiveness for climate mitigation of seaweed/kelp ecosystems is summarized to be of a small magnitude or have low feasibility in this sentence. In Section 5.5.1.1.3 the literature cited states that the carbon stored in this ecosystems are globally important, and on par with other blue carbon ecosystems (e.g. Krause-Jensen and Duarte 2016). The low confidence assigned in section 5.5.1.1.3 is associated to the high uncentrality related to the transport pathways and fate, and calls out for more knowledge and data on the processes involved. Therefore, the emphasis in the executive summary should rather be on the need for more knowledge and data to accurately determine the effectiveness of seaweed/kelp in climate change mitigation, rather than to state that it is presumed to be of low importance or have low feasibility. This summary also does not mention the potential associated with seaweed aquaculture, which is assumed to have higher effectiness in 5.5.1.1.3 [frigstad helene, Norway]	Taken into account. "Low feasibility" changed to "currently have high associated uncertainties. Seaweed aquaculture warrants further research attention"
29835	5	5	51	5	53	Please modify text. The climate change mitigation effectiveness of seaweed blue carbon systems are not are not necessarily lower than those of other blue carbon ecosystems (seagrasses,mangroves, saltmarsh). Rather, a recent paper proposes that C-sequestration contributed by seaweeds doubles the previous estimates of blue carbon (Krause-Jensen & Duarte 2016. Nature Geoscience). Also, there is a large potential in seaweed aquaculture for climate change mitigation and adaptation (Duarte et al. 2017). Indeed there is a need for further research effort in the field of seaweed blue carbon both in terms of science and policy for seaweeds to be fully integrated blue carbon accounting and action. An science and policy research agenda for this field has recently been proposed (Krause-Jensen et al. 2018. Biology Letters.) [Dorte Krause-Jensen, Denmark]	Taken into account. "Low feasibility" changed to "currently have high associated uncertainties. Seaweed aquaculture warrants further research attention"
15821	5	5	52	5	52	A difference should be made in here between seaweed ecosystems and seaweed production through aquaculture, as mentioned ahead in the chapter, on which there is an agreement that it provides a pathway to carbon removal from the oceans which is worth mentioning in the summary. [EUCE, Belgium]	Taken into account. "Low feasibility" changed to "currently have high associated uncertainties. Seaweed aquaculture warrants further research attention"
7015	5	5	53	0		Remove one instance of "currently" [Nina Hunter, South Africa]	Accept
444	5	5	53	5	53	delete "currently" the last word [Kathiresan Kandasamy, India]	Accept
16971	5	5	53	5	53	The word "currently" is used twice. [Hege Gundersen, Norway]	Accept

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Comment id	Chapter	From page	From line	To page	To line	Comment	
33583	5	5	53	5	53	Delete redundant "currently". [Government of United States of America, United States of America]	Accept
28899	5	5	55	5	55	Replace "Blue carbon ecosystems.." with "Protection, enhancement or restoration of coastal or marine ecosystems..." [Government of Brazil, Brazil]	Reject - for reasons given previously given (primarily because blue carbon is specifically mentioned in approved SROCC scoping).
14127	5	5	55	5	56	Non -neutral language that goes beyond the remit of the report "very rapid phase-out of fossil fuels, and the control of all other emissions..." - consider revising to ensure this isn't policy prescriptive. [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	To be taken into account (and discussed). How is this policy-prescriptive when it has already been internationally agreed?
23677	5	5	55	5	57	This is a trivial statement. Suggest using a variant of the third and fourth statement as bold text. [Government of Sweden, Sweden]	To be taken into account.
15909	5	5	55	6	7	<p>I am not certain that "no regret" is the best way to qualify blue carbon sequestration. I am also wondering how convinced a policymaker will be about the importance of blue carbon habitats after reading these lines.</p> <p>There are a few arguments that can be used to justify the role of blue carbon:</p> <p>1. Although blue carbon is considered to mitigate 0.42% of the global anthropogenic fossil fuel (FF) emissions, this % can increase if (i) national (FF) emissions are reduced, (ii) blue carbon habitat conversion is stopped, and (iii) blue carbon habitat restoration is developed.</p> <p>Taillardat P, Friess DA, Lupascu M. Mangrove blue carbon strategies for climate change mitigation are most effective at the national scale. Biology Letters 2018; 14.</p> <p>2. Although blue carbon might not be globally important for mitigating global FF emissions, it can play a huge role for some countries with extensive coastlines. Considering that the Paris Agreement is based on NDCs, the potential of blue carbon needs to be assessed at the national scale. If countries like Indonesia, Malaysia or Brazil were to stopped mangrove deforestation, this ecosystem would already offset a few % of their national FF emissions as of today.</p> <p>Taillardat P, Friess DA, Lupascu M. Mangrove blue carbon strategies for climate change mitigation are most effective at the national scale. Biology Letters 2018; 14.</p> <p>3. Preserving and restoring blue carbon habitats is the best way to prevent CO2 re-emissions that occurs during land conversion/degradation. Consequently, blue carbon is a win-win strategy for carbon dioxide removal as it is supposed to cease CO2 emissions from conversion and increase CO2 sequestration from vegetation uptake.</p> <p>Hamilton SE, Friess DA. Global carbon stocks and potential emissions due to mangrove deforestation from 2000 to 2012. Nature Climate Change 2018: 1.</p> <p>4. Recent studies have suggested that carbon sequestration from blue carbon might be underestimated as most of their produced carbon is exported to coastal water via tidal</p>	Taken into account. Rewording to "an important contribution to both mitigation and adaptation at the national scale". Extra refs to be used in text

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
29743	5	5	55	6	7	This finding needs to be rewritten to enhance clarity--I just did not find it all very clear. Is this intending to indicate that promoting productivity out in the open ocean, as Russ George and some others have suggested, cannot be made strong enough to take out fossil fuel emissions at current (or near-current) levels? Clearly taking a stand on what the science says about such proposals is an important statement to make if this is what the broader scientific community is saying--and if this is the case, the argument needs to be very clearly stated and explained as Russ George is planning to seek to prove the opposite. From the text, I get a sense that both positions are being put forward, and so would really urge a more clearly stated finding. [Michael MacCracken, United States of America]	This focuses on coastal blue carbon. Ocean fertilization is not accounted for here.
11559	5	5	56	5	56	Provide brief definition here of what is meant by 'novel ocean conditions' [William Howard, Australia]	COMMENT OUT OF SEQUENCE? No mention of 'novel ocean conditions' on p 5
22545	5	5	56	5	56	Suggest defining what is meant by 'novel ocean conditions'. [Government of Australia, Australia]	COMMENT OUT OF SEQUENCE? No mention of 'novel ocean conditions' on p 5
24665	5	5	56	5	57	missing words from this sentence as the technology focus is missing. So should this sentence say: ...environmentally -friendly negative emission energy generation technologies. [Shutler Jamie, United Kingdom (of Great Britain and Northern Ireland)]	Reworded, now omitting the phrase commented on. Original text not intended to relate to 'energy generation'
5461	5	5	57	106	57	Invasive alien species reduce the resilience of natural habitats, making them more vulnerable to the impacts of climate. Biological invasions are a major threat to global food security and livelihoods ((IUCN, 2017 (Issues Brief, Invasive Alien Species and Climate Change)). [IRFAN UYSAL, Turkey]	Invasive alien species do not seem relevant here.
23229	5	6	0	6		There is a potential to strengthen the relevance of the key findings for several activity sectors by being more explicit (shipping, transport infrastructure, tourism, health) and by matching risks with response options, and maybe limits to adaptation. [Valerie Masson-Delmotte, France]	Taken into account.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
1837	5	6	2	6	2	Same as comment #5 for SPM. Protection of blue carbon ecosystems is not a "no regrets" action if it displaces resources intended for carbon sequestration and the protection of the blue carbon stock fails (e.g., heat wave, restoration failure). For example, if the goal of a city is to reduce CO2 emissions, funding and resources on reducing CO2 emissions from public transport and cars may be much more effective in reaching those goals than using the funding and resources to invest in blue carbon. I do not think this high level report is in the position to label any action as "no regrets", and why specifically is it only used for blue carbon? Couldn't "no regrets" also be said for marine protected areas? The cost-benefit assessment for implementing strategies should be done on a much more local scale, and one may find that there could be regrets in the distribution of management resources. "no regrets" is based on assumptions/opinions and not scientific evidence. [Lydia Kapsenberg, Spain]	Accepted. "No regrets" wording no longer used in ES for blue carbon.
14137	5	6	2	6	2	Please explain why this is a 'no regrets' option [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	"No regrets" wording no longer used in ES for blue carbon.
15711	5	6	2	6	3	This is a good example where the adaptation role of blue carbon ecosystems should be paired with their mitigation potential. The synergy is better covered later in 5.5.1.1. However, it is important to elevate co-benefits at a more visible level of the report. [EUCE, Belgium]	Noted. Adaptation benefits now mentioned.
9713	5	6	3	6	5	Evidence for this is equivocal due to limited number of large scale experiments. To emphasize the uncertainty, suggest 'could' rather than 'would' [Government of France, France]	Accepted - and taken into account in re-wording of this paragraph

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
25835	5	6	3	6	5	<p>the statement of "...nearly all the extra carbon removed would be returned to the atmosphere on decadal timescales." is probably wrong. Each year, an estimated ~50 Pg C is fixed in the euphotic zone by primary production, though only a small fraction of the carbon is transported down to the deep and dark ocean interior and to the deep sediment for long-term carbon sequestration, and this carbon can be stored in the deep ocean for thousands of years and even longer (see 5.5.1 in this chapter and Hansell, 2013; Jiao et al., 2010). The average age of the deep DOC is about 4000–6000 years (Bauer et al., 1992), and a recent study shows that the deep DOC is resistant to microbial degradation even after being concentrated to 10-fold (Shen and Benner, 2018). Though the time scale associated with the meridional overturning circulation is of the order of 500–2000 years, it is likely that the deep DOC can be exposed to photochemical degradation at some point in its lifetime (Medeiros et al., 2015), but still, range of 500–2000 years is much longer than the "decadal times". References are:</p> <p>Bauer et al (1992), ¹⁴C activity of dissolved organic carbon fractions in the north-central Pacific and Sargasso Sea, <i>Nature</i>, 357, 667–670.</p> <p>Hansell, D. A. (2013), Recalcitrant dissolved organic carbon fractions, <i>Annu. Rev. Mar. Sci.</i>, 5, 421–445.</p> <p>Jiao, N., et al. (2010), Microbial production of recalcitrant dissolved organic matter: long-term carbon storage in the global ocean, <i>Nat. Rev. Microbiol.</i>, 8(8), 593-599.</p> <p>Medeiros PM, Seidel M, Powers LC, Dittmar T, Hansell DA, Miller WL (2015). Dissolved organic matter composition and photochemical transformations in the northern North Pacific Ocean. <i>Geophys Res Lett</i> 42: 863-870.</p> <p>Shen Y, Benner R (2018). Mixing it up in the ocean carbon cycle and the removal of refractory dissolved organic carbon. <i>Sci Rep</i> 8. [Jihua Liu, China]</p>	<p>Taken into account in re-wording of this paragraph. The importance of refractory DOC is recognised. However, as stated in the comment "only a small fraction of the carbon is transported to the deep and dark ocean interior... for longterm carbon sequestration". The majority (= large fraction) is therefore returned to the atmosphere relatively rapidly, as stated. But there are uncertainties, making carbon accounting difficult: a point that it now made.</p>
15823	5	6	3	6	7	<p>Within the anthropogenic interventions to enhance ocean carbon uptake it is important to make clear (i) the level of confidence on the effectiveness and ecological consequences of such interventions, and (ii) mention technical challenges (as listed ahead in 5.5.1) - as these are both key points to inform policy-makers on best-available evidence. This is well covered in 5.5.1, but not herein. [EUCE, Belgium]</p>	<p>Taken into account in the re-wording of this paragraph</p>

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
12095	5	6	4	11	44	The changing sea surface temperature, which is an important variable affecting the energy exchange of water vapor in the ocean and atmosphere, plays an important role in climate change. However, this section does not address the spatial pattern of sea surface temperature changes. Fig 5.1 gives only the heat uptake of the upper ocean, not changes in sea surface temperature. So it is suggested to add words on sea surface temperature changes, long-term trends and their impacts. [Government of China, China]	Considered - As noted, sea surface temperature is integral to the dynamics of the ocean and atmosphere. This Chapter is primarily addressing changes within the ocean and ocean ecosystems. There is a sub-plot to Figure 5.16 addressing projected near-surface ocean temperature changes, in the context of changing marine ecosystems. However, it is our expectation that changing sea surface temperatures will be thoroughly assessed from both the atmospheric and oceanic perspectives in AR6, even as it was in AR5.
31965	5	6	5	0	7	This reads like an add-on with Little imagination of the magnitude of its contribution. [Hans-Otto Poertner and WGII TSU, Germany]	Not sure what this comment relates to
10027	5	6	5	6	7	The mention of ocean alkalization here is unnecessary and misleading for an executive summary. In addition to governance challenges this is something that has never been performed at scale (especially over time). At best it would be a high cost method to protect limited areas under ideal conditions. If geoengineering options are going to be included in the executive summary (or the document as a whole) the risk and their experimental nature should be clearly spelled out and a full summary on what it would take to scale them should be included. [Tommy Moore, United States of America]	Reject. Brief mention in ES seems necessary (identifying limitations) since they are covered in text.
4573	5	6	6	6	6	What is 'contested governance'? [The UBern Team Group Review, Switzerland]	Taken into account - re-worded
17147	5	6	6	6	7	Missing word between "with risk" should be "with the risk". [Shalini Singh, Fiji]	Accepted - and to be taken into account in re-wording of BC paras
15825	5	6	9	6	11	The sentence is long, complex and not clear. Please, consider rephrasing. [EUCE, Belgium]	Text rewritten.
24629	5	6	9	6	11	This headline statement is unclear, I would suggest to reverse the sentence and increase the focus on reducing multiple stressors to alleviate risk and increase co-benefits. Could a summary be made of impacts and co-benefits with Sustainable Development Goals (SDGs) from Section 5.4.2.4 in this paragraph? [frigstad helene, Norway]	Text re-written. Comment no longer applicable.
23679	5	6	9	6	9	Suggest "greenhouse gas emission" [Government of Sweden, Sweden]	Text re-written. Comment no longer applicable.
33585	5	6	9	6	9	This is a somewhat ponderous lead sentence. How about deleting a few words, yielding: "Management of non-climatic human stressors..." [Government of United States of America, United States of America]	Text rewritten.
10661	5	6	10	0		Rather "resistance and resilience". [Jean-Pierre Gattuso, France]	Text re-written. Comment no longer applicable.
25473	5	6	13	5	13	WHAT DO YOU MEAN EXACTLY WITH "with increasing CO2 emission"? ARE YOU REFEREING TO EMISSIONS OR CUMULATED EMISSIONS OR C=2 CONCENTRATIONS? I SUGGEST REMOVING THE STATEMENT. [Christophe Deissenberg, Luxembourg]	Wording on mitigation of carbon emission removed.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
15713	5	6	13	6	13	The inclusion of poverty at the same level as other drivers warrants more explanation [EUCE, Belgium]	Accepted. Text edited.
33587	5	6	13	6	14	Turn this statement around, with climate risk reduction being the co-beneficiary. [Government of United States of America, United States of America]	The focus of the assessment is on climate risk reduction, so the formulation of the statement reflects the assessment in the chapter.
31967	5	6	14	0	16	Message unclear due to odd sentence structure. [Hans-Otto Poertner and WGII TSU, Germany]	Text re-written.
7017	5	6	14	6	15	Sentence does not make sense. Please amend. [Nina Hunter, South Africa]	Text re-written.
22735	5	6	14	6	15	IMP: Add "Well-managed marine reserves have been shown to help marine ecosystems and people adapt to impacts of climate change and to be a viable low-tech, cost- effective adaptation strategy that would yield multiple cobenefits from local to global scales." after "... with large co-benefits in supporting sustainable development." This needs to be cross-referenced to 5.5.2.2. [Greenpeace Group Review, Republic of Korea]	Taken into consideration. We have highlight the literature reporting MPA as a potential measure and referenced to 5.5.2.
24667	5	6	14	6	15	this sentence (sentence beginning 'Built-infrastructure adaption..') doesn't make sense and needs re-wording. [Shutler Jamie, United Kingdom (of Great Britain and Northern Ireland)]	Text re-written.
28117	5	6	14	6	15	I cannot make sense of this sentence [Hilary Kennedy, United Kingdom (of Great Britain and Northern Ireland)]	Text re-written.
15685	5	6	14	6	16	This sentences requires clarification/re-wording [EUCE, Belgium]	Text re-written.
15715	5	6	14	6	16	The sentence "Built-infrastructure..." does not seem to make sense. Truncated? [EUCE, Belgium]	Text re-written.
33589	5	6	14	6	16	Edit sentence for proper English use and clarity. [Government of United States of America, United States of America]	Text re-written.
4475	5	6	15	6	15	are optimally by' needs to be changed [The UBern Team Group Review, Switzerland]	Text re-written.
32519	5	6	15	6	15	"... are designed optimally ..." [Yassir Eddebbar, United States of America]	Text re-written.
23681	5	6	16	6	17	Is effectiveness maintained for low and mid-range emission scenarios? (Effectiveness reasonably reduced with increasing emissions, but is not a step-change...) [Government of Sweden, Sweden]	ES statement re-written. Comments no longer applicable.
31969	5	6	21	0		Can the magnitude of adaptation efforts be quantified, e.g. consult Chapter 4 for some examples? [Hans-Otto Poertner and WGII TSU, Germany]	Text re-written.
23949	5	6	21	6	22	Suggest adding more explanation for necessary conditions of effectiveness as increase of finance would not be the only condition. [Government of Japan, Japan]	More conditions are included in the text now.
23683	5	6	21	6	23	Suggest replacing the first (bold) sentence with the second sentence a, as it is more informative. "International" could then be added in the last sentence of the paragraph. [Government of Sweden, Sweden]	Text re-written.

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Comment id	Chapter	From page	From line	To page	To line	Comment	
7127	5	6	21	6	25	The effectiveness of coastal ecosystem-based adaptation is supported by a growing body of literature and increased international funding for this approach. I disagree with this assertion; in a very quick search in the Web of Science under the "Climate change" AND "Ecosystem services" for the Pacific coast of Latin America, only 36 peer-reviewed papers were found. Moreover, there are some countries such as El Salvador, Nicaragua and Panama that have no studies. Regarding funding, only one large project for the Humboldt Current Large Marine Ecosystem was found. [Luis Eduardo Calderon-Aguilera, Mexico]	ES statement re-written. Comments no longer applicable.
16853	5	6	21	6	28	Ecosystem based adaptation is very important for SIDS. However, its applicability is limited by the impacts of climate change on these very ecosystems. Please comment on the limits of these adaptation measure in particular in relation to the impacts of climate change beyond 1.5°C. [Government of Grenada, Grenada]	Limits on adaptation is now made explicit in the statement.
24631	5	6	21	6	28	A link to blue carbon and coastal wetland restoration could be made in this paragraph [frigstad helene, Norway]	A link is mentioned between ecosystem based adaptation approach and carbon sequestration as co-benefit is mentioned.
28483	5	6	21	6	28	Ecosystem based adaptation is very important for SIDS. However, its applicability is limited by the impacts of climate change on these very ecosystems. Please comment on the limits of these adaptation measure in particular in relation to the impacts of climate change beyond 1.5°C. [Government of Saint Lucia, Saint Lucia]	Limits on adaptation is now made explicit in the statement.
15827	5	6	22	6	23	Please, clarify which habitats. [EUCE, Belgium]	Text re-written.
7019	5	6	23	0		Change "enhances" to "enhance" [Nina Hunter, South Africa]	Text re-written.
17149	5	6	23	6	23	Should read "enhance" not "enhances". [Shalini Singh, Fiji]	Text re-written.
7021	5	6	24	0		Change "support livelihood" to "livelihood support" [Nina Hunter, South Africa]	Text re-written.
446	5	6	24	6	24	delete "support" [Kathiresan Kandasamy, India]	Text re-written.
4477	5	6	24	6	24	delete 'provide' and 'dependent' [The UBern Team Group Review, Switzerland]	Text re-written.
17151	5	6	24	6	24	Missing word between "support livelihood" should be "support for livelihood". [Shalini Singh, Fiji]	Text re-written.
17153	5	6	24	6	24	Word to be removed "dependent". [Shalini Singh, Fiji]	Text re-written.
32521	5	6	24	6	24	" ... support for livelihood ..." [Yassir Eddebbar, United States of America]	Text re-written.
33591	5	6	24	6	24	Delete "provide" and add "s" to livelihood to make it "livelihoods". [Government of United States of America, United States of America]	Text re-written.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
15829	5	6	25	6	28	A series of recommendations could be distilled from chapter 5 and considered within this summary. This is a very good example of one. Would suggest picking these up and collating them as a list of (high confidence) recommendations which can be easily used by policy makers and practitioners. Chapter 5.5.1. alone, provides a range of extremely relevant recommendations that could be added to this, notably to consider ocean-based mitigation through renewable energy (pp.115, ln21), consider accounting coastal carbon storage in national emission inventories (pp. 117, ln. 12), extending blue carbon to other components of the coastal oceans (pp.117, ln. 15), strengthen research on rates of carbon uptake and long term removal in ocean systems (pp.118, ln. 37), maintaining the integrity of natural carbon stores in the coastal zone (pp.115 ln 27) and associated measures (pp. 119, ln28-47), seaweed aquaculture for mitigation purposes (pp.120, ln 45), ICZM (pp.121, ln 34-44; 5.5.1.1.5), strengthen research on the full range of environmental conditions to improve the low confidence in current estimates of carbon loss from degraded vegetated coastal ecosystems (pp.120, ln. 29-30) and need for large-scale and multi-year tracking studies to provide reliable data on carbon sequestration (pp.120, ln. 42), listed adaptation responses (pp. 125, Table 5.8),etc. [EUCE, Belgium]	Taken into consideration.
14139	5	6	27	6	27	Please explain what 'adaptation planning within frameworks' is [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	Text re-written.
20405	5	6	30	0		C2: Since 2017, international agreement on banning commercial fishing in Arctic Ocean for the next 16 years for protecting the environment. [APECS Group Review, Germany]	ES statement re-written. Comments no longer applicable.
448	5	6	30	6	30	after "processess" insert "of their implementation" [Kathiresan Kandasamy, India]	ES statement re-written. Comments no longer applicable.
22737	5	6	30	6	31	Suggestion to add High Seas Alliance's (including more than 37 NGOs and IUCN) perspective: "Currently, there are no legally binding mechanisms for establishing marine protected areas outside State' territorial seas, or for undertaking environmental impact assessments" [Greenpeace Group Review, Republic of Korea]	ES statement re-written. Comments no longer applicable.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
26449	5	6	30	6	31	I don't believe the information presented in this chapter support with high confidence that the international and national legislation ARE NOT sufficient to provide an effective adaptation response. I could agree with "maybe" or "is unlikely", because there are several international and national processes and legislations that are available. In other words, the statement is written in a black and white manner, when talking about many types of adaptations and processes. [Florence Poulain, Italy]	ES statement re-written. Comments no longer applicable.
33593	5	6	33	6	33	UNCLOS only relates to the open seas while most of the impacts are in (coastal) EEZs. [Government of United States of America, United States of America]	ES statement re-written. Comments no longer applicable.
4941	5	6	34	6	38	A prerequisite for this will be cooperation among parties to the Convention. [Debra Roberts and Durban Team, South Africa]	ES statement re-written. Comments no longer applicable.
22739	5	6	36	6	37	Add "Further, full implementation of already existing laws and regulations is lacking and it is fundamental that these are complied with." after "... regional and national institutions" [Greenpeace Group Review, Republic of Korea]	ES statement re-written. Comments no longer applicable.
24633	5	6	36	6	39	This sentence is not easy to understand to readers not expert in the field in question. Suggest to rephrase in simpler terms and potentially include more information to increase understandability. [frigstad helene, Norway]	ES statement re-written.
25475	5	6	38	6	39	Climate risks can be further reduced by shortening the implementation lead time for these adjustments [THE FOLLOWING SENTENCE PART IN IS INEXACT AND DOES NOT ADD USEFUL CONTENT. DELETE? relative to the time of emergence of climate stressors and their impacts in the marine system] (medium confidence). {Box 5.1, 5.5.4.1} [Christophe Deissenberg, Luxembourg]	ES statement re-written. Comments no longer applicable.
3203	5	7	1	8	8	This chapter doesn't really incorporate or consider changes in the ocean in the context of paleoclimate archives. AR5 had an entire section dedicated to paleoclimate archives that compared modern changes to past changes in order to highlight the extent to which the climate is changing. It might be helpful to incorporate some of this information and these types of comparisons. [Sloane Garelick, United States of America]	Taken in account - the use of paleoclimate archives is out of scope for this chapter.
31767	5	7	1	8	8	This entire introduction section needs to be polished and revised. Be concise. [Hans-Otto Poertner and WGII TSU, Germany]	Taken into account - section revised and polished

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
33595	5	7	3	7	10	Several important functions of the world's oceans appear to have been omitted which are vastly more important than tourism. These include the role of the oceans in the hydrologic cycle (e.g. recharge of aquifers, making land arable, etc.) and also supplying most of the earth's oxygen production. Also, they scavenge excess carbon from the atmosphere buffering the climate system. These seem like a couple of key points which should be mentioned before tourism and aesthetic appeal. [Government of United States of America, United States of America]	Taken into account - we clarified in the FD that the ecosystem services that we listed are only examples.
4575	5	7	3	7	3	It does not store 'THE' heat trapped in the atmosphere, about 93% of the heat; other is stored in land, etc.. [The UBern Team Group Review, Switzerland]	Accepted - "the" deleted
20263	5	7	3	7	5	(E1a) The sentence can be shortened. Suggestion of 'It stores the heat trapped in the atmosphere resulting from rising greenhouse gases, it stores carbon dioxide at depth and it slows surface warming of the Earth.' [APECS Group Review, Germany]	Accepted - sentence shortened and modified
21915	5	7	4	7	4	The result is not from RISING greenhouse gases, but from increasing concentrations of greenhouse gases. [David Schoeman, Australia]	Taken into account - text altered rising concentrations of greenhouse gases....
27775	5	7	4	7	4	"stores carbon dioxide in its ocean depths and sediments", sediments are important to mention here upfront as carbon storage given also the stress on Blue Carbon in the executive summary [Momme Butenschön, Italy]	Taken into account - text altered to take into account.
28119	5	7	4	7	4	the use of the word "rising" may cause confusion. Suggest replace with "increasing" [Hilary Kennedy, United Kingdom (of Great Britain and Northern Ireland)]	Accepted - text revised
9715	5	7	5	7	7	And include biogeochemical cycles as well. Can be added at the end of the sentence. [Government of France, France]	Taken into account - now refer to other biogeochemical cycles
14147	5	7	7	7	7	You could also mention the importance of the ocean to the global economy as the medium for most global trade [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	Taken into account
20265	5	7	7	7	8	(E1a) As written the sentence suggests additional services than described above. Climate regulation has already been mentioned. [APECS Group Review, Germany]	Taken into account
4403	5	7	8	7	8	How can the ocean itself sustain local and traditional knowledge? This is unclear [The UBern Team Group Review, Switzerland]	Taken into account - this is now clarified by saying the ocean forms the basis of local and traditional knowledge
5039	5	7	8	7	8	Consider adding "cultural and religious practices" [Debra Roberts and Durban Team, South Africa]	Accepted - text revised
4479	5	7	9	7	9	Not clear what is meant here with 'approaches' [The UBern Team Group Review, Switzerland]	Taken into account - clarified
7023	5	7	15	0		Was "of" intended after "90%"? [Nina Hunter, South Africa]	Taken into account
10935	5	7	15	7	15	Missing "of" after 90% [Abigail Bodner, United States of America]	Taken into account
17155	5	7	15	7	15	Missing word "more than 90% the energy" should read " more than 90% of the energy". [Shalini Singh, Fiji]	Taken into account

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
730	5	7	15	7	16	Is the 2nd conclusion updated in this special report? It is said that 25±5% of emissions is absorbed by the ocean according to the executive summary. If so, it should be clarified. [Mengxi Wu, United States of America]	Taken into account - The executive summary now has the correct number for carbon uptake
20231	5	7	16	7	16	Need a semi colon after "...acidification" to complete the list [APECS Group Review, Germany]	Accepted - text revised
33597	5	7	16	7	16	Confirm the 30% figure is specific to 'emitted' anthropogenic carbon (i.e., does it include land use changes). Over what period is the 30% referencing? Since pre-industrial or recent decades? Between 2008-2017 it was only 22% (see global carbon project: http://www.globalcarbonproject.org/carbonbudget/18/highlights.htm). [Government of United States of America, United States of America]	Taken into account - confirmed that it is emitted carbon, this is a direct quote from AR5.
33599	5	7	16	7	16	Gruber et al. (2018, resubmitted) get 30 % based on inventory change between 1994 and 2007 (including land use change). Also, they refer to a previous result presented in AR5. [Government of United States of America, United States of America]	Taken into account -
728	5	7	17	7	20	This sentence does not seem necessary to me in this special report. [Mengxi Wu, United States of America]	Accepted - sentence deleted
31769	5	7	17	7	20	Not clear why this detailed information about chapter in AR5 should be relevant, here. Suggest deleting. [Hans-Otto Poertner and WGII TSU, Germany]	Accepted - sentence deleted
4577	5	7	23	7	23	What is a 'human dependent society'? [The UBern Team Group Review, Switzerland]	Paragraph deleted - no longer relevant
732	5	7	23	7	27	This sentence does not seem necessary to me in this special report, too. [Mengxi Wu, United States of America]	Accepted - sentence deleted
31771	5	7	23	7	27	Not clear why this detailed information about chapter in AR5 should be relevant, here. Suggest deleting. [Hans-Otto Poertner and WGII TSU, Germany]	Accepted - sentence deleted
14141	5	7	27	28	7	It sounds as though the only effects are via warming, acidification and deoxygenation, in fact, there are more effects that will affect marine life, just perhaps not to the same degree. Suggest that this is clarified here. [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	Accepted - these changing properties are not only stated as examples
14143	5	7	31	7	31	"demonstrated altering" is a strange phrase in this context - consider revising [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	The exact wording in AR5 is used here.
31773	5	7	32	7	32	Provide proper citations here [Hans-Otto Poertner and WGII TSU, Germany]	Accepted - citation added
23739	5	7	32	7	33	The AR5 conclusion that future species diversity will increase at high latitude is based on the fact that high latitude species will be replaced by invading lower latitude species (Cheung et al. 2009: "a 60% turnover of present diversity leading to disruption of ecosystem services"). It would be misleading to simply state that biodiversity will increase without also mentioning that this new diversity is mainly about invading species and that the original ecosystem may be disrupted. Please redraft as appropriate. [Government of Sweden, Sweden]	Accepted - this is now clarified by adding further explanation.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
24039	5	7	32	7	33	The AR5 conclusion that future species diversity will increase at high latitude is based on the fact that high latitude species will be replaced by invading lower latitude species (Cheung et al. 2009: "a 60% turnover of present diversity leading to disruption of ecosystem services"). I find it misleading to simply state that biodiversity will increase without also mentioning that this new diversity is mainly invading species and that the original ecosystem may be disrupted. Specifically, the loss of multi-year sea ice will fundamentally change the entire under ice-ecosystem, which support polar cod and higher trophic levels. [Peter Thor, Sweden]	Accepted - this is now clarified by adding further explanation.
20267	5	7	35	7	36	(C2) Ocean acidification poses a threat to sensitive ecosystems like coral reefs, but others can be less sensitive. For example, primary production may not change or could become stimulated (improved ecosystem function) with greater CO ₂ [Hoppe et al. (2018) Compensation of ocean acidification effects in Arctic phytoplankton assemblages. Nature Climate Change 8: 529-533]. As written this sentence is misleading and suggests all ocean ecosystems are at (negative) risk. [APECS Group Review, Germany]	This is a direct quote from AR5 report. New assessment on the impacts of ocean acidification is done in the chapter.
28295	5	7	39	0		I suggest this sentence should read as "...this chapter which is focused on global oceans undertakes..." [Nsikak Benson, Nigeria]	Taken into consideration - this is now revised
14145	5	7	45	7	45	suggest "Such geo-engineering approaches are ... addressed " [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	Accepted
31775	5	7	46	7	46	Provide proper citation for SR15 [Hans-Otto Poertner and WGII TSU, Germany]	Accepted - citation provided
608	5	7	51	7	56	It could be helpful to bullet point these. [Jenna Pearson, United States of America]	Accepted
10937	5	7	52	7	52	Confusing phrasing in part of sentence "and major habitats and their taxonomic groups" [Abigail Bodner, United States of America]	Phrases deleted in FD
26451	5	8	0	32		As a general comment, I found the physical and chemical oceanography sections in pages 8-32 much more balanced, synthetic and informative than the biological and ecological sections that follow, which are not comprehensive not synthetic and often not well balanced. [Florence Poulain, Italy]	Taken into account
14159	5	8	4	8	6	While the geographic scope of this chapter is global' - please clarify if the reference to chapters 4 and 6 means these are also focussed at the regional level. [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	Regional differences are also highlighted. This is now clarified.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
28705	5	8	4	8	7	Text can be in parallel structure avoiding the word "while" twice; this chapter and all the others, then the same. Suggestion "While the geographic scope of this chapter is global, Chapter 3 covers the Polar (i.e., Arctic and Antarctic) ecosystems and circulation changes in more detail, Chapter 4 covers the effects of sea level and its implications, and Chapter 6 covers extremes and abrupt events. We draw on some of the sub-systems assessments addressed in other chapters when necessary." [Government of Brazil, Brazil]	Taken into account
5041	5	8	7	8	8	Consider describing these in footnotes as is the case with other chapters. [Debra Roberts and Durban Team, South Africa]	Taken into account - Lets have the TSU put them in every chapter as a standard set of words, we were asked to take them out in the last draft.
744	5	8	11	0		It might be helpful to have a summarizing schematic like Figure 3.22 on p. 302 in Chapter 3 of AR5. [Mengxi Wu, United States of America]	Taken into account - this is an interesting idea for expressing up the principles of this chapter
31783	5	8	11	75	25	adapt structure and titles of subsection in 5.2 to 5.3. structure and titles should be identical/similar in these two sections [Hans-Otto Poertner and WGII TSU, Germany]	Structure has been revised.
31781	5	8	11	8	11	The title is confusing. Be clear in the title of this section that this is about changing "open ocean" and biodiversity. And then rename 5.2.1 "introduction to changing open ocean" (as done in section 5.3.1 for coastal seas) and move the text from 5.2.2.1 up. [Hans-Otto Poertner and WGII TSU, Germany]	Taken into account
25317	5	8	13	8	27	Why starting from Open Ocean? I found more logic the structure proposed in the first version of this report starting with changing in physical and biogeochemical properties. So, I would warmly suggest to remove Open Ocean from the beginning and start with paragraph 5.2.2 'Changes in Physical and Biogeochemical Processes'. This section is not substantially changed respect to the first version of the Chapter, and it is describing processes of the Ocean as a whole, which is a more reasonable start for the Chapter 5. [Chiara Lombardi, Italy]	Taken into account
14153	5	8	15	8	15	Please be consistent with use of metres vs m. [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	Taken into account
21917	5	8	15	8	15	The way this definition is written is confusing for anybody who is not already familiar with the report. On first reading, it seemed to me that euphotic oceanic waters were excluded. These definitions need to be more clearly expressed. [David Schoeman, Australia]	Accepted - the text was modified to clarify the definition of the open ocean.
31777	5	8	15	8	16	This first sentence might be misunderstood (sounds like 'open ocean' is everything below the upper 200m of the water column). Suggest saying something like "the open ocean is the area of ocean far from land where water depth exceeds 200m..." [Hans-Otto Poertner and WGII TSU, Germany]	Accepted - the text was modified to clarify the definition of the open ocean.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
14155	5	8	15	8	27	Suggestion - this might be a good place for a small figure or box explaining exactly what the RCPs are and what they correspond to. [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	Accepted - a reference was added the relevant section of Chapter 1.
27777	5	8	15	8	27	"The open ocean extends from areas with a water depths of 200m..." is clearer. [Momme Butenschön, Italy]	Accepted - the text was modified to clarify the definition of the open ocean.
10939	5	8	20	8	20	Would be good to remind the reader what 2.6 and 8.5 stand for in the RCP scenarios [Abigail Bodner, United States of America]	Accepted - a reference was added the relevant section of Chapter 1.
31779	5	8	20	8	20	Refer to Chapter 1 where RCPs are explained, here. [Hans-Otto Poertner and WGII TSU, Germany]	Accepted - a reference was added the relevant section of Chapter 1.
20279	5	8	21	8	24	Pelagic ecosystems are not defined initially, but later sub categories are defined. [APECS Group Review, Germany]	This is now defined
3525	5	8	22	8	22	In relation to the terms used in this phrase, I suggest to state "pH level" instead of "ocean acidification. [Marius Müller, Brazil]	Taken into consideratin
4481	5	8	22	8	22	please add here changes in carbon uptake [The UBern Team Group Review, Switzerland]	Text re-written
4579	5	8	22	8	22	should be 'acidity' instead of acidification [The UBern Team Group Review, Switzerland]	Text re-written
28297	5	8	23	0		Change "...exposed sunlight" to "...exposed to sunlight." [Nsikak Benson, Nigeria]	This sentence was removed in the revision of this chapter.
17157	5	8	23	8	23	Missing word in between " exposed sunlight" should read "exposed to sunlight". [Shalini Singh, Fiji]	This sentence was removed in the revision of this chapter.
20269	5	8	25	8	25	(C3) Use of the word 'perhaps'. Rephrase. Signals of change in the open ocean are clearer than in coastal and shelf seas. [APECS Group Review, Germany]	This sentence was removed in the revision of this chapter.
28121	5	8	26	8	26	the use of the word "rising" may cause confusion. Suggest replace with "increasing" [Hilary Kennedy, United Kingdom (of Great Britain and Northern Ireland)]	This sentence was removed in the revision of this chapter.
13007	5	8	29	34	31	Only very general statements related to fate of contaminants and invasive species including diseases of aquatic organisms are provided. Please consider to expand and specify. [Government of Germany, Germany]	This sentence was removed in the revision of this chapter.
11489	5	8	31	18	44	It doesn't make logical sense to start the section with projections of T,S, circulation and then go back to detection and attribution. I think it makes more sense to start with observing T, S, circulation, detecting and attributing changes of these parameters, and then lastly projections. [Anson Cheung, United States of America]	The first order draft used the reviewer's proposed order, but we found that the text dealing with interannual variability was complicated and that the current order makes for a simpler description of the changes that are expected to drive the ecological changes that make up most of this chapter.
28299	5	8	33	0		It is not always straightforward for a reader to fully grasp what might be on the mind of an author. When it is stated that the "...ocean is getting progressively warmer and fresher..." Does the refreshing of the ocean ecosystem apply generally to the global ocean or is region specific? I suggest that there should be a follow up statement to clarify this. [Nsikak Benson, Nigeria]	The statement that the ocean is getting fresher has been removed; it made sense in an earlier context of the ocean as a whole getting measurably fresher on average due to net freshwater input, but not as currently written.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
4163	5	8	33	8	33	I'm not sure that oceans are getting progressively fresher. It may be true in the Pacific, but not so clear in the Atlantic... See, for example, Durack, P.J., 2015. Ocean salinity and the global water cycle. Oceanography 28, 20-31. and Skliris, N., Marsh, R., Josey, S.A., Good, S.A., Liu, C., Allan, R.P., 2014. Salinity changes in the World Ocean since 1950 in relation to changing surface freshwater fluxes. Climate Dynamics 43, 709-736. In any case, this sentence should be substantiated by a couple references. I see later in the chapter that salinity changes are better described, but it would be worth to already denote in the sentence that the warmer trend is much more consistent/spread than the fresher trend. [Carles Pelejero, Spain]	The statement that the ocean is getting fresher has been removed; it made sense in an earlier context of the ocean as a whole getting measurably fresher on average due to net freshwater input, but not as currently written.
4483	5	8	33	8	33	What is 'fundamental chemistry'? Inorganic carbonate chemistry? [The UBern Team Group Review, Switzerland]	This sentence has been revised to avoid this confusion.
14149	5	8	33	8	33	"fresher" - figure 5.2 does not make this evident - the global obs and (to some extent) projection sections at the bottom right both show tropics and subtropics getting saltier. There are regional complexities in the warming too but salinity response is definitely more complicated than a generalised 'freshening'. Suggest text is amended to reflect this. [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	The statement that the ocean is getting fresher has been removed; it made sense in an earlier context of the ocean as a whole getting measurably fresher on average due to net freshwater input, but not as currently written.
33601	5	8	33	8	33	With respect to the ocean getting progressively "fresher", this is overly simplistic. According to Argo float observations coupled with climate simulations, there are indications that while much of the North Atlantic and eastern tropical South Pacific is freshening, waters in the western Indian Ocean and near the equator in the western and central tropical Pacific, as well as in the high evaporation areas of the eastern subtropical Pacific in both hemispheres, are becoming increasingly salty (e.g. Johnson et al 2014 [in [state of the Climate in 2013]. Bulletin of the American Meteorological Society. [Government of United States of America, United States of America]	The statement that the ocean is getting fresher has been removed; it made sense in an earlier context of the ocean as a whole getting measurably fresher on average due to net freshwater input, but not as currently written.
14157	5	8	33	8	38	It would make the report easier to read if it was made clear (without consulting the references) that these were some of the conclusions of WGI AR5. [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	A clause identifying these findings as coming from WGI-AR5 has been added.
738	5	8	33	8	39	It will be very helpful if the statements in this paragraphs are assigned a confidence level or likelihood (although there is the confidence level and likelihood in the following paragraphs) because these are pieces of essential information. [Mengxi Wu, United States of America]	These are all quoting directly from AR5 findings, and rather than repeating their certainty statements that might be mistaken for new certainty statements, this report will later provide certainty language for all take-away messages, including updates to the AR5 statements.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
10941	5	8	33	8	39	Missing certainty statements [Abigail Bodner, United States of America]	These are all quoting directly from AR5 findings, and rather than repeating their certainty statements that might be mistaken for new certainty statements, this report will later provide certainty language for all take-away messages, including updates to the AR5 statements.
31785	5	8	33	8	39	All this is already mentioned in the introduction and should not be repeated. [Hans-Otto Poertner and WGII TSU, Germany]	The introduction has been greatly shortened, so there is no longer repetition.
25319	5	8	34	8	34	ocean acidification and oxygen loss' should be changed in 'ocean acidification and hypoxia' or in 'pH decrease and oxygen loss'. Otherwise we compare a process (acidification) versus a variable decrease. [Chiara Lombardi, Italy]	Text revised
32523	5	8	35	8	35	Not sure any of these can be described as well understood, at least edit to " ... relatively well understood .. ", especially for O2. [Yassir Eddebbar, United States of America]	Accepted - this sentence now explicitly refers to the warming and acidification trends, the drivers of which are well understood.
24669	5	8	36	8	36	incorect use of the phrase 'climate models'. climate models are defined as models that predate earth system models. Suggest change this sentence to say: Earth System Models (ESM) used to predict future climate . [Shutler Jamie, United Kingdom (of Great Britain and Northern Ireland)]	The suggested change in terminology (often using the ESM acronym) has been adopted throughout this section, except where the text is specifically is discussing older generations of climate models without a carbon cycle.
33603	5	8	41	8	42	This is a weak first sentence of the paragraph (isn't it self-evident that this is how impacts would be driven, manifested?). How about: "The impacts of changing ocean conditions are felt locally, where their severity will vary around the global mean." [Government of United States of America, United States of America]	Text revised
33605	5	8	42	8	42	This is equally true in the case of acidification. [Government of United States of America, United States of America]	Accepted - acidification has been added to this list.
11931	5	8	44	8	46	Every system has natural variability. Is not natural variability in the open ocean lower than in other marine systems? [Wolfgang Kiessling, Germany]	Yes, but it the open ocean is now known to exhibit sufficient natural variability that it complicates the direct identification long-term climate-change signals in observational records, which is the point that is being made here.
33607	5	8	45	8	45	Change "days" to "minutes". [Government of United States of America, United States of America]	Changed as suggested.
3527	5	8	46	153	40	Throughout the chapter the terms "stressor" and "driver" are interchangeably applied. As changing oceanic physico-chemical conditions are not necessarily negative for marine organisms, the term "driver" might be a more neutral expression. [Marius Müller, Brazil]	The word stressor is appropriate in this context of discussing compounding risks.
33609	5	8	46	8	46	It should be noted that multiple stressors are not always compounding, they also can be synergistic (e.g., they amplify) or even antagonistic (e.g., muted response). [Government of United States of America, United States of America]	The statement that multiple stressors can compound risks is valid, even though synergistic or antagonistic interactions can occur.
22741	5	8	46	8	47	"Less well understood" and similar wordings like such could be found throughout the report. Suggestion to add more constructive call for improvement in knowledge and evidence that does not replace immediate government actions to reduce climate risk to the oceans [Greenpeace Group Review, Republic of Korea]	This sentence has been revised and tied into the next sentence about new findings.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
12675	5	8	48	8	50	- The sentence seems unclear. [Noureddine Benkeblia, Jamaica]	Considered - this sentence expresses the intended point.
10943	5	8	55	9	2	I think this sentence is weak and may contradict some key points throughout the text. Perhaps would be better to start with "it is important to note" and finish with a reminder that is report represents the current state of climate science and that mixing in this context is an area of active research. [Abigail Bodner, United States of America]	The sentence in question has been removed, and the sentiment is now reflected in the later "Gaps" section.
14151	5	8	56	9	2	Sentence on mixing is there to help justify the sentence on projections, but it is complex in its generalisation. If understanding and model capability is not good enough to give confidence then please be explicit about this here. [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	The sentence in question has been removed, and the sentiment is now reflected in the later "Gaps" section.
12097	5	9	1	17	1	<p>With regard to the spatial distribution of heat content, this chapter compares the 10-year observed trend (2004-2015) and the 10-year CMIP5 modeled one (2003-2018). However, the observation data of about 10 years are too subject to the internal variability of the ocean to be comparable to the time period taken by the model in this chapter. So it is suggested to use observed long-term trends, such as 1960-2017. Please refer to the following literature.</p> <p>Cheng, L.; Wang, G.; Abraham, J.P.; Huang, G. Decadal Ocean Heat Redistribution Since the Late 1990s and Its Association with Key Climate Modes. <i>Climate</i> 2018, 6, 91.</p> <p>Liu, W.; Xie, S.-P. An Ocean View of the Global Surface Warming Hiatus. <i>Oceanography</i> 2018, 31, doi:10.5670/oceanog.2018.217.</p> <p>Lee, S.; Park, W.; Baringer, M.; Gordon, A.; Huber, B.; Liu, Y. Pacific origin of the abrupt increase in Indian Ocean heat content during the warming hiatus. <i>Nat. Geosci.</i> 2015, 8, 445–449.</p> <p>Drijfhout, S.S.; Blaker, A.T.; Josey, S.A.; Nurser, A.J.G.; Sinha, B.; Balmaseda, M.A. Surface warming hiatus caused by increased heat uptake across multiple ocean basins. <i>Geophys. Res. Lett.</i> 2015, 41, 7868–7874.</p> <p>Yan, X.-H.; Boyer, T.; Trenberth, K.; Karl, T.R.; Xie, S.-P.; Nieves, V.; Tung, K.-K.; Roemmich, D. The global warming hiatus: Slowdown or redistribution? <i>Earth's Future</i> 2016, 4, 472–482. [Government of China, China]</p>	Following this suggestion and others, we have revised the relevant figure and text to show the observed long term (1971-1990) to (1998-2017) regional trend in heat content. Given the limited interior ocean data coverage in the early 1960s, 1960 seemed to us like it was too early to start, but by taking this longer-term trend and differences in 20-year averages, we are confident that internal variability does not dominate the trends we are now presenting.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
12099	5	9	1	17	1	<p>It is suggested to give reasons for selecting SODA reanalysis data for assessment. Following AR5, a systematic comparative study of the reanalysis data has been made internationally (Palmer et al. 2015) (ORA-IP activity). At the same time, a large number of post-AR5 studies have used other reanalysis data such as ECCO and ORAS. So it is suggested to supplement the latest research advances since AR5 and explain the reasons for selecting a certain type of reanalysis data.</p> <p>Palmer, M.D.; Roberts, C.D.; Balmaseda, M.; Chang, Y.-S.; Chepurin, G.; Ferry, N.; Fujii, Y.; Good, S.A.; Guinehut, S.; Haines, K.; et al. Ocean heat content variability and change in an ensemble of ocean reanalyses. <i>Clim. Dyn.</i> 2015, 49, 909–930.</p> <p>Andrea Storto, Simona Masina, Simona Simoncelli, Doroteaciro Iovino, Andrea Cipollone, Marie Drevillon, Yann Drillet, Karina von Schuckman, Laurent Parent, Gilles Garric, Eric Greiner, Charles Desportes, Hao Zuo, Magdalena A. Balmaseda, K. Andrew Peterson. (2018) The added value of the multi-system spread information for ocean heat content and steric sea level investigations in the CMEMS GREP ensemble reanalysis product. <i>Climate Dynamics</i> 49.</p> <p>Balmaseda, MA, Trenberth KE, Källén E... Distinctive climate signals in reanalysis of global ocean heat content. <i>Geophys. Res. Lett.</i>, (2013) 40, 1754-1759, doi: 10.1002/grl.50382.</p> <p>Li, Y.; Han, W.; Zhang, L., Enhanced Decadal Warming of the Southeast Indian Ocean During the Recent Global Surface Warming Slowdown. <i>Geophysical Research Letters</i> 2017, 44, (19), 9876-9884.</p> <p>K. E. Trenberth, J. T. Fasullo, K. von Schuckmann, L. Cheng, Insights into Earth's energy imbalance from multiple sources. <i>J. Climate</i> 29, 7495-7505 (2016).</p> <p>Karina von Schuckmann et al. (2018) Copernicus Marine Service Ocean State Report, <i>Journal of Operational Oceanography</i>, 11:sup1, S1-S142, DOI: 10.1080/1755876X.2018.1489208 [Government of China, China]</p>	<p>Considered: SODA is not used in the globally integrated heat content estimates in the new section 5.2.2.2.1, and for the recent observationally-rich (2005 onward) period where SODA is used to provide maps of vertically integrated heat content changes or zonal mean salinity and temperature changes (in figures 5.2c and 5.3a), it gives results that are very similar to other reanalyses, but with fewer artefacts of data voids than some. We do not think that the results presented here are at all sensitive to this particular choice.</p>
4485	5	9	4	9	4	<p>It would be good to include a paragraph about changes in sea surface temperature given that this quantity is relatively well observed. [The UBern Team Group Review, Switzerland]</p>	<p>Sea surface temperature changes are well observed, but they are also extensively discussed in AR5 and will be extensively discussed in AR6. Given the vast scope of this chapter and tight space restrictions, we have chosen to restrict our analysis to changes that are not well explored in other assessment reports and that are of particular importance for changing ocean ecosystem.</p>
14161	5	9	4	9	4	<p>Section 5.2.2.2 This is quite a long sub-section. One of the reasons that it is hard to read is that its first two sub-sections are long and the rationale for the division of material is not evident to the reader. Please consider re-structuring for clarity. [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]</p>	<p>Thank you for this suggestion. This section has now been restructured, into one section discussing the trends in globally integrated ocean heat uptake (both as observed, simulated, and projected), and another section on the regional and vertical structure of anthropogenic climate change related physical oceanographic changes from both projections and as observationally documented. We agree that this presentation is clearer.</p>

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
24687	5	9	4	9	4	<p>this section that reviews methods to study circulation has completely ignored satellite observations which have enabled us to begin to monitor ocean circulation (global and regional) for at least the last 20 years. Such methods are key (along with in situ and modelling) to enable us to continue to monitor circulation into the future i.e. the model results are only as good as the observations used to parameterise them and over-reliance on spatially sparse in situ data is likely to completely miss synoptic scale (global!) variations and changes in ocean circulation. to help please see see Rio et al., 2014 and the review section in Shutler et al 2016 - both full references are listed here: Shutler JD, Quartly GD, Donlon CJ, Sathyendranath S, Platt T, Chapron B, et al. Progress in satellite remote sensing for studying physical processes at the ocean surface and its borders with the atmosphere and sea ice. Progress in Physical Geography [Internet]. SAGE Publications; 2016 Apr 1;40(2):215–46. Available from: http://dx.doi.org/10.1177/0309133316638957 Rio M-H, Mulet S, Picot N. Beyond GOCE for the ocean circulation estimate: Synergetic use of altimetry, gravimetry, and in situ data provides new insight into geostrophic and Ekman currents. Geophysical Research Letters [Internet]. Wiley-Blackwell; 2014 Dec 18;41(24):8918–25. Available from: http://dx.doi.org/10.1002/2014gl061773 [Shutler Jamie, United Kingdom (of Great Britain and Northern Ireland)]</p>	Text revised

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
4851	5	9	6	11	12	It must be exceedingly difficult to model the ocean processes. Having said that, in Figure 5.1 the visible differences between the modelled and observed are a bit disconcerting. e.g. the strongest red in d is in an area where b is strongest blue; the equatorial Atlantic in d is a darker red than the equatorial Pacific, whereas in b the same area is blue; the Indian ocean shows darker red around Madagascar and along the equator and in a line heading off SE, but in the observed data the same area is blue; the ocean W of Australia also differs between observed and modelled. There are many other glaring differences between d&b and e&c. The question is, how good are these ocean models at modelling the observations? It is also disconcerting that the green line (observed) in (a) lies almost outside the bottom range of the models. The immediate conclusion for a reader is that the models are not yet skilled at reproducing global ocean processes. Please could you explain. The text says that models are 'consistent' with observations "once the limitations of the historical ocean observing.... are taken into account" (p 11 line 3), referring to Section 5.2.2.2. That section explains how complicated ocean is but does not explain the major apparent difference between the models and observations in this figure. All the confidence statements in this section presumably relate to the CMIP ensemble. A non-specialist reader is likely to feel uncomfortable with the conclusions. This gets addressed somewhat on pg 17 line 36ff, but doesn't answer the question fully. The short answer is probably that the models are the best we have right now, and they show the trends they show. Hopefully over time the Argo data will improve our understanding and the ability to model the ocean (pg 18, line 25ff). Due to these concerns, it would be beneficial to see much more of the new observational data, and any trends that have been detected over the past decades. In the light of model weaknesses, changes in observed data convey a more powerful message. [Debra Roberts and Durban Team, South Africa]	This section was previously written focusing on oceanic observations in the ARGO era (from 2005 onward), during which the state of the ocean is reasonably well observed, but in so doing the observations conflated internally generated interannual variability with anthropogenic climate changes. Figure 5.1 (now 5.2) has been extensively modified to (1) show only the uppermost 700 m of the ocean, (2) compare longer term trends (1971-1990) to (1998-2017) between the observations and models (even though there are issues with observational data coverage in the extratropical Southern Hemisphere earlier in this time series, as was also noted by IPCC AR5-WGI), and (3) use two realizations of identical climate models to illustrate how internal variability can mask anthropogenic climate change. We feel that the concerns highlighted by this comment should no longer be an issue for a non-specialist reader, and that the message of this section is much clearer.
3419	5	9	6	9	30	Need more references - this whole section depends too much on Bindoff et al. 2013. [Patrick Orenstein, United States of America]	Bindoff et al. 2013 is the corresponding chapter in the IPCC AR5 Report, and as such it draws upon hundreds of citations.
33611	5	9	6	9	6	Change the title to "Projected global and regional ocean changes over the 21st century" [Government of United States of America, United States of America]	This subsection and the next have been reorganized, so this suggestion is no longer germane.
22887	5	9	7	7	9	The statement: "The ocean is warming as a direct result of anthropogenic changes to the radiative properties of the atmosphere and the heat budget of the Earth (very likely)..." is not true, as it is a conjecture made on the basis of un-scientific methods. Please exchange with a true statement, for example: "The ocean is warming as a direct result of heat from the sun, and is only partly caused by anthropogenic changes in the atmosphere (in accordance with FAR, WG1). [Martin Hovland, Norway]	This is a direct quote of a finding from the IPCC AR5, and we stand by it.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
14163	5	9	7	9	14	It would make the report easier to read if it was made explicit in the text that these are conclusions from WGI AR5. [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	This has been made explicit.
31787	5	9	7	9	14	Make clear that this is information from AR5 [Hans-Otto Poertner and WGII TSU, Germany]	This has been made explicit.
32529	5	9	7	9	14	Perhaps this section should describe other warming rates than the 0.42 W/m2 more up front than in the later subsequent sections, which should also contain an uncertainty range. The addition of future warming rates in this section is very helpful in this regard. [Yassir Eddebbar, United States of America]	Accepted - The section on rates of ocean warming has been extensively revised, including combining observationally derived estimates with projections in the same well-focused section.
1699	5	9	7	9	30	Somewhere near the beginning of this section, ocean heat content vs. temperature should be defined. [Nora Richter, United States of America]	Accepted - The footnote defining the ZettaJoule has been extended to include text converting heating in ZJ to amounts of temperature change for the whole ocean or just the top 100 m.
26399	5	9	7	9	8	What is the distinction here between "very likely" and stronger language, e.g. "virtually certain"? [Ethan Pierce, United States of America]	The calibrated uncertainty language used here has been used for several generations of IPCC reports, and is documented in footnotes in Chapter 1.
20275	5	9	8	9	10	In Figure 5.1, label bar labels are absent. [APECS Group Review, Germany]	These numeric labels were actually present in the committee's final draft of the SOD, but somehow were hidden behind the figure elements when Chapter 5 was processed for dissemination for review. These labels have been restored to their proper (visible) position, and the committee will insist on reviewing the final draft before it is made public.
20277	5	9	8	9	10	Also, the time period for 0-700m heat uptake for CMIP5 models is not same as that for SODA. The figure caption wrongly says that time periods are same. [APECS Group Review, Germany]	These panels both show differences between corresponding pentads. The labels within the figure were wrong and have been corrected.
20281	5	9	8	9	10	SODA is an ocean reanalysis data set. This is mentioned in the text but not in figure title. Misleading to call it observations in figure title. [APECS Group Review, Germany]	Accepted - The figure titles now indicate that these are inferred from observations.
33613	5	9	8	9	8	This statement seems like it qualifies as virtually certain. [Government of United States of America, United States of America]	This sentence is quoting from the findings of the IPCC AR5-WGI, and we are quoting the level of certainty from that previous report.
33615	5	9	8	9	8	Seems like this should be virtually certain. [Government of United States of America, United States of America]	This sentence is quoting from the findings of the IPCC AR5-WGI, and we are quoting the level of certainty from that previous report.
24671	5	9	10	9	10	the value of 93% for heat is inconsistent with values stated earlier in this chapter and chapter 1 (90% was previously used). [Shutler Jamie, United Kingdom (of Great Britain and Northern Ireland)]	"about 93%" is "more than 90%". These statements are consistent.
4487	5	9	11	9	12	Please add uncertainties to the ocean heat uptake and energy imbalance estimates [The UBern Team Group Review, Switzerland]	Accepted - Uncertainties have been added to ocean heat uptake estimates. However, assessing the entire energy budget of the planet would also require assessment of land, atmosphere and cryosphere heat uptake, as well as the top-of-the-atmosphere net heat flux, several of which are clearly outside of the scope of this chapter and the report as a whole. It is expected that the planetary heat budget will be assessed in the forthcoming AR6 report.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
13009	5	9	11	9	12	Please revise the estimate 274ZJ & 0.42W/m ² , considering the following: "increasing at a steady rate" (17) & "1970-2010 ... 0.42W/m ² " (20). Resplandy et al. 2018 provide in their Fig.1b various DOHC estimates for periods starting ~1990 and ending ~2015. These trends vary between 9 and 12 ZJ/yr or 225 and 300ZJ in 25 years. 0.42W/m ² is based on 274ZJ for the period 1970-2010 (cf. Chp. 5.2.2.2.1, p.9, line 11-12). By comparison, 0.42W/m ² appears much too low, or the heat gain rate is not steady (time-invariant), or both. Resplandy et al., Nature 536, 105-108,2018. Note that the Authors are correcting their own estimate: http://www.realclimate.org/index.php/archives/2018/11/resplandy-et-al-correction-and-response/ [Government of Germany, Germany]	The Resplandy et al. 2018 paper is an indirect inference of heat content changes from oxygen changes, which is a technically impressive feat but is not as reliable as direct inferences from in-situ ocean temperature measurements, and have proven to be the subject of significant technical controversy. As such, the committee does not consider Resplandy et al. 2018 to be a reliable citation for this chapter. The values cited here are from taken from a survey of numerous published reanalyses of temperature changes.
9717	5	9	11	9	13	Here EEI is not at all introduced, nor emphasis is given to the 93% heat surplus stored in the ocean. Even if this fact has been discussed in AR5, a couple of sentences would be beneficial to the general reader (the ocean is the 0-order factor in climate change because of this energy storage). And this is also what is affecting most the marine ecosystems. [Government of France, France]	Discussing the Earth's Energy Imbalance (EEI) would also require an assessment of heat content changes in the land, atmosphere and cryosphere, as well as the top-of-the-atmosphere net heat flux, several of which are clearly outside of the scope of this chapter and the report as a whole. It is expceted that the planetary heat budget will be assessed in the forthcoming AR6 report.
10945	5	9	13	9	13	Missing linkage between this sentence and the previous paragraph. Specifically some information linking between heat uptake and sea level rise would be useful before discussing thermal expansion. [Abigail Bodner, United States of America]	A linking phrase has been added.
740	5	9	13	9	14	This sentence may be unnecessary because the scientific findings of sea level change are updated in Chapter 4. [Mengxi Wu, United States of America]	The statement now reflects the values from the assessment in Chapter 4, along with a cross-reference.
742	5	9	16	9	30	I think the introduction to the modeling approach is better done in Chapter 1 instead. [Mengxi Wu, United States of America]	Chapter 5 now refers to the section in chapter 1 describing the RCP forcing scenarios.
3897	5	9	17	0		'atmospheric forcing' is not appropriate. Probably 'radiative forcing' should be used, as (greenhouse gases, aerosols, solar [Zhaomin Wang, China]	We agree with the reviewer's concept that it is changes in the atmosphere that drive the ocean, so this sentence was correct as written.
3899	5	9	17	0		radiation and volcanic eruptions) also drive changes in the atmosphere. [Zhaomin Wang, China]	We agree with the reviewer's concept that it is changes in the atmosphere that drive the ocean, so this sentence was correct as written.
24673	5	9	22	9	22	incorect use of the phrase 'climate models'. climate models are defined as models that predate earth system models. Suggest change this sentence to use: Earth System Models. [Shutler Jamie, United Kingdom (of Great Britain and Northern Ireland)]	The phrase "Earth System Model" or the acronym ESM is now used throughout this section, except when discussing older or simplified climate models that do not include biogeochemical processes. Thank you for catching this.
3529	5	9	22	9	24	Here, ocean properties are listed and it might be more suitable to state "pH level" instead of "ocean acidification" as the latter is a process related term. [Marius Müller, Brazil]	Text revised
7025	5	9	27	0		"such as natural forcing such as" - suggest rephrasing [Nina Hunter, South Africa]	This passage was rephrased.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
10947	5	9	27	9	27	"such as" followed by "such as" [Abigail Bodner, United States of America]	This passage was rephrased.
17159	5	9	27	9	27	Remove "such as solar variability" and replace with comma; should be ", solar variability". [Shalini Singh, Fiji]	This passage was rephrased.
7027	5	9	28	0		Move bracket from before "2013" to before "Bindoff" [Nina Hunter, South Africa]	The reference has been changed to section 1.3 of this special report.
10949	5	9	28	9	28	Citation missing \citep{} [Abigail Bodner, United States of America]	The reference has been changed to section 1.3 of this special report.
16513	5	9	28	9	28	Bindoff et al. (2013) may be (Bindoff et al., 2013)? [Tsuneo Ono, Japan]	The reference has been changed to section 1.3 of this special report.
9719	5	10	0	0		Why is it 2003-2018 in panel d) instead of 2006-2014 as the other three panels (b), c) and e)))? [Government of France, France]	These panels both show differences between corresponding pentads. The labels within the figure were wrong and have been corrected.
10771	5	10	0	10	0	Figure 5.1b shows that the ocean is losing heat in some regions as indicated by the dark blue areas. While most of such regions correspond to the hatched areas in Figure 5.1d, there seems to be a significant difference between the observations and models in the northernmost part of the Atlantic. This may be demonstrating a serious deficiency of CMIP5 models since this is a very important and delicate part of the ocean. It may be difficult to identify the cause of this discrepancy, but there should at least be a mentioning on its existence somewhere in the text, for example after "(see Section 5.2.2.2)" of page 11, line4. [Michio Kawamiya, Japan]	This section was previously written focusing on oceanic observations in the ARGO era (from 2005 onward), during which the state of the ocean is reasonably well observed, but in so doing the observations conflated internally generated interannual variability with anthropogenic climate changes. Figure 5.1 (now 5.2) has been extensively modified to (1) show only the uppermost 700 m of the ocean giving space for more panels on that region, (2) compare longer term trends (1971-1990) to (1998-2017) between the observations and models, and (3) use two realizations of identical climate models to illustrate how internal variability can mask anthropogenic climate change. We feel that the concerns highlighted by this comment should no longer be an issue for a non-specialist reader, and that the message of this section is much clearer.
3901	5	10	0	0		Fig. 5.1b and 5.1c: why not used the same time period? [Zhaomin Wang, China]	These panels both show differences between corresponding pentads. The labels within the figure were wrong and have been corrected.
3903	5	10	0	0		Fig. 5.1: the numbers with the color bars are missing [Zhaomin Wang, China]	These numeric labels were actually present in the committee's final draft of the SOD, but somehow were hidden behind the figure elements when Chapter 5 was processed for dissemination for review. These labels have been restored to their proper (visible) position, and the committee will insist on reviewing the final draft before it is made public.
4853	5	10	0	0		Figure 5.1. The colour legend is missing a numeric definition. The blue colour gives the idea of cooling, whereas it probably just means a lower degree of heat uptake? Or does it show heating/cooling? This is not totally clear. Is 'heat uptake' the transfer of energy from atmosphere to ocean or v.v.? Unless the colours mean heating/cooling, it may be better to use a colour scheme that is not intuitively associated with hot-cold. - Why is the time window used for observed in b and c (2006 to 2014) different from the time window for the CMIP in d and e (2003 to 2018)? [Debra Roberts and Durban Team, South Africa]	These numeric labels were actually present in the committee's final draft of the SOD, but somehow were hidden behind the figure elements when Chapter 5 was processed for dissemination for review. These labels have been restored to their proper (visible) position, and the committee will insist on reviewing the final draft before it is made public. Also, the time windows are consistent, as is now reflected in the labels within the figure.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
10951	5	10	0	0		Figure a would be clearer if a box and arrows would enclose the magined subplot shown in the top left coner, and help orient the reader. Additionally, the line representing observations should be thicker. [Abigail Bodner, United States of America]	After revision, including a separation of Figure 1a out from the previous panels, we think that the presentation is now clear.
28301	5	10	0	0		The units in the Figs. a – g should be separated from the digits. [Nsikak Benson, Nigeria]	Changed as suggested
28707	5	10	0	0		Figure5.1: b–g scale bars missing values [Government of Brazil, Brazil]	These numeric labels were actually present in the committee's final draft of the SOD, but somehow were hidden behind the figure elements when Chapter 5 was processed for dissemination for review. These labels have been restored to their proper (visible) position, and the committee will insist on reviewing the final draft before it is made public.
28709	5	10	0	0		Figure5.1: time periods described in the legend and graphics are very confusing, seems there lileky is flaw in the figure. [Government of Brazil, Brazil]	These panels both show differences between corresponding pentads. The labels within the figure were wrong and have been corrected.
28711	5	10	0	0		Figure5.1: this figure can be edited for improvement. Y axis can be used to to represent : Observed, CEMIP 5 and RCP8.5 and year, and x axis (above) for meters Heat Uptake . Scales bar can be in horizontaly (below low x axis) as in Fig. 5.2, saving space for font increasing in left legends (ENS and Global Average). Note duplicated meters information can be removed. [Government of Brazil, Brazil]	This figure has been split into two and extensively revised taking these suggestions into account.
28713	5	10	0	0		What mens the greenlines in the inset sub-panel in a, it is missing in legend. [Government of Brazil, Brazil]	These lines are various observationally derived estimates, as described in the caption. Because this time-series panel has been separated out from the maps, we think that the presentation and the caption are now much clearer.
28715	5	10	0	0		Suggestion: (f) Projected CMIP5 ensemble mean RCP8.5 heat content uptake for the top 700 m (average of 2081 to 2100 minus average of 1986 to 2005), [Government of Brazil, Brazil]	This figure has been split into two and extensively revised taking these suggestions regarding the clarity of the captions into account.
14165	5	10	0	10		Figure 5.1. The colour bars for the heat fluxes (in W m-2) should have numbers on them. [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	These numeric labels were actually present in the committee's final draft of the SOD, but somehow were hidden behind the figure elements when Chapter 5 was processed for dissemination for review. These labels have been restored to their proper (visible) position, and the committee will insist on reviewing the final draft before it is made public.
17161	5	10	0	10		Figures 5b-g in caption need space between "0m" should be "0 m". [Shalini Singh, Fiji]	Changed as suggested.
31675	5	10	1	0		Figure 5.1. The three central legend bars between the panels b through g could be reduced to a single one on the right bottom corner, and it needs units on it. [Hans-Otto Poertner and WGII TSU, Germany]	This figure has been extensively revised, and now has a single color bar at the bottom.
746	5	10	1	10	1	The colorbars are incomplete In addition, it seems the average over 2006-2014 is strongly influenced by oceanic decadal oscillations but this is not properly mentioned in the caption. [Mengxi Wu, United States of America]	This figure has been extensively revised, including the use of several different time-periods, and now has a single color bar (with labels) at the bottom.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
3189	5	10	1	10	1	The color bar for Figures 5.1b-g don't have numerical values for the ocean heat uptake. Although the relative relationship shown in the plots can be understood without corresponding numerical values, it might be helpful to provide a more quantitative context as well. [Sloane Garelick, United States of America]	These numeric labels were actually present in the committee's final draft of the SOD, but somehow were hidden behind the figure elements when Chapter 5 was processed for dissemination for review. These labels have been restored to their proper (visible) position, and the committee will insist on reviewing the final draft before it is made public.
3195	5	10	1	10	1	The magnified inset in Figure 5.1 can provide important information but it might be helpful to zoom in even further so that we can more clearly see differences between the observation and CMIP5 records. It also may be helpful to draw a small box around the original area on the larger time series that is magnified in the inset. [Sloane Garelick, United States of America]	We have expanded the inset as suggested and made its axis labels much easier to read.
3197	5	10	1	10	1	Although the meaning of the colored lines in Figure 5.1a are described in the caption, including a legend on the figure that explains the source of each colored line might make it easier to understand the figure. [Sloane Garelick, United States of America]	We have expanded the inset as suggested and made its axis labels much easier to read, and by separating Figure 5.1a out from the other panels that had been in Figure 5.2, the caption should be much more understandable.
3549	5	10	1	10	1	Figure 5.1 has color bars for plots b-g which are labeled W m-2, but have no other labels, i.e. values corresponding to the tick marks. Values need to be added to the color bars. [Sonya Legg, United States of America]	These numeric labels were actually present in the committee's final draft of the SOD, but somehow were hidden behind the figure elements when Chapter 5 was processed for dissemination for review. These labels have been restored to their proper (visible) position, and the committee will insist on reviewing the final draft before it is made public.
4405	5	10	1	10	1	Values are missing for the color bar. [The UBern Team Group Review, Switzerland]	These numeric labels were actually present in the committee's final draft of the SOD, but somehow were hidden behind the figure elements when Chapter 5 was processed for dissemination for review. These labels have been restored to their proper (visible) position, and the committee will insist on reviewing the final draft before it is made public.
4489	5	10	1	10	1	Panels b-g: Why not showing time-integrated changes so that it is more consistent with panel (a)? [The UBern Team Group Review, Switzerland]	This figure has now been split up into two figures, so that all of the panels in the new Figure 5.2 have the same units.
11469	5	10	1	10	1	Figure 5.1a requires a legend to show what each color represents. Also, it is difficult to find the green lines. [Anson Cheung, United States of America]	We have expanded the inset and made its axis labels much easier to read, and by separating Figure 5.1a out from the other panels that had been in Figure 5.2, the caption should be much more understandable.
11471	5	10	1	10	1	Figure 5.1d why is the period covered different from b,c,e? [Anson Cheung, United States of America]	These panels both show differences between corresponding pentads. The labels within the figure were wrong and have been corrected.
11473	5	10	1	10	1	Figure 5.1d and e. CMIP5 historical simulation only runs till 2005. So I wonder what RCPs are used in the "observed" scenario after 2005? [Anson Cheung, United States of America]	An average of both RCP2.6 and RCP8.5 ensemble members were shown, but they do not differ much through 2017.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
11475	5	10	1	10	1	Tick mark labels needed for all the colorbars [Anson Cheung, United States of America]	These numeric labels were actually present in the committee's final draft of the SOD, but somehow were hidden behind the figure elements when Chapter 5 was processed for dissemination for review. These labels have been restored to their proper (visible) position, and the committee will insist on reviewing the final draft before it is made public.
13011	5	10	1	10	1	Figure 5.1a: Explain the black lines. [Government of Germany, Germany]	The black lines were the ensemble means for all of the historical or projections, but they have been removed in the revision of this figure to avoid confusion.
13013	5	10	1	10	1	Figure 5.1.b-g: Labels on the color scale are missing. [Government of Germany, Germany]	These numeric labels were actually present in the committee's final draft of the SOD, but somehow were hidden behind the figure elements when Chapter 5 was processed for dissemination for review. These labels have been restored to their proper (visible) position, and the committee will insist on reviewing the final draft before it is made public.
13015	5	10	1	10	1	Figure 5.1b through g: Numeric labels are missing at the W/m ² color bars [Government of Germany, Germany]	These numeric labels were actually present in the committee's final draft of the SOD, but somehow were hidden behind the figure elements when Chapter 5 was processed for dissemination for review. These labels have been restored to their proper (visible) position, and the committee will insist on reviewing the final draft before it is made public.
20233	5	10	1	10	1	I would define ZJ in the legend, just in case a reader is not familiar with the term "Zeta Joules" since it isn't defined in the text [APECS Group Review, Germany]	Zetta Joules is defined in a footnote shortly before this figure.
26401	5	10	1	10	1	The inset in Figure 5.1a does not add any new information (it is zoomed out to almost the size of the main figure itself). The dates on 5.1d do not match 5.1b. It is not clear how the figures 5.1b through 5.1g are organized (which are meant to be read together). The scale bars have no units. There should be an explicit connection made between the units of the geographic figures 5.1b-g and the summary figure 5.1a. [Ethan Pierce, United States of America]	Panel 5.1a is now Figure 1, and the remaining panels are Figure 2, with different selections of images to help tell the story of section 5.2.2.2. The numeric labels were actually present in the committee's final draft of the SOD, but somehow were hidden behind the figure elements when Chapter 5 was processed for dissemination for review. These labels have been restored to their proper (visible) position, and the committee will insist on reviewing the final draft before it is made public.
32525	5	10	1	10	1	Color bar missing numbers. Also, perhaps add labels on Figure 5.1.a in the actual figure to help follow the different trends (green magenta, for different products etc.). Also, separate the two plots into two subplots, left and right, pretty hard to distinguish what's going on in this figure.. This is one of the most important figures in this report, and should be edited further to clarify the ocean warming rates, different products, and CMIP5 model estimates. [Yassir Eddebbar, United States of America]	These figures have been extensively revised for clarity, and we now feel that they illustrate the main messages of this section more clearly.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
33619	5	10	1	10	1	A Tyler-series diagram would be more useful in objectively assessing the agreement between the observed versus model data. As shown, there appears considerable disagreement in the North Atlantic which requires some explanation. [Government of United States of America, United States of America]	This section was previously written focusing on oceanic observations in the ARGO era (from 2005 onward), during which the state of the ocean is reasonably well observed, but in so doing the observations conflated internally generated interannual variability with anthropogenic climate changes. It has been revised extensively. Figure 5.1 (now 5.2) has been extensively modified to (1) show only the uppermost 700 m of the ocean giving space for more panels on that region, (2) compare longer term trends (1971-1990) to (1998-2017) between the observations and models, and (3) use two realizations of identical climate models to illustrate how internal variability can mask anthropogenic climate change. We feel that the concerns highlighted by this comment should no longer be an issue for a non-specialist reader, and that the message of this section is much clearer.
33621	5	10	1	10	1	The differences between observations and models is striking. Panel a (insert) is very difficult to read or interpret, including the negative heat content prior to 2005. Legend needs to state 2005 is used as zero. [Government of United States of America, United States of America]	The inset panel has been expanded and has better labeling to improve clarity. The caption states that these are changes relative to the average from 2000 to 2010 for both the observations and the models.
33623	5	10	1	10	1	Model agreement with observations appears quite poor especially for the North Atlantic. [Government of United States of America, United States of America]	This section was previously written focusing on oceanic observations in the ARGO era (from 2005 onward), during which the state of the ocean is reasonably well observed, but in so doing the observations conflated internally generated interannual variability with anthropogenic climate changes. Figure 5.1 (now 5.2) has been extensively modified to (1) show only the uppermost 700 m of the ocean giving space for more panels on that region, (2) compare longer term trends (1971-1990) to (1998-2017) between the observations and models, and (3) use two realizations of identical climate models to illustrate how internal variability can mask anthropogenic climate change. We feel that the concerns highlighted by this comment should no longer be an issue for a non-specialist reader, and that the message of this section is much clearer.
33617	5	10	1	10	13	Numbers of the color bar from b to g are missing. The title of d should read "CMIP5 0m-700 m Heat Uptake 2006 to 2014" [Government of United States of America, United States of America]	These numeric labels were actually present in the committee's final draft of the SOD, but somehow were hidden behind the figure elements when Chapter 5 was processed for dissemination for review. These labels have been restored to their proper (visible) position, and the committee will insist on reviewing the final draft before it is made public. Also, the title for d was corrected.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
610	5	10	1	10	14	The colors on both of the subplots without a legend for (a) make it difficult to discern what all the lines correspond to. The inset could be better defined, boxed and with lines to show the portion of the data on the larger plot it represents. Please include magnitudes for the colorbars, and why are there different time periods, for example (d) does not match any of the others. This figure should be discussed more in the text. Why are the ARGO floats biased low? Is it only because they are capturing more variability than the models, and if so why do they agree before the 2000s? The variability not captured by the models should also be addressed by lower than 95% confidence almost everywhere. How do the lower panels relate to oceanographic features? [Jenna Pearson, United States of America]	This figure has been extensively revised taking this and other reviewer comments into account. This figure has been split into two, with new regional panels in Figure 5.2 showing longer-term observed and historical model trends, all using the same colorbar. Also the reference period for the timeseries of heat content changes in Figure 5.1 has been expanded to the average of 2000 to 2010, and there is clearer labeling in the figure and caption.
1701	5	10	1	10	14	The scale bars in all of the figures are missing values. [Nora Richter, United States of America]	These numeric labels were actually present in the committee's final draft of the SOD, but somehow were hidden behind the figure elements when Chapter 5 was processed for dissemination for review. These labels have been restored to their proper (visible) position, and the committee will insist on reviewing the final draft before it is made public.
1703	5	10	1	10	14	It would be useful to include another figure here that compares modern ocean heat content/temperature with those observed in the paleoclimate record during major warm periods (there was great figure in AR5, Chapter 5, Box 5.1, Figure 1). [Nora Richter, United States of America]	Unfortunately a paleoclimate comparison goes beyond the scope of this chapter and what its word-count limits can support.
1913	5	10	1	10	14	Figure 5.1. Panel a: Perhaps separate into two figures, because the smaller figure is hard to read, and it has different axis than the larger figure, so there is no reason for it to be inside. Regarding maps: the colour scale is missing values (min,max), and it is difficult to differentiate between the intensity of the colours, perhaps a step-wise scale would be more useful [Katarzyna B. Tokarska, United Kingdom (of Great Britain and Northern Ireland)]	Figure 5.1a has been reformatted for greater clarity, and the remaining panels separated out as Figure 2, with a single common color-bar.
5367	5	10	1	10	4	Specify the time period for the green lines in the figure. [Ragnhild Bieltvedt Skeie, Norway]	The figure axis labels make this clear.
5369	5	10	1	10	4	Possible to include observational data prior to ~1994 in Fig 5.1a? In the main text changes in ocean heat content since 1971 is mentioned. I would have liked a figure with all observational datasets included (with observational uncertainties), similar to AR5 Chapter 3 Fig. 3.2 [Ragnhild Bieltvedt Skeie, Norway]	This figure shows heat content changes down to 2000 m, which can not be reliably inferred year-by-year before the WOCE era. The heat content changes since 1971 reported by AR5 were only for the topmost 700 m of the oceans.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
32549	5	10	1	11	12	Figure 5.1 panel (a) seems to suggest that OHC estimates based on observations are at the bottom edge of model projections. Is it possible to infer from this analysis that models overestimated OHC increase at least for the period 2007-2017? Could an explanation be provided and the uncertainty be shown on the figure and/or explained? What would be possible consequences if most models overestimate OH uptake? Will it be revised following the publication of Cheng et al 2019 (http://science.sciencemag.org/content/363/6423/128) ? [Philippe Marbaix, Belgium]	Considered - this apparent discrepancy was the artefact of using an overly narrow reference period. This has now been corrected. In addition the Cheng et al (2019) ensemble of CMIP5 models is now used for the projections, although the results are virtually indistinguishable from those of the previous ensemble.
5399	5	10	4	10	4	"modes" should be "models" [Kate Moran, Canada]	Corrected
7029	5	10	9	0		Change "(B)" to "(b)" [Nina Hunter, South Africa]	In revising this figure, the caption text this comment refers to was eliminated.
27779	5	10	9	10	10	The main figure caption suggests the same time period, but the sub-figure titles suggest different ranges (2006-14 vs 2003-2018 for sub-figure d). While they share roughly the same center point, this is not quite the same, considering that 2014-16 were major ENSO events.) [Momme Butenschön, Italy]	These panels both show differences between corresponding pentads. The labels within the figure were wrong and have been corrected. Five year averages were taken to reduce the imprint of of interannual variability events like ENSO.
14175	5	11	0	11	0	Figure 5.2: Some of the contour labels are very difficult to read. It is very odd to display observed changes for 2014 minus 2006 on the SAME scale as projected changes for 2090 minus 1990. [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	In both cases, these changes have been converted to rates of change per 50 years, so they are comparable quantities. Also, the illegible contour labels have been removed.
32527	5	11	1	11	12	This report was aimed at informing recent updates in OHC changes since the AR5, and should perhaps focus more on recent advances in warming than restating the IPCC AR5 report findings. A more detailed discussion of different OHC estimates I think should be a major part of this section, which is focused on CMIP5 models and doesn't clearly describe the various warming rates and convergence of recent estimates as summarized for instance in Cheng et al (2019): http://science.sciencemag.org/content/363/6423/128 [Yassir Eddebbar, United States of America]	This material has been extensively revised, and is now presented in a single section covering both observational estimates of OHC and projections. The numerous new references do include Cheng et al (2019).
33625	5	11	1	11	12	This paragraph should be checked for accuracy. [Government of United States of America, United States of America]	This material has been extensively revised, and is now presented in a single section covering both observational estimates of OHC and projections. It has been carefully checked for accuracy using multiple independent calculations or citations.
27781	5	11	5	11	5	"...that under RCP2.6 until the end of this century..." [Momme Butenschön, Italy]	The date 2100 has been added to the text.
20235	5	11	5	11	6	The use of "...about 3 times the roughly 500 ZJ" is just a repeat of the 1500 ZJ previously stated, I would shorten this sentence [APECS Group Review, Germany]	The text of this section has been extensively revised to avoid repetitive text.
14171	5	11	6	11	6	Please specify explicitly the date (2100?) when the ocean will have taken up 1500 ZJ of heat. [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	The date 2100 has been added to the text.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
20237	5	11	8	11	8	"much more heat" the use of more is not required [APECS Group Review, Germany]	The word more has been removed as suggested.
31971	5	11	10	0	12	A key projection relevant for impact would be how and for how long ocean temperatures would lag behind the warming of the atmosphere and when with mitigated climate change equilibrium conditions would be reached and how they would look like. At the same time, one wonders whether the underlying background text is too lengthy for this chapter and could be moved into online supplementary material. [Hans-Otto Poertner and WGII TSU, Germany]	Accepted - The point that the oceans will continue to take up heat for centuries after the radiative forcing is stabilized is now made explicitly both in the text and the ES.
26403	5	11	10	11	12	What is the likelihood of a continued rise in ocean heat content through 2200 or 2300? [Ethan Pierce, United States of America]	We think it highly likely, but these longer timescales are not well supported by the CMIP5 datasets. At least some of the CMIP6 experiments are designed to address this point, so we think it would be better to leave it to the forthcoming AR6 report.
748	5	11	14	11	22	This paragraph lacks concrete explanations compared with the following paragraph, so I think it might be deleted without losing much information. [Mengxi Wu, United States of America]	Accepted; this introductory paragraph was unnecessary and has been deleted in the interest of brevity.
1705	5	11	14	11	22	This paragraph needs clarification and more specific references to either the figure and/or processes. As it currently stands it is very abstract and hard to understand, there is also no actual evidence presented in this paragraph. [Nora Richter, United States of America]	This introductory paragraph was unnecessary and has been deleted in the interest of brevity.
4491	5	11	15	11	15	Clarify what atmospheric composition means [The UBern Team Group Review, Switzerland]	This introductory paragraph was unnecessary and has been deleted in the interest of brevity.
21599	5	11	16	11	16	"land and cryosphere" implies that they are mutually exclusive, try to rephrase [Stephan Gruber, Canada]	This introductory paragraph was unnecessary and has been deleted in the interest of brevity.
250	5	11	19	11	22	This statement might not be true. Isn't this because we can measure T and S more accurately than U and V, or do we have sufficient data (particular those for U and V) to support this statement? If we do, references are helpful. We need to compare the detected change (δX) to the natural variability (ΔX). Are there clear data showing $\delta(U,V)/\Delta(U,V) < \delta(T,S)/\Delta(T,S)$. My impression is that we simply cannot measure the left hand side as accurately as the right hand side. Another reason is (U,V) data are "noisier" than (T,S) because under geostrophy (U,V) are spatial derivative of the dynamic height which is vertically integrated (T,S). [Katsuro Katsumata, Japan]	This introductory paragraph was unnecessary and has been deleted in the interest of brevity. A much longer explanation would have gone into the challenges detecting long-term circulation changes from highly variable fields, as you suggest, along with a discussion of the role of nonlinearities in the circulation fields, flow-topography interactions, and lack of detailed agreement between models.
11477	5	11	19	11	22	Evidence (figures, citation etc.) needed to support the conclusion ocean circulation changes are relatively modest. Also, how is the intensity of changes quantified? [Anson Cheung, United States of America]	As stated in the text, circulation changes are measured by the transports, and this conclusion was determined by assessing published papers (several examples of which were already cited here) examining circulation changes.
27615	5	11	19	11	22	Regarding the claim that most of the changes in ocean circulation are relatively modest makes us wonder if these are observed changes published in recent time? [Government of Norway, Norway]	This introductory paragraph was unnecessary and has been deleted in the interest of brevity.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
26247	5	11	20	11	21	"most of the changes in ocean circulation are relatively modest" This statement sounds in contrast with what is said later (eg. line 37) and needs to be circumstanced by timescale indication. [Angela Landolfi, Germany]	This vague introductory paragraph was unnecessary and has been deleted in the interest of brevity.
12677	5	11	20	11	22	- It looks to me there is a contradiction in this sentence. Please review. [Noureddine Benkeblia, Jamaica]	This introductory paragraph was unnecessary and has been deleted in the interest of brevity.
24675	5	11	21	11	21	incomplete detail. Aren't these modelled/simulated circulations, not observed over long periods? In which case I would suggest changing the sentence to explain this, suggestt: ...most of the resultant changes in ocean circulation from the model simulations are relatively modest. [Shutler Jamie, United Kingdom (of Great Britain and Northern Ireland)]	This vague introductory paragraph was unnecessary and has been deleted in the interest of brevity.
4493	5	11	21	11	22	most obvious signatures': is that true? I think there are more obvious signatures of climate change in the ocean than changes in temp and salt. [The UBern Team Group Review, Switzerland]	This vague introductory paragraph was unnecessary and has been deleted in the interest of brevity.
33627	5	11	21	11	22	While not climate change specifically, ocean acidification is also readily discernible. In fact, recent ToE studies (ref?) demonstrate that changing ocean carbonate chemistry is more readily observable than either temperature or salinity on a global scale. [Government of United States of America, United States of America]	This vague introductory paragraph was unnecessary and has been deleted in the interest of brevity.
1707	5	11	24	11	44	How do these patterns compare to what was previously observed in paleoclimate records? [Nora Richter, United States of America]	Unfortunately a paleoclimate comparison goes beyond the scope of this chapter and what its word-count limits can support.
14167	5	11	27	11	29	NADW is formed in the Labrador Sea and Irminger Sea as well, and by processes mediated by the overflow of the Greenland Scotland Ridge. Fig 5.1f is not the full depth integrated - only the 0-700m depths. The Gulf Stream extension area looks to be the largest red area in the figure but is not mentioned here? [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	Accepted - these water masses in the Nordic Seas are now described as NADW precursors.
3905	5	11	29	0		The water mass in the Nordic Seas is not called North Atlantic Deep Water. NADW is a mixture of water masses formed in the Nordic Seas and Labrador Sea. [Zhaomin Wang, China]	Accepted - these water masses are now described as NADW precursors.
7031	5	11	29	0		Where is footnote 5? [Nina Hunter, South Africa]	That is a good question. It has been restored.
4495	5	11	29	11	29	Footnote 5 is not described [The UBern Team Group Review, Switzerland]	Footnote 5 disappeared in the final text merge. It has been restored.
10953	5	11	29	11	29	Missing footnote 5 [Abigail Bodner, United States of America]	Footnote 5 disappeared in the final text merge. It has been restored.
13017	5	11	29	11	29	Footnote 5 is not resolved [Government of Germany, Germany]	Footnote 5 disappeared in the final text merge. It has been restored.
20283	5	11	29	11	29	Footnote 5 is missing. [APECS Group Review, Germany]	Footnote 5 disappeared in the final text merge. It has been restored.
7033	5	11	31	0		Suggest insert degree and direction after "15" as well for clarity [Nina Hunter, South Africa]	Added as suggested.
14173	5	11	35	11	40	"Two areas ..." These two points may be correct but they are not clearly illustrated by several of the figures within Figure 5.1. [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	These are the light area in Figure 5.2c, indicating small long-term mean heat uptake, as the text now indicates.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
27617	5	11	35	11	40	Regarding the argument that the AMOC is slowing down - it could be added that this is a projection about expected changes. Reading it as it is - it was confusing if this is a change already documented. [Government of Norway, Norway]	The text is now clearer when it is discussing projections or recent observed changes, and much of the discussion of the details of recent trends has been removed.
14169	5	11	36	11	36	Please improve specification of the location and refer to the figure (Fig 5.1 f again I think). This reduced warming is the subpolar gyre in the northern North Atlantic. Most of the northern North Atlantic is warming. [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	These are the light area in Figure 5.2c, indicating small long-term mean heat uptake, as the text now indicates, and "northern North Atlantic" is now "northwestern North Atlantic".
4497	5	11	40	11	40	Maybe add here reference to Morrison et al. (2015): Morrison, A. K., T. L. Frölicher, J. L. Sarmiento, 2015, Upwelling in the Southern Ocean, Physics Today, 68(1), 27-32. [The UBern Team Group Review, Switzerland]	Considered - This is a nice general-interest review paper, but the Armour et al. (2016) reference discusses this point adequately.
26441	5	11	40	11	41	I suggest including this line: "... (Armour et al., 2016). The upwelling in the Southern Ocean has increased during the last decades (according to observations) by the strengthening of the westerly wind jet, promoting colder surface temperatures and increasing sea-ice concentrations (Purich et al., 2016)." Purich doi: 10.1038/ncomms10409 [Pedro J. Llanillo, Chile]	This is a useful point, but one that is already discussed in the Southern Oceans cross-chapter box.
24677	5	11	42	11	42	incorrect use of the phrase 'climate model'. This issue keeps arising and needs correcting throughout this chapter. Please see my previous comments on this. [Shutler Jamie, United Kingdom (of Great Britain and Northern Ireland)]	The phrase "Earth System Model" or the acronym ESM is now used throughout this section, except when discussing older or simplified climate models that do not include biogeochemical processes. Thank you for catching this.
20239	5	11	42	11	43	I would re word "understood theoretically" to theoretical understanding. [APECS Group Review, Germany]	Revised as suggested
20285	5	11	43	11	44	From Figure 5.1, it is apparent that CMIP5 multi-model mean does not capture the reduced heat uptake in the Atlantic and western Pacific. Although, the papers cited in this paragraph suggest our understanding of internal variability has improved, but it is not clear to me how the "high confidence" that the CMIP5 projections represent the future real world state is arrived at. More justification is required before making the final statement. [APECS Group Review, Germany]	This section was previously written focusing on oceanic observations in the ARGO era (from 2005 onward), during which the state of the ocean is reasonably well observed, but in so doing the observations conflated internally generated interannual variability with anthropogenic climate changes. It has been revised extensively. Figure 5.1 (now 5.2) has been extensively modified to (1) show only the uppermost 700 m of the ocean giving space for more panels on that region, (2) compare longer term trends (1971-1990) to (1998-2017) between the observations and models, and (3) use two realizations of identical climate models to illustrate how internal variability can mask anthropogenic climate change. We feel that the concerns highlighted by this comment should no longer be an issue for a non-specialist reader, and that the message of this section is much clearer.
31789	5	12	0	13	3	Indicate source(s) of the data on which this figure is based [Hans-Otto Poertner and WGII TSU, Germany]	The data sources are the same as in Fig. 5.1, as is now noted in the caption.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
4855	5	12	0	0		Figure 5.2: "Shaded areas show where the projected changes are not statistically significant at the 95% level" - meaning the non-shaded areas differ significantly between different models? That is by far the majority of the graph area. How good are the models at replicating the observed data? As per previous comment, for a non-specialist this raises grave questions. Why is the Indian Ocean graph cut off abruptly at about 20N? Why don't the contours show what happens as we hit the continent of Asia? Do these graphs represent straight-line transects of the oceans from South to North, or do they represent a mean at each latitude? The legend does not explain this clearly. If transects, then a small global map showing where these transects lie would help. - what does "present contours of these fields" actually mean? What exactly do the contour lines show? At first one assumed the contours refer to the underlying colour map as in Fig 5.5, but looking more closely, they do not seem to after all. They criss-cross red and blue areas. [Debra Roberts and Durban Team, South Africa]	There are lots of subcomments here, and all are addressed: 1. Salinity does not have as robust climate-change related trends as do temperature and density changes, but the stipled areas definitely do not cover the majority of the area for density and temperature. 2. The observed data differs from the ensemble mean of the projections, but it does resemble individual members in its degree of natural variability, as is explained in the text. 3. The Indian Ocean ends at 20N, and this panel does not include marginal seas (although they are in the global average), although in the revised version the Pacific and Indian oceans are combined to save space. 4. The caption clearly states that these are zonal means. 5. The contours are the present day zonal means of each of these fields, whereas the colors are rates of change, as is clearly stated in the caption.
31677	5	12	1	0		Figure 5.2. This figure is probably too dense. It may be lightened by removing the repeated x-axes leaving only the ones at the very bottom along with only one color gradient bar on the side. Similarly, the y-axis labels can be left only on the left side. [Hans-Otto Poertner and WGII TSU, Germany]	The duplicated axes have been removed.
750	5	12	1	12	1	The color scheme may need adjustment because a higher density should be related to a colder temperature. [Mengxi Wu, United States of America]	We have adopted different color schemes for temperature, salinity and density.
3191	5	12	1	12	1	This is a very minor suggestion, but it may be helpful to flip the color bars for temperature, density and salinity so that the changes in these three characteristics correspond. For example, colder and saltier water is denser than warmer and less saltier water, so it would be helpful to have blue on the color bar correspond to colder temperatures, saltier conditions and an increase in density. [Sloane Garelick, United States of America]	We have adopted different color schemes for temperature, salinity and density.
3455	5	12	1	12	1	Is there a glitch in the bottom right two cross-sections, around 40N? [Patrick Orenstein, United States of America]	The zonal means here include the Mediterranean sea (which is much saltier than average) and the Black sea (which is much fresher), and these contours of the zonal mean salinity are correct. These marginal seas are excluded from the averages of the 3 ocean basins, which is why there is no such signal in the Atlantic plot. This was already explained in the caption of Fig. 5.2, which unfortunately spanned a page-break.
13019	5	12	1	12	1	Figure 5.2: The white lines are hard to see and the caption does not explain their meaning. Remove. [Government of Germany, Germany]	The white contours have been removed, as suggested.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
26405	5	12	1	12	1	What are the vertical stripes in the global salinity change figures? They appear as well in the global observations of density change. [Ethan Pierce, United States of America]	The zonal means here include the Mediterranean sea (which is much saltier than average) and the Black sea (which is much fresher), and these contours of the zonal mean salinity are correct. These marginal seas are excluded from the averages of the 3 ocean basins, which is why there is no such signal in the Atlantic plot. This was already explained in the caption of Fig. 5.2, which unfortunately spanned a page-break.
33629	5	12	1	12	1	Given the disparate time-periods being compared between the observed versus modeled figures, not sure what is intended with this figure. The modeled period overlaps with the observed record but greatly exceeds the rates observed. This difference may be an artifact of the different periods being considered and is likely an apples to orange comparison. Consider deleting it. [Government of United States of America, United States of America]	Both the projected and observed rates of change are an important part of the story, but to address the concern about these changes not being directly comparable, we have regrouped these figures into the recent observed changes and the projected changes.
612	5	12	1	12	5	What does the stippling indicate? The white contours are very very hard to read, and many of the numbers overlaps with other lines or text so that they are also unreadable.. It could be more intuitive to think of blue as denser. The Global salinity cross-sections do not seem to reflect the contributions from the basin cross-sections, particularly around 40N. [Jenna Pearson, United States of America]	As explained in the caption, the stippling indicates where the anthropogenic signals are not different from 0 at the 95% confidence level. Also, the white contours and contour labels have been removed. The global salinity cross-sections include the Mediterranean Sea, which is not in the Atlantic or Indian and Pacific panels.
1709	5	12	1	12	5	Why is there a strange spike around 40N in the salinity change figures for Global Obs. 2006-2014 and Proj. 1990-2090? [Nora Richter, United States of America]	The zonal means here include the Mediterranean sea (which is much saltier than average) and the Black sea (which is much fresher), and these contours of the zonal mean salinity are correct. These marginal seas are excluded from the averages of the 3 ocean basins, which is why there is no such signal in the Atlantic plot. This was already explained in the caption of Fig. 5.2, which unfortunately spanned a page-break.
12101	5	12	1	12	5	Figure 5.2 is not easy to understand due to the factors of 1) being too messy, 2) having too many sub-panels and 3) the period selected for observation being too short (2004-2014). So it is suggested that the figure be redesigned, in particular the start time (the period is too short). [Government of China, China]	This figure has been extensively redesigned for clarity, including reducing the number of sub-panels, regrouping the panels, and using different color-bars for temperature, salinity and density changes. Unfortunately the start time could not be easily advanced due to the limited coverage of salinity observations in the pre-Argo period (XBTs do not measure salinity, and are a large part of the earlier temperature dataset), but we have extended the end of the period through 2017. The changing density stratification is a critical part of the message for the remainder of the chapter, and that depends on salinity.
32095	5	12	2	12	5	This is a great figure, but it contains a lot of detail that are not necessarily needed and also not discussed much in the text. I thus suggest to restrict this figure to just showing the global sections shown at the bottom. Please indicate also the source of the data/figure. [Nicolas Gruber, Switzerland]	The committee strongly feels that the global means by themselves are inadequate to reveal the oceanographic changes. In this figure we are following the lead of the Observed ocean changes chapter in (AR5), although curiously the projected changes in AR5 did not provide a breakdown by ocean basin. The data source is the same as in Fig. 5.1 and is now described in the caption.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
33631	5	12	2	12	5	The Atlantic density change figure (first row, middle column) is identical to the salinity change figure on the same row. Should be replaced by the correct figure. [Government of United States of America, United States of America]	Thank you for catching this. It has been replaced with the correct figure.
14177	5	12	3	12	3	The panels on the table should be labelled to make it more usable (as is fig 5.1). [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	We have regrouped the figures into observed and projected changes, and labeled each group. Also, we are using different color-scales for temperature, salinity and density, which should help make it more usable.
7035	5	12	4	0		Insert space between "1981" and "to" [Nina Hunter, South Africa]	Corrected as suggested.
28717	5	12	4	0		LEGEND: Figure 5.2: add a spece after 1981. "1981 to 2000" [Government of Brazil, Brazil]	Corrected as suggested.
25479	5	13	19	13	20	Deeper in the ocean, salinity changes reflect changes in the rates of formation of water-masses or THIS IS RATHER OBSCURE AT THIS PLACE. AS IT IS DESCRIBED LATER ON AND NOT CRUCIALLY IMPORTANT HERE, ONE MIGHT WANT TO DELETE THE WHOLE SENTENCE, INSTEAD OF REFORMULATING IT their newly formed properties. [Christophe Deissenberg, Luxembourg]	This sentence has been revised for greater clarity and to avoid the dangling antecedant to the comparison.
25481	5	13	25	13	26	these water-masses WHICH ONE? are transported away from their sources in marginal seas or at the ocean's surface, these distinctive properties WHICH ONE? [Christophe Deissenberg, Luxembourg]	This is a generic statement about the preservation of anomalous source properties as watermasses are transported into the interior ocean.
7815	5	121	52	0		Suggest change "remobilize" to "the remobilization of" [Nina Hunter, South Africa]	The page number should have been 121, not 12.
4557	5	13	1	13	1	Not clear what is meant with shaded areas: colors or dotted areas/areas with stippling? [The UBern Team Group Review, Switzerland]	The caption of Figure 2 explained this, but unfortunately in the published draft the caption spanned a page break, hence the reviewer's confusion.
27191	5	13	6	13	17	The discussion of surface salinity changes is interesting but would be strengthened by inclusion of recent research (Zika et al., 2018) that identifies a significant contribution to the salinity change from ocean warming (via increased stratification). Please include an assessment of this new finding. Zika et al. 2018: Improved estimates of water cycle change from ocean salinity: the key role of ocean warming, Env. Res. Lett., 13,7,doi: 10.1088/1748-9326/aace42. [Simon Josey, United Kingdom (of Great Britain and Northern Ireland)]	Accepted - This point has now been included. Thank you for this suggested reference.
28719	5	13	7	0	10	Remove the word speaking, "of the ocean", current, and generally. Results in "Generally, the ocean surface in areas that currently have net evaporation are expected to become saltier, while areas with net precipitation are expected to get fresher (Rhein et al., 2013), as the patterns of precipitation and evaporation are expected to be amplified (Held and Soden, 2006)." [Government of Brazil, Brazil]	Thank you for these suggestions; this sentence has been revised as suggested.
12679	5	13	8	13	8	- Maybe a word is missing in this sentence? [Noureddine Benkeblia, Jamaica]	I am not sure what this comment refers to, but this line has been revised so this comment may have been addressed.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
20241	5	13	9	13	10	Is there a certainty level for this statement? [APECS Group Review, Germany]	This result is simply carried forward from AR5, as is now stated here, with little new literature that we assess and none on atmospheric circulation changes, so the confidence statement on this point should come from AR5 or AR6.
13021	5	13	11	13	11	Century scale is not resolved in Fig. 5.2, remove "to centuries" from the sentence [Government of Germany, Germany]	These words have been removed.
3907	5	13	12	0		'increasingly salty tropical' not true [Zhaomin Wang, China]	The word "tropical" has been removed.
4499	5	13	14	13	17	What about changes in Greenland ice melt and river runoff? [The UBern Team Group Review, Switzerland]	Considered - The impacts of Greenland ice melt are discussed later in the chapter.
14179	5	13	14	13	17	"...Arctic basin is also consistent..." as otherwise this appears to say that the high latitude response in the N Atlantic-Arctic is only explained by these, when we know that river catchments/the hydrological cycle are part of the story here too. [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	Accepted - The phrase "hydrological cycle changes" has been added to the sentence in question.
27619	5	13	15	13	17	The claim about a widely expected weakening of AMOC - should this be backed up with likelihood, available evidence and degree of agreement? We see that there is a reference to chapter 6, but maybe this should be reflected here as well? [Government of Norway, Norway]	Considered - All of the assessment of changes in AMOC is being handled in chapter 6, so rather than repeat that assessment, we are referring to that chapter.
11479	5	13	20	13	22	This sentence doesn't serve any purpose. [Anson Cheung, United States of America]	This sentence has been deleted for brevity.
13023	5	13	20	13	22	Add "either" after "tend to be" in line 20 or change sentence, otherwise it is confusing. [Government of Germany, Germany]	The word either was added; thank you for that suggestion.
13025	5	13	21	13	21	Why is North Atlantic Intermediate Water listed here? It is saltier than Antarctic Intermediate Water and a minor water mass of the Eastern North Atlantic. Should it be Labrador Sea Water? [Government of Germany, Germany]	Yes, this should be Labrador Sea Water, and it has been changed.
4559	5	13	25	13	25	which 'these'? Before you talked about heat uptake, not water masses. [The UBern Team Group Review, Switzerland]	The word 'these' was removed.
10955	5	13	29	13	29	"there" instead of "here"? [Abigail Bodner, United States of America]	Yes, thank you for this suggestion.
1711	5	13	33	13	36	Paleoclimate records should be mentioned here in relation to increased freshwater capping in the North Atlantic region. [Nora Richter, United States of America]	Unfortunately a paleoclimate comparison goes beyond the scope of this chapter and what its word-count limits can support.
10957	5	13	33	13	36	Confusing and hard to follow. I suggest to split this into two separate points. [Abigail Bodner, United States of America]	This sentence has been shortened and simplified.
13027	5	13	33	13	36	Note the strong convection in the Labrador Sea in recent years, as well as the uncertainty in modeled trends shown in Figure 5.2 (not significant) for this region. [Government of Germany, Germany]	The projected changes by the end of the century are consistent across models and significant, even if natural variability is large enough to dominate any anthropogenic signal in the recent trends. This sentence has been revised to make it clear that it is discussing projections.
614	5	13	38	13	38	Ocean circulation' should be defined here, to ensure that readers understand that ocean turbulence is indeed changing, and also that tracer concentrations are responding in kind. Especially since mesoscale eddies are mentioned in the next paragraph. [Jenna Pearson, United States of America]	This text has been extensively revised to differentiate between the predominately wind- and buoyancy-driven aspects of the circulation, and the discussion of the mesoscale eddies has been relocated to the section discussing uncertainties.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
24681	5	13	38	13	38	need to be careful and upfront that these conclusions are based mostly on model projections (and therefore existing knowledge). So holes in our knowledge can mean that model projections can be incorrect. This sentence needs to be clarified to say: Based on simulations, the ocean circulation at the end of the 21st century is expected to be qualitatively similar to that of today.' [Shutler Jamie, United Kingdom (of Great Britain and Northern Ireland)]	This paragraph now makes it clear that ESM projections are the source of these expectations.
9721	5	13	38	13	42	Explain why there would be an increase or a decrease. [Government of France, France]	The discussion of the circulation changes has been extensively revised and now clearly differentiates between the wind driven circulation (which are projected not to change by more than 20% in transport strength) and predominantly buoyancy driven circulation. By highlighting the atmospheric drivers of the various circulations, we feel that the reasons behind the ESM projections of significant circulation changes (or the lack thereof) should be clearer to the reader.
33633	5	13	38	13	57	The storyline of this paragraph is confusing. The beginning states that the circulation is expected to be "qualitatively similar to that today". In the middle there is a discussions of the "significant changes in ocean circulation", and a "significant reduction in the AMOC". In the end it goes back to "qualitatively similar to the circulation today". If similar to the circulation today, why the discussion in the middle? What exactly are the authors trying to say? [Government of United States of America, United States of America]	The contrasting messages about the large-scale wind-driven circulation (for which there are not consistent projections of large changes) and several important buoyancy driven circulations like AMOC and the AABW cell (which are projected to change dramatically), are now articulated more clearly.
14183	5	13	38	15	29	Some of this text is over detailed and long, suggest that the section on AABW could be shortened and the introduction to eddies could be removed. [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	The discussion of eddies has been moved to the section discussing key uncertainties, the section on AABW is now shorter.
4561	5	13	41	13	41	Currents (without transport) [The UBern Team Group Review, Switzerland]	This is a statement about the integrated transports of current-systems (in Sv), not the peak or mean current speeds (in m/s), about which we could not find reliable projections and which are not well captured in climate models.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
24679	5	13	41	13	43	incomplete sentence and detail. this section also seems to be confusing different processes and presents an outdated view of ocean current systems. e.g. regarding the sentence ' many current transports are expected to exhibit smaller... etc.'is missing a reference. and do you mean 'large scale ocean curent systems' or internal transport across mulitple depths or something else? Ocean currents are composed of many different components (e.g. driven by density, wind, pressure, gravity etc and many of these are climate sensitive) and 'transport' is the resulting (integrated) movement due to currents across multiple depths. the combination and impact of different current components varies geographically, with depth and temporally. e.g. so in some areas wind driven curents dominate, and wind is now considered fundamental for driving internal ocean ciculation. so this section needs to reflect this knowledge and clarify the difference between ocean currents and surface/internal circulation which are subtly different. as it exists, this section seems confused and effectively downplays the importance of the ocean current sections that come later. [Shutler Jamie, United Kingdom (of Great Britain and Northern Ireland)]	Thank you for pointing out the ambiguity of this terminology. Following your suggestion we now use "current-system transports". In addition, this paragraph has been revised to reflect the contrasting messages about the large-scale wind-driven circulation (for which there are not consistent projections of large changes) and several important buoyancy driven circulations like AMOC and the AABW cell (which are projected to change dramatically).
3909	5	13	42	13	43	should directly report the future changes in AMOC, rather than mentioning its role in the climate of northern Europe and [Zhaomin Wang, China]	Context can be helpful to the reader.
3911	5	13	42	13	43	Atlantic. [Zhaomin Wang, China]	Context can be helpful to the reader.
24385	5	13	42	13	45	Recommend "The heat transported by the AMOC, in particular, contributes to the 43 relatively clement climate of northern Europe and the North Atlantic Basin as a whole, although the wind-driven ocean gyres in the indo-Pacific also contribute to the meridional ocean heat transport (see the review by Buckley and Marshall". This change reflects that in BM2015, they say "OHT in the Indo-Pacific is the result of wind-driven gyres and overturning cells confined to the thermocline, but in the Atlantic the majority of the OHT is associated with a circulation that spans the thermocline and the deep ocean." their page 16. [Eleanor Frajka-Williams, United Kingdom (of Great Britain and Northern Ireland)]	Considered - The suggested text could be read as excluding the heat transport by the Atlantic wind-driven gyres altogether. I think we all agree that the Atlantic wind-driven heat transport is not negligible, even if it is smaller than the overturning transport or the Pacific gyre heat transport, and we do not want to use language that could be misunderstood in this way.
28721	5	13	44	13	45	Please, remove () from 2015 and add a comma after Marshall. Results in "(see the review by Buckley and Marshall, 2015)." [Government of Brazil, Brazil]	Modified as suggested.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
10959	5	13	45	13	45	"significant changes in ocean circulation could lead to" but earlier in the chapter it is mentioned that there are no major changes in ocean circulation (p. 11 Lines 20-22). This distinction should be made clearer. [Abigail Bodner, United States of America]	That earlier vague introductory paragraph has been eliminated for brevity.
14181	5	13	48	13	48	"result of forcing from Greenland" is not clear. Do you mean freshwater fluxes from Greenland or changes in atmospheric circulation associated with loss of ice sheet, or to change in sea level /gravitational effect of Greenland ice mass? Please specify. [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	The previous phrasing "forcing from Greenland" has been changed to "forcing by Greenlandic meltwater" for specificity.
11481	5	13	49	13	49	Change Atlantic Meridional Overturning circulation back AMOC, since the short form has been introduced already. [Anson Cheung, United States of America]	Altered as suggested.
31973	5	13	55	0	57	Such a concluding message would be relevant to have in the ES? At the same time, one wonders whether the underlying text is too lengthy for this chapter and could be moved into online supplementary material. [Hans-Otto Poertner and WGII TSU, Germany]	This text has been revised for conciseness and clarity.
10961	5	13	55	13	57	It should be noted that local changes in the wind patterns can affect circulation, as discussed in p.14 line 30. [Abigail Bodner, United States of America]	This point has been made implicitly by revisions that now differentiate between expected changes in the wind- and buoyancy-driven circulations.
10963	5	14	1	14	18	Missing from this paragraph is connecting between the text and the intensification of the Southern Ocean eddy field under a changing climate. [Abigail Bodner, United States of America]	This point is discussed in the Southern Ocean cross-chapter box.
616	5	14	2	14	18	What impact do the modest changes in large scale circulation have on the mesoscale and submesoscale eddy fields, as well as gravity wave breaking? Additionally, these modest changes should not be downplayed, as there are references after (e.g. DeVries and Weber, 2017) for which changes to ocean circulation are credited. EDIT: I see this is discussed in more detail later in the section. Perhaps the connections should still be made clear here too. [Jenna Pearson, United States of America]	Given our word-count constraints, we can not discuss this same point in multiple places.
11483	5	14	2	14	18	This paragraph describes mesoscale and submesoscale eddies, but doesn't evaluate how they will change or whatsoever. So I don't think this paragraph should be included in this section, as this section describes changes of temperature, salinity and circulation. [Anson Cheung, United States of America]	The discussion of mesoscale and submesoscale eddies has been moved into a section on sources of uncertainty in climate projections.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
33635	5	14	2	14	18	The discussion of mesoscale eddies does not fit to the whole context. Section 5.2.2.2.1 starts with temperature and salinity, then moves to upper circulations and abyssal circulation, and ends with stratification. This whole paragraph is not very necessary to be discussed except for the last sentence, which can be merged into the upper circulation or the stratification paragraphs. [Government of United States of America, United States of America]	The discussion of mesoscale and submesoscale eddies has been moved into a section on sources of uncertainty in climate projections.
752	5	14	2	14	4	The definition and explanation of mesoscale eddies may be a bit too long. I think the synonym of ocean's weather and the analogy are unnecessary. [Mengxi Wu, United States of America]	Shortened as suggested.
14185	5	14	2	14	4	Too much detail here, suggest just keeping "rotating vortices with spatial scales of 10-100 km that penetrate deeply into the water column, and are often described as the ocean's weather" [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	Shortened as suggested.
4563	5	14	5	14	5	replace 'more fully' with in more detail' [The UBern Team Group Review, Switzerland]	This adjective has been removed.
13029	5	14	5	14	5	Change "Box CC" to "Cross Chapter Box 5" for clarity [Government of Germany, Germany]	Accepted - corrected as suggested.
754	5	14	6	14	16	This paragraph does not make it very clear to me why submesoscale eddies are important for the changing ocean properties. [Mengxi Wu, United States of America]	The discussion of mesoscale and submesoscale eddies has been moved into a section discussing key sources of uncertainty in projections.
13031	5	14	6	14	6	Submesoscale eddies can also occur in bottom plumes, delete "surface intensified" [Government of Germany, Germany]	Shortened as suggested.
28723	5	14	9	0		add a spece after 100. "100 s" [Government of Brazil, Brazil]	"100s" has been changed to "hundreds" for clarity.
28725	5	14	9	0		Please, remove () from 2016 and add a comma after Mahadevan. Results in "(see the review by Mahadevan, 2016)." [Government of Brazil, Brazil]	Changed as suggested.
16515	5	14	11	14	16	These sentences are not wrong, but I am afraid these sentences imply that all the sub-mesoscale processes bring only positive effect to phytoplankton. In practice, anti-cyclonic eddies works opposit way to that of cyclonic eddies, and even in cyclonic eddies enhanced vertical mixing sometimes cause phytoplankton decreasing by shortening their residence time witin high-light zone. I think it would be better here to emphasize that sub-mesoscale processes brings local perturbation of phytoplankton productibility both positive and negative direction. [Tsuneo Ono, Japan]	The discussion of mesoscale and submesoscale eddies has been moved into a section discussing key sources of uncertainty in projections. The points being make in this comment are valuable, but they go into more detail than we can accommodate here.
28727	5	14	14	0		Please, remove "so that the sub-mesoscale structures are" or the entire sentence can be removed. [Government of Brazil, Brazil]	The dependent clause has been removed as suggested.
24683	5	14	14	14	14	incomplete detail (satellite data are direct observations, not images or pictures). Suggest: ...readily visible in satellite ocean colour observations. [Shutler Jamie, United Kingdom (of Great Britain and Northern Ireland)]	The dependent clause has been removed as suggested.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
14191	5	14	17	14	18	Lines 17-18: Are the Southern Ocean eddy fields expected to intensify as a consequence of the strengthening westerly winds? Evidence for this has not been presented yet. If the sentence is not intended to imply this "will likely" should be changed to "would likely" [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	These anticipated changes are discussed in Southern Ocean eddy intensity with intensifying observed and projected Southern Ocean winds is discussed in detail in the Southern Ocean Cross-chapter box.
20287	5	14	17	14	18	"Intensifying sub-mesoscale eddies..." It has not been pointed out in this paragraph that they will intensify. [APECS Group Review, Germany]	The discussion of mesoscale and submesoscale eddies has been moved into a section discussing key sources of uncertainty in projections. The cross-chapter box discusses of the intensification of the Southern Ocean mesoscale eddy fields, and the text has been modified to make it clear that it is the mesoscale eddies that are robustly projected to increase in intensity.
28123	5	14	17	14	18	It would aid clarity if the likely direction of change could be indicated i.e. increase biological productivity etc. [Hilary Kennedy, United Kingdom (of Great Britain and Northern Ireland)]	The discussion of mesoscale and submesoscale eddies has been moved into a section discussing key sources of uncertainty in projections.
13033	5	14	19	14	19	Information on the deep water layer (2000 m to 4000 m) are missing here: Figure 5.2. ends at 2000 m and Line 20 continues with a discussion of the abyssal ocean [Government of Germany, Germany]	Considered. There is a brief discussion of this depth region in the text, but much of the Common Deep Water in this depth range is renewed on a much longer timescale than the waters above at the very bottom of the ocean, so the changes in this depth range are much slower and there is not too much more to say about observed or projected trends based on our assessment of the literature.
4165	5	14	20	14	22	Maybe it is worth to quote the following reference here: de Lavergne, C., Madec, G., Roquet, F., Holmes, R.M., McDougall, T.J., 2017. Abyssal ocean overturning shaped by seafloor distribution. Nature 551, 181. [Carles Pelejero, Spain]	This is a very nice paper, but a proper discussion of the dynamics elucidated by this paper goes beyond what can be accommodated in this chapter.
26407	5	14	20	14	24	When discussing differences in model performance between different ocean zones, it might be useful to include a figure ('spaghetti plot') showing a visual comparison. It would be interesting to see how well the CMIP5 generation represent the changes discussed in this paragraph. [Ethan Pierce, United States of America]	Thank you for this useful suggestion, but unfortunately we are already having to reduce this chapter in length by a third and do not have the space to accommodate this additional figure and related discussion.
14187	5	14	22	14	22	Loose reference to "climate change" - is this formally attributing to anthropogenic component or generic change in climate? Please specify. [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	This sentence has been changed to make it clear that this refers to anthropogenic climate change.
28729	5	14	24	0		Too long. A dot can be inserted in line 22, and beging with a however, : "...various climate models. However, climate models consistently..." [Government of Brazil, Brazil]	This sentence has been changed as suggested.
7037	5	14	27	0		Change "water" to capital letter [Nina Hunter, South Africa]	Changed as suggested.
5213	5	14	28	14	28	Drop "NADW" as the acronym was used only twice in the chapter. [Debra Roberts and Durban Team, South Africa]	The acronym has been deleted.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
33637	5	14	29	14	30	This sentence repeats the information stated at the beginning of this paragraph, and is unnecessary. Change it to "A slow down in AABW formation rates is due to freshening of shelf waters, ..." [Government of United States of America, United States of America]	Abbreviated as suggested.
26409	5	14	33	14	34	The description of polynya formation is not clear for readers without prior familiarity with polynyas. [Ethan Pierce, United States of America]	This sentence has been rephrased for clarity.
3913	5	14	34	0		'intense cooling of the ocean by convective mixing ...' is wrong. It should be 'intense surface warming of the ocean ...' [Zhaomin Wang, China]	This has been rephrased as "intense heat loss to the atmosphere".
25321	5	14	35	0		...Weddell Polynya in particular.) The...'. Full stop should be out of the bracket. [Chiara Lombardi, Italy]	Because the entire sentence is inside parentheses, the period belongs inside of the parentheses.
3915	5	14	36	0		'first three years ...' is wrong, as there was no WP in 1973 and the Nimbus-5 satellite was launched on December 11 1972. [Zhaomin Wang, China]	This has been rephrased.
4565	5	14	37	14	38	not needed ' for the first time in decades' [The UBern Team Group Review, Switzerland]	Deleted as suggested.
26411	5	14	37	14	44	What about polynyas in other regions? What makes the Weddell polynya so significant, besides its size? [Ethan Pierce, United States of America]	The well documented episodic nature of this polynya, along with its size, makes it important for assessing whether observed long-term abyssal trends are possibly due to related natural variability, as is described in detail in this paragraph.
33639	5	14	40	14	40	Is there an extraneous forward slash in "spread /thermal signals"? [Government of United States of America, United States of America]	Yes there was, and it is now gone.
26413	5	14	46	14	48	The Executive Summary suggests that ocean-wide stratification is increasing; this section limits that conclusion to the upper few hundred meters, and reverses that conclusion in the abyssal zone. [Ethan Pierce, United States of America]	The text in the executive summary was corrected.
14189	5	14	51	14	51	Recommend to delete "after effects of compressibility have been corrected for" this detail is not needed. [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	Deleted as suggested.
24685	5	14	52	14	52	incorercr used of the phrase 'climate model'. This issue keeps arising and needs correcting throughout this chapter. Please see my previous comments on this. [Shutler Jamie, United Kingdom (of Great Britain and Northern Ireland)]	The phrase "Earth System Model" or the acronym ESM is now used throughout this section, except when discussing older or simplified climate models that do not include biogeochemical processes. Thank you for catching this.
31975	5	14	56	15	3	Such a concluding message would be relevant to have in the ES? [Hans-Otto Poertner and WGII TSU, Germany]	This message about increasing upper ocean stratification has been added to the Chapter 5 ES.
3963	5	15	1	15	10	Figure 5.3 (left) is informative and really easy to understand. Figure 5.3 (right) looks really confusing and complicated to decipher. Maybe it can be made a bit simpler or be entirely removed? [Aakash Sane, United States of America]	This entire figure is an updated version of Fig 3.3 from of IPCC AR5 WGI with newer data in the same format. The right panel is critical for illustrating that the abyssal warming trends emanate from around Antarctica, as is discussed in the text.
31679	5	15	5	0		Figure 5.3. The caption reads" various ocean basins (whose boundaries are shown in grey 10 lines..." but because in the map there are also some bold and rather blacklines, it is not clear is these are the basin margins, or are they defined by the gray border outline of the colored parts? The different meaning between these two types of lines needs to be clear. [Hans-Otto Poertner and WGII TSU, Germany]	The caption has been changed to indicate that the heavy black lines are the repeat hydrographic sections upon which this figure is based.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
31681	5	15	5	0		Figure 5.3. Place the color gradient legend outside of the map. [Hans-Otto Poertner and WGII TSU, Germany]	The figure format has been altered as suggested.
31791	5	15	5	15	10	Please provide the source of data for this figure. [Hans-Otto Poertner and WGII TSU, Germany]	A reference and the data source have been added to the caption.
618	5	15	7	15	10	Perhaps (a) and (b) in the caption instead of left panel and right would be easier to find. A supertitle instead of the one for (a) would be helpful, since observed warming rate is the unit of both plots. [Jenna Pearson, United States of America]	This labeling of the panels was changed as suggested.
4567	5	15	7	15	10	Maybe include (a) and (b) in figure caption [The UBern Team Group Review, Switzerland]	This caption was changed as suggested.
9723	5	15	7	15	10	Replace « left panel » and « right panel » by a) and b). [Government of France, France]	This caption was changed as suggested.
26415	5	15	7	15	10	It is not clear why this figure is located here. What is the important information to gather from this? [Ethan Pierce, United States of America]	This figure is discussed 5 times in the text.
4569	5	15	7	15	7	Clarify what the black lines and purple line in panel (b) are [The UBern Team Group Review, Switzerland]	The caption has been changed to indicate that the heavy black lines are the repeat hydrographic sections upon which this figure is based, and that the purple line is the location of the Sub-Antarctic front.
4167	5	15	8	15	10	Regarding the right pannel in figure 5.3, probably indicate what are the black lines, repeat cruise tracks. [Carles Pelejero, Spain]	The caption has been changed to indicate that the heavy black lines are the repeat hydrographic sections upon which this figure is based.
14195	5	15	13	15	13	It would be more accurate to say "Some of the dynamical consequences" or "Many dynamical consequences" [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	This has been revised to "Many ..." as suggested.
14193	5	15	13	15	25	The impact of changes in wave speeds may be harder to grasp for readers with no specialist knowledge of basin scale ocean dynamics. Please consider specifying how changes in the propagation of internal Rossby waves, the internal deformation radius and internal gravity waves will be manifested in the ocean's circulation and properties. [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	This paragraph has been restructured to help bring out the big-picture consequences of stratification changes.
756	5	15	13	15	29	I cannot see the big-picture influences of some of the consequences of increased stratification described in this paragraph. [Mengxi Wu, United States of America]	This paragraph has been restructured to help bring out the big-picture consequences of stratification changes.
1713	5	15	13	15	29	A figure showing how stratification would lead to dynamical changes would be useful here (maybe show one panel without weaker stratification and another panel with increased stratification). [Nora Richter, United States of America]	This paragraph has been restructured to help bring out the big-picture consequences of stratification changes, and a figure has been added illustrating the projected zonal mean upper ocean stratification changes.
4501	5	15	13	15	29	This reads more like a textbook rather than an assessment of the recent literature. Maybe delete. [The UBern Team Group Review, Switzerland]	This paragraph has been restructured to help bring out the big-picture consequences of stratification changes.
10965	5	15	13	15	29	I think this paragraph would be clearer if the ordering would be flipped. First describing how increase in stratification affects the climate, followed by the differen dynamical possibilities for this. [Abigail Bodner, United States of America]	This paragraph has been restructured as suggested to help bring out the big-picture consequences of stratification changes.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
26417	5	15	13	15	29	This paragraph is rather difficult to parse for a non-specialist. Is there a way to explain with less jargon? Or, could the main conclusions be separated from the jargon into a concluding line or two at the end? [Ethan Pierce, United States of America]	This paragraph has been restructured to help bring out the big-picture consequences of stratification changes.
28731	5	15	14	0		Please, remove) in 2017: "Vallis (2017)." [Government of Brazil, Brazil]	The outer parentheses have been replaced with square brackets.
3551	5	15	21	15	29	This paragraph references several other sections. However the section numbers are incorrect. Sections 5.2.1.2.4, 5.2.1.2.5, 5.2.1.3, 5.2.1.4 and 5.2.1.5 do not exist (section 5.2.1 is a short section with no subsections). [Sonya Legg, United States of America]	These cross-references were not properly updated when the chapter structure changed. Sorry for this oversight, and thank you for catching this. They have been corrected.
31977	5	15	31	0		There may still be some confusion between proper relations between review (out of scientific interest) and assessment with relevant background information as well as a lack of focus on policy-relevant storylines. Much of this undoubtedly interesting background information following on the next 6 pages could be shortened or moved to OSM if truly needed as background information for the assessment. [Hans-Otto Poertner and WGII TSU, Germany]	This proposal to essentially drop sections 5.2.2.2.2 through 5.2.2.2.4 is interesting, but it would strip many of the novel findings about changes to the physical ocean out of this chapter. Section 5.2.2.2 as a whole has been restructured and shortened to bring the predicted and observed patterns of changes together in a single subsection, and to collect other material from throughout this section in a new subsection on key gaps.
1715	5	15	31	18	44	Paleoclimate data is also an important component of validating that changes in the current ocean are due to anthropogenic forcings. The appropriate paleoclimate studies should be cited in this section. [Nora Richter, United States of America]	Unfortunately a paleoclimate comparison goes beyond the scope of this chapter and what its word-count limits can support.
25323	5	15	31	18	44	The title, the meaning and the position of this paragraph (5.2.2.2.2) are not very easy to understand. This section (5.2.2.) should discuss about physical and geochemical properties, so I would proceed in providining an overview of all properties. Thus, I would move this paragraph at the end of 5.2.2 section for discussing the problems/discrepancies about data and measurments, accuracy of instruments and previsional models etc. and the validity in compining the different approaches in assessing the climate change. If shifted at the end of the section, I would recommend to implement this paragraph for not limiting the discussion to temperature, salinity, circulation only. [Chiara Lombardi, Italy]	Section 5.2.2.2 as a whole has been restructured and shortened to bring the predicted and observed patterns of changes together in a single subsection, and to collect other material from throughout this section in a new subsection on key gaps.
32097	5	15	31	18	44	Section 5.2.2.2.2 contains several repetitions from the previous section and thus would benefit from a careful pruning of the text. [Nicolas Gruber, Switzerland]	Section 5.2.2.2 as a whole has been restructured and shortened to bring the predicted and observed patterns of changes together in a single subsection, and to collect other material from throughout this section in a new subsection on key gaps.
4571	5	15	33	15	33	Rephrase to 'with timescales ranging from tidel to multi-decadal' [The UBern Team Group Review, Switzerland]	Edited as suggested.
5371	5	16	1	16	1	200 m -> 2000 m [Ragnhild Bieltvedt Skeie, Norway]	That extra 0 makes a big difference! Thank you for catching this.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
28733	5	16	4	16	5	I suggest to change verb tense leaving the present, and so acceptable, to the second sentence, as follows: "Observationally based estimates of global ocean heat content changes prior to the Argo era have been complicated by systematic instrumental errors and limited data coverage. Since AR5, there are improvements in our ability to understand and correct for XBT instrumental errors." [Government of Brazil, Brazil]	After careful reading, we think that the original wording does make sense - the estimates of what was happening are still taking place, but the techniques have improved.
21697	5	16	9	16	9	"... in time and space, have ... "should be corrected with "... in time and space has ..." [Government of Republic of Korea, Republic of Korea]	Corrected as suggested.
5373	5	16	10	16	11	IPCC AR5 did not include five estimates of OHC for the upper 2000 meter. They had five estimates for the OHC in the upper 700 meter. [Ragnhild Bieltvedt Skeie, Norway]	Yes, you are correct. Thank you for catching this.
5375	5	16	12	16	12	Why is there an reference to figure 5.1 here? [Ragnhild Bieltvedt Skeie, Norway]	Considered - All the heat content discussion is now in a single section discussing observations and projections. Figure 5.1 is the main graphic of this section.
21699	5	16	14	16	14	Remove the comma in "... observation , suggest ..." so that it should be corrected as "... observation suggest ..." [Government of Republic of Korea, Republic of Korea]	The comma has been removed.
20243	5	16	14	16	15	Are all 3 estimates from Ishii et al., 2017? If so I would put the citation at the end of the 3 rather than just one, or if not from Ishii et al., 2017 then these need a citation [APECS Group Review, Germany]	Corrected - These references were accidentally removed late in the merging of documents to create the SOD, and have been restored.
5377	5	16	15	16	15	Please include the reference for the last two estimates of OHC [Ragnhild Bieltvedt Skeie, Norway]	Corrected - These references were accidentally removed late in the merging of documents to create the SOD, and have been restored.
13035	5	16	15	16	15	Add references to both 6.3 ZJ estimates [Government of Germany, Germany]	Corrected - These references were accidentally removed late in the merging of documents to create the SOD, and have been restored.
14197	5	16	15	16	15	It would be helpful to provide references for these estimates (as is done for Ishii et al 2017). [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	Corrected - These references were accidentally removed late in the merging of documents to create the SOD, and have been restored.
33641	5	16	15	16	15	It looks like references are missing. [Government of United States of America, United States of America]	Corrected - These references were accidentally removed late in the merging of documents to create the SOD, and have been restored.
12681	5	16	15	16	17	Review this sentence. [Noureddine Benkeblia, Jamaica]	Corrected - These references were accidentally removed late in the merging of documents to create the SOD, and have been restored.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
12103	5	16	19	16	35	The main conclusion of this chapter that new observed and modeled heat contents after AR5 are more consistent lacks literature support. So it is suggested that the following literature be used for assessment: L. Cheng, K. E. Trenberth, M. D. Palmer, J. Zhu, J. P. Abraham, Observed and simulated full-depth ocean heat-content changes for 1970–2005. Ocean Sci. 12, 925-935 (2016). P. J. Gleckler, P. J. Durack, R. J. Stouffer, G. C. Johnson, C. E. Forest, Industrial-era global ocean heat uptake doubles in recent decades. Nat. Climate Change 6, 394-398 (2016). [Government of China, China]	Accepted - The discussion of ocean heat content changes is now the sole focus of a subsection with much more extensive support from the literature, including papers by Cheng et al. and Gleckler et al.
17361	5	16	22	16	24	References are needed for this statement. It is not obvious that the hiatus or slowdown is due to change in heat redistribution from surface ocean to the interior and exchange between basins. [Svein Sundby, Norway]	Rejected - This section is discussing the long-term heat budget, not the skin-temperature trends. The only point being made here is that warming of the ocean as a whole can occur even when there the surface temperatures are not warming over timescales of a few years. Further discussion of the hiatus are outside of the scope of this chapter.
20289	5	16	22	16	24	References are required to point out different explanations for warming hiatus. [APECS Group Review, Germany]	Rejected - This section is discussing the long-term heat budget, not the skin-temperature trends. The only point being made here is that warming of the ocean as a whole can occur even when there the surface temperatures are not warming over timescales of a few years. Further discussion of the hiatus are outside of the scope of this chapter.
32099	5	16	27	16	28	While this correct, I would like to point out that this does not have to be the case, i.e., hiatus periods in SAT can come about even in the absence of increased ocean heat uptake (see e.g., von Känel et al. (2017) (doi 10.1002/2017GL073578)) [Nicolas Gruber, Switzerland]	Rejected - This section is discussing the long-term heat budget, not the skin-temperature trends. The only point being made here is that warming of the ocean as a whole can occur even when there the surface temperatures are not warming over timescales of a few years. Further discussion of the hiatus are outside of the scope of this chapter.
5043	5	16	28	16	28	Drop "OHC" as it was used only twice in the chapter. Replace the acronym in line 30 with the actual texts [Debra Roberts and Durban Team, South Africa]	Accepted - the acronym OHC has been dropped.
9725	5	16	28	16	35	A link with the EEI and its evolution can be made here. [Government of France, France]	Discussing the Earth's Energy Imbalance (EEI) would also require an assessment of heat content changes in the land, atmosphere and cryosphere, as well as the top-of-the-atmosphere net heat flux, several of which are clearly outside of the scope of this chapter and the report as a whole. It is expected that the planetary heat budget will be assessed in the forthcoming AR6 report.
4503	5	16	30	16	31	Maybe add here reference to: Frölicher et al. (2015, Journal of Climate) Dominance of the ... [The UBern Team Group Review, Switzerland]	Considered - This is a very good reference for the behavior of models, but this particular passage is addressing the observed heat uptake in the well-observed recent period.
4857	5	16	31	0		Is something missing here? "0.40±0.09 W m-2 6.4±1.4 ZJ yr-1" [Debra Roberts and Durban Team, South Africa]	These are equivalent values for the same thing; parentheses have now been added around the second value.
28735	5	16	32	0		add a spece after 2000. "2000 m" [Government of Brazil, Brazil]	Corrected as suggested.
28737	5	16	32	0		change – to - . "0 m-2000" [Government of Brazil, Brazil]	Text revised

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
27621	5	16	39	16	42	Is this claim consistent with figure 5.1? Shouldn't the North Atlantic also be highlighted as an area of significant warming? [Government of Norway, Norway]	Rejected - The described pattern is consistent with the recent observed warming patterns show in Fig 5.2d, in which much of the North Atlantic is cooling.
27783	5	16	48	16	49	The Southern Ocean is entirely extra-tropical and sub-tropical and doesn't include the south pacific and indian Ocean gyres? Is Southern hemisphere meant here? [Momme Butenschön, Italy]	The sentence in question was removed when this subsection was shortened.
33643	5	16	48	16	49	The Southern Ocean proper only covers the subpolar and polar domains. [Government of United States of America, United States of America]	The sentence in question was removed when this subsection was shortened.
3657	5	16	49	16	50	One of missing references here is an example of other marginal sea in the East Asia, e.g., see Yoon et al. (2018, Scientific Reports). In this paper, it is shown from decade-long hydrographic observations that climate-driven changes of water properties (temperature, salinity, and dissolved oxygen) in the Asian marginal sea associated with its ventilation system. [Nam SungHyun, Republic of Korea]	This comment is no longer relevant. This section has been extensively revised to emphasize long-term trends, noting the short-term variations only in the context of the complications in separation of forced climate signals from natural variability in short observational records.
21701	5	16	49	16	50	One of missing references here is an example of other marginal sea in the East Asia, e.g., see Yoon et al. (2018, Scientific Reports). In this paper, it is shown from decade-long hydrographic observations that climate-driven changes of water properties (temperature, salinity, and dissolved oxygen) in the Asian marginal sea associated with its ventilation system. [Government of Republic of Korea, Republic of Korea]	This comment is no longer relevant. This section has been extensively revised to emphasize long-term trends, noting the short-term variations only in the context of the complications in separation of forced climate signals from natural variability in short observational records.
27623	5	16	50	17	3	It would be informative if you could add where this cooling is happening. Is this statement referring to "the blue dot" close to Greenland? So this cooling is not linked to melting of the Greenland ice cap? [Government of Norway, Norway]	This comment is no longer relevant. This section has been extensively revised to emphasize long-term trends, noting the short-term variations only in the context of the complications in separation of forced climate signals from natural variability in short observational records.
24391	5	16	54	16	54	Recommend additional reference for "anomalous atmospheric conditions" with Duche et al. (2016) who made a strong case for atmospheric conditions driving the recent reduction in cold subsurface conditions in the North East Atlantic. [Eleanor Frajka-Williams, United Kingdom (of Great Britain and Northern Ireland)]	This comment is no longer relevant. This section has been extensively revised to emphasize long-term trends, noting the short-term variations only in the context of the complications in separation of forced climate signals from natural variability in short observational records.
24393	5	16	54	16	54	Recommend removing reference to McCarthy et al. (2015) which was not discussing anomalous atmospheric conditions, but rather oceanic drivers of changing conditions. [Eleanor Frajka-Williams, United Kingdom (of Great Britain and Northern Ireland)]	This comment is no longer relevant. This section has been extensively revised to emphasize long-term trends, noting the short-term variations only in the context of the complications in separation of forced climate signals from natural variability in short observational records.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
24389	5	16	55	16	57	Text reads "This robust cooling of the North Atlantic is consistent with a the persistent reduced intensity and heat transport of the North Atlantic Current (Smeed et al., 2018)" however the strongest results in Smeed et al are regarding the persistent reduced ... heat transport of the Atlantic Meridional Overturning circulation. In the part where they reference the North Atlantic Current, it is a reference to Zhang 2008 (their page 1531) and where they use gradients in SSH as a proxy for the strength of the NAC (their page 1530), but Smeed does not try to discuss heat transport by the NAC. [Eleanor Frajka-Williams, United Kingdom (of Great Britain and Northern Ireland)]	This comment is no longer relevant. This section has been extensively revised to emphasize long-term trends, noting the short-term variations only in the context of the complications in separation of forced climate signals from natural variability in short observational records.
4407	5	16	55	17	3	This is a rather long sentence and should be split into two sentences. [The UBern Team Group Review, Switzerland]	This comment is no longer relevant. This section has been extensively revised to emphasize long-term trends, noting the short-term variations only in the context of the complications in separation of forced climate signals from natural variability in short observational records.
24387	5	16	55	17	3	Very long sentence with multiple parts. Difficult to understand. "Reduced northward heat transport" is followed by record LOW densities in the Labrador Sea, followed by subsequent intensification of deep convection (HIGH densities). Seems to be internally conflicting, as written. [Eleanor Frajka-Williams, United Kingdom (of Great Britain and Northern Ireland)]	This comment is no longer relevant. This section has been extensively revised to emphasize long-term trends, noting the short-term variations only in the context of the complications in separation of forced climate signals from natural variability in short observational records.
33645	5	16	55	17	3	This sentence can use a rewrite. [Government of United States of America, United States of America]	This comment is no longer relevant. This section has been extensively revised to emphasize long-term trends, noting the short-term variations only in the context of the complications in separation of forced climate signals from natural variability in short observational records.
7039	5	16	56	0		"a the" - suggest remove "a" [Nina Hunter, South Africa]	Corrected as suggested.
4409	5	17	3	17	3	insert '700 m are also' [The UBern Team Group Review, Switzerland]	This sentence was removed in the revision of this chapter.
26419	5	17	5	17	6	There should be either a citation or a likelihood estimate here. [Ethan Pierce, United States of America]	This comment is no longer relevant. This section has been extensively revised to emphasize long-term trends, noting the short-term variations only in the context of the complications in separation of forced climate signals from natural variability in short observational records.
10967	5	17	6	17	8	This contradicts the statement in p.13 line 55 that the wind driven circulation hasn't changed much. [Abigail Bodner, United States of America]	This comment is no longer relevant. This section has been extensively revised to emphasize long-term trends, noting the short-term variations only in the context of the complications in separation of forced climate signals from natural variability in short observational records.
15717	5	17	9	17	13	The use of CMIP-5 to compare trends and natural variability during 2006-2016 would be stronger if based on observations. Are there not enough data? Could other datasets be used to show same pattern, eg. SST? [EUCE, Belgium]	The natural variability among ensemble members can only be estimated by models; we only have one realization of our home planet. Observed temporal variability is a proxy for variability between realizations, but it also includes the effects of natural and anthropogenic forcing.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
28739	5	17	11	0		Please, change 2016 to 2014, OR 2006 to 2004. "trends over the period of 2006-2014 are" OR "trends over the period of 2004-2016 are" [Government of Brazil, Brazil]	The trends from the difference of averages between multi-year periods are now described more explicitly throughout this section.
14199	5	17	11	17	11	Figure 5.1b should be 5.1d. [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	Corrected as suggested (after also taking revisions to the figures into account).
32407	5	17	14	0		check reference Munday et al. 2013 seems to be wrong here. [Daniela Storch, Germany]	These line numbers seem to be wrong. There is no reference to Munday et al. at the designated location.
14201	5	17	17	17	17	should "particularly significant" be changed to "particularly large" to clarify meaning? [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	Considered - this is a statement about the statistical significance of the trends, rather than their absolute magnitude relative, for example, to higher in the water column where both forced trends and natural variability are larger.
14203	5	17	24	17	26	First sentence: it is difficult to be sure of this in the Atlantic from figures 5.1b, 5.1c and 5.2. [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	Accepted - the figure reference for this point has been relocated for clarity.
28741	5	17	26	0		Please, remove) and add a comma after al. "(Figure 5.1 b and c, Figure 5.2, and also Desbruyères et al., 2016a)" [Government of Brazil, Brazil]	Accepted - the parentheses are now properly paired and the suggested comma added.
758	5	17	26	17	28	This statement is merely a repetition of Line 39-42 on p. 16. [Mengxi Wu, United States of America]	Accepted - This section has been extensively restructured and revised, and duplications eliminated.
20245	5	17	29	17	29	Don't need a % after 67, also is there an IPCC certainty for the 67-98% as this seems like a large estimate? [APECS Group Review, Germany]	Rejected - This is the 90% confidence interval reported in the assessed literature.
14205	5	17	30	17	30	"warming of the ocean" change to "warming of the global ocean" for clarity. [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	The text has been altered as suggested.
28743	5	17	31	0		Please, change 2014 to 2016, OR 2004 to 2006. "For the recent period (2004 to 2016)" OR "For the recent period (2006-2014)" [Government of Brazil, Brazil]	The text has been corrected as suggested.
32101	5	17	35	17	44	I very much like the idea of highlighting the caveats, this is a bit repetitive to some earlier statements. [Nicolas Gruber, Switzerland]	Considered - The text has been extensively reorganized and revised to avoid undue repetition.
28745	5	17	39	0		2003, is not proper. Change it to 2004 or 2006. PLEASE, be consistent in all over the text! [Government of Brazil, Brazil]	The text has been corrected as suggested.
13037	5	17	39	17	39	Add "modeled heat uptake distributions" before "historical periods" [Government of Germany, Germany]	The text has been corrected as suggested.
25483	5	17	39	17	40	IS THE SENTENCE CORRECT? [Christophe Deissenberg, Luxembourg]	This sentence has been corrected.
33647	5	17	39	17	41	Make clear that these 'smooth historical periods' are from simulations. [Government of United States of America, United States of America]	The text has been corrected as suggested.
10969	5	17	53	17	53	Missing comma after "profiles" [Abigail Bodner, United States of America]	This sentence was revised.
17163	5	18	1	18	1	Missing word in between " the earth's energy balance the" should read "the earth's energy balance and the". [Shalini Singh, Fiji]	This sentence was revised.
3553	5	18	1	18	2	This sentence does not make sense. I think it should read instead: "Using energy conservation for the earth, simplified climate models also show that the observed trends in the earth's energy balance are extremely unlikely (< 5%) to be caused by internal variability..." [Sonya Legg, United States of America]	This sentence was revised.

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Comment id	Chapter	From page	From line	To page	To line	Comment	
20247	5	18	1	18	2	Re word the end of line 1 to .."the observed trends in the Earth's energy balance are extremely unlikely...." [APECS Group Review, Germany]	This sentence was revised.
7041	5	18	5	0		Remove one of the "changes" [Nina Hunter, South Africa]	Corrected
10971	5	18	5	18	5	"change change" [Abigail Bodner, United States of America]	Corrected
17165	5	18	5	18	5	Repeated word " heat changes changes". [Shalini Singh, Fiji]	Corrected
10973	5	18	30	18	30	The word "change" is redundant [Abigail Bodner, United States of America]	Estimates of absolute ocean heat content via Argo are complicated by incomplete knowledge of bathymetry, even if we can make reliable estimates of ocean heat content change.
28747	5	18	32	0		Please do not begin sentence with Although. Suggestion: "Climate models are able to capture the dynamics of the climate system, but all numerical models have approximations and biases." [Government of Brazil, Brazil]	Changed as suggested.
24689	5	18	32	18	32	incorerct used of the phrase 'climate model'. This issue keeps arising and needs correcting throughout this chapter. Please see my previous comments on this. [Shutler Jamie, United Kingdom (of Great Britain and Northern Ireland)]	The phrase "Earth System Model" or the acronym ESM is now used throughout this section, except when discussing older or simplified climate models that do not include biogeochemical processes. Thank you for catching this.
4859	5	18	34	0		What is "diapycnal mixing"? Is that the same as "diapycnal diffusivity" (19-40)? What are "isopycnals" (19-43)? It would be good to give a clear explanation, especially to make Figure 5.4 understandable. [Debra Roberts and Durban Team, South Africa]	The word "diapycnal" has been eliminated in the interest of more general readability, even at the expense of less specificity.
10975	5	18	35	18	37	This sentence is very confusing. Missing "that" after "thermocline"? [Abigail Bodner, United States of America]	Changed as suggested.
7043	5	18	36	0		Please check "there is a ... CMIP5" and amend for clarity [Nina Hunter, South Africa]	This sentence has been altered for clarity.
20249	5	18	36	18	36	Re word this sentence (add that is not cancelled out) [APECS Group Review, Germany]	This sentence has been altered for clarity.
26421	5	18	41	18	44	How is the uncertainty calculated here? [Ethan Pierce, United States of America]	This is an order-of-magnitude estimate based on individual published values.
32445	5	18	43	18	56	Update ocean heat content (OHC) estimates increase the confidence of CIMP5. They illustrate the ability of futur climate models to better anticipate future thermal expansion. Cheng, L. et al., 2018: How fast are the oceans warming?Science, 2019.Vol. 363, Issue 6423, pp. 128-12 11. Jan 2019 [nicolas siorak, France]	The new suggested reference is now used extensively.
760	5	18	46	19	30	A 2018 paper written by Schindelegger et al. (doi:10.1029/2018jc013959) can be cited in this subsection, too. [Mengxi Wu, United States of America]	Thank you for this suggestion.
14207	5	18	46	19	30	The section on tides seems misplaced - it would fit better in Chapter 4. It cites a lot of work from 2003-2011, which in other sections would just be covered by one review or IPCC AR chapter. Much of the section is actually coastal/shelf seas where the emphasis of 5.2 is on open ocean. [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	Subsection 5.2.2.3 now explicitly addresses coastal physical changes as well as the tides, and a number of more recent references have been added. Also, tidal flushing is important to coastal ecosystems, so it is not just the connection to high-water that matters. We think the revised version is better motivated.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
25325	5	18	46	19	30	Any prediction about tides in a changing climate? No predictions are reported. [Chiara Lombardi, Italy]	The nonstationarity of tidal amplitudes and patterns documented here is the prediction that policy makers need to be aware of. Whether specific tidal modes will increase or decrease in a given location is going to vary, and there are no general statements that can be made about the sign of the trend. However, this is a significant source of uncertainty that should be taken into account when adapting to rising sea-levels.
31793	5	18	46	19	30	Why having this discussion of changes in tides and impacts on coastal ecosystems in this section on open ocean? The structure and distinction between 5.2 (open) ocean and 5.3 coastal seas does not at all work [Hans-Otto Poertner and WGII TSU, Germany]	Subsection 5.2.2.2.3 now explicitly addresses coastal physical changes as well as the tides.
26423	5	19	1	19	6	Are there updated citations for changes in tides over the past ~100 years? The citations here all predate AR5. [Ethan Pierce, United States of America]	Some citations predate AR5 because a discussion of the tides was omitted from AR5, but a number of more recent citations have been added replacing the older ones.
10977	5	19	3	19	3	Unclear what is meant by "internal M ₂ tide phase" and how it differs from the external tide. [Abigail Bodner, United States of America]	This sentence has been edited for clarity and brevity.
26425	5	19	10	19	11	What percentage of tidal changes are explained by changes in water column thickness? Great opportunity to include quantitative information here. [Ethan Pierce, United States of America]	The relative contributions of water column thickness and stratification vary spatially and nonlinearly, so giving a simple global percentage is difficult.
10979	5	19	13	19	13	Missing comma after reference. [Abigail Bodner, United States of America]	Comma added as suggested.
7045	5	19	16	0		Insert "the" before "majority" [Nina Hunter, South Africa]	Corrected as suggested.
20251	5	19	16	19	16	Add "...that the majority" [APECS Group Review, Germany]	Corrected as suggested.
5045	5	19	20	19	30	It is not evident if this is referring to Pelling and Green's study on the European Shelf or if it is your assessment of the literature in this section. Please be explicit. [Debra Roberts and Durban Team, South Africa]	The assessment statement has been revised for specificity and to make it clear that it flows from the entire paragraph.
10255	5	19	26	19	27	Pelling et al. (2013) demonstrate that the rapid coastline changes in China's Bohai Sea have altered the tides in that region and throughout the Yellow Sea (Hwang et al., 2014) --> Pelling et al. (2013) and Hwang et al. (2014) demonstrate that the rapid coastline changes in China's Bohai Sea have altered the tides in that region and also throughout the Yellow Sea. [Jinsoon Park, Republic of Korea]	Modified as suggested.
21703	5	19	26	19	27	Pelling et al. (2013) demonstrate that the rapid coastline changes in China's Bohai Sea have altered the tides in that region and throughout the Yellow Sea (Hwang et al., 2014) --> Pelling et al. (2013) and Hwang et al. (2014) demonstrate that the rapid coastline changes in China's Bohai Sea have altered the tides in that region and also throughout the Yellow Sea. [Government of Republic of Korea, Republic of Korea]	Modified as suggested.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
14211	5	19	32	19	32	Section 5.2.2.2.4 It's not entirely clear what is meant by turbulent mixing here; does it include the turbulent mixing by mesoscale eddies; does it exclude mixing within the near surface layers ? [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	Considered - This section has been extensively revised and combined with other text, so both vertical mixing and eddy stirring are discussed as sources of uncertainty in projections, with plain-language text making it clear when the mixing being discussed is predominantly vertical. Figure 5.6 does not include mixing within the near surface boundary layer (as is now explicitly stated in the caption), but this is discussed briefly in the text as something that all viable ocean models must account for to capture near-surface seasonal and diurnal cycles.
15719	5	19	32	19	32	Section about turbulence. Ocean turbulence is also a fundamental ocean property affecting life in the ocean - especially but not only in the plankton. E.g., effects on primary production, feeding rates and success, patchiness, etc. This should be briefly mentioned to alert readers that turbulence is not only important for ocean physics. See e.g., papers by Kiorboe, Visser, Saiz, etc. [EUCE, Belgium]	The broader consequences of potentially changing turbulent mixing are now more explicitly described in the text.
620	5	19	32	19	40	It could be useful to define turbulence, at least loosely. In particular, that turbulent mixing is irreversible, that is we cannot undo any mixing done from turbulence. Additional definitions of diapycnal diffusivity and turbulent kinetic energy are necessary. [Jenna Pearson, United States of America]	Accepted - This section has been extensively edited, and the effects of vertical eddy mixing on biologically interesting quantities has been made more explicit, and discipline-specific terminology, like "diapycnal diffusivity" is avoided.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
11873	5	19	32	21	16	I like that the authors try to assess the turbulence in the climate change narrative. But I find that the text as it stands does not do the job. The first part of this section is more textbook-like than climate change assessment. Consistently the figure 5.4 presents estimates of turbulence but does not serve the climate change story. I would suggest to remove, unless that can be compared to potential changes, or to model deficiencies that would pose problem to our assessment of climate change. But as it is, the first part of the section and the figure, only serve a general description of the turbulence which appears irrelevant to the climate change story. then the second part starts tackling what would be potential future change of turbulence. Which I find a very interesting exercise. But something is missing: what do we learn for climate change? If turbulence is cranked up or reduced in ways as described in the text, what should we expect for the overturning circulation? Or other things? Should we expect a more rapid lower cell than changes predicted by climate models? I think that something relevant to climate change needs to be added. If that text cannot be added, I would suggest to remove the entire 5.2.2.2.4 section altogether. Personally I would encourage the authors to cut some of the textbook-like text, remove the figure, and discuss implications of the turbulence change that are discussed, for overturning, tracers and other things assessed in the chapter. How does that section help us better understand climate change or its impact? [Jean baptiste SALLEE, France]	This material has been shortened and folded into a new section discussing key sources of uncertainty in projections of oceanic climate changes.
14209	5	19	32	21	16	Section 5.2.2.2.4 - this is very general - please make the key messages clearer. [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	This material has been shortened and folded into a new section discussing key sources of uncertainty in projections of oceanic climate changes.
32569	5	19	32	21	16	This section is interesting in that these measurements are new since AR5, but it is not yet well motivated in that it does not clearly connect to a policy-relevant or climate-change relevant quantity. That is, the spatial variability of ocean interior small-scale turbulence potentially contributes to water masses and AMOC, etc., but the magnitude of these downstream consequences should be more carefully assessed here. Furthermore, the stronger turbulence in the upper and bottom boundary layers may have a more significant climate effect, but it is not contrasted or emphasized here. [Baylor Fox-Kemper, United States of America]	This material has been shortened and folded into a new section discussing key sources of uncertainty in projections of oceanic climate changes.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
33649	5	19	32	21	17	Section clearly needs to delineate between horizontal ocean turbulence and vertical ocean turbulence. There is no clarity in this section and the Redi and GM components of the horizontal are completely obscured with the vertical mixing (e.g., KPP) where representation of mixing horizontally and vertically are both broadly important for the global ocean, particularly for modeling efforts. [Government of United States of America, United States of America]	Accepted - This paragraph has been extensively revised, clarified and shortened, including the specification of where this is discussing vertical mixing, instead of quasi-lateral eddy stirring.
3193	5	19	33	20	2	Figure 5.4 shows the average diapycnal diffusivity throughout the ocean. Although the text corresponding to this figure explains the importance of changes in turbulence and states that diapycnal diffusivity is a measure of ocean turbulence, it is still slightly unclear how these two are related and why specifically looking at changes in diapycnal diffusivity is useful. [Sloane Garelick, United States of America]	Accepted - This section has been extensively edited, and the effects of vertical eddy mixing on biologically interesting quantities has been made more explicit.
11485	5	19	33	20	2	While I think it is important to highlight the motivation to understand turbulence, I think a lot of details in this paragraph can be excluded because it doesn't help the discussion of this section, which is on how energy that drives turbulence is changing. [Anson Cheung, United States of America]	Accepted - This paragraph has been extensively revised and shortened.
10981	5	19	43	19	44	In my opinion this sentence makes more sense after the first opening sentence of this section. [Abigail Bodner, United States of America]	This paragraph has been extensively revised and shortened, and the sentence in question has been removed altogether.
28749	5	19	45	0		Please add the word oceanic before stratification: "smaller with stronger oceanic stratification" [Government of Brazil, Brazil]	We are short on words, and the use of the phrase "water column" should suffice to make it clear that this sentence is discussing the ocean.
3421	5	19	45	19	48	This claim requires a reference. [Patrick Orenstein, United States of America]	Rejected - This statement is central to any discussions of the energetics of mixing, almost to the point of being a textbook truism, and is extensively supported by the various references in this paragraph.
28751	5	19	51	0		Please add the word ocean before turbulence "Ocean turbulence also fluctuates in time, ..." [Government of Brazil, Brazil]	This sentence was modified as suggested.
252	5	19	52	19	52	Whalin et al. (2018, https://doi.org/10.1038/s41561-018-0213-6) might be a better reference for seasonal changes. [Katsuro Katsumata, Japan]	The reference has been replaced with the suggested one. Thank you for this suggestion.
14219	5	20	0	20	0	Figure 5.4: Are these numbers calculated only with contributions from fluid outside the near-surface mixed layers ? [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	These values do exclude water in the near-surface mixed layer from the average, and the caption has been updated. Thank you for asking.
14217	5	20	1	20	2	"help shape" and "regulate" tracer distributions are quite different statements. The latter is probably an over-statement. [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	Accepted - the word "regulate" has been removed.
762	5	20	5	20	5	This figure may be deleted because its connection with the changing ocean is unclear. [Mengxi Wu, United States of America]	This figure is a vivid illustration of the rich structure of ocean mixing that is not currently captured in ESMs. It is being retained in a new section on key sources of uncertainty.
28753	5	20	6	0		change – to - . "250-1000 m" [Government of Brazil, Brazil]	We changed this to "and" for even greater clarity.
20253	5	20	6	20	9	What is k? It is not defined in the legend for the figure [APECS Group Review, Germany]	The legend of the figure has been modified to avoid using log ₁₀ (kappa) in the description.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
26427	5	20	6	20	9	It is not immediately clear how this figure contributes to the larger goal of the chapter. It is interesting from an oceanographic standpoint, but there is a missing explanatory link between spatial patterns of diffusivity and large-scale ocean changes. [Ethan Pierce, United States of America]	This figure is a vivid illustration of the rich structure of ocean mixing that is not currently captured in ESMs. It is being retained in a new section on key sources of uncertainty.
622	5	20	12	20	14	It could be worth pointing out in the text that some of the features expected to be energy sources can be identified from figure 5.4 (e.e mid ocean ridges), which is only previously referenced to say that the diffusivity is highly variable. It's also important to note that the variability presented is for the interior ocean. [Jenna Pearson, United States of America]	This is a useful suggestion, but this section had to be substantially reduced already to meet word-count limitations. A proper discussion of why some mid-ocean ridges are evident in this figure while others are not goes beyond the scope of what could be accommodated here and is also one of the open questions regarding this mixing that has yet to be fully resolved in the literature. The caption now notes that only Argo data from the interior ocean (i.e., below the mixed layer) is included.
764	5	20	12	20	18	This paragraph can become more concise by fusing with the following paragraph and emphasizing the changing energy sources. [Mengxi Wu, United States of America]	This material has been shortened and folded into a new section discussing key sources of uncertainty in projections of oceanic climate changes.
33651	5	20	20	20	21	Key point that could be emphasized more. [Government of United States of America, United States of America]	Accepted - this point is re-emphasized in revisions to this section.
14213	5	20	25	20	25	Incorrect citation: Jones and Cheung 2016 is about fish habitat suitability, a citation to the originating information on SAM would be more appropriate here. [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	This citation has been corrected to the proper Jones et al. paper.
10983	5	20	26	20	26	Slightly confusing. Consider replacing "and" with "leading to" [Abigail Bodner, United States of America]	Considered, but rejected both for brevity and because of nuances in the indirect pathways between the wind energy input and the baroclinic instability that predominantly drives these eddies, we preferred the less directly causal "and".
9155	5	20	26	20	28	That is not what Melet et al. 2015 indicates: The energy flux into lee waves is projected to decrease during the 21st and 22nd centuries in their study. The citation to Melet et al. 2015 should be corrected (see next comment). [Angelique Melet, France]	This sentence was eliminated when this section was shortened.
14215	5	20	31	20	31	"climate-change" loose definition of the phrase does this mean variability and anthropogenic? Please specify. [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	Both natural and anthropogenic changes are being documented. To the extent that observed natural changes are a proxy for anthropogenic changes that must be included in projections, both underlying causes of changing turbulence are relevant here.
33653	5	20	37	20	39	There is nuance here because of eddy saturation and compensation effects in the Southern Ocean and there is a large literature on this topic; not completely sure the issue has been fully resolved and perhaps "likely" here would be more helpful. More references may also be needed. [Government of United States of America, United States of America]	This topic has been discussed extensively in a cross-chapter box in Chapter 3 with numerous citations.
25705	5	20	53	21	45	"Risk Management and Adaptation subsection on Cyclones has limited information on the global/ regional dimension of the problem as well as adaptive measures required for risk mitigation at the global level." [Government of India, India]	The line numbers on this comment appear to be incorrect. Perhaps this refers to a different chapter?

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
12685	5	21	0	0		- Section 5.2.2.3: Temperature of the sea should also be considered in the DIC. [Noureddine Benkeblia, Jamaica]	Text revised
17545	5	21	1	21	4	Reduced Arctic sea ice allows greater swell of waves in the Arctic Ocean, which can further disrupt sea ice and accelerate breaking up of ice, becoming a positive feedback loop; see Thomson J. & Rogers W. E. (2014) Swell and sea in the emerging Arctic Ocean, GEOPHYSICAL RESEARCH LETTERS 41:3136–3140; 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. [Kristin Campbell, United States of America]	This is a very good point. Unfortunately this chapter was well over its allotted page limit, and the discussion of an increasingly ice-free Arctic was already present in Chapter 3, so this paragraph has been deleted from Chapter 5.
17657	5	21	1	21	4	Reduced Arctic sea ice allows greater swell of waves in the Arctic Ocean, which can further disrupt sea ice and accelerate breaking up of ice, becoming a positive feedback loop; see 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.”). [Durwood Zaelke, United States of America]	These are all very good points. Unfortunately this chapter was well over its allotted page limit, and the discussion of an increasingly ice-free Arctic was already present in Chapter 3, so this paragraph has been deleted from Chapter 5.
28303	5	21	2	0		Change “CO2” to “CO ₂ ” with a subscript. [Nsikak Benson, Nigeria]	Accepted This comment does not pertain to the cited page and line number. Perhaps the location is wrong. However, changes like that suggested have been made throughout the chapter.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
25485	5	21	3	21	3	and at rough topography YOU MIGHT WANT TO DEFINE TE CONCEPT [Christophe Deissenberg, Luxembourg]	This passage was eliminated when this section was being revised.
10985	5	21	7	21	7	Replace second instance of "climate changes" with "them"? [Abigail Bodner, United States of America]	Replaced.
3423	5	21		21	16	This claim requires a reference [Patrick Orenstein, United States of America]	This passage was eliminated when this section was being revised.
33655	5	21	14	21	16	The connection to the ecosystem in this section is weak and this sentence feels like it was just "tacked on". [Government of United States of America, United States of America]	Considered - The connection between mixing and relevant ecosystem variables are more explicitly addressed in this extensively revised section.
7047	5	21	15	0		Add apostrophe to "oceans" [Nina Hunter, South Africa]	Added.
10663	5	21	18	0		Several suggestions to improve this section are provided below but I wanted to mention that I found this section very well written overall. [Jean-Pierre Gattuso, France]	Accepted Accepted
21403	5	21	18	0		I strongly suggest a section about organic carbon in the ocean including dissolved and particular forms, as well as their cycling. [Rui Zhang, Canada]	Rejected - Due to space constraints in the final draft, its only tangential relation to the scoping document and lack of clear assessment we regret this could not be included Rejected - Due to space constraints in the final draft, its only tangential relation to the scoping document and lack of clear assessment we regret this could not be included
15721	5	21	18	21	18	It would be beneficial to add a section, or at least some lines, about how the global C cycle is affected by cc, by taking account of recent science findings since IPCC AR5. This section is about DIC, but what about DOC and POC? What improvements in understanding C cycle have been made? What are the remaining process knowledge and data gaps, and how to reduce them to make better models and scenarios of e.g., C flux to aphotic zone and sequestration? Do we now have all answers and no room for improvements? I am not sure the large table is sufficient to capture this information. [EUCE, Belgium]	Rejected - Due to space constraints in the final draft, its only tangential relation to the scoping document and lack of clear assessment we regret this could not be included Rejected - Due to space constraints in the final draft, its only tangential relation to the scoping document and lack of clear assessment we regret this could not be included
22899	5	21	18	21	27	In the first paragraph, there is a major factor or system that is missing. DIC is also consumed and produced in fluid flow processes located between the Oceanic Crust and the Seawater Column, in hot hydrothermal circulation systems occurring in most deep oceans, the world over. As long as these factors are not included in this report, the results cannot be accurate. It has to be underlined that the Oceanic Crust, which actually transmits about 50% of the transmitted heat from the upper mantle to the surface and into the ocean/atmosphere climate system. The Ocean Crust covers about 60% of the globe. [Martin Hovland, Norway]	Rejected - out of scope Rejected - out of scope

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22859	5	21	18	26	19	<p>Section "5.2.2.3 Changes in Ocean Carbon" focused on the DIC or CO₂ but barely assessed organic carbon. Assessing the tremendous marine organic carbon reservoir and relative biogeochemistry processes (e.g. microbial process, photochemical degradation, photochemical reaction, etc.) and carbon sequestration mechanisms (biological carbon pump and microbial carbon pump) are also important, which should be referred. Please check the following references:</p> <p>Decription of the tremendous marine organic carbon pool: Hansell DA, Carlson CA, Repeta DJ, Schlitzer R (2009). Dissolved organic matter in the ocean: new insights stimulated by a controversy. <i>Oceanography</i> 22: 202-211. Hansell DA (2013). Recalcitrant dissolved organic carbon fractions. <i>Annu Rev Mar Sci</i> 5: 421-425. Legendre L, Rivkin RB, Weinbauer MG, Guidi L, Uitz J (2015). The microbial carbon pump concept: Potential biogeochemical significance in the globally changing ocean. <i>Prog Oceanogr</i> 134: 432-450.</p> <p>Biotic processes: Volk T, Hoffert MI (1985). Ocean carbon pumps: Analysis of relative strengths and efficiencies in ocean-driven atmospheric CO₂ changes. <i>Natural Variations Archean to Present</i>. Washington, DC: American Geophysical Union 99-110. Jiao N, Herndl GJ, Hansell DA, Benner R, Kattner G, Wilhelm SW et al (2010). Microbial production of recalcitrant dissolved organic matter: long-term carbon storage in the global ocean. <i>Nat Rev Microbiol</i> 8: 593-599. Lechtenfeld OJ, Hertkorn N, Shen Y, Witt M, Benner R (2015). Marine sequestration of carbon in bacterial metabolites. <i>Nat Commun</i> 6: 6711.</p> <p>Abiotic processes (e.g. photochemical reaction, hydrothermal reaction): Hawkes JA, Rossel PE, Stubbins A, Butterfield D, Connelly DP, Achterberg EP et al (2015). Efficient removal of recalcitrant deep-ocean dissolved organic matter during hydrothermal circulation. <i>Nat Geosci</i> 8: 856-861. Medeiros PM, Seidel M, Powers LC, Dittmar T, Hansell DA, Miller WL (2015). Dissolved organic matter composition and photochemical transformations in the northern North Pacific</p>	Rejected - Due to space constraints in the final draft, its only tangential relation to the scoping document and lack of clear assessment we regret this could not be included Rejected - Due to space constraints in the final draft, its only tangential relation to the scoping document and lack of clear assessment we regret this could not be included
1719	5	21	20	26	19	<p>Somewhere in this section it would be important to emphasize what expected CO₂ concentrations are thought to be based off of ice core measurements and observed changes in ocean paleo records. This could help put the current changes in CO₂ into context. [Nora Richter, United States of America]</p>	Accepted Accepted
28125	5	21	20	26	19	<p>This section lacks the clarity of other sections e.g. changing ocean oxygen [Hilary Kennedy, United Kingdom (of Great Britain and Northern Ireland)]</p>	Accepted Accepted
28137	5	21	20	26	19	<p>are all estimates of CO₂ sink from changes in DIC or have other (like isotopic) methods been utilised? [Hilary Kennedy, United Kingdom (of Great Britain and Northern Ireland)]</p>	Rejected - they are from pCO ₂ and carbon inventory approaches Rejected - they are from pCO ₂ and carbon inventory approaches

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28149	5	21	20	26	19	It would be informative to understand whether changes in biological (say primary production) and abiotic changes due to climate change would have any significant effect on the CO2 sink/source. The text here just discusses fluxes associated with changes in atmospheric CO2 and maybe because this is the over-riding influence? [Hilary Kennedy, United Kingdom (of Great Britain and Northern Ireland)]	Rejected - Due to space constraints in the final draft, its only tangential relation to the scoping document and lack of clear assessment we regret this could not be included Rejected - Due to space constraints in the final draft, its only tangential relation to the scoping document and lack of clear assessment we regret this could not be included
10041	5	21	20	26	20	Missing from Section 5.2.2.3 is an estimate on how long it will take the deep ocean to equilibrate with current/future changes. [Tommy Moore, United States of America]	Accepted Accepted
28127	5	21	22	21	24	make explicit that carbonate production results in CO2 production and CO2 removal in dissolution [Hilary Kennedy, United Kingdom (of Great Britain and Northern Ireland)]	Accepted Accepted
7049	5	21	29	0		Suggest remove colon after "means" [Nina Hunter, South Africa]	Accepted Accepted
33657	5	21	30	21	30	The "i.e., anthropogenic" should be placed inside a paraenthetical. [Government of United States of America, United States of America]	accepted accepted
33659	5	21	32	21	32	...and mixing *primarily* (chemical difusion also plays a role). [Government of United States of America, United States of America]	Accepted Accepted
33661	5	21	33	21	34	This appears to simply be restating the "first" statement starting on line 30. [Government of United States of America, United States of America]	Accepted Accepted
28129	5	21	36	21	36	atmospheric CO2 incese cause chnages to abiotic as well as biological processes [Hilary Kennedy, United Kingdom (of Great Britain and Northern Ireland)]	Accepted Accepted
22901	5	21	39	21	42	The following statements are false and need rephrasing: "...as well as progress in modeling have substantially increased our quantitative understanding of each of the above processes, improving also the confidence levels. The most important progress concerns the data-based quantification of the temporal variability of the ocean carbon sink." As long as the carbon flux in and out of the Oceanic Crust and out of the sedimentary basins is not included in the assessment, these statements become false and untrue. (see for example Kvenvolden and Rogers, 2005: "Gaia's breath - global methane exhalations." (Marine Geology 22, 579-590. [Martin Hovland, Norway]	Rejected - see above Rejected - see above

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24695	5	21	47	21	48	Whilst the SOCAT datasets have been key and are critical. The synoptic scale analysis of these SOCAT data has only been possible through exploiting long-time series of climate quality satellite observations and re-analysis datasets. For example, without satellite sea surface temperature it is impossible to calculate the near surface CO2 concentration, and wind measurements are needed to calculate the exchange between the ocean and atmosphere. this paragraph ignores these contributions which is problematic as it undermines the ability and need for these observation records and efforts to be maintained and without them, the future exploitation of the SOCAT data will be severely compromised. e.g. Landshutzer et al. 2016 work requires multiple satellite observation datasets, model re-analyses - without which the work would have been impossible. Suggest that this section is revised to explain this. e.g. suggest '.when combined with climate quality satellite observations and re-analysis datasets demonstrate that the net ocean uptake of CO2 from the atmosphere has..etc [Shutler Jamie, United Kingdom (of Great Britain and Northern Ireland)]	Accepted Accepted
13039	5	21	47	21	50	Please add this message to the Executive Summary in its first paragraph (ES p 3 lns 8-14): "The net ocean uptake of CO2 from the atmosphere has increased from around 1.2 +/- 0.5 PgC /yr in the early 1980s to 2.0 +/- 0.5 Pg/yr in 2010-2015." [Government of Germany, Germany]	Accepted Accepted
7051	5	21	48	0		Closing bracket missing [Nina Hunter, South Africa]	Accepted Accepted
14221	5	21	51	21	51	Is the 0.45 Pg C yr-1 an outgassing or an uptake of CO2 ? The combination of numbers suggest the latter. Please clarify in text. [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	Accepted Accepted
33663	5	21	51	21	51	Use the Resplandy et al. (2018) estimate for river input of 0.8 Pg C/yr for better agreement between flux and inventory estimate. [Government of United States of America, United States of America]	Accepted Accepted
1723	5	22	1	22	4	What lines of evidence indicate that the ocean has taken up 25% CO2 since the mid 1980s? [Nora Richter, United States of America]	Rejected - this is assessed from the literature Rejected - this is assessed from the literature
3425	5	22	1	22	4	Is there a stylistic reason why there are no references for this paragraph? [Patrick Orenstein, United States of America]	Accepted Accepted
14223	5	22	1	22	57	All: There are some useful summary paragraphs on this page (lines 1-4, 29-31, 49-53) that make the section easier to read than the previous section. The chapter would be easier to read if the summaries were made more explicit and presented in a more uniform manner. The sentence starting "The consistency .." on lines 50-52 does not say what it means to say and needs to be re-written. [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	Accepted Accepted
17167	5	22	2	22	2	Subscripting of "CO2" to "CO ₂ " [Shalini Singh, Fiji]	Accepted Accepted

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20255	5	22	2	22	2	CO2 not subscripted [APECS Group Review, Germany]	Accepted Accepted
10665	5	22	3	0		"25±5%": one should be more precise. Why not mentioning the range? [Jean-Pierre Gattuso, France]	Accepted Accepted
23951	5	22	9	0		<p>We would suggest citing Ishii et al. (2014) in addition to Rodenbeck et al., 2015 and Landschutzer 2016. Ishii et al. 2014 well describes interannual variability of air-sea CO2 flux in the equatorial Pacific over the two decades of 1990s and 2000s based on the several diagnostic models and prognostic ocean biogeochemical models.</p> <p>M. Ishii, R. A. Feely, K. B. Rodgers, G.-H. Park, R. Wanninkhof, D. Sasano, H. Sugimoto, C. E. Cosca, S. Nakaoka, M. Telszewski, Y. Nojiri, S. E. Mikaloff Fletcher, Y. Niwa, P. K. Patra, V. Valsala, H. Nakano, I. Lima, S. C. Doney, E. T. Buitenhuis, O. Aumont, J. P. Dunne, A. Lenton, and T. Takahashi, Air-sea CO2 flux in the Pacific Ocean for the period 1990–2009, Biogeosciences, 11, 709–734, 2014.</p> <p>www.biogeosciences.net/11/709/2014/doi:10.5194/bg-11-709-2014. [Government of Japan, Japan]</p>	Accepted Accepted
7053	5	22	13	0		Suggest change "this" to "these" [Nina Hunter, South Africa]	Accepted Accepted
10667	5	22	15	0		It is unclear whether this refers to the period 1990 to 2000 or the 1990s and 2000s [Jean-Pierre Gattuso, France]	Accepted Accepted
2801	5	22	16	22	17	<p>This statement is made without a citation, and I don't think it is accurate. Winds only shifted south during the DJF season, and not in the annual mean (e.g. Swart et al. 2015). Secondly, there is not a robust attribution study available, as stated on pg 22 of chapter 3. Le Quere et al. (2007), the original paper which made this claim, used a very coarse resolution model with a fixed eddy parameterization and also used highly biases reanalysis wind trends to drive their model. In Swart et al. (2014), we showed that if you run a model with a variable eddy parameterization, and account for uncertainty in the wind forcing you do not get a weakening trend in the Southern Ocean CO2 sink. So this causality is disputed. Also check for consistency with chapter 3, e.g. pg 164. I suggest sticking with the statements "precludes a formal attribution" and "natural (unforced) variations. Swart et al. 2014, Wind-driven changes in the ocean carbon sink. Biogeosciences, 11, 6107–6117, 2014 ; Swart, N.C., J.C. Fyfe, N. Gillett, and G.J. Marshall, 2015: Comparing Trends in the Southern Annular Mode and Surface Westerly Jet. J. Climate, 28, 8840–8859, https://doi.org/10.1175/JCLI-D-15-0334.1 [Neil Swart, Canada]</p>	Taken into Account - text in Chapter 3 Taken into Account - text in Chapter 3

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4169	5	22	16	22	19	The sentence can be substantiated with the following ref: Gruber, N., Landschutzer, P., Lovenduski, N.S., 2018. The Variable Southern Ocean Carbon Sink. Annual Review of Marine Science. [Carles Pelejero, Spain]	Accepted Accepted
28755	5	22	18	0		Subscript the 2 in CO2. [Government of Brazil, Brazil]	Accepted Accepted
17169	5	22	18	22	18	Subscripting of "CO2" to "CO2" [Shalini Singh, Fiji]	Accepted Accepted
28131	5	22	18	22	18	why add the word natural before CO2? Was the proportion of natural/anthropogenic CO2 assessed? Does it really matter whether natural or anthropogenic? [Hilary Kennedy, United Kingdom (of Great Britain and Northern Ireland)]	Accepted Accepted
27785	5	22	19	22	21	This should be supported by references. [Momme Butenschön, Italy]	Accepted Accepted
24691	5	22	21	22	21	The original reference is missing from here (for observational evidence of the interannual variation across decadal scales). Suggest that the sentence should say: The majority of ocean carbon cycle models do not capture this decadal variability (Le Quéré et al., 2018; Rodenbeck et al, 2015). the missing reference is: https://www.biogeosciences.net/12/7251/2015/bg-12-7251-2015.html [Shutler Jamie, United Kingdom (of Great Britain and Northern Ireland)]	Rejected - Due to space constraints in the final draft, this text has been removed / reorganised Rejected - Due to space constraints in the final draft, this text has been removed / reorganised
7055	5	22	24	0		Suggest insert "a" before "lesser" [Nina Hunter, South Africa]	Accepted Accepted
2799	5	22	25	22	27	No citation is given for the statement that "weakening trend of the Southern Ocean sink in the 1990s was consistent with"... Gillett and Thompson does not mention carbon.Winds only shifted south during the DJF season, and not in the annual mean (e.g. Swart et al. 2015). Secondly, there is not a robust attribution study available, as stated on pg 22 of chapter 3. Le Quere et al. (2007), the original paper which made this claim, used a very coarse resolution model with a fixed eddy parameterization and also used highly biases reanalysis wind trends to drive their model. In Swart et al. (2014), we showed that if you run a model with a variable eddy parameterization, and account for uncertainty in the wind forcing you do not get a weakening trend in the Southern Ocean CO2 sink. So this causality is disputed. Also check for consistency with chapter 3, e.g. pg 164. I suggest sticking with the statements "precludes a formal attribution" and "natural (unforced) variations. Swart et al. 2014, Wind-driven changes in the ocean carbon sink. Biogeosciences, 11, 6107–6117, 2014 ; Swart, N.C., J.C. Fyfe, N. Gillett, and G.J. Marshall, 2015: Comparing Trends in the Southern Annular Mode and Surface Westerly Jet. J. Climate, 28, 8840–8859, https://doi.org/10.1175/JCLI-D-15-0334.1 [Neil Swart, Canada]	Taken into Account - text in Chapter 3 Taken into Account - text in Chapter 3

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
33665	5	22	29	22	29	The evidence referenced here requires a citation. [Government of United States of America, United States of America]	Taken into Account - text in Chapter 3 Taken into Account - text in Chapter 3
1717	5	22	29	22	31	What evidence is being referenced here? Elaborate on this statement and include citations [Nora Richter, United States of America]	Taken into Account - text in Chapter 3 Taken into Account - text in Chapter 3
7057	5	22	30	0		Change "alter" to plural [Nina Hunter, South Africa]	Accepted Accepted
254	5	22	40	22	42	Gruber et al. (2018) not found in the reference list. Kouketsu and Murata (2014, https://doi.org/10.1002/2014GL060516) estimated the increase with an errorbar. [Katsuro Katsumata, Japan]	Accepted Accepted
4171	5	22	41	22	41	I don't see the reference Gruber et al 2018 in the list. [Carles Pelejero, Spain]	Accepted Accepted
28133	5	22	41	22	41	Gruber not in reference list and so cannot assess validity of statement [Hilary Kennedy, United Kingdom (of Great Britain and Northern Ireland)]	Accepted Accepted
28135	5	22	45	22	47	The value and error from Khattiwala 2013 is identical to AR5 chapter 6. Is this correct? Are the values from the same source or determined independently? [Hilary Kennedy, United Kingdom (of Great Britain and Northern Ireland)]	Rejected - Due to space constraints in the final draft, this text has been removed / reorganised Rejected - Due to space constraints in the final draft, this text has been removed / reorganised
7059	5	22	46	0		Which estimate is meant? Please be specific [Nina Hunter, South Africa]	Rejected - Due to space constraints in the final draft, this text has been removed / reorganised Rejected - Due to space constraints in the final draft, this text has been removed / reorganised
28757	5	22	47	0		Remove the first Pg and space after 155, as follows "in the year 2011 of 155±31 Pg C" [Government of Brazil, Brazil]	Rejected - Due to space constraints in the final draft, this text has been removed / reorganised Rejected - Due to space constraints in the final draft, this text has been removed / reorganised
10669	5	22	49	0		How is ±5% calculated? Why not provide real values from Le Quéré et al. (2018) [Jean-Pierre Gattuso, France]	Rejected - Due to space constraints in the final draft, this text has been removed / reorganised Rejected - Due to space constraints in the final draft, this text has been removed / reorganised
1721	5	22	49	22	50	Why is the period 1750-2011 referenced here? How do we know the contribution of CO2 from anthropogenic emissions at that time? Also why is a different time frame and estimate given than what was reported in lines 3-4 on this page (22). [Nora Richter, United States of America]	Rejected - Due to space constraints in the final draft, this text has been removed / reorganised Rejected - Due to space constraints in the final draft, this text has been removed / reorganised
10855	5	22	49	22	50	Clarify that the emissions regard CO2 (if that is the case) [Ola Kalén, Sweden]	Accepted Accepted
23737	5	22	49	22	50	Clarify that the emissions that are mentioned here regard CO2 (if that indeed is the case). [Government of Sweden, Sweden]	Accepted Accepted
26429	5	22	49	22	53	This paragraph is inconsistent with the Executive Summary. [Ethan Pierce, United States of America]	Taken into Account Taken into Account
33667	5	22	57	22	57	The Perez et al. reference is for the subpolar North Atlantic. A better description is in Gruber et al., Woosley et al., and Wanninkhof et al. that the N. Atlantic storage rate decreased and South Atlantic storage rate has increased. [Government of United States of America, United States of America]	Accepted Accepted
4861	5	23	0	0		Figure 5.5. Please spell out acronyms in legend. What exactly does "zonal mean sections" mean? Transects or means per latitude? If transects, then a small global map showing where these transects lie would help. [Debra Roberts and Durban Team, South Africa]	Accepted Accepted
3965	5	23	1	23	15	Figure 5.5 needs to be of higher quality. [Aakash Sane, United States of America]	Accepted Accepted
7061	5	23	3	0		Should "largely" not be "large" [Nina Hunter, South Africa]	Accepted Accepted

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
624	5	23	4	23	4	Perhaps it could be included how the wind driven and AMOC etc. correlate with these features. That is the gyres are pronounced. This would help relate some of the features discussed previously to carbonization. [Jenna Pearson, United States of America]	Text revised
7063	5	23	6	23	7	Suggest change "this is the result of primarily" to "this is primarily the result of" [Nina Hunter, South Africa]	Accepted Accepted
3465	5	23	9	23	13	Are the color scheme and isobars showing the same information (CO2)? Duplicate plotting. [Patrick Orenstein, United States of America]	Taken into account - yes Taken into account - yes
10263	5	23	10	23	10	Figure 5.5 has low resolution and file with higher resolution would be better. [Jinsoon Park, Republic of Korea]	Accepted Accepted
21705	5	23	10	23	10	Figure 5.5 has low resolution and file with higher resolution would be better. [Government of Republic of Korea, Republic of Korea]	Accepted Accepted
766	5	23	11	23	11	I am not sure whether this is the best way to present the data, because now the features in the Indian Ocean are partly hidden in the figure. [Mengxi Wu, United States of America]	Rejected - unfortunately, this is the best figure we could make of the data Rejected - unfortunately, this is the best figure we could make of the data
14225	5	23	12	23	12	JGOFS/WOCE/GOSHIP - acronyms for programmes or initiatives that are not explained - suggest these are removed as not needed. [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	Accepted Accepted
4173	5	23	15	23	15	I don't see the reference Gruber et al 2018 in the list. [Carles Pelejero, Spain]	Accepted Accepted
7065	5	23	18	0		Suggest change "has" to "have" [Nina Hunter, South Africa]	Rejected - Due to space constraints in the final draft, this text has been removed / reorganised Rejected - Due to space constraints in the final draft, this text has been removed / reorganised
33669	5	23	18	23	18	Should be "there have been limited new insights" (or "there has been limited new insight"). [Government of United States of America, United States of America]	Rejected - Due to space constraints in the final draft, this text has been removed / reorganised Rejected - Due to space constraints in the final draft, this text has been removed / reorganised
7067	5	23	20	0		Suggest change "was" to "is" [Nina Hunter, South Africa]	Rejected - Due to space constraints in the final draft, this text has been removed / reorganised Rejected - Due to space constraints in the final draft, this text has been removed / reorganised
3427	5	23	26	23	28	Major claim - needs a reference. [Patrick Orenstein, United States of America]	Rejected - Due to space constraints in the final draft, this text has been removed / reorganised Rejected - Due to space constraints in the final draft, this text has been removed / reorganised
11995	5	23	26	23	28	IS this a reduction in the total global ocean uptake of CO2 or the fractional ocean uptake (i.e. a decline in the efficiency of the ocean carbon pump)? The point should be clarified as the change in magnitude of uptake would be expected to be highly dependent on emission scenario, whereas a decline in efficiency would be expected for all emission scenarios (although scale of decline would vary for different scenarios) [Nicholas Hardman-Mountford, United Kingdom (of Great Britain and Northern Ireland)]	Rejected - Due to space constraints in the final draft, this text has been removed / reorganised Rejected - Due to space constraints in the final draft, this text has been removed / reorganised
20291	5	23	26	23	28	A confidence statement should be provided instead. [APECS Group Review, Germany]	Rejected - Due to space constraints in the final draft, this text has been removed / reorganised Rejected - Due to space constraints in the final draft, this text has been removed / reorganised

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
24697	5	23	27	23	27	incomplete exaplantion. Suggest: ...will lead to a sustained reduction in the global ocean uptake of CO2 from the atmosphere, predominantly due the high temperature sensitivity of CO2 solubility in sea water (Woolf et al., 2016), and that this.... Reference is https://agupubs.onlinelibrary.wiley.com/doi/full/10.1002/2015JC011427# [Shutler Jamie, United Kingdom (of Great Britain and Northern Ireland)]	Rejected - Due to space constraints in the final draft, this text has been removed / reorganised Rejected - Due to space constraints in the final draft, this text has been removed / reorganised
4505	5	23	28	23	28	larger than that for the land': This probably only applies for longer timescales, not for the 21st century. [The UBern Team Group Review, Switzerland]	Rejected - Due to space constraints in the final draft, this text has been removed / reorganised Rejected - Due to space constraints in the final draft, this text has been removed / reorganised
10031	5	23	30	24	7	This paragraph is confusing and needs to be rewritten. It is worthwhile to acurately detail the inorganic C system as few people fully understand how OA works. In particular the line about the "buffer system" is confusing and unnessary. The addiion of the chemical equations for the inorganic C cycle would be good and a discussion on alkalinity. [Tommy Moore, United States of America]	Rejected - Due to space constraints in the final draft, its only tangential relation to the scoping document and lack of clear assessment we regret this could not be included Rejected - Due to space constraints in the final draft, its only tangential relation to the scoping document and lack of clear assessment we regret this could not be included
26431	5	23	30	24	7	How sensitive is the oceanic carbon buffering system to changes in pH? On long time scales, is the system stable or unstable? This is helpful contextual information for scientists in other disciplines to understand this part of the chapter. [Ethan Pierce, United States of America]	Rejected - Due to space constraints in the final draft, its only tangential relation to the scoping document and lack of clear assessment we regret this could not be included Rejected - Due to space constraints in the final draft, its only tangential relation to the scoping document and lack of clear assessment we regret this could not be included
32103	5	23	30	26	19	I think it is very worthwhile pointing out a bit more prominently that OA leads also to a quite a substantial modification of the seasonal cycle in pCO2, pH etc (see e.g., Kwiatkowski and Orr 10.1038/s41558-017-0054-0 and McNeil and Sasse (2016) etc) and that this change has already been observed (Landschützer et al. 2018, doi 10.1038/s41558-017-0057-x). For example, McNeil and Sasse (2016) point out that this increases the chances for ocean organisms to reach hypercapnia very substantially. [Nicolas Gruber, Switzerland]	Accepted Accepted
33671	5	23	31	23	31	"primarily" three species. Carbonic acid contributes as a minor species. [Government of United States of America, United States of America]	Rejected - Due to space constraints in the final draft, this text has been removed / reorganised Rejected - Due to space constraints in the final draft, this text has been removed / reorganised
10671	5	23	33	0		I think it is the first time I hear about the "buffer system". In any case it is not a widely used expression. Why not use "carbonate system"? [Jean-Pierre Gattuso, France]	Rejected - Due to space constraints in the final draft, this text has been removed / reorganised Rejected - Due to space constraints in the final draft, this text has been removed / reorganised

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
23953	5	23	33	24	1	"buffer system" sounds inappropriate here, as buffering capacity of seawater is low. We would suggest to replace 'via a set of reversible reactions known as the 'buffer system' and their relative abundance is strongly controlled by ocean pH.' by 'via a series of reversible reactions known as the 'CO2 system' and their relative abundance is strongly controlled by ocean pH (Dickson et al., 2007).' Dickson, A.G., Sabine, C.L. and Christian, J.R. (Eds.) 2007. Guide to best practices for ocean CO2 measurements. PICES Special Publication 3, 191 pp. [Government of Japan, Japan]	Rejected - Due to space constraints in the final draft, this text has been removed / reorganised Rejected - Due to space constraints in the final draft, this text has been removed / reorganised
3531	5	23	33	24	3	Here, the causality has been reversed. The ocean pH is controlled by the relative distribution/abundance of the three inorganic carbon species. Therefore, the increase in aquatic CO2 is responsible for lowering oceanic pH and not vice versa. [Marius Müller, Brazil]	Rejected - Due to space constraints in the final draft, this text has been removed / reorganised Rejected - Due to space constraints in the final draft, this text has been removed / reorganised
28139	5	24	1	24	7	to aid clarity can text be added to explain the saturation state of calcite minerals and the effect of pH on them ? This concept is used in the next paragraph but not really explained. [Hilary Kennedy, United Kingdom (of Great Britain and Northern Ireland)]	Rejected - Due to space constraints in the final draft, this text has been removed / reorganised Rejected - Due to space constraints in the final draft, this text has been removed / reorganised
33673	5	24	2	24	2	There is no reason to state in the example a change of 1 in pH; any decrease in pH will increase CO2aq and decrease CO3. Also the causality is unclear. It's the ratio of carbonate and CO2 that controls the ocean pH, not the other way around as implied here. The effect of OA only extends to depth of penetration of anthropogenic CO2 (Fig 5.5) with a strong decrease with depth. [Government of United States of America, United States of America]	Rejected - Due to space constraints in the final draft, this text has been removed / reorganised Rejected - Due to space constraints in the final draft, this text has been removed / reorganised
7069	5	24	5	0		Suggest single quotation mark after "acidification" [Nina Hunter, South Africa]	Rejected - Due to space constraints in the final draft, this text has been removed / reorganised Rejected - Due to space constraints in the final draft, this text has been removed / reorganised
10673	5	24	5	0		This paragraph addresses anthropogenic carbon (first sentence). Hence, in keeping with the IPCC definition, one should rather use "anthropogenic ocean acidification". [Jean-Pierre Gattuso, France]	Rejected - Due to space constraints in the final draft, this text has been removed / reorganised Rejected - Due to space constraints in the final draft, this text has been removed / reorganised
7071	5	24	6	0		"ie" not written correctly [Nina Hunter, South Africa]	Taken into account - In response to the reviewers this section on pH changes, saturation states and seasonality has been rewritten and reorganised Taken into account - In response to the reviewers this section on pH changes, saturation states and seasonality has been rewritten and reorganised
28759	5	24	6	0		Change (ie to (i.e., [Government of Brazil, Brazil]	Text revised
33675	5	24	6	25	6	The "ie" should be changed to "i.e.". [Government of United States of America, United States of America]	Text revised

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
14227	5	24	9	24	24	For what depth ranges are these estimated rates of change of pH valid ? [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	Taken into account - In response to the reviewers this section on pH changes, saturation states and seasonality has been rewritten and reorganised Taken into account - In response to the reviewers this section on pH changes, saturation states and seasonality has been rewritten and reorganised
24701	5	24	9	24	9	unusual use of 'ocean acidity'. The oceans are not acidic and this is misleading. The scientific community tends to avoid this term. [Shutler Jamie, United Kingdom (of Great Britain and Northern Ireland)]	Taken into account - In response to the reviewers this section on pH changes, saturation states and seasonality has been rewritten and reorganised Taken into account - In response to the reviewers this section on pH changes, saturation states and seasonality has been rewritten and reorganised
10675	5	24	11	0		What is the source of this range? A citation is needed. If the source is the table in the appendix, then its citation should come earlier. Note my comment on this table later. [Jean-Pierre Gattuso, France]	Taken into account - In response to the reviewers this section on pH changes, saturation states and seasonality has been rewritten and reorganised Taken into account - In response to the reviewers this section on pH changes, saturation states and seasonality has been rewritten and reorganised
33677	5	24	11	24	11	pH is unitless. [Government of United States of America, United States of America]	Taken into account - In response to the reviewers this section on pH changes, saturation states and seasonality has been rewritten and reorganised Taken into account - In response to the reviewers this section on pH changes, saturation states and seasonality has been rewritten and reorganised
4175	5	24	11	24	12	The sentence can be substantiated with the following ref: Bates, N.R., Astor, Y.M., Church, M.J., Currie, K., Dore, J.E., González-Dávila, M., Lorenzoni, L., Muller-Karger, F., Olafsson, J., Santana-Casiano, J.M., 2014. A time-series view of changing ocean chemistry due to ocean uptake of anthropogenic CO2 and ocean acidification. Oceanography 27, 126-141. [Carles Pelejero, Spain]	Taken into account - In response to the reviewers this section on pH changes, saturation states and seasonality has been rewritten and reorganised Taken into account - In response to the reviewers this section on pH changes, saturation states and seasonality has been rewritten and reorganised
768	5	24	14	24	16	It may be helpful to give the definition of alkalinity here. [Mengxi Wu, United States of America]	Taken into account - In response to the reviewers this section on pH changes, saturation states and seasonality has been rewritten and reorganised Taken into account - In response to the reviewers this section on pH changes, saturation states and seasonality has been rewritten and reorganised
4863	5	24	15	0		What is "fugacity"? [Debra Roberts and Durban Team, South Africa]	Taken into account - In response to the reviewers this section on pH changes, saturation states and seasonality has been rewritten and reorganised Taken into account - In response to the reviewers this section on pH changes, saturation states and seasonality has been rewritten and reorganised
33679	5	24	15	24	15	Replace fugacity by partial pressure as they are essentially the same and pCO2 is used throughout. [Government of United States of America, United States of America]	Taken into account - In response to the reviewers this section on pH changes, saturation states and seasonality has been rewritten and reorganised Taken into account - In response to the reviewers this section on pH changes, saturation states and seasonality has been rewritten and reorganised

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
28761	5	24	16	24	16	change all long dashes – to - [Government of Brazil, Brazil]	Taken into account - In response to the reviewers this section on pH changes, saturation states and seasonality has been rewritten and reorganised Taken into account - In response to the reviewers this section on pH changes, saturation states and seasonality has been rewritten and reorganised
11997	5	24	19	24	19	Please also cite Kitidis et al. (2017) for the lower rate in the Atlantic Ocean: Kitidis, V., I. Brown, N. Hardman-Mountford, N. Lefevre (2016). Surface ocean carbon dioxide during the Atlantic Meridional Transect (1995-2013); evidence of ocean acidification. Progress in Oceanography. DOI: 10.1016/j.pocean.2016.08.005 [Nicholas Hardman-Mountford, United Kingdom (of Great Britain and Northern Ireland)]	Taken into account - In response to the reviewers this section on pH changes, saturation states and seasonality has been rewritten and reorganised Taken into account - In response to the reviewers this section on pH changes, saturation states and seasonality has been rewritten and reorganised
10033	5	24	19	24	22	The sentence regarding saturation state is confusing and needs to be rewritten with greater detail. It should also be moved to the previous paragraph where the general scientific informaion is presented. [Tommy Moore, United States of America]	Taken into account - In response to the reviewers this section on pH changes, saturation states and seasonality has been rewritten and reorganised Taken into account - In response to the reviewers this section on pH changes, saturation states and seasonality has been rewritten and reorganised
28141	5	24	20	24	22	the implications of undersaturation i.e. carbonate dissolution should be introduced. [Hilary Kennedy, United Kingdom (of Great Britain and Northern Ireland)]	Taken into account - In response to the reviewers this section on pH changes, saturation states and seasonality has been rewritten and reorganised Taken into account - In response to the reviewers this section on pH changes, saturation states and seasonality has been rewritten and reorganised
28143	5	24	20	24	22	what exactly has lower mean values? The carbonate ion concentration? Saturation? [Hilary Kennedy, United Kingdom (of Great Britain and Northern Ireland)]	Taken into account - In response to the reviewers this section on pH changes, saturation states and seasonality has been rewritten and reorganised Taken into account - In response to the reviewers this section on pH changes, saturation states and seasonality has been rewritten and reorganised
33681	5	24	22	24	22	The greatest magnitude of change in saturation state (and rate of change) has been experinced in the tropics (espicially in the Atlantic). [Government of United States of America, United States of America]	Taken into account - In response to the reviewers this section on pH changes, saturation states and seasonality has been rewritten and reorganised Taken into account - In response to the reviewers this section on pH changes, saturation states and seasonality has been rewritten and reorganised
10035	5	24	22	24	24	The pCO2 variability here is so small that is not worth mentioning in the the context of organisms. [Tommy Moore, United States of America]	Taken into account - In response to the reviewers this section on pH changes, saturation states and seasonality has been rewritten and reorganised Taken into account - In response to the reviewers this section on pH changes, saturation states and seasonality has been rewritten and reorganised

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
98	5	24	22	24	54	<p>The discussed changes in ocean carbonate chemistry seasonal amplitude is somewhat unorganised in this section and in my opinion misses out some of the key references in the literature in this area. Historical increases in the seasonal amplitude of pCO₂ are discussed (i.e. reference to Landschützer et al., 2018) but projected future increases in pCO₂ seasonal amplitude (e.g. McNeil & Sasse, 2016) are not mentioned. In addition, there is no mention of potential changes in the seasonal amplitude of calcium carbonate saturation state, which the CMIP5 models project will decline in most of the surface ocean but increase in certain subtropical regions (Kwiatkowski & Orr, 2018). While statements regarding changes in the seasonal amplitude of pH are generally not consistent with CMIP5 projections of declining seasonal amplitude of pH under RCP8.5 (Kwiatkowski & Orr, 2018). It would perhaps be clearer to have a separate paragraph on changes in carbonate chemistry seasonal amplitude than to include this discussion in paragraphs that are focussed on trends in mean state chemistry.</p> <p>References:</p> <p>McNeil, B. I. & Sasse, T. P., 2016. Future ocean hypercapnia driven by anthropogenic amplification of the natural CO₂ cycle. <i>Nature</i> 529, 383–386.</p> <p>Kwiatkowski, L. & Orr, J. C., 2018. Diverging seasonal extremes for ocean acidification during the twenty-first century. <i>Nature Climate Change</i>, 8 (2), 141-145. [Lester Kwiatkowski, France]</p>	<p>Taken into account - In response to the reviewers this section on pH changes, saturation states and seasonality has been rewritten and reorganised Taken into account - In response to the reviewers this section on pH changes, saturation states and seasonality has been rewritten and reorganised</p>

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
92	5	24	23	24	23	<p>The text "and hence also pH" is incorrect here and reflects a common misconception. Landschützer et al., 2018 show that pCO₂ seasonal amplitude increases over the historical period. Therefore, due to the near-linear relationship between changes in pCO₂ and hydrogen ion concentration ([H⁺]), one can assume that there were similar relative increases in the seasonal amplitude of [H⁺] over the same period. This however does not mean that pH seasonal amplitude increased over the same period. Due to the log scale that defines pH, changes in pH seasonal amplitude are the consequence of changes in both the mean state [H⁺] and the seasonal amplitude of [H⁺]. That is, if the relative increase in [H⁺] mean state is the same as the relative increase in [H⁺] seasonal amplitude then the seasonality of pH remains constant. In 9 CMIP5 models studied, surface ocean pCO₂ and [H⁺] seasonal amplitude have both been shown to increase substantially by 2100 under RCP8.5, however in the same models, pH seasonal amplitude declines slightly as the models project greater relative increases in [H⁺] mean state than in [H⁺] seasonal amplitude (Kwiatkowski & Orr, 2018).</p> <p>I suggest the text "and hence also pH" is changed to "and hence also [H⁺]" or removed.</p> <p>References:</p> <p>Kwiatkowski, L. & Orr, J. C., 2018. Diverging seasonal extremes for ocean acidification during the twenty-first century. Nature Climate Change, 8 (2), 141-145. [Lester Kwiatkowski, France]</p>	<p>Taken into account - In response to the reviewers this section on pH changes, saturation states and seasonality has been rewritten and reorganised</p> <p>Taken into account - In response to the reviewers this section on pH changes, saturation states and seasonality has been rewritten and reorganised</p>
11999	5	24	23	24	23	<p>pH does not vary by units of μatm. Please amend the sentence accordingly. [Nicholas Hardman-Mountford, United Kingdom (of Great Britain and Northern Ireland)]</p>	<p>Taken into account - In response to the reviewers this section on pH changes, saturation states and seasonality has been rewritten and reorganised</p> <p>Taken into account - In response to the reviewers this section on pH changes, saturation states and seasonality has been rewritten and reorganised</p>

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
25295	5	24	23	24	34	Delete “, and hence also pH,”. The link between pCO ₂ and pH is not so obvious in terms of the amplification of the seasonal cycle, as detailed by Kwiatkowski and Orr (2018, Nature Climate Change). Alternatively, use “and hence also [H+],” While the amplification of the seasonal cycle of [H+] goes hand in hand with that for pCO ₂ , it is more complicated for the amplification of the seasonal cycle of pH. This contrast exists because a change in pH represents a relative change in H, i.e., ΔpH is proportional to $\Delta[H+] / [H+]$, and the increase in the numerator (the seasonal amplitude of [H+] amplitude) is less than that of the denominator (the annual mean [H+]). [James Orr, France]	Taken into account - In response to the reviewers this section on pH changes, saturation states and seasonality has been rewritten and reorganised Taken into account - In response to the reviewers this section on pH changes, saturation states and seasonality has been rewritten and reorganised
10677	5	24	24	0		“would enhance the exposure to organisms to lower pH” [Jean-Pierre Gattuso, France]	Taken into account - In response to the reviewers this section on pH changes, saturation states and seasonality has been rewritten and reorganised Taken into account - In response to the reviewers this section on pH changes, saturation states and seasonality has been rewritten and reorganised
3533	5	24	24	24	24	It is not completely clear to me what is meant by “acidification exposure”. Maybe “exposure to decreased pH regimes” might be more appropriate? [Marius Müller, Brazil]	Taken into account - In response to the reviewers this section on pH changes, saturation states and seasonality has been rewritten and reorganised Taken into account - In response to the reviewers this section on pH changes, saturation states and seasonality has been rewritten and reorganised
24699	5	24	24	24	24	This sentence omits predominantly atmosphere and ocean interaction driven episodic acidification events which can have sudden and dramatic impact on marine organisms and the frequency of these is thought to be increasing (Feely et al., 2008, Science, Evidence for upwelling of corrosive acidified water onto the continental shelf). [Shutler Jamie, United Kingdom (of Great Britain and Northern Ireland)]	Taken into account - In response to the reviewers this section on pH changes, saturation states and seasonality has been rewritten and reorganised Taken into account - In response to the reviewers this section on pH changes, saturation states and seasonality has been rewritten and reorganised
16517	5	24	26	24	37	It seems strange that authors do not mention about contribution of water circulation change (i.e., increase of water mass age due to circulation change) to the present DIC increase of ocean interior in this paragraph. [Tsuneo Ono, Japan]	Taken into account - In response to the reviewers this section on pH changes, saturation states and seasonality has been rewritten and reorganised Taken into account - In response to the reviewers this section on pH changes, saturation states and seasonality has been rewritten and reorganised
770	5	24	27	24	29	This statement may need more clarification because a substantial effect on ocean interior pH of the overturning circulation in the North Pacific is not trivial. [Mengxi Wu, United States of America]	Taken into account - In response to the reviewers this section on pH changes, saturation states and seasonality has been rewritten and reorganised Taken into account - In response to the reviewers this section on pH changes, saturation states and seasonality has been rewritten and reorganised

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
24871	5	24	29	0		Include "García-Ibáñez et al., 2016" after (Rios et al., 2015). This article report well constrained acidification rates resulting from sistematic repeated sections (GOSHIP A-25 OVIDE). We also proposed include these results in the Appendix 5. A . Table 1 Garcia-Ibañez et al. 2016 Biogeosciences, 13, 3701–3715, 2016 www.biogeosciences.net/13/3701/2016/ [Fernandez Fiz, Spain]	Taken into account - In response to the reviewers this section on pH changes, saturation states and seasonality has been rewritten and reorganised Taken into account - In response to the reviewers this section on pH changes, saturation states and seasonality has been rewritten and reorganised
10679	5	24	31	0		Delete "carbon speciation variable" which does not apply to saturation states. [Jean-Pierre Gattuso, France]	Taken into account - In response to the reviewers this section on pH changes, saturation states and seasonality has been rewritten and reorganised Taken into account - In response to the reviewers this section on pH changes, saturation states and seasonality has been rewritten and reorganised
3659	5	24	33	24	35	One of missing references here is Nam et al. (2011, Geophysical Research Letters). In this paper, it is shown from five years of continuous observations of subsurface dissolved oxygen (and others) that large additional oxygen (and pH) deficiencies relative to the seasonal cycle is associated with interannual climate events - El Niño/La Niña. [Nam SungHyun, Republic of Korea]	Taken into account - In response to the reviewers this section on pH changes, saturation states and seasonality has been rewritten and reorganised Taken into account - In response to the reviewers this section on pH changes, saturation states and seasonality has been rewritten and reorganised
21707	5	24	33	24	35	One of missing references here is Nam et al. (2011, Geophysical Research Letters). In this paper, it is shown from five years of continuous observations of subsurface dissolved oxygen (and others) that large additional oxygen (and pH) deficiencies relative to the seasonal cycle is associated with interannual climate events - El Niño/La Niña. [Government of Republic of Korea, Republic of Korea]	Taken into account - In response to the reviewers this section on pH changes, saturation states and seasonality has been rewritten and reorganised Taken into account - In response to the reviewers this section on pH changes, saturation states and seasonality has been rewritten and reorganised
10681	5	24	35	0		Should read "total alkalinity" [Jean-Pierre Gattuso, France]	Taken into account - In response to the reviewers this section on pH changes, saturation states and seasonality has been rewritten and reorganised Taken into account - In response to the reviewers this section on pH changes, saturation states and seasonality has been rewritten and reorganised
28145	5	24	35	24	37	What causes the change in alk and its ratio to DIC. How does this effect saturation states? What processes, affected by climate, cause these changes [Hilary Kennedy, United Kingdom (of Great Britain and Northern Ireland)]	Taken into account - In response to the reviewers this section on pH changes, saturation states and seasonality has been rewritten and reorganised Taken into account - In response to the reviewers this section on pH changes, saturation states and seasonality has been rewritten and reorganised
10683	5	24	36	0		Should read "total alkalinity" [Jean-Pierre Gattuso, France]	Taken into account - In response to the reviewers this section on pH changes, saturation states and seasonality has been rewritten and reorganised Taken into account - In response to the reviewers this section on pH changes, saturation states and seasonality has been rewritten and reorganised
4865	5	24	39	0		"virtually certain" - based on observed or modelled data? It would be very helpful if any detected changes in observed data were reported clearly - they carry more weight than the models re what is and isn't happening. [Debra Roberts and Durban Team, South Africa]	Accepted Accepted

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
10687	5	24	39	0		I am not sure it is correct to say that datasets remain sparse in the Arctic. As far as I know, there is no published time-series observations in this region and none is listed in Table1. [Jean-Pierre Gattuso, France]	Taken into account - In response to the reviewers this section on pH changes, saturation states and seasonality has been rewritten and reorganised Taken into account - In response to the reviewers this section on pH changes, saturation states and seasonality has been rewritten and reorganised
31981	5	24	39	0	43	How much has ocean pH declined by now and what are the regional differences? [Hans-Otto Poertner and WGII TSU, Germany]	Taken into account - In response to the reviewers this section on pH changes, saturation states and seasonality has been rewritten and reorganised Taken into account - In response to the reviewers this section on pH changes, saturation states and seasonality has been rewritten and reorganised
31795	5	24	39	24	39	This is a strange mixture of likelihood, confidence and agreement. Please revise. [Hans-Otto Poertner and WGII TSU, Germany]	Taken into account - In response to the reviewers this section on pH changes, saturation states and seasonality has been rewritten and reorganised Taken into account - In response to the reviewers this section on pH changes, saturation states and seasonality has been rewritten and reorganised
33683	5	24	39	24	39	These are surface values; also worth mentioning that these declines are in accord with observed increases in surface water pCO ₂ . [Government of United States of America, United States of America]	Taken into account - In response to the reviewers this section on pH changes, saturation states and seasonality has been rewritten and reorganised Taken into account - In response to the reviewers this section on pH changes, saturation states and seasonality has been rewritten and reorganised
10685	5	24	39	24	40	This statement is incorrect. As mentioned earlier, the range is much larger, which is confirmed by some of the missing references in Table 2 Appendix 5. For example Kapsenberg et al. report -0.028 pH units per decade in the NW Mediterranean. [Jean-Pierre Gattuso, France]	Taken into account - In response to the reviewers this section on pH changes, saturation states and seasonality has been rewritten and reorganised Taken into account - In response to the reviewers this section on pH changes, saturation states and seasonality has been rewritten and reorganised
22861	5	24	39	24	40	"We assess that it is virtually certain (high confidence – high agreement) that ocean pH is declining by ~0.02 pH units per decade everywhere time-series observations exist." can you specify the reference or data source? [Yantao Liang, China]	Accepted Accepted
33685	5	24	40	24	40	There are a number of time-series in coastal waters and even on the continental shelf where this rate is not observed on account of other drivers. [Government of United States of America, United States of America]	Taken into account - In response to the reviewers this section on pH changes, saturation states and seasonality has been rewritten and reorganised Taken into account - In response to the reviewers this section on pH changes, saturation states and seasonality has been rewritten and reorganised
33687	5	24	41	24	41	It's not clear how that wouldn't be the case as that is fundamental chemistry. As buffer capacity is being titrated out due to ocean acidification, then by basic chemistry the amplitudes in carbonate chemistry to which organisms are exposed must also have changed. [Government of United States of America, United States of America]	Taken into account - In response to the reviewers this section on pH changes, saturation states and seasonality has been rewritten and reorganised Taken into account - In response to the reviewers this section on pH changes, saturation states and seasonality has been rewritten and reorganised
4507	5	24	41	24	42	delete 'that organisms are exposed to' [The UBern Team Group Review, Switzerland]	Taken into account - In response to the reviewers this section on pH changes, saturation states and seasonality has been rewritten and reorganised Taken into account - In response to the reviewers this section on pH changes, saturation states and seasonality has been rewritten and reorganised

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
4509	5	24	41	24	42	seasonal cycle in pH decreases, not increases. Seasonal cycle in H ⁺ increases, but pH is the log of H ⁺ [The UBern Team Group Review, Switzerland]	Taken into account - In response to the reviewers this section on pH changes, saturation states and seasonality has been rewritten and reorganised Taken into account - In response to the reviewers this section on pH changes, saturation states and seasonality has been rewritten and reorganised
4511	5	24	41	24	42	why is there low confidence for the decrease in the seasonal cycle of pH? This is based on well-understood inorganic chemistry and has been shown in observations (Landschützer et al. 2018) and modeling studies (Kwiatkowski et al. 2018, Hauck and Völker 2015). See chapter 3 for a nice summary on this [The UBern Team Group Review, Switzerland]	Taken into account - In response to the reviewers this section on pH changes, saturation states and seasonality has been rewritten and reorganised Taken into account - In response to the reviewers this section on pH changes, saturation states and seasonality has been rewritten and reorganised
94	5	24	41	24	43	<p>I think the statement "There is low confidence that the amplitude of the seasonal changes in pH that organisms are exposed to has increased" is not accurate and reflects an ocean carbonate chemistry misconception. To the best of my knowledge there are no robust large-scale observations of increasing pH seasonal amplitude over the historical period. Indeed, there are limited pH time series that extend over a sufficient time period to separate changes in pH seasonal amplitude from long-term trends. In addition, the CMIP5 models actually project the opposite of that stated here (i.e. they project reductions in the seasonal amplitude of surface ocean pH under RCP8.5). In 9 CMIP5 models studied, surface ocean pCO₂ and [H⁺] seasonal amplitude were both shown to increase substantially by 2100 under RCP8.5 (Kwiatkowski & Orr, 2018). These model projections are supported by historical observations of increasing pCO₂ seasonal amplitude (e.g. Landschützer et al., 2018). However, in the same models, pH seasonal amplitude was shown to decline slightly as the models project greater relative increases in [H⁺] mean state than in [H⁺] seasonality (Kwiatkowski & Orr, 2018).</p> <p>I suggest "pH" is changed to "[H⁺]" in the above statement. The log scale of pH makes the discussion of changes in pH seasonal amplitude particularly counter intuitive to readers that are not specialists in ocean carbonate chemistry.</p> <p>References:</p> <p>Kwiatkowski, L. & Orr, J. C., 2018. Diverging seasonal extremes for ocean acidification during the twenty-first century. <i>Nature Climate Change</i>, 8 (2), 141-145.</p> <p>Landschützer, P. et al., 2018: Strengthening seasonal marine CO₂ variations due to increasing atmospheric CO₂. <i>Nature Climate Change</i>, 8 (2), 146-150, doi:10.1038/s41558-017-0057-x. [Lester Kwiatkowski, France]</p>	Taken into account - In response to the reviewers this section on pH changes, saturation states and seasonality has been rewritten and reorganised Taken into account - In response to the reviewers this section on pH changes, saturation states and seasonality has been rewritten and reorganised

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
25299	5	24	41	24	43	Low confidence is being attributed to a statement that is wrong. The seasonal amplitude of pH has not increased significantly. It has more than likely declined (see my previous comment regarding the work by Kwiatkowski and Orr, 2018). [James Orr, France]	Taken into account - In response to the reviewers this section on pH changes, saturation states and seasonality has been rewritten and reorganised Taken into account - In response to the reviewers this section on pH changes, saturation states and seasonality has been rewritten and reorganised
24873	5	24	43	0		<p>Add at the end of paragraph (lines 39-43)</p> <p>"In deep waters, time series are less abundant and show generally lower trends than those observed on the ocean surface. However, the intermediate and deep layers of the Irminger Sea, in the subpolar North Atlantic, presents acidification rates very similar (-0.015+-0.001 per decade) to surface observations (García-Ibáñez et al., 2016). The high acidification rates observed in the intermediate and deep waters (1000 and 3300 m) of the North Atlantic subpolar gyre are related to the deep vertical convection guided by southern overturning that transports acidified waters to very deep layers (Perez et al. 2018). [Fernandez Fiz, Spain]</p>	Taken into account - In response to the reviewers this section on pH changes, saturation states and seasonality has been rewritten and reorganised Taken into account - In response to the reviewers this section on pH changes, saturation states and seasonality has been rewritten and reorganised
24703	5	24	43	24	43	need to fully explain the low confidence here and therefore imply how this could be addressed as its an important issue for understanding pressure on fishters, aquaculture, reef systems etc and become even more important when compound events are considered. Suggest that the sentence is updated to say: ...drivers of change at regional scales, predominantly due to lack of observations at both local, regional and synoptic scales. [Shutler Jamie, United Kingdom (of Great Britain and Northern Ireland)]	Taken into account - In response to the reviewers this section on pH changes, saturation states and seasonality has been rewritten and reorganised Taken into account - In response to the reviewers this section on pH changes, saturation states and seasonality has been rewritten and reorganised

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
24875	5	24	44	0		<p>Perez et al. (2018) using a database analysis showed that the present rate of supply of acidified waters to the deep Atlantic could cause the aragonite saturation horizon to shoal by 1,000–1,700 metres in the subpolar North Atlantic within the next three decades. They also find that, during 1991–2016, the decrease in the concentration of carbonate ions in the Irminger Sea caused the aragonite saturation horizon to shoal by about 10–15 metres per year. The transport of the excess of carbonate ion over aragonite saturation (xc[CO32-])—an indicator of the availability of aragonite to organisms—by the Atlantic meridional overturning circulation shows that the present-day transport of carbonate ions towards the deep ocean is about 44 per cent lower than it was in preindustrial times. Perez et al. (2018) inferred that a doubling of atmospheric anthropogenic CO2 levels—which could occur within three decades according to a 'business-as-usual scenario' for climate change—could reduce the transport of xc[CO32-] by 64–79 per cent of that in preindustrial times, which could severely endanger cold-water coral habitats. The Atlantic meridional overturning circulation would also export this acidified deep water southwards, spreading corrosive waters to the world ocean.</p> <p>https://www.nature.com/articles/nature25493 DOI 10.1038/nature25493 [Fernandez Fiz, Spain]</p>	Accepted Accepted
14229	5	24	45	24	46	are these the declines projected to occur by 2100 ? Please clarify. [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	Taken into account - In response to the reviewers this section on pH changes, saturation states and seasonality has been rewritten and reorganised Taken into account - In response to the reviewers this section on pH changes, saturation states and seasonality has been rewritten and reorganised
27625	5	24	45	24	46	What is the reference year for the projected pH declines mentioned here? [Government of Norway, Norway]	Taken into account - In response to the reviewers this section on pH changes, saturation states and seasonality has been rewritten and reorganised Taken into account - In response to the reviewers this section on pH changes, saturation states and seasonality has been rewritten and reorganised
4177	5	24	45	24	47	Need to state the timeframe of these projections. End of the XXI century? And in relation to which date, present or pre-industrial times? [Carles Pelejero, Spain]	Taken into account - In response to the reviewers this section on pH changes, saturation states and seasonality has been rewritten and reorganised Taken into account - In response to the reviewers this section on pH changes, saturation states and seasonality has been rewritten and reorganised

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
10037	5	24	47	24	53	On line 52 is should read "... be undersaturated with respect to Aragonite...". Also, this paragraph could be confusing as it jumps from discussing CO32- concentrations to saturation to pH. It would be better to be more consistent throughout this section. If CO32- concentrations are going to be discussed then it is important to discuss why they are important to organisms prior to this paragraph. Also in the paragraph, there is reference to pH changes in North Atlantic, what about other ocean basins? If no information on other basins is available then use "for example" in the sentence, otherwise it sounds like only the North Atlantic sea floor is changing. [Tommy Moore, United States of America]	Taken into account - In response to the reviewers this section on pH changes, saturation states and seasonality has been rewritten and reorganised Taken into account - In response to the reviewers this section on pH changes, saturation states and seasonality has been rewritten and reorganised
7073	5	24	48	0		Remove "a" [Nina Hunter, South Africa]	Taken into account - In response to the reviewers this section on pH changes, saturation states and seasonality has been rewritten and reorganised Taken into account - In response to the reviewers this section on pH changes, saturation states and seasonality has been rewritten and reorganised
4513	5	24	52	24	52	What about eastern boundary upwelling systems (e.g. Gruber et al. 2018 or Franco et al. 2018, JGR)? Franco et al., for example, shows that part of the Humboldt EBUS is projected to become undersaturated with respect to calcite by the end of this century. [The UBern Team Group Review, Switzerland]	Taken into account - In response to the reviewers this section on pH changes, saturation states and seasonality has been rewritten and reorganised Taken into account - In response to the reviewers this section on pH changes, saturation states and seasonality has been rewritten and reorganised

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
96	5	24	53	24	53	<p>The text "Models also predict that the seasonal cycle in pH will be amplified in the future." is not accurate. There is no reference supporting this statement in the text. Models actually show the opposite of this after trends in mean state pH are removed from future projections. That is, in 9 CMIP5 models studied, the seasonal amplitude of global surface ocean pH was shown to decrease by $16\pm 7\%$ by 2100 under RCP8.5 (Kwiatkowski & Orr, 2018). This is despite the seasonal cycle of $[H^+]$ increasing by $81\pm 17\%$ in the same models over the same RCP8.5 projections. Although somewhat counter intuitive, the projected decrease in pH seasonality is simply a consequence of the log scale of pH and the fact that the CMIP5 models typically project greater relative increases in $[H^+]$ mean state ($117\pm 3\%$) than in $[H^+]$ seasonal amplitude ($81\pm 17\%$) over RCP8.5 (see figures 1 and 2 in Kwiatkowski & Orr, 2018).</p> <p>I suggest "pH" is changed to "$[H^+]$" in the above statement. The log scale of pH makes the discussion of changes in pH seasonal amplitude particularly counter intuitive to readers that are not specialists in ocean carbonate chemistry.</p> <p>References:</p> <p>Kwiatkowski, L. & Orr, J. C., 2018. Diverging seasonal extremes for ocean acidification during the twenty-first century. Nature Climate Change, 8 (2), 141-145. [Lester Kwiatkowski, France]</p>	Taken into account - In response to the reviewers this section on pH changes, saturation states and seasonality has been rewritten and reorganised Taken into account - In response to the reviewers this section on pH changes, saturation states and seasonality has been rewritten and reorganised
4179	5	24	53	24	53	<p>Need to substantiate the sentence on seasonal cycle amplification with a reference. [Carles Pelejero, Spain]</p>	Taken into account - In response to the reviewers this section on pH changes, saturation states and seasonality has been rewritten and reorganised Taken into account - In response to the reviewers this section on pH changes, saturation states and seasonality has been rewritten and reorganised
4515	5	24	53	24	53	<p>Seasonal cycle in pH decreases, but increases for H^+ (see Kwiatkowski et al. 2018, NCC) [The UBern Team Group Review, Switzerland]</p>	Taken into account - In response to the reviewers this section on pH changes, saturation states and seasonality has been rewritten and reorganised Taken into account - In response to the reviewers this section on pH changes, saturation states and seasonality has been rewritten and reorganised

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
25297	5	24	53	24	53	The statement that “Models also predict that the seasonal cycle in pH will be amplified in the future.” is just plain wrong. See Kwiatkowski and Orr (2018, Nature Climate Change). They show that the amplitude of the seasonal cycle of pH actually declines (based on an ensemble of CMIP5 models forced under the RCP8.5 scenario. Conversely, the seasonal amplitude of [H+] is amplified. [James Orr, France]	Taken into account - In response to the reviewers this section on pH changes, saturation states and seasonality has been rewritten and reorganised Taken into account - In response to the reviewers this section on pH changes, saturation states and seasonality has been rewritten and reorganised
25327	5	24	54	24	54	anthropopogenc' should be 'anthropogenic' [Chiara Lombardi, Italy]	Taken into account - In response to the reviewers this section on pH changes, saturation states and seasonality has been rewritten and reorganised Taken into account - In response to the reviewers this section on pH changes, saturation states and seasonality has been rewritten and reorganised
33689	5	24	54	24	54	The models show that the greatest change in saturation state is, in fact, the lower latitudes and not the higher latitudes. While they may remain supersaturated for the foreseeable future, the relative change in free-energy to drive calcification is greatest in the tropical systems. [Government of United States of America, United States of America]	Taken into account - In response to the reviewers this section on pH changes, saturation states and seasonality has been rewritten and reorganised Taken into account - In response to the reviewers this section on pH changes, saturation states and seasonality has been rewritten and reorganised
10773	5	25	0	25	0	It would be more reader-friendly if the locations OMZs are somehow indicated in Figure 5.6e. [Michio Kawamiya, Japan]	Rejected - the figure is already quite complex Rejected - the figure is already quite complex

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
4867	5	25	0	0		Figure 5.6. Visually beautiful figure! Define NPP. Is there no observational data for NO3? Please explain the observed squiggle in NPP? The i) label is in the wrong place. Model uncertainty and internal variability is not shown in the ph graph – or is the variability so minor it is invisible? If so this needs to be explained. In the legend it is not necessary to repeat "in surface pH, upper 100 m nitrate, O2 averaged over 100–600 m, and NPP integrated 1 over top 100 m". Just say "...for the same". It would be more interesting to see observed levels of pH, O2 and NO3, rather than the linear trend. Also the 'arbitrary' reference period is not helpful. In fact, It would be helpful if the graphs showed actual levels rather than deviations, if that can be done, then there is no need for an 'arbitrary' reference period at all. What is the reference period in the models? Or do the models model change rather than actual levels? What one really wants to see here is observed concentrations against modelled concentrations. The maps in the central panels can show the change, that's fine. - "Panels b, e, h and k show spatial patterns" of which scenario? And for which time point? It would help if the contours in the maps corresponded to the legend categories (at least every second bin), currently they do not and this is confusing, because it means the black lines cross over the colour categories. [Debra Roberts and Durban Team, South Africa]	Accepted Accepted
23955	5	25	0	0		Figure 5.6 b,e,h,and k: We would request to clarify which scenarios (RCP8.5?) were used to make these figures. [Government of Japan, Japan]	Accepted Accepted
28763	5	25	0	0		editing: the indication of panel i) is down on l) [Government of Brazil, Brazil]	Accepted Accepted
28765	5	25	0	0		editing: y axis label in panel j) is not alined with above ones, panels a) d) and g) [Government of Brazil, Brazil]	Accepted Accepted
4517	5	25	3	25	3	delete 'deep' [The UBern Team Group Review, Switzerland]	Taken into account - In response to the reviewers this section on pH changes, saturation states and seasonality has been rewritten and reorganised Taken into account - In response to the reviewers this section on pH changes, saturation states and seasonality has been rewritten and reorganised
10689	5	25	8	0		Mongwe et al. (2018) do no appear to provide pH data. [Jean-Pierre Gattuso, France]	Taken into account - In response to the reviewers this section on pH changes, saturation states and seasonality has been rewritten and reorganised Taken into account - In response to the reviewers this section on pH changes, saturation states and seasonality has been rewritten and reorganised

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
7075	5	25	9	0		Remove "the" [Nina Hunter, South Africa]	Taken into account - In response to the reviewers this section on pH changes, saturation states and seasonality has been rewritten and reorganised Taken into account - In response to the reviewers this section on pH changes, saturation states and seasonality has been rewritten and reorganised
7077	5	25	12	0		Should "reliance" be spelt "reliance"? [Nina Hunter, South Africa]	Taken into account - In response to the reviewers this section on pH changes, saturation states and seasonality has been rewritten and reorganised Taken into account - In response to the reviewers this section on pH changes, saturation states and seasonality has been rewritten and reorganised
33691	5	25	13	25	13	Make it clear these are values for surface water only. [Government of United States of America, United States of America]	Taken into account - In response to the reviewers this section on pH changes, saturation states and seasonality has been rewritten and reorganised Taken into account - In response to the reviewers this section on pH changes, saturation states and seasonality has been rewritten and reorganised
31683	5	25	16	0		Figure 5.6. Rename the order of letters for them to be sequential in the legend, i.e. a-d would be the ones on the left, d-h at the middle... [Hans-Otto Poertner and WGII TSU, Germany]	Accepted Accepted
31685	5	25	16	0		Figure 5.6. For the color legend at bottom, which seems to correspond to the panels at the right, you may want to shift the legend to that side and also use a different set of color for these panels because this uncertainty is different than the uncertainty of the panels at the left - so in order to make all distinctions clear, its best to use different color for different things in the same figure. For the RCPs, use the corresponding official IPCC colors. [Hans-Otto Poertner and WGII TSU, Germany]	Accepted Accepted
31687	5	25	16	0		Figure 5.6. The caction should be reworded to avoid so much repetition of these technical aspects - as it is right now, it adds unecesarry complexity. [Hans-Otto Poertner and WGII TSU, Germany]	Accepted Accepted
15687	5	25	16	25	16	What is the timescale of panels "b, e, h and k"? Presumably "patterns of simulated change" in 2100 under RCP8.5? It's not clear from the figure or legend. (also, the x-axys need units). Legend items need to be re-ordered to be in agreement with the actual order of panels (i.e., pH, O2, NO3, NPP) [EUCE, Belgium]	Accepted Accepted

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
12005	5	25	16	25	23	Fig 5.6 and caption. I am somewhat confused regarding the observational data sets used in panels a, d, g and j and some of the references given are dated. For NPP, Behrenfeld et al. 2006 is referenced but this dataset has long been surpassed with the production of the ocean colour and NPP climate data records produced by ESA's CCI projects, with numerous publications (e.g. Melin et al. 2017, Remote Sens. Env., 203, 139-151, https://doi.org/10.1016/j.rse.2017.03.039). If it just refers to the use of the Behrenfeld et al. 2006 algorithm with the updated satellite record, this should be made clear, although I would encourage an ensemble of algorithms to be used with uncertainties given the variability between them (e.g. Lobanova et al. 2018, Remote Sens., 10, 1116; doi:10.3390/rs10071116). Reference is also made to Smith et al. 2008 for SST, but no SST data set is presented and again the reference is dated, with more up to date records available. Stramma et al. 2011 for oxygen is not quite so dated but there has been a vast increase in oceanic oxygen measurements since then, especially from biogeochemical floats, so maybe the record could be extended? [Nicholas Hardman-Mountford, United Kingdom (of Great Britain and Northern Ireland)]	Accepted Accepted
4521	5	25	16	25	26	Panels i and l are not marked [The UBern Team Group Review, Switzerland]	Accepted Accepted
27627	5	25	16	26	5	Figure caption lacks information about which emission scenario panel b, e, h and k are based on, and what is the time scale for the simulated changes. [Government of Norway, Norway]	Accepted Accepted
31797	5	25	16	26	5	add "i)" and "l)" to the two panels on the lower right [Hans-Otto Poertner and WGII TSU, Germany]	Accepted Accepted
32571	5	25	17	25	23	This is a wonderful figure. I think it illustrates a lot of complicated aspects of model & scenario uncertainty in a clearer way than has been shown in previous reports. [Baylor Fox-Kemper, United States of America]	Accepted Accepted
26249	5	25	18	25	18	figure 5.6a. Observational estimates balck line is very difficult to see, make thicker or change color [Angela Landolfi, Germany]	Accepted Accepted
626	5	25	18	25	23	Label the colorbars for (b), and titles, for example 'Surface Ph' help for quick assessments. Are there no errorbars for a)? [Jenna Pearson, United States of America]	Accepted Accepted

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
12001	5	25	18	25	23	Caption for Fig 5.6. The variables represented by the maps of spatial uncertainty in the middle column and the plots of uncertainty in the right column are listed in a different order in the caption to those in the left hand column, with the orders for oxygen and nitrate reversed between panels d/g and e/h and f/i. The figure itself seems to follow the same order between columns, so please adjust the caption accordingly. [Nicholas Hardman-Mountford, United Kingdom (of Great Britain and Northern Ireland)]	Accepted Accepted
12003	5	25	18	25	23	Caption for Fig 5.6. Also, the scenario represented by these maps of spatial variability in the middle column is not given: is this RCP2.6 or RCP8.5. [Nicholas Hardman-Mountford, United Kingdom (of Great Britain and Northern Ireland)]	Accepted Accepted
4519	5	25	19	25	19	add abbreviation NO3 for nitrate [The UBern Team Group Review, Switzerland]	Accepted Accepted
27787	5	25	20	25	22	What are the referece periods (and scenario) for these changes? [Momme Butenschön, Italy]	Accepted Accepted
26251	5	25	22	25	23	figure 5.6c,f,l,l - specificy the varibales each panels refers to [Angela Landolfi, Germany]	Accepted Accepted
28767	5	26	1	0		change – to - . "100-600 m" [Government of Brazil, Brazil]	Accepted Accepted
31983	5	26	3	0	5	Suggest assessing the 2018 papers on larger changes in oxygen reservoirs and the processes used in the methodology. [Hans-Otto Poertner and WGII TSU, Germany]	Accepted
4523	5	26	8	26	19	Needs to be specfied for the entire paragraph, which reference period is assumed in the different studies.. [The UBern Team Group Review, Switzerland]	Accepted
10039	5	26	8	26	19	The opening sentence in this paragraph is broken and needs to be fixed. Also, the concept of time of emergence needs to be defined. [Tommy Moore, United States of America]	Taken into account - this text has been revised and ToE aspects moved
32105	5	26	8	26	19	There is very little text about the changes in OA variables other than pH. This is essentially the only dedicated paragraph to this effect. There has been substantial new work that points out how certain regions, e.g., the Humboldt Current System might transition toward widespread undersaturated conditions with regard to aragonite within a few decades (Franco et al, 2018, doi: 10.1002/2018JC013857) Similar early crossing of critical threshold conditions have been projected to occur in the Arctic and the Southern Ocean, and the California CS. I thus also suggest to downway the prominence of the ToE concept in favor of the absolute changes and the reaching of super critical thresholds. [Nicolas Gruber, Switzerland]	Accepted
16939	5	26	9	26	10	Figure 5.7: For consistency, I would suggest to employ the same units as in the text and in the paper (Tmol decade-1) instead of using in this figure the units umol kg-1 decade-1 which are also employ in the text when referring to the upper 1200m while Tmol decade-1 are used in the text for the entire water column description. [Pedro J. Llanillo, Chile]	Rejected - it was not straight forward to remake this figure

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
15689	5	26	10	26	11	Text needs to be revised: "with the detection of open ocean pH trends requiring around 15 years of data is needed for the resolving of a pH trend" [EUCE, Belgium]	Rejected - text moved / modified
28147	5	26	10	26	11	End of this sentence needs changing [Hilary Kennedy, United Kingdom (of Great Britain and Northern Ireland)]	taken into account
7079	5	26	11	0		Suggest removing "is" to make the sentence read better? [Nina Hunter, South Africa]	taken into account
7081	5	26	16	0		Suggest "of" instead of "for" [Nina Hunter, South Africa]	taken into account
10775	5	26	18	25	18	Some readers may not be familiar with the term Time of Emergency. Please put a reference to Box 5.1 (e.g., "Time of Emergence (see Box 5.1) is longer in coastal regions with..."). [Michio Kawamiya, Japan]	Accepted - ToE parts have been moved to the Box
21709	5	26	18	26	18	".. Is longer ..." may be better expressed as ".. Is later ..." [Government of Republic of Korea, Republic of Korea]	Accepted - ToE parts have been moved to the Box
21711	5	26	18	26	18	Add "(Box 5.1)" right after "Time of Emergence" such that "Time of emergece (Box 5.1)" [Government of Republic of Korea, Republic of Korea]	Accepted - ToE parts have been moved to the Box
21713	5	26	18	26	18	"Time of Emergence" shoule be "Time of emergence" [Government of Republic of Korea, Republic of Korea]	Accepted - ToE parts have been moved to the Box
4183	5	26	18	26	19	This sentence is substantiated by a paper (Sutton et al., 2018) which was submitted but withdrawn, as far as I understand. Hence, the reference should be removed unless another version of this paper is accepted for publication. [Carles Pelejero, Spain]	Accepted - ToE parts have been moved to the Box
15723	5	26	21	26	21	A relevant and interesting paper by Penn et al. appeared in Science in December about the role of deoxygenation on the Permian extinction. It should be cited in the report, including in this section. DOI: 10.1126/science.aat1327 [EUCE, Belgium]	Rejected - Due to space constraints in the final draft, this is considered out of scope
16597	5	26	21	28	54	A large plume of hydrogen sulfide has been observed in the ocean in coastal regions without restricted circulation (Schunck et al., 2013, doi:10.1371/journal.pone.0068661). This may be a relevant point to include in the section on O2 loss, to note that large parts of the open ocean are becoming anoxic and even (periodically) sulfidic. This may also be relevant for the deep pelagic ocean section or the changing coastal seas (section 5.3). Related to this is "functional anoxia" in the Eastern Tropical South Pacific (Thamdrup et al., 2012 doi: 10.1016/j.dsr.2012.03.001). In total, these and similar references point to an ocean not simply losing O2 but actually becoming anoxic and/or sulfidic. [David Janssen, Switzerland]	Rejected - Due to space constraints in the final draft, this is considered out of scope

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
10053	5	26	21	28	55	This section is missing a discussion on why this is a cause for concern. In surface waters a decline in O2 concentration of 3.5% is noticeable, but not a cause for concern. Are we expecting to see the formation of broadscale hypoxic zones in the open ocean? Or is this just a trend that we need to be aware of? [Tommy Moore, United States of America]	Taken into account - we have allocated some of our limited space to this
28151	5	26	23	26	23	Think respiration also has an effect at the surface and net primary production is a better term. [Hilary Kennedy, United Kingdom (of Great Britain and Northern Ireland)]	Accepted
10043	5	26	23	26	25	O2 levels are also controlled by respiration. [Tommy Moore, United States of America]	Accepted
16931	5	26	23	26	26	I would rephrase to: "Dissolved oxygen (O2) levels at the ocean surface are in equilibrium with the atmosphere through air-sea exchange, which is mainly controlled by the water temperature. The photosynthetic activity, by adding dissolved oxygen to the water, may influence the final result of the air-sea exchange. In the dark ocean, dissolved oxygen is provided by ocean circulation and mixing and it is consumed by the biological respiration of the organic matter". [Pedro J. Llanillo, Chile]	Taken into account - the intro has been rephrased slightly
32107	5	26	23	28	28	It is great to see that deoxygenation has been given more space compared to earlier assessments. But this text requires some careful editing and most importantly are more critical evaluation, in my opinion. While the three global assessment of the changes in oxygen indicate a rather similar level of total change, the spatial pattern are actually very, very different. Helm et al. find that most of the changes occurred in the high latitudes, while Schmidtke et al. suggest that most of the changes occurred in the low latitudes. Given this very substantial and at the moment unresolved discrepancy, I find it a bit premature to declare that there is "high agreement" and "robust evidence" at the global scale. This global number is, in the end, the summing up of all the regional changes, and thus reflect thus the regional uncertainties and errors. Instead it behooves the authors here to dig a bit deeper and to assess what the commonalities and differences between the different estimates are and which part we can consider as robust, and which part less. [Nicolas Gruber, Switzerland]	Taken into account - we have delved into the studies and adjusted the confidence assessment
4525	5	26	24	26	24	Maybe say 'solubility controlled' instead of only temperature controlled [The UBern Team Group Review, Switzerland]	Taken into account - text slightly adjusted

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32109	5	26	24	26	27	"equilibrium". This is confusing. I suggest to write here about the air-sea gas exchange, and that the exchange time scale tends to be smaller than the perturbation timescale, which leads to the surface ocean being, on average, relatively close to the saturation level. [Nicolas Gruber, Switzerland]	Taken into account - text slightly adjusted
10045	5	26	29	26	36	The discussion OMZs is poorly phrased and confusing. OMZs are just the minimum, the don't necessarily have any biological significance. This discussion confounds OMZs with hypoxic/dead zones. An explicit definition of hypoxia and anoxia should be added and this paragraph should be revised accordingly. Additionally, estimates of the current extent of hypoxic/anoxic/dead zones and their future extent should be included, not just referenced in passing. [Tommy Moore, United States of America]	Rejected - section revised / altered
16933	5	26	29	26	36	I would include useful information and further clarify some concepts regarding OMZs as in the following: "Oxygen minimum zones (OMZs) are large oceanic volumes with very low dissolved oxygen concentrations. The OMZs are found below the surface mixed layer and are a natural feature of the world ocean. Their existence is due to a combination of weak water ventilation plus a large biological consumption of oxygen. Most of them are found in the biologically productive eastern boundaries of the tropical oceans, as these regions (shadow zones) are not directly ventilated by the well-oxygenated waters of the wind-driven subtropical gyres, i.e. they are not covered by the mean-advective pathways of the subtropical gyres (Reid, 1965; Stommel, 1979; Luyten et al., 1983). Almost the 8% of the total oceanic area presents a permanent subsurface OMZ, and some of them present cores that reach suboxic values (<20 µM) (Paulmier and Ruiz-Pino, 2009). Inside these suboxic cores, denitrification and anammox processes substitute oxygen respiration and this promotes the loss of ~20–40% of the global oceanic-fixed nitrogen (Gruber, 2004). Furthermore, a powerful greenhouse gas (nitrous oxide) is produced inside the OMZs suboxic core (Martinez-Rey et al., 2015; Battaglia and Joos, 2018). There is evidence of an intensification of the OMZs suboxic cores in the geologic past in response to climate warming (Praetorius et al., 2015)". [Pedro J. Llanillo, Chile]	Rejected - section revised / altered

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26253	5	26	34	26	34	promote the ocean source of nitrous oxide - current model projections suggest quite the opposite: a decline in the global net production of N ₂ O, and in the oceanic emissions, due to the combination counteracting effects of ocean warming and deoxygenation (Battaglia and Joos 2018; Landolfi et al., 2017; Martinez-Rey et al., 2015). [Angela Landolfi, Germany]	Rejected - section revised / altered
26255	5	26	34	26	34	The oceanic N ₂ O sources and sinks are regulated by microbial processes that depend both on oxygen concentrations and also on the supply of organic matter. (In oxygenated waters N ₂ O is produced during nitrification, the oxidation of ammonium to nitrate, with a O ₂ -dependent yield. In suboxic waters N ₂ O is produced during an intermediate step of denitrification, the anaerobic remineralization of organic matter via NO ₃ reduction through N ₂ O to N ₂ , and it is consumed during the final step of denitrification when oxygen is sufficiently low). Thus, the warming-induced projected decline in export production leads to a reduction of N ₂ O production by nitrification which is larger than the potential increase in N ₂ O production from denitrification under low oxygen conditions. In all current model projections, this yields an overall net decline in N ₂ O production, which contributes to the projected decline of oceanic N ₂ O emissions (Battaglia and Joos 2018; Landolfi et al., 2017; Martinez-Rey et al., 2015). However, incomplete understanding of the sensitivity to O ₂ of N ₂ O production and consumption pathways, lead to large uncertainties in model parameterizations and thus in future trajectories of marine N ₂ O emissions under global change [Angela Landolfi, Germany]	Rejected - section revised / altered
26257	5	26	34	26	34	Additional references: Landolfi, A., C. J. Somes, W. Koeve, L. M. Zamora, and A. Oschlies (2017), Oceanic nitrogen cycling and N ₂ O flux perturbations in the Anthropocene, Global Biogeochem. Cycles, 31, 1236–1255, doi:10.1002/2017GB005633. [Angela Landolfi, Germany]	Rejected - section revised / altered
4869	5	26	38	0		It would be extremely useful to see graphs of observed oxygen levels at different depths (as well as for observed pH, NO ₃ levels). Somehow broken down by ocean, or showing examples for different regions. i.e. some of the time series that Figure 5.7 is based on. Especially since some of the confidence statements (eg 27-24) appear to be based on observed data. [Debra Roberts and Durban Team, South Africa]	Taken into consideration
7083	5	26	38	0		Suggest change "has" to "have" [Nina Hunter, South Africa]	Accepted

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
11933	5	26	38	28	5	Important reference missing here: A. Oschlies, P. Brandt, L. Stramma, S. Schmidtke, Drivers and mechanisms of ocean deoxygenation. Nature Geoscience 11, 467-473 (2018) provide a good review on the drivers and mechanisms of deoxygenation, warning that projections may be too conservative because they underestimate the impact of increasing oxygen demand by heterotrophic organisms. Perhaps also cite Breitburg et al. (2018, op. cit.) in this section [Wolfgang Kiessling, Germany]	Accepted
28769	5	26	39	0		remove space between numbers and ± [Government of Brazil, Brazil]	Accepted
16935	5	26	39	26	39	The correct number according to the Extended Data Table 1 in Schmidtke et al. 2017 (after rounding) should be 960 ± 429 Tmol decade ⁻¹ , this figure was apparently wrong in the Table 1 (not extended). I would advise to add the quantity that the 2% reduction represents in parenthesis: "or by 2% (4.8 ± 2.1 petamoles) in total since...". [Pedro J. Llanillo, Chile]	Accepted
10047	5	26	39	26	40	If you are going to give a rate of change you need to also give a reservoir size. I.e. how many Tmol of O ₂ are stored in the ocean? Additionally, what is the significance of a 2% reduction in O ₂ ? For most areas of the surface ocean this is negligible. Some discussion on the significance of this is warranted. [Tommy Moore, United States of America]	Rejected - section revised / altered
16947	5	26	40	226	40	I would add: "With oxygen loss estimates for the upper 1000m ranging from 243 ± 124 Tmol O ₂ decade ⁻¹ since the decade of 1960 (Ito et al. 2017) to 550 ± 130 Tmol O ₂ decade ⁻¹ between 1970 and 1990 (Helm et al. 2011)." Ito paper doi: 10.1002/2017GL073613 [Pedro J. Llanillo, Chile]	Accepted
13041	5	26	40	26	43	The message of the sentence is not clear, in particular regarding the Arctic Ocean. [Government of Germany, Germany]	Accepted

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
16937	5	26	40	26	43	According to the Extended Data Table 1 in Schmitdtko et al. 2017 the lowest oxygen levels are found in the North Pacific not in the Equatorial regions, followed by those in the Equatorial Pacific. In addition the decreasing trend is of similar magnitude in the Arctic, the south pacific and the Eq atlantic, I have updated the info in the following: "By region, the largest trends are seen in the Equatorial Pacific ocean (that contain the second lowest oxygen levels), followed by the North Pacific (lowest oxygen levels), the Southern Ocean and the South Atlantic (from 210 to 119 Tmol decade ⁻¹ respectively) regarding the entire water column or 1-3 umol kg ⁻¹ decade ⁻¹ in the upper 1,200m (Figure 5.7), while the Arctic, the South Pacific and the Equatorial Atlantic show an intermediate decline (Schmidtke et al., 2017)". [Pedro J. Llanillo, Chile]	Accepted
27629	5	26	40	26	43	Typo -strong written twice. [Government of Norway, Norway]	Accepted
7087	5	26	41	0		Opening bracket before "from" but where is the closing bracket? [Nina Hunter, South Africa]	Accepted
7085	5	26	42	0		Suggest remove "strong" after "shows" [Nina Hunter, South Africa]	Accepted
628	5	26	42	26	42	What is going on at the equator? Is this a wave signal? [Jenna Pearson, United States of America]	Rejected - out of scope
17171	5	26	42	26	42	Extra word "strong a strong" should be " a strong" [Shalini Singh, Fiji]	Accepted
20257	5	26	42	26	42	Remove strong at the end of line 42 [APECS Group Review, Germany]	Accepted
16519	5	26	42	26	43	strong a strong decline.....?? [Tsuneo Ono, Japan]	Accepted
32531	5	26	42	5	42	typo: "strong" twice. [Yassir Eddebbar, United States of America]	Accepted
7089	5	26	43	0		Suggest change "in" to "on" [Nina Hunter, South Africa]	Accepted
32111	5	26	43	26	45	This discussion about the differences between the different methods needs to be greatly expanded. Given its crucial importance in supporting the summary statement that goes all the way into the SPM, these fundamental differences cannotbe pushed away with one sentence. [Nicolas Gruber, Switzerland]	Accepted
4527	5	26	44	26	44	the estimates also differ in the deep ocean [The UBern Team Group Review, Switzerland]	Accepted
7091	5	26	45	0		Change "affects" to singular [Nina Hunter, South Africa]	Accepted
10049	5	26	45	26	50	This a coastal feature seen amongst all EBUCs and is not reflective of the open ocean. Given that this paragraph focuses on the large scale features this statement either needs to explicitly state this or be moved elsewhere as it is misleading otherwise. [Tommy Moore, United States of America]	Accepted

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
23957	5	26	46	26	47	<p>We would suggest citing original papers and add another work in the Northwestern Pacific. i.e., "with oxygen declines of over 20% at sites in the Northeastern Pacific between 1956-2006 and the California Current between 1964-2006 (Levin, 2017)." should be replaced by "with oxygen declines of over 20% at sites in the Northeastern Pacific between 1956-2006 (Whitney et al. 2007), the Northwestern Pacific between 1954-2014 (Sasano et al., 2018) and the California Current between 1984-2011 (Bograd et al. 2011)."</p> <p>Whitney, F. A., H. J. Freeland, and M. Robert, Persistently declining oxygen levels in the interior waters of the eastern subarctic Pacific, <i>Progress in Oceanography</i>, 75, 179-199 (2007). https://doi.org/10.1016/j.pocean.2007.08.007</p> <p>Sasan, D., Y. Takatani, N. Kosugi, T. Nakano, T. Midorikawa, M. Ishii, Decline and bidecadal oscillations of dissolved oxygen in the oyashio region and their propagation to the western North Pacific, <i>Global Biogeochemical Cycles</i>, 32. https://doi.org/10.1029/2017GB005876</p> <p>Bograd, S. J., M. Pozo Buil, E. Di Lorenzo, C. G. Castro, I. D. Schroeder, R. Goericke, C. R. Anderson, C. Benitez-Nelson, F. A. Whitney, Changes in source waters to the Southern California Bight, <i>Deep-Sea Research II</i>, 112, 42-52, 2015. https://doi.org/10.1016/j.dsr2.2014.04.009 [Government of Japan, Japan]</p>	Accepted
7093	5	26	48	0		Insert "the" before "Southern Ocean" [Nina Hunter, South Africa]	Accepted
16943	5	26	48	26	48	The correct percentage according to Helm et al. 2011 is 27% [Pedro J. Llanillo, Chile]	Accepted
28771	5	26	49	0		change – to - . "1970-1992" [Government of Brazil, Brazil]	Accepted
16941	5	26	49	26	49	The correct number according to the Table1 in Schmitdtko et al. 2017 (after rounding) should be 152 Tmol decade-1 [Pedro J. Llanillo, Chile]	Accepted
3917	5	26	52	0		'oxygen increases in subtropics and southern hemisphere'. Please consider the relationship between subtropics and [Zhaomin Wang, China]	Accepted
3919	5	26	52	0		southern hemisphere. [Zhaomin Wang, China]	Accepted

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
32113	5	26	54	26	56	15%: I suggest to be more specific here. Schmidtke reported that this ratio is about 50% over the top 1000m, 25% over the top 2000m and only if the changes over the entire ocean are considered, did they come up with this very low number. There are two reasons why I think that this needs to be discussed and evaluated more carefully. First, the reconstruction of the O2 changes in the deep ocean are much more difficult because of data quality issues. In the past, people often used the relative constancy of the deep ocean properties to adjust the O2 data to arrive at an internally consistent data set. Schmidtke decided against the application of any correction. This permits them to analyze changes in the deep ocean, but at the cost of large uncertainties. I am thus highly sceptical of their deep ocean estimates. Second, a 15% warming contribution implies a huge O2/heat change ratio (see table 2 in Keeling et al., 2010) , much larger than anything we have seen from analyses of the seasonal cycle, basin scale changes, and many other studies. This would also imply much larger changes in the future than any of the models simulate. I think this number needs to be critically evaluated. [Nicolas Gruber, Switzerland]	Accepted
26259	5	26	56	26	57	In addition, there are numerous biogeochemical feedbacks, not fully represented in current earth system models models, that may contribute to marine O2 decline and to the model-data mismatch. A quantitative understanding of the individual contribution of these processes to the observed O2 change is lacking, hindering the attribution of the main drivers of marine O2 decline (Oschlies et al., 2018) Additional reference: Andreas Oschlies et al, Drivers and mechanisms of ocean deoxygenation, Nature Geoscience (2018). DOI: 10.1038/s41561-018-0152-2 [Angela Landolfi, Germany]	Accepted
4871	5	27	0	0		Figure 5.7 - is this difference a modelled trend over time, or a simple difference between the means of two time periods? - what do the solid and dotted lines mean? Spell out DO? [Debra Roberts and Durban Team, South Africa]	Accepted
23959	5	27	0	0		Suggest adding citation in the caption of Figure 5.7. [Government of Japan, Japan]	Accepted
28775	5	27	0	0		Query: is the scale bar missing for a) or is the same? If the same it can be centered. [Government of Brazil, Brazil]	Accepted

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
16945	5	27	1	27	1	I think you should include Helm reference here: (Helm et al., 2011,Talley et al., 2016b). Nevertheless, I believe Helm et al. 2011 managed to quantify the oxygen changes due to the increased upper-ocean stratifications by means of their Figure 3c and 3d. [Pedro J. Llanillo, Chile]	Accepted
14231	5	27	3	27	3	Some indication of what is meant by "ocean physics" would be helpful here. [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	Accepted
16521	5	27	3	27	4	inappropriate bracketting of references [Tsuneo Ono, Japan]	Accepted
28773	5	27	3	27	4	Remove the) after 2013, add comma in al and remove next (in 2015, as follow: "(Whitney et al., 2013; Sasano et al., 2015)," [Government of Brazil, Brazil]	Accepted
7095	5	27	4	0		It is not clear how "Sasano et al" fits into what is being said? Please consider removing or rephrase. [Nina Hunter, South Africa]	Accepted
630	5	27	6	27	7	Can you provide a detail or two as two why the eddies induce low oxygen concentrations? [Jenna Pearson, United States of America]	Rejected - out of scope
16949	5	27	6	27	7	I would modify to include a recent study in the ESP by Czeschel et al. 2018: "... such as the tropical north Atlantic or the tropical eastern Pacific, low oxygen eddies can have a significant impact on oxygen dynamics (Karstensen et al., 2015; Grundle et al., 2017; Czeschel et al., 2018; Stramma et al., 2014)." Czeschel et al. 2018 doi: https://doi.org/10.5194/os-14-731-2018 , Stramma doi: 10.1002/2013JC009470.Received [Pedro J. Llanillo, Chile]	Taken into consideration
31689	5	27	8	0		Figure 5.7 has some lines (dotted and continuous) that are not explained in the caption. [Hans-Otto Poertner and WGII TSU, Germany]	Accepted
1725	5	27	8	27	10	Describe what the solid and dashed lines in the Pacific ocean indacte either in the legend or in the figure caption. [Nora Richter, United States of America]	Accepted
11487	5	27	8	27	10	What do the contours represent? [Anson Cheung, United States of America]	Accepted
3463	5	27	8	27	12	It is unclear what the isobars represent. [Patrick Orenstein, United States of America]	Accepted
256	5	27	8	27	9	Figure 5.7. Please indicate in the caption what the solid and dashed lines are. [Katsuro Katsumata, Japan]	Accepted
632	5	27	9	27	10	Center colorbar. [Jenna Pearson, United States of America]	Accepted
4529	5	27	9	27	9	Need to state that this Figure is based on Schmidtko et al. [The UBern Team Group Review, Switzerland]	Accepted
29193	5	27	9	27	9	source of figure not indicated, and there is no indication of the significance of the trends. I assume it is from Schmidtko et al (2017). They do not contour this field at this fine a level. Is the level of confidence assessed appropriate given reliance on a single study for much of the deep ocean, taking into account that some of the large signals (e.g. South Atlantic) are assessed by Schmidtko et al as reflecting decadal variability not trends? [Stephen Rintoul, Australia]	Accepted

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
5401	5	27	14	27	14	"ocea" should be "ocean" [Kate Moran, Canada]	Accepted
16951	5	27	14	27	14	The reference to Schmitdtko et al. 2017 is missing here. [Pedro J. Llanillo, Chile]	Accepted
17173	5	27	14	27	14	Miss spelled word "ocea" should be "ocean" [Shalini Singh, Fiji]	Accepted
32533	5	27	14	27	14	Typo: Ocean [Yassir Eddebbar, United States of America]	Accepted
27789	5	27	14	27	16	What is driving this increase? [Momme Butenschön, Italy]	Accepted
20293	5	27	15	27	16	"moderate oxygen increase below 1200m": since this is a striking feature in Figure 5.7b, it needs to be elaborated upon. [APECS Group Review, Germany]	Accepted
16953	5	27	20	27	20	Include reference of Brewer: "...due to temperature enhancement (Brewer and Peltzer 2017)". Brewer doi: 10.1098/rsta.2016.0319 [Pedro J. Llanillo, Chile]	Rejected - text revised / section removed
17175	5	27	24	27	24	Removal of repeated word "the" [Shalini Singh, Fiji]	Accepted
29199	5	27	24	27	24	How do you reconcile the statement that oxygen concentrations in the ocean interior have declined, with high confidence (implying there is a trend that exceeds the magnitude of variability), with the discussion of time of emergence of changes in oxygen (which suggests it will be a long time before significant trends emerge)? [Stephen Rintoul, Australia]	Accepted
16955	5	27	26	27	27	The equatorial and tropical Pacific is missing here as a region with measured oxygen loss (Schmitdtko et al., 2017, Ito et al., 2017, Czeschel et al., 2012, Stramma et al., 2008). Czeschel 2012 doi: 10.1029/2012JC008043. Regarding the tropical oceans, instead of saying that "there is limited agreement and limited evidence" I would say that the identification of long-term oxygen trends for the tropical oceans should be regarded with caution due to the strong interannual and interdecadal natural variability found these latitudes. [Pedro J. Llanillo, Chile]	Accepted
3661	5	27	29	27	32	One of missing references here is Nam et al. (2011, Geophysical Research Letters). In this paper, it is shown from five years of continuous observations of subsurface dissolved oxygen (and others) that the ENSO variability does not only regulate oxygen solubility and respiratory demand but also upwelling and undercurrent. Another example of physical control of dissolved oxygen can be seen from Nam et al. (2015, Journal of Geophysical Research - Ocean) how undercurrent and mixture of different water masses can modify the dissolved oxygen and pH. [Nam SungHyun, Republic of Korea]	Rejected - we preferred to highlight recent papers

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
16957	5	27	29	27	32	I suggest stating more clearly the coexistence of natural variability and anthropogenic climate change forcing here. I also advise including a reference to Czeschel et al., 2012 and to Llanillo et al. 2013 doi: 10.5194/bg-10-6339-2013. Finally, I suggest including some key results of the new references. In short, I would rephrase to: "Besides the long-term anthropogenic climate change forcing, the superimposed natural climate variability influences oceanic oxygen levels on interannual and decadal timescales, especially for the tropical ocean OMZs (Deutsch et al., 2011; Czeschel et al., 2012; Llanillo et al., 2013). ENSO variability affects the heat content and respiration rates in the tropical Pacific waters which, while located in the mixed layer, regulate oxygen solubility and respiratory demand (Ito and Deutsch, 2013; Eddebbar et al., 2017). During La Niña phase (north of 10°S) the upper-part of the eastern South Pacific OMZ (ESP-OMZ) is found at shallower depths and denitrification activity increases inside the ESP-OMZ core; while during El Niño the upper-200m in the eastern tropical Pacific are warmer and better oxygenated and the ESP-OMZ is found deeper in the water column (Llanillo et al., 2013)." [Pedro J. Llanillo, Chile]	Taken into account - notwithstanding the space limitations, some of this has been included
21715	5	27	29	27	32	One of missing references here is Nam et al. (2011, Geophysical Research Letters). In this paper, it is shown from five years of continuous observations of subsurface dissolved oxygen (and others) that the ENSO variability does not only regulate oxygen solubility and respiratory demand but also upwelling and undercurrent. Another example of physical control of dissolved oxygen can be seen from Nam et al. (2015, Journal of Geophysical Research - Ocean) how undercurrent and mixture of different water masses can modify the dissolved oxygen and pH. [Government of Republic of Korea, Republic of Korea]	Rejected - paper only tangentially related to topci
4873	5	27	30	0		What is "OMZ"? [Debra Roberts and Durban Team, South Africa]	accepted
32115	5	27	30	27	32	"ENSO variability affects the heat content and respiration rates ..." This statement is not consistent with most studies (see e.g. also Yang et al. Doi:10.1002/2016GB005596). Most studies suggest that it is the change in the thermocline structure (heaving) together with changes in ocean circulation that dominates rather than changes in productivity and export affected the respiration rates. This needs to be reformulated. [Nicolas Gruber, Switzerland]	Accepted

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
16959	5	27	32	27	33	I advise mentioning all the physical processes involved in the ventilation of the OMZs and the corresponding references like in this phrase: "Natural climate variability, combined with the anthropogenic climate forcing, may modify the oceanic circulation and overturning, and thus, the ventilation of the OMZs by lateral jets (Stramma et al. 2010, Duteil et al., 2012, Hahn et al., 2017), turbulent diffusion (Hahn et al., 2014) and diapycnal one-way fluxes (Peña-Izquierdo et al., 2015; Llanillo et al., 2018)." Peña-Izquierdo et al. 2015 (doi 10.1002/2014JC010557); Hahn et al. 2017 (doi 10.1002/2014JC010557), Llanillo et al. 2018 (doi 10.1002/2017JC013509), Stramma et al. 2010 (doi 10.1029/2009JC005976), Hahn et al. 2014 (doi 10.1007/s00382-014-2065-0). [Pedro J. Llanillo, Chile]	Rejected - unfortunately due to space constraints this was not possible
32537	5	27	33	27	33	Duteil et al 2014? [Yassir Eddebbbar, United States of America]	accepted
32535	5	27	36	27	36	Deutsch et al 2014? [Yassir Eddebbbar, United States of America]	rejected - paper included
16961	5	27	37	27	37	I suggest including this reference: "...on oxygen observations (Czeschel et al., 2012; Llanillo et al., 2013), ...". Llanillo et al. 2013 doi: 10.5194/bg-10-6339-2013 [Pedro J. Llanillo, Chile]	Accepted

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
26261	5	27	39	27	40	<p>Estimates of the impact of atmospheric N deposition on global O2 decline differ in magnitude among different model studies that employ different assumption about biological feedbacks, such as the response of nitrogen fixation and denitrification to changes in the N load (Oschlies et al., 2018, Landolfi et al., 2017, Ito et al., 2016, Yang and Gruber, 2016). However, the impact is small as compared to the direct and the indirect effects of the arming driven circulation changes (Oschlies et al., 2018, Landolfi et al., 2017).</p> <p>Additional reference: Oschlies, A., Duteil, O., Getzlaff, J., Koeve, W., Landolfi, A. and Schmidtko, S. (2017) Patterns of deoxygenation: sensitivity to natural and anthropogenic drivers. Philosophical Transactions of the Royal Society A: Mathematical, Physical and Engineering Sciences, 375 (2102). p. 20160325. DOI 10.1098/rsta.2016.0325.</p> <p>Landolfi, A., Somes, C. J., Koeve, W., Zamora, L. M. and Oschlies, A. (2017) Oceanic nitrogen cycling and N2O flux perturbations in the Anthropocene. Global Biogeochemical Cycles, 31 (8). pp. 1236-1255. DOI 10.1002/2017GB005633. [Angela Landolfi, Germany]</p>	rejected - the proposed text does not add anything new to the statement, which in itself is only a small component of the assessment
20261	5	27	41	27	43	<p>Decline of tropical oxygen is shown to be reversed in intermediate layers due to the increase of production in the Southern Ocean with sustained climate warming. W. Fu, F. Primeau, J. K. Moore, K. Lindsay, J. T. Randerson, Reversal of Increasing Tropical Ocean Hypoxia Trends With Sustained Climate Warming. Global Biogeochemical Cycles 32, 551-564 (2018). [APECS Group Review, Germany]</p>	accepted
4531	5	28	1	28	2	<p>high confidence': I think this is debatable: Schmidtko shows relative large total O2 changes in the deeper ocean, where data availability is sparse. I would therefore say medium confidence [The UBern Team Group Review, Switzerland]</p>	accepted

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
32117	5	28	1	28	5	I don't think that there is enough evidence to support this statement, i.e. that there is "high agreement" that only around 10 to 20% of the oxygen decline can be explained by a warmer ocean. This statement is based essentially on two studies only, i.e., on Helm et al. (2011) and Schmidtko et al. (2017). I mentioned already above that the 15% in Schmidtko et al. apply only if the O2 changes are computed across the whole water column, i.e. the thermal component in their study was actually 50% for the upper 1000 m. This is the depth scale over which Helm et al. report their change, i.e., 16% by ocean warming. Thus, when one writes that the two studies are in agreement, one is comparing apples and oranges. The two studies are NOT in agreement with regard to the role of ocean warming. The third study, i.e., Ito et al. (2017) unfortunately do not report the fractional contribution of ocean warming to their inventory change, but their O2/heat change ratio over the top 1000m is about -8 nmol O2/J. This implies a fractional contribution of about 25%, i.e., in between Helm and Schmitko We can contrast this global number with e.g. more regional studies. Stendardo and Gruber (2012) analyzed the O2/heat ratio changes in the North Atlantic (top 1000 m) between ~1950 and 2010 and obtained a value of -3.6 ± 2.8 nmol J ⁻¹ . This implies a warming contribution of nearly 50%. Ocean biogeochemical models tend to find fractional values of around 30%. Thus, I don't see the basis for this statement. What can and should be written here is that ocean warming and other processes tend to reinforce each other and that the contribution of these other processes is very likely larger than that of warming alone (high confidence). [Nicolas Gruber, Switzerland]	accepted
16963	5	28	2	28	2	I would clarify like here: "... explained by the decreased solubility of oxygen in a warmer ocean (Ito et al., 2017; Schmitdko et al., 2017; Helm et al., 2011)". [Pedro J. Llanillo, Chile]	Taken into account - this part has been revised
7097	5	28	3	0		Suggest change "has" to "have" [Nina Hunter, South Africa]	accepted
4411	5	28	3	28	4	medium confidence arising from medium agreement from medium evidence' This is confusing and should be rewritten. [The UBern Team Group Review, Switzerland]	accepted
32119	5	28	4	28	5	I would add here that there is also evidence of substantial interannual variations in the OMZ extent, i.e., Yang et al. (2016) but see also Deutsch et al. (2011) [Nicolas Gruber, Switzerland]	accepted

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
32543	5	28	7	28	24	Perhaps add a discssuion of uncertainties and poorly understood processes from BGC feedbacks as well, as described in the Nature Geoscience review article by Oschlies et al 2018? [Yassir Eddebbar, United States of America]	Taken into account - notwithstanding the space limitations, some of this has been included
4541	5	28	7	28	7	Add references here [The UBern Team Group Review, Switzerland]	accepted
32539	5	28	7	28	9	Which RCP? [Yassir Eddebbar, United States of America]	accepted
16965	5	28	8	28	8	Please specify the time period for this modeling estimation. [Pedro J. Llanillo, Chile]	accepted
20295	5	28	8	28	8	Here and elsewhere in the text, "projected" instead of "predicted" is preferred. Prediction can mean that models are initialized but that is not the case. [APECS Group Review, Germany]	accepted
4187	5	28	8	28	9	Need to state the timeframe of these projections. End of the XXI century? And in relation to which date, present or pre-industrial times? [Carles Pelejero, Spain]	accepted
10051	5	28	8	28	9	Over what time period is this change predicted to occur? By 2100? And from when? [Tommy Moore, United States of America]	accepted
4533	5	28	9	28	9	Not only in the tropics, but also in high latitudes stratification increased and lead to decreases in O2 [The UBern Team Group Review, Switzerland]	accepted
4543	5	28	19	28	19	Add reference to Bopp et al. (2015) here [The UBern Team Group Review, Switzerland]	accepted
32541	5	28	19	28	19	Typo: Resolution [Yassir Eddebbar, United States of America]	accepted
4535	5	28	19	29	19	Add here reference to Cabré et al. [The UBern Team Group Review, Switzerland]	accepted
28777	5	28	20	0		change – to - . "200-3000 m" [Government of Brazil, Brazil]	accepted
4537	5	28	24	28	24	Add here reference to Schmittner et al. (2018, GBC), Yamamoto et al. (GBC) [The UBern Team Group Review, Switzerland]	rejected
4539	5	28	26	28	26	Isn't there high confidence that O2 will decrease but medium confidence in the absolut numbers... [The UBern Team Group Review, Switzerland]	taken into account - assessments amended
32545	5	28	26	28	26	Which RCP? [Yassir Eddebbar, United States of America]	accepted
28153	5	28	28	28	28	I do not understand the term " reduced skill" in this context. [Hilary Kennedy, United Kingdom (of Great Britain and Northern Ireland)]	accepted
16967	5	28	28	28	29	I would modify to: "... and reduced skill to simulate the equatorial zonal jets and the mesoscale/submesoscale turbulence (Bopp et al., 2013; Duteil et al., 2014)". Duteil doi: 0.1002/2013GL058888 [Pedro J. Llanillo, Chile]	rejected - text revised / section removed
4545	5	28	28	28	32	This is only true under sustained high global warming levels. John et al (2016, GRL) shows that NPP recovers under negative CO2 emission scenario [The UBern Team Group Review, Switzerland]	Taken into consideration

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
23961	5	28	29	28	35	<p>It would be beneficial to discuss oxygen dynamics also on a millennium timescale, which is missing in the present formulation of this paragraph. We would suggest adding the below sentence between "..., but with low confidence due to limited evidence." and "At the global scale, ..." .</p> <p>"On millennial rather than centennial timescales, global deep oxygen also may recover or overshoot owing to the influence of enhanced ventilation in the Weddell Sea on the Antarctic Bottom Water (Yamamoto et al., 2015)."</p> <p>The reference is as seen below.</p> <p>Yamamoto A, A. Abe-Ouchi, M. Shigemitsu, A. Oka, A, K. Takahashi and Y. Yamanaka, 2015: Global deep ocean oxygenation by enhanced ventilation in the Southern Ocean under long-term global warming. Global Biogeochemical Cycles, 29, 1801-1815, doi:10.1002/2015GB005181. [Government of Japan, Japan]</p>	accepted
32123	5	28	32	28	35	<p>There are also simulations that suggest a reversal in a warmer climate. Yamamoto et al. (2015) (doi:10.1002/2015GB005181) showed that in a long-term warmer world, deep convection in the Southern Ocean can turn on again, leading to a vigorous ventilation of the deep ocean, enhancing the O2 content of the ocean substantially. Interestingly, paleorecords show something similar, i.e., an increase of O2 in the deep ocean as the ocean is warming (see e.g. Jaccard et al. 2014 (doi:10.5670/oceanog.2014.05). Thus, it seems as if the ocean's transient response to warming is different from its equilibrium response. I recommend to reflect a bit more on this more nuanced perspective [Nicolas Gruber, Switzerland]</p>	accepted
32121	5	28	37	28	49	<p>Take also a look at Long et al (2016) (doi:10.1002/2015GB005310). They suggest slightly longer ToE. [Nicolas Gruber, Switzerland]</p>	Taken into account - ToE text shortened and moved
7099	5	28	38	0		<p>Insert "of" after "years" [Nina Hunter, South Africa]</p>	accepted

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
26453	5	28	39	28	41	I find the sentence "by 2100 the anthropogenic signal...is projected to have emerged above uncertainties...for around 25% of the oceans in the 100-600 m depth range" quite confusing, both linguistically and in terms of its message. It could easily be turned around to say "...in 75% of the ocean the anthropogenic signal will not emerge above uncertainties by 2100", which would have a very different interpretation. To me the main message is that natural variability in the oxygen content of 75% of the ocean interior will still be larger than the climate change signal by 2100. This is also what Box 5.1, Fig.1 c shows, and it is an important conclusion [Florence Poulain, Italy]	Taken into account - ToE text shortened and moved
27791	5	28	47	28	49	Do conservative estimates of time of emergence tend to under- or overestimate the time? From the text my understanding is they underestimate, as they underestimate low frequency variability, but I wouldn't call that conservative. [Momme Butenschön, Italy]	Taken into account - ToE text shortened and moved
5047	5	28	51	28	54	Consider adding if there is a difference for low and high RCP scenarios [Debra Roberts and Durban Team, South Africa]	Taken into account - ToE text shortened and moved
11935	5	28	52	0		regional --> regional [Wolfgang Kiessling, Germany]	accepted
25691	5	28	52	28	52	regional to be changed to regional [Government of India, India]	accepted
32125	5	28	52	28	52	I suggest to replace "in the future" with "in this century". (to reflect my comment above) [Nicolas Gruber, Switzerland]	accepted
32547	5	28	52	28	52	Typo: Regional [Yassir Eddebbar, United States of America]	accepted
25693	5	28	53	28	53	too much use of "robust", please use another term (correlations etc) [Government of India, India]	accepted
21405	5	28	56	0		It seems the major primary producer in the open ocean, cyanobacteria, is missing in this section. [Rui Zhang, Canada]	rejected - specific groups discussed in Pelagic section
16599	5	28	56	32	37	This section addresses the influence of warming and circulation on nutrients well. I think this section would benefit from including the influence of declining O2 on macro- and micronutrient cycles, as this will also influence nutrient delivery from circulation, upwelling, etc. Here are some suggested references N: Kuypers et al., 2005 (doi:10.1073/pnas.0502088102); Lam et al., 2009 (doi:10.1073/pnas.0812444106); Ward et al., 2009 (doi:10.1038/nature08276); Penn et al., 2016 (doi:10.1002/2016GL070438); Fe: Scholz et al. 2014 (doi: 10.1038/ngeo2162). [David Janssen, Switzerland]	rejected - not enough space to go into this - apologies

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
16601	5	28	56	32	37	I would be happy to see discussion of the role that particle-associated anoxic microenvironments may play in removal of bioavailable N species and trace metal micronutrients and/or toxins. I think this is important to consider because it highlights that anoxic waters are not necessary for redox cycling and potential removal of important nutrients. The potential role of these microenvironments will likely expand considering that O2-depleted waters are spatially expanding and intensifying with respect to O2-depletion. Some examples of the role of microenvironments are: Bianchi et al., 2018 (doi:10.1038/s41561-018-0081-0); Glud et al., (2015 doi: 10.1002/lno.10149); Ploug & Bergkvist, 2015 (doi:10.1016/j.marchem.2015.08.012); Stief et al., 2016 (doi:10.3389/fmicb.2016.00098); Wright et al., 2012 (doi: 10.1038/nrmicro2778). Studies such as Wright et al may also be relevant for the Deep Pelagic Ocean section. [David Janssen, Switzerland]	rejected - not enough space to go into this - apologies
20297	5	28	56	32	37	Projected changes in nutrients should be discussed before the primary production. Sometimes, information from the later paragraphs is used already. [APECS Group Review, Germany]	taken into account - this section was reorganised
16579	5	29	0	29		The color scale of figure 5.8 is not suited for daltonians. Please modify the scale avoiding red/green contrast [Jens Rassmann, Belgium]	taken into account
20273	5	29	1	29	18	(C1) The importance of nutrients in controlling marine primary production is highlighted in this section of text, yet as a precursor, the term nutrient is not explicitly defined. Instead, vague terms like 'nutrient resources' or 'nutrient levels' are used. Relevant elements are mentioned later in the section and in the Figure 5.8 caption, but such information should also be provided at the onset of this discussion, or reference to report sections with this information should be provided. For example, in in some contexts CO2 may be considered a nutrient supporting primary production, but that is clearly not the focus here. [APECS Group Review, Germany]	taken into account - this section was reorganised
32129	5	29	1	29	18	In addition to expanding its horizon to include the role of factors other than nutrients, this introductory paragraph needs to be much better referenced. [Nicolas Gruber, Switzerland]	taken into account - this section was reorganised

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
20271	5	29	1	29	4	(E1a) Break into two sentences 1. [Light and nutrients support the base of marine food webs.] 2. [Nutrient levels...], and insert sentence discussing light availability (lines 5-7) between [1] and [2]. Light is mentioned first and should thus be discussed first, before the remainder of the section that focuses on nutrients. [APECS Group Review, Germany]	taken into account - this section was reorganised
27793	5	29	1	29	4	I'm wouldn't call the nutrient supply via mixing and upwelling external, as these nutrients result from the remineralisation processes in the water column and sediments mentioned in the second half of the phrase. I'd rather mention land-derived inputs her such as riverin discharges. [Momme Butenschön, Italy]	taken into account - this section was reorganised
32127	5	29	1	32	37	The whole section 5.2.2.5 needs quite a bit of work. The most important comment pertains to the perspective of net primary production being almost exclusively being determined by the nutrient levels and their ratios. While this view is a good zero order approximation, it falls way short of reality. The magnitude of NPP in today's ocean is to a substantial degree also governed by temperature and zooplankton grazing. This differs from net community production (NCP) and export production (EP), whose magnitude is much more closely tied to the magnitude of the nutrient supply. This overly strong bottom up control perspective on NPP then also clouds the analysis of the future changes, for which Laufkötter et al. (2015) (doi:10.5194/bg-12-6955-2015) demonstrated the key role of e.g., temperature in driving the results of the CMIP5 models. [Nicolas Gruber, Switzerland]	taken into account - this section was reorganised
7101	5	29	2	0		Was "resulting" meant instead of "result"? [Nina Hunter, South Africa]	accepted
26263	5	29	2	29	3	"external nutrient supply (e.g.,..." should include also N2 fixation, which is the largest source of fixed N to the ocean (eg. Jickells et al., 2017). [Angela Landolfi, Germany]	taken into account - this section was reorganised
28779	5	29	5	0		suggestion: ...they can again support phytoplankton growth CHANGE to " support phytoplankton growth again" [Government of Brazil, Brazil]	taken into account - this section was reorganised

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
10863	5	29	5	29	7	<p>In the sentence, "The depth of ocean mixing also controls the light environment that phytoplankton are exposed to, but outside of dark polar regions during winter, spatial variations in phytoplankton activity reflect changes in nutrient levels", the statement about the light control in polar in region is not clear and misleading. Light availability is the main controlling factor of phytoplankton productivity in high-latitude regions (Doney et al., 2007 Nature) – not only "in polar region in winter" as stated in section 5.2.2.5.</p> <p>Please consider suggestion to rephrase the sentence as follows: 'In high-latitude regions, phytoplankton production is primarily limited by light availability, which is controlled by the depth of ocean mixing and water column stratification. Whereas in the low- and mid-latitude regions, spatial variations in phytoplankton activity primarily reflect changes in nutrient levels (Doney et al., 2007)'</p> <p>Reference: Doney, S.C. (2007) Oceanography - Plankton in a warmer world. Nature 444: 695-6. Doi: 10.1038/444695a [Marie-Fanny Racault, United Kingdom (of Great Britain and Northern Ireland)]</p>	taken into account - this section was reorganised
20407	5	29	6	29	7	<p>Here, and throughout the paragraph, the emphasis is very much on nutrients. I fully agree that once there is sufficient light for photosynthesis, nutrient availability will be the prominent factor determining rates of primary productivity. But I think the absolute need for light comes bit short here. At the very least, I would suggest to change "out of polar night" to "whenever sufficient light energy is available". Its not just polar night, its every night anywhere, and all regions below the euphotic zone. [APECS Group Review, Germany]</p>	taken into account - this section was reorganised

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
10865	5	29	7	29	11	<p>The statement "is regulated by available nutrient resources" is not accurate. Please see previous comment on page 29, Lines 5-7, and also note that the highest rates of phytoplankton productivity occur in high-latitude regions (which are primarily controlled by light availability) and in coastal and upwelling regions (Longhurst et al., 1995).</p> <p>Please consider rephrasing the sentence as follows: 'Indeed, the overall production of particulate organic matter by phytoplankton primary production is an important component of ocean biogeochemical cycling and atmospheric CO2 uptake (see Section 5.2.2.3), as well as being a source of food for both pelagic and benthic ecosystems.'</p> <p>References: Doney, S.C. (2007) Oceanography - Plankton in a warmer world. Nature 444: 695-6. Doi: 10.1038/444695a</p> <p>Longhurst, Alan, Shubha Sathyendranath, Trevor Platt, and Carla Caverhill. "An Estimate of Global Primary Production in the Ocean from Satellite Radiometer Data." Journal of Plankton Research 17, no. 6 (June 1, 1995): 1245–71. Doi:10.1093/plankt/17.6.1245 [Marie-Fanny Racault, United Kingdom (of Great Britain and Northern Ireland)]</p>	taken into account - this section was reorganised
8147	5	29	10	0		Benthic and pelagic - please define in parentheses [Nina Hunter, South Africa]	accepted
31799	5	29	11	29	11	where is the footnote #5? [Hans-Otto Poertner and WGII TSU, Germany]	accepted
26265	5	29	13	29	13	"specific forms" should be referred to as phytoplankton species [Angela Landolfi, Germany]	accepted

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
26267	5	29	13	29	14	"plankton is closely linked to the match between the relative supply of different nutrients and their requirements (Hagstrom et al., 2017)..." Although studies based on the resource-ratio theory (Hagstrom et al., 2017, Ward et al., 2013) represent a development in the process-based understanding of the effects of changing biogeochemistry on phytoplankton biogeography, they provide an idealized conceptual framework which assumes equilibrium state and a (bottom-up) nutrient major control. To my knowledge they have never been tested in more complex earth system models under transient climate scenarios where light, temperature and grazing controls of phytoplankton activity are also accounted for. Thus they may appear inappropriate for projecting changes in phytoplankton community structure with high confidence. [Angela Landolfi, Germany]	taken into account - this section was reorganised
26269	5	29	17	29	17	'...competitive success of .." A more recent comprehensive model study under RCP8.5 scenario, which takes into account changes in warming and atmospheric N deposition, suggests that N2 fixers cannot take advantage of the more favourable warm temperatures because they increasingly become P limited (Landolfi et al., 2017). [Angela Landolfi, Germany]	taken into account - this section was reorganised
20409	5	29	20	29	22	I would suggest that in polar regions, in particular the Arctic ocean, changes in light availability might be just as important than changes in nutrient supply. [APECS Group Review, Germany]	accepted
32133	5	29	20	29	22	I don't agree with this statement. It is not in line with most of the analyses I am aware of. Unfortunately, no references are provided here [Nicolas Gruber, Switzerland]	taken into account - this section was reorganised
1727	5	29	23	29	30	Avoid using red and green for anyone who is colorblind. [Nora Richter, United States of America]	taken into account
16603	5	29	23	29	30	Figure 5.8: This figure does not include studies showing Zn limitation or co-limitation from the Costa Rica dome. References for this include Franck et al., 2003, doi: 10.3354/meps252015 (see table 7); Chappell et al., 2016, doi:10.1093/plankt/fbw018. Franck et al. 2003 also showed Zn limitation/co-limitation along the California coast (table 6). There may also be Si limitation in Costa Rica (Chappell et al. 2016 as well as Goes et al., 2016 doi: 10.1093/plankt/fbv108) [David Janssen, Switzerland]	Rejected - this is included
772	5	29	24	29	24	It is better to provide legends in addition to the description of different symbols in the caption. [Mengxi Wu, United States of America]	accepted
3457	5	29	24	29	24	Hard to find Cyan and Yellow circles [Patrick Orenstein, United States of America]	accepted

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
634	5	29	25	29	30	This is not a colorblind friendly figure. Perhaps the size of the dots could indicate the level of certainty of this limitation. [Jenna Pearson, United States of America]	accepted
3201	5	29	25	29	30	It might be helpful to include a legend on this figure that shows the meaning of the colored dots. This would allow the reader to more easily glance at the figure and understand the main points being made, before reading the corresponding text and caption. [Sloane Garelick, United States of America]	accepted
15725	5	29	25	29	30	Some observations on Fig. 5.8 map showing global spatial distribution of pp: pp is very low outside the extreme coastal areas of the major upwelling zones (Humboldt, Benguela, California/Oregon, NW Africa). Do not these upwelling zones have a larger spatial extent? The N. Atlantic is one of the world's most productive regions so has big role on ocean biogeochemical, cycling and global C fluxes and dynamics. These points should be mentioned in text. [EUCE, Belgium]	taken into account - this section was reorganised
26433	5	29	25	29	30	It would be interesting to see a discussion of the outliers in this figure (P, Co, and/or Zn limited systems). [Ethan Pierce, United States of America]	rejected - not enough space to go into this - apologies
29207	5	29	25	29	30	Figure 5.8: Map of the dominant limiting resource - the eastern Mediterranean is P limited, in the figure is indicated only N limited. [Patrizia Ziveri, Spain]	rejected - eastern part is P limited
32131	5	29	25	29	30	I am not convinced that this is the best figure here. It emphasizes the relative role of the different nutrients in limiting NPP, which is clearly interesting, but only marginally relevant in the context of this report. Instead I think a figure emphasizing the change in NPP or production, or a figure showing the relative contribution of different factors in driving the change in NPP would be more powerful. Of course, this is self-serving, but Laufkötter et al (2015) produced some highly relevant figures, showing e.g. the spread of models, the factors controlling the changes in production, etc. [Nicolas Gruber, Switzerland]	taken into account - this section was reorganised
7103	5	29	27	0		Was "Production" meant instead of "Productin"? [Nina Hunter, South Africa]	accepted
9727	5	29	29	29	30	The explanation is difficult to follow and a visual legend could help to understand the figure. [Government of France, France]	accepted
32409	5	30	1	30	5	There is a limit to evolutionary adaptation potential which is correlated to the complexity of the organisms and the complexity of an organisms very likely is also correlated to the life span of an organism. Complex multicellular animals and plants are more vulnerable than unicellular eukarya, bacteria and archaea (Storch et al. 2014) [Daniela Storch, Germany]	rejected - unclear what is requested

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
17363	5	30	1	30	55	The content of this page should be modified with respect to the importance of vertical turbulence flux of nutrients to the photic zone for the primary production (PP), since PP also depends on a subsequent period of stabilization to take off. This is clearly an important factor at high latitudes where too little stabilization during spring bloom is a limiting factor for getting PP going, while in subtropical regions the permanent strong density stratification is always so large that more turbulent mixing is always beneficial for PP. This is nicely demonstrated by Kahru et al. (2010): they showed oppsite influence increased wind mixing on cholorphyll concentration in lower and higher latitudes: Kahru, M., Gille, ST., Murtugudde, R., Strutton, PG., Manzano-Sarabia, M., Wang, H., and Mitchell, BG: 2010. "Global correlations between winds and ocean chlorophyll". Journal of Geophysical Research 115; C12040, doi:10.1029/2010JC006500. [Svein Sundby, Norway]	taken into account - this section was reorganised
32135	5	30	12	30	15	Similar to the statement above, no evidence is provided in support of this statement. The fact that a particular community is limited by a particular nutrient in a proximal way, does not imply that this is the dominant mechanism in the future. Instead, most modeling studies indicate that it is the interaction of multiple factors, including nutrient supply, temperature, and grazing that regulate the response of phytoplankton primary production in the future. Current models come to rather different conclusions about the relative roles of these different mechanisms. [Nicolas Gruber, Switzerland]	taken into account - this section was reorganised
32137	5	30	17	30	32	I got really confused about this paragraph. It starts with a statement of "nutrient changes in the surface ocean over the last few decades" without reference, implying that there is good agreement that nutrients have changed in the recent decades. To my knowledge, no systematic global survey of changes in nutrients has been undertaken so far. There are some notable exceptions at the regional scale, e.g. Kim et al. (2014) (doi:10.1126/science.1258396) reported changes in the nitrogen content relative to phosphorus in the North Pacific, and some of the work from the BATS/HOT programs (e.g. Karl et al.) [Nicolas Gruber, Switzerland]	taken into account - this section was reorganised
26435	5	30	20	30	20	Reconsider word choice. [Ethan Pierce, United States of America]	accepted
7105	5	30	22	0		Remove "at" [Nina Hunter, South Africa]	accepted

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
26271	5	30	24	30	25	<p>"anthropogenic nitrogen..." Earth system model studies suggest that the increase in atmospheric N deposition appears compensated by the onset of biogeochemical feedbacks (suppression of N₂ fixation and onset of denitrification) that prevent changes in biological productivity (Somes et al., 2016; Jickells et al., 2017; Landolfi et al., 2017).</p> <p>Somes, C. J., A. Landolfi, W. Koeve, and A. Oschlies (2016), Limited impact of atmospheric nitrogen deposition on marine productivity due to biogeochemical feedbacks in a global ocean model, Geophys. Res. Lett., 43, 4500–4509, doi:10.1002/2016GL068335. [Angela Landolfi, Germany]</p>	taken into account - this section was reorganised
32139	5	30	27	30	28	<p>Enhanced nitrogen input: Given the strong emphasis on the role of nutrients, I was actually surprised not to find more text on the way the atmospheric nitrogen deposition is changing the ocean's stoichiometry and NPP. E.g. Duce et al., 2008; Okin et al., 2011; Krishnamurthy et al., 2007, 2009; Doney et al., 2007; Suntharalingam et al., 2012, Yang et al. 2016. An interesting outcome from all of these studies is the fact that despite a very substantial increase in the input of reactive nitrogen to the ocean, NPP has not changed much. This is, in part, a consequence of large regional compensations in part owing to a strengthening P limitation in the Atlantic (Yang et al. 2016 (doi:10.1002/2016GB005421). Also important are the strong negative feedbacks in the marine N cycle (reduced N₂-fixation and increased denitrification), substantially reducing the buildup of excess N (see e.g. Somes et al. (2016) 10.1002/2016GL068335) [Nicolas Gruber, Switzerland]</p>	taken into account - this section was reorganised
20411	5	30	38	30	39	<p>I would suggest to specify "trends in surface ocean primary production", since you are talking about satellite data. [APECS Group Review, Germany]</p>	accepted

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
24661	5	30	38	30	55	this paragaph is factually incorrect and overly negative e.g. primary productivity is not purely estimated from ocean colour derived chlorophyll. These approaches also use satellite sea surface temperature and some form of optical light dataset (often also satlelite derived) observations. This whole paragraph needs to be re-written e.g. some references are out of date. e.g. there are have 4 international intercomaparisons (e.g. https://www.bco-dmo.org/project/2080) and they allowed the extensive evaluation with in situ datasets. To help the first sentence should be changed to: Much effort has been made to extract information on the trends in primary production over the recent past (~30 years) using satellite datasets. These approaches are our best approach for observing the global (synoptic scale) distributions of primary production and now, given the ~30 year time series of observations, have the potential to allow trend analysis. [Shutler Jamie, United Kingdom (of Great Britain and Northern Ireland)]	taken into account - this section was reorganised
32141	5	30	38	30	55	It's important to state here the time periods which the different studies reported their trends for. [Nicolas Gruber, Switzerland]	accepted
4875	5	30	38	32	37	This and surrounding paragraphs, raises a concerning issue re: the reliability of knowledge of ocean primary production and related measures. In the light of this, the confidence statements in the concluding paragraph 32-28ff may need to be revisited. A high confidence in model predictions only means that the models agree with each other, and not that they reflect reality accurately. If our confidence of what reality looks like is low, then on what basis can we believe the models? Also in the light of this, it is vital that it is always entirely clear whether the text (throughout the chapter) refers to observations or models. [Debra Roberts and Durban Team, South Africa]	taken into account - this section was reorganised
20413	5	30	41	30	43	I think it would be prudent to specify a time-period over which the changes of X% yr-1 were observed. [APECS Group Review, Germany]	accepted
20349	5	30	45	45	41	Regarding the caption of the section, does this chapter consider floor systems of the deep sea or the deep sea AND its floor systems? The term „Deep sea floor systems“ only indicates the sea flor but it is also about the deep sea. [APECS Group Review, Germany]	Taken into account - later section
26437	5	30	47	30	49	Consider if there are updated citations that could be included here (there are certainly some from other fields discussing issues with mismatched remote sensing retrievals and poorly sampled in situ measurements). [Ethan Pierce, United States of America]	taken into account - this section was reorganised

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
22825	5	30	49	30	49	While Kahru 2009 is a perfectly acceptable reference, there are at least two updates that attempt to either improve the NPP estimates or merge more satellites, which you may consider referencing. Kahru et al. 2015, J. Mar. Sys. 147: 94-102, and Jacox et al. 2015, DSRII 112:107-116. Lee et al. 2015 (J. Mar. Sys. 149:50-59) also provide an assessment of satellite NPP estimates, generally. [Raphael Kudela, United States of America]	taken into account - this section was reorganised
28781	5	30	52	0		Add ~ in Nino: "Niño" [Government of Brazil, Brazil]	accepted
20415	5	30	53	30	55	This sentence is very confusing to me, in the first part it appears to compare different satellite datasets (i.e. MODIS vs SeaWiFS), but the second part is about a comparison of different algorithms. [APECS Group Review, Germany]	accepted
15727	5	31	1	31	4	Important conclusion regarding (un)reliability of satellite data for detecting long term trends, and the need for in situ measurements. What is the reason for the inability to detect long-term trends? Is it because the length of satellite-derived time series is still fairly short, or is it a more fundamental issue related to the inability of satellites to reliably estimate primary production, due to e.g., subsurface production processes? An explanation for failure of consistent trend detection by satellites should be provided to avoid reader ambiguity and misinterpretations. This statement seems quite contradictory to the value of satellite-derived primary production estimates, given that they have been extensively used in biological oceanography, including global studies of role of oceans in C cycles, links of primary production to fish productivity (eg. Platt et al Nature 2003) and fishing yields (Jennings and Brander 2010 J. Mar. Sys.; Chassot et al. 2010 Ecol. Lett; etc.). Please clarify the text here. [EUCE, Belgium]	taken into account - this section was reorganised
20417	5	31	2	31	2	As a reader, this leaves me wondering what "other validation time series" might be. [APECS Group Review, Germany]	taken into account - this section was reorganised
20419	5	31	3	31	4	(...), especially at regional scales where productivity is controlled by distinct sets of poorly understood processes. [APECS Group Review, Germany]	accepted
32143	5	31	3	31	4	"Low confidence in satellite base trends:" I would go beyond this statement. The satellite records are just hitting their 20 year anniversary. This is fundamentally too short to make any statement about long-term trends in the context of climate change [Nicolas Gruber, Switzerland]	accepted

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
32145	5	31	6	31	12	I suggest to completely revise this paragraph and the next one. Surface nutrients are a VERY BAD predictor of NPP. They are a good predictor of the efficiency of the biological pump, i.e., the net impact biology has on the air-sea CO ₂ flux. See Sarmiento and Gruber (2006). Thus, the implied connection between nutrients and NPP misleads the reader [Nicolas Gruber, Switzerland]	taken into account - this section was reorganised
26455	5	31	6	31	7	What do the authors consider "tropical upwellings"? As mentioned in the upwelling box EBUS are not well resolved in CMIP and therefore there is great uncertainty in the direction of trends in strength and seasonality of upwelling. Maybe this should be noted in this sentence as well? [Florence Poulain, Italy]	taken into account - this section was reorganised
15729	5	31	14	31	15	Redundant. These are modelled trends. Hence, they are not too surprising and probably reflect how the model is parameterised. [EUCE, Belgium]	taken into account - this section was reorganised
32147	5	31	14	31	31	By focusing almost exclusively on the role of nutrients as a the cause for the changes, this text paints a very different picture from that that was found e.g. by Laufkötter et al. (2015). There, the authors emphasized the role of temperature and grazing in driving the changes in addition to the role of nutrient supply. I strongly recommend to completely revise this paragraph. For example, it is very noteworthy to point out that the emergent constraint used by Kwiatkowski et al. (2017) is based on temperature. [Nicolas Gruber, Switzerland]	taken into account - this section was reorganised
26457	5	31	14	31	44	In this section values for RCP8.5 are provided, but not for other RCPs. It is customary to provide values for RCP2.6 and 8.5 to provide a range of scenarios [Florence Poulain, Italy]	accepted
28783	5	31	18	31	23	remove space between numbers and ± [Government of Brazil, Brazil]	taken into account - this section was reorganised
28785	5	31	20	0		Query: It is missing a value before ± 6%? " ...restricted to ± 6% if emergent..." [Government of Brazil, Brazil]	accepted
27795	5	31	20	31	20	this should read +- 3%, see line 23 [Momme Butenschön, Italy]	accepted
26439	5	31	34	31	39	What does "food quality" specifically mean in this context? Consider clearly defining this here. [Ethan Pierce, United States of America]	taken into account - this section was reorganised
32149	5	31	34	31	39	It is again unclear to me what the basis for this statement is. The study by Kwiatkowski et al. (2017) certainly does not provide such information. Oligotrophic regions tend to have a higher N:P and a higher C:P ratio. Is this what the authors are referring to? [Nicolas Gruber, Switzerland]	taken into account - this section was reorganised

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
4189	5	31	36	31	39	I don't think the Kwiatkowski et al 2017 reference in the list (Kwiatkowski, L. et al., 2017: Emergent constraints on projections of declining primary production in the tropical 50 oceans. Nature Climate Change, 7 (5), 355-358, doi:10.1038/nclimate3265) is a good reference in this assertion. The right one may be Kwiatkowski, L., Aumont, O., Bopp, L., Ciais, P., 2018. The Impact of Variable Phytoplankton Stoichiometry on Projections of Primary Production, Food Quality, and Carbon Uptake in the Global Ocean. Global Biogeochemical Cycles 32, 516-528. [Carles Pelejero, Spain]	taken into account - this section was reorganised
27797	5	31	36	31	39	Is this the right reference here? [Momme Butenschön, Italy]	taken into account - this section was reorganised
84	5	31	39	31	39	The reference here (Kwiatkowski et al., 2017) is incorrect. It should be (Kwiatkowski et al., 2018): Reference: Kwiatkowski, L., Aumont, O., Bopp, L. and Ciais, P., 2018. The impact of variable phytoplankton stoichiometry on projections of primary production, food quality, and carbon uptake in the global ocean. Global Biogeochemical Cycles, 32 (4), 516-528. [Lester Kwiatkowski, France]	taken into account - this section was reorganised
332	5	31	39	31	39	add the following text at the end of the paragraph: "As a result of projected decline in phytoplankton in oligotrophic regions, zooplankton is expected to proportionally higher decline, following a process named trophic negative amplification (Chust et al. 2014)" Reference: [Chust, G., J. I. Allen, L. Bopp, C. Schrum, J. Holt, K. Tsiaras, M. Zavatarelli, M. Chifflet, H. Cannaby, I. Dadou, U. Daewel, S. L. Wakelin, E. Machu, D. Pushpadas, M. Butenschon, Y. Artioli, G. Petihakis, C. Smith, V. Garçon, K. Goubanova, B. Le Vu, B. A. Fach, B. Salihoglu, E. Clementi, and X. Irigoien. 2014. [Guillem Chust, Spain]	taken into account - this section was reorganised
26273	5	31	41	31	42	"Changes in the organic matter flux..." Suggest rephrasing: the sign of change of net primary production (NPP) may as well be decoupled from the change in export production (EP). NPP responds to the direct effect of temperature on the metabolic rates of phytoplankton and zooplankton growth and of remineralizing heterotrophic organisms (Schmittner et al., 2008; Taucher and Oschlies, 2011). EP depends on the resupply of new nutrients in the surface photosynthetic layer (as opposed to recycled nutrients) that are strongly controlled by ocean stratification and thus warming (Bopp et al., 2013; Laufkotter et al., 2016; Landolfi et al., 2017) [Angela Landolfi, Germany]	taken into account - this section was reorganised

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
15731	5	31	41	31	53	The changes in pp and especially its export to deep layers and benthos will have major impacts on food webs, and the relative functional composition of fish communities. See e.g., van Denderen et al. 2018 for details. [EUCE, Belgium]	taken into account - this section was reorganised
20259	5	31	41	31	53	Many models do not include "mixotrophic" life styles of marine plankton, which can lead to an enhanced trophic transfer efficiency and C flux (see Ward & Follows, 2016 Marine mixotrophy increases trophic transfer efficiency, mean organism size, and vertical carbon flux, PNAS), and it has been suggested that the conditions mixotrophs thrive in may be enhanced with changing climate conditions described in this section (see Mitra et al., 2014, The role of mixotrophic protists in the biological carbon pump, Biogeosciences, 11(4) 995-1005. Mention of this is warranted given that it could alter some of the changes suggested within this paragraph [APECS Group Review, Germany]	taken into account - this section was reorganised
28787	5	31	43	0		change – to - [Government of Brazil, Brazil]	accepted
12967	5	31	47	31	47	insert 'the' before 'sea floor' ('...flux of organic material to the sea floor ...') [Roberta Hansman, France]	accepted
9729	5	31	49	31	52	How food web structure modulates the "transfer efficiency" is addressed using a new approach in Guidi et al. (2016) Plankton networks driving carbon export in the oligotrophic ocean. Nature 532:465-470 Another up to date summary of diatom contribution to C export is : Treguer et al. (2016) Influence of diatom diversity on the ocean biological carbon pump. Nature Geoscience 11: 27–37 [Government of France, France]	accepted
26275	5	31	55	31	57	maybe oversimplifying. A CMIP5 intercomparison model study suggests that top-down control (grazing) plays a role in regional patterns of NPP Laufkotter et al., 2015. [Angela Landolfi, Germany]	accepted
32151	5	31	55	32	13	Surface nutrients are unfortunately a very poor constraint for ocean productivity. See e.g. Figure 1 in Laufkötter et al. (2015). Thus no such conclusion can be drawn. [Nicolas Gruber, Switzerland]	taken into account - this section was reorganised
27799	5	31	57	32	5	The fact that to my knowledge only one of the CMIP5 models considers dynamic stoichiometry in the nutrient quotas, which doesn't help in resolving the heterogeneity mentioned. [Momme Butenschön, Italy]	taken into account - this section was reorganised

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
4877	5	32	0	0		Box 5.1 It is not clear what data or models these ToE numbers are based on. If ToE values are sometime in the future, does this mean significant trends have not yet been detected in the observed data? The word "observation" appears repeatedly, but does this refer to 'observation' of model data? This is very confusing. [Debra Roberts and Durban Team, South Africa]	Taken into account - the box has been streamlined and simplified in reponse to the range of reviewers comments
9731	5	32	1	32	3	It should be noted more clearly that iron bioavailability will likely change as a function of temperature and pH, as well as altered storm activity, and that overall knowledge of iron bioavailability is poor, even in cyanobacteria and diatoms that have been the best studied. [Government of France, France]	accepted
28155	5	32	2	32	2	Gere and elsewhere in this chapter a definition of the phrase model skill would be useful. [Hilary Kennedy, United Kingdom (of Great Britain and Northern Ireland)]	taken into account - this section was reorganised
28789	5	32	9	0		Please, remove) after 2017 [Government of Brazil, Brazil]	accepted
28157	5	32	10	32	10	Is an improvement in model skill an improvement in parameterisation or sophistication or what? [Hilary Kennedy, United Kingdom (of Great Britain and Northern Ireland)]	taken into account - this section was reorganised
15733	5	32	17	32	19	The long time required to detect trends could arguably be used to start them ASAP and not delay longer. [EUCE, Belgium]	taken into account - this section was reorganised
31985	5	32	28	0	37	Can something be said about the magnitude of spatial shifts in nutrient distribution? Also, primary production also responds to warming, acidification and oxygen loss. These relationships and interactions should also be considered and assessed. [Hans-Otto Poertner and WGII TSU, Germany]	taken into account - this section was reorganised
32153	5	32	28	32	37	Based on all my comments about, this conclusion section needs to be reformulated [Nicolas Gruber, Switzerland]	taken into account - this section was reorganised
32163	5	32	28	32	37	The assessment of the changes in nutrients and NPP here does not make any connection to the role of other stressors, such as those emanating from OA or from things such as extreme events, i.e., heat waves, etc. [Nicolas Gruber, Switzerland]	taken into account - this section was reorganised
7107	5	32	33	0		Suggest insert "a" before "modest" [Nina Hunter, South Africa]	accepted
7109	5	32	35	32	37	Was "as our understanding worsens" intended? [Nina Hunter, South Africa]	accepted
31803	5	32	40	34	33	This is a very useful and informative box. [Hans-Otto Poertner and WGII TSU, Germany]	accepted

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
4901	5	32	42	0		Box 5.1 The one concern with ToE is that the concept is basically just of a statistical nature, and does not in fact supply useful information for decision making. For instance, comparing pH and NPP in Figure 1, all this tells you is that pH is less variable and/or more predictable than NPP, and that real/actual divergence from the mean will be statistically significant over a shorter data series (as explained on p33-22). It does not mean attending to pH is more urgent, or that changes in NPP are going to happen later. Changes in NPP may be enormous already, with huge repercussions, it is just that a statistical analysis will not be able to detect these changes conclusively, due to the tremendous local and temporal variability in the data. In this light even the concept of 'detection' is problematic. Sometimes 'statistical significance' or 'confidence level' is overrated and misused (see https://www.ncbi.nlm.nih.gov/pubmed/27209009 for example). So when using "ToE" and "policy responses" (32-47, 34-23) in the same sentence, this needs to come across clearly. Policy makers cannot use ToE to make decisions on what issue is most urgent. This whole issue has given climate-deniers decades of wriggle-room! While it was amply clear to everyone else that something big was unfolding, the deniers could hide behind statistical confidence. It is really dangerous to perpetuate this error. ToE does that. So how do you deal with it? Obviously there is no easy answer. In a clinical medicine trial, if there is even the slightest indication that a new drug has a detrimental effect, the trial can be cancelled. It is a question of 'cost of action' vs 'risk of inaction'. If the risk of inaction is infinite then no cost is too high, basically. But policy makers want to know, 'how sure are we that the risk is real? How serious is the risk really?', because nobody wants to pay the cost. So exactly what question does ToE answer? It tells us 'The trends we are seeing, when analysed statistically, will remain hidden behind internal variability, until we have x amount of data' - but this does not mean the trend is not real or that the risk is negligible. If we wait until statistics gives us the thumbs-up, it may be too late. [Debra Roberts and Durban Team, South Africa]	Taken into account - the box has been streamlined and simplified in reponse to the range of reviewers comments
31995	5	32	42	0		While interesting is time of emergence such a useful concept to provide a wider basis for the understanding of climate related phenomena in the oceans? It shines through in the box text that mechanisms of impacts are also relevant but an update on those is not fully developed? [Hans-Otto Poertner and WGII TSU, Germany]	The text highlighted its relevance to impacts now, however, a comprehensive assessment that directly relates biological impacts to time of emergence is limited and this is an area that need new research
32435	5	32	42	34	31	This box seems to contain very important and useful information. However, it is difficult to understand what this mean for the two selected species. Please try to make the text more understandable and explain the impacts. [Government of Norway, Norway]	Figure deleted. Examples are mentioned in the text now.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
14233	5	32	42	34	33	Box 5.1 - please make explicit what is meant throughout the chapter by Time of Emergence. At the moment it is not clear that all the references to emerging mean the same or similar things. Exposure to Climate Hazards needs to be better highlighted in the box too. [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	Clarified in the text.
16605	5	32	42	34	33	Christian (2014) (doi: 10.1371/journal.pone.0109820) would probably be a useful reference to include in this emergence time discussion. [David Janssen, Switzerland]	Taken into consideration
32157	5	32	42	34	33	The ToE is an interesting concept, but I think it is overemphasized throughout this chapter. I suggest to have this box here, but then to vigorously cut the text in the rest of the chapter. [Nicolas Gruber, Switzerland]	Taken into consideration
31801	5	32	44	33	9	When referring to chapter/sections in AR5, please make sure you also provide the proper reference (not always done). [Hans-Otto Poertner and WGII TSU, Germany]	Text edited
13043	5	32	44	34	31	This comment refers to the text in Box 5.1 and Figure 2. At this place, the relation between the size of the suitable area and the ToE is not clear. One has to read Appendix 5.A.1 at the end of the chapter to have a clearer idea of what the ToE is. Moreover, the Appendix is not cross-referenced in the Box 5.1 or in Figure 2? The text of Box 5.1 should make the relation between suitable area and ToE clearer, without the need of the appendix (a sentence is enough). Why not to mark the ToE in the graphic, for instance with an arrow? Moreover, it seems that the ToE is almost the same for both cod and skipjack (roughly year 2000) but from the text I understood that fish species with small range size (like North Sea cod) are at risk of having earlier ToEs than open ocean fishes. The figure does not reflect this, by indicating an almost simultaneous ToE for both the oceanic and the near-coast species. Or is the ToE not the moment at which changes in area start to occur but the moment at which areas reach their maximum (and start to decrease)? As I say, this is not clear from the text. [Government of Germany, Germany]	Figure deleted.
28791	5	32	49	0		seems the "the ToE" can be removed: "However, there is not a single agreed metric of ToE and for a given variable" [Government of Brazil, Brazil]	Text edited
4547	5	32	54	32	54	Maybe add here reference to Frölicher et al. (2016): Sources of uncertainties in 21st century projections of potential ocean ecosystem stressors. Global Biogeochem. Cycles, 30, 1224-1243. [The UBern Team Group Review, Switzerland]	Text edited

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
20363	5	32	56	33	3	C1: When the terms essential and internal variability are introduced, these concepts are not explained and it makes it hard to follow the rest of the box. [APECS Group Review, Germany]	Taken into account
26459	5	33	0	33		The fact that Nitrate and NPP signals are only dominant over natural variability beyond 2100, while temperature and pH are already dominant in most of the ocean is surprisingly underplayed in the text. It is a major piece of evidence and it would be useful to highlight. [Florence Poulain, Italy]	Taken into account
20365	5	33	3	33	5	C1: This part on variability is unclear, partly because it's not explained what variability exactly means (previous comment), but also because they mention 'considered here'. Is this because we are looking on a local scale? This should be specified. [APECS Group Review, Germany]	Text edited and clarified
25329	5	33	4	33	4	I would remove 'considered here', in agreement with an adjustment of the section structure as suggested above. [Chiara Lombardi, Italy]	Text edited
4549	5	33	8	33	8	should be Frölicher et al. (2016) [The UBern Team Group Review, Switzerland]	Text edited
13045	5	33	8	33	9	Further about the clarity of the text in Box 5.1: "Pelagic organisms with small range size may thus be more (or less) at risk to warming with earlier (or later) ToE at the scale of the area that they inhabit": Is the risk for these pelagic organisms "larger" or "smaller"? It is not clear from the sentence. Particularly, the sense of the sentences in parentheses ("or less"; "or later") is not clear. I think if you delete them, the whole sentence is still correct and clearer. [Government of Germany, Germany]	Text edited
7111	5	33	9	0		Suggest change "to" to "of" [Nina Hunter, South Africa]	Text edited
20367	5	33	11	33	11	C1: It is unclear what detrended data means [APECS Group Review, Germany]	Clarified in the text.
32155	5	33	11	33	12	It is important, I think, to emphasize that one uses here the model generated variability as the "noise". Since most models tend to underestimate variability, the diagnosed ToE is much more likely an underestimate (too early ToE) than an overestimate (too late ToE). This important caveat needs to be explicitly stated here. [Nicolas Gruber, Switzerland]	Clarified in the text.
20373	5	33	14	33	15	E1a: In the figure, cod is mentioned but this should be specified to Atlantic cod (there's also polar cod, Greenland cod etc.) [APECS Group Review, Germany]	Figure deleted
9957	5	33	15	0		Considering model resolution and uncertainty, it may be more accurate to use "regional" where "local" is used throughout Box 5.1. [Adrienne Sutton, United States of America]	Taken into account
14235	5	33	21	33	24	"From an observational viewpoint... "How much data is needed to detect trend and then emergence versus estimates of the actual ToE? Make clear this is a step or part of the ToE but not the full story. [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	Clarified in the text.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
20301	5	33	23	33	24	Here should be stressed that according to the cited study in the mean ~13-15 years are needed. And this varies strongly, with higher latitudes longer time series are needed. Longer time series also result in higher confidence, since long-term oscillation are better captured. As already discussed local responses to natural variability vary and may have a strong impact on ocean variables and alter the magnitude of the calculated trends (they could either amplify or mask anthropogenic warming in the future) [APECS Group Review, Germany]	Clarified in the text.
20299	5	33	24	33	35	Reverse the colorbar as the colours of the figures are not intuitive. The earlier ToE is, the worse for marine species. But the colors indicate the other way round. It would be better to have red for early years and getting to green for late years. In addition here it should be mentioned that these results are calculated from global models. More detailed regional climate models may result in different estimates (since local dynamics are much more complex and specific – e.g. for the Baltic Sea) [APECS Group Review, Germany]	Figure deleted
31691	5	33	26	0		Box 5.1, Figure 1. Here, it seems that the yellow color in maps D and E represents area in which the corresponding data is not existent/not applicable... because the yellow color is not in the legend - however, if this is the case, then a different color such as white would be preferable to explain this because as it is now, it is easy to get the wrong message, specially for quick-readers, who may confuse yellow with the green at the end point of the scale. [Hans-Otto Poertner and WGII TSU, Germany]	Figure changed
3459	5	33	26	33	32	What is the yellow color in D, E, and the polar regions of C? Does that mean insufficient data? [Patrick Orenstein, United States of America]	Figure changed
20369	5	33	26	33	32	E1a: The description on top of the figures is not completely the same as in the description below the figures. For instance, (a) temperature refers to sea surface temperature but this is unclear when only looking at the figure itself. [APECS Group Review, Germany]	Figure changed
32573	5	33	27	33	33	The brightest colors on this colorbar on this figure draw attention to the least well-known and furthest removed impacts. Reversing the direction of the colorbar to go from yellow to blue at long times would draw attention to immediate issues. [Baylor Fox-Kemper, United States of America]	Figure changed
11229	5	33	29	0		unclear what the yellow colour represents; needs explanation in the legend [Inka Bartsch, Germany]	Figure changed
11235	5	33	29	33	29	unclear what the yellow colour represents; needs explanation in the legend [Inka Bartsch, Germany]	Figure changed

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
774	5	33	29	33	31	The caption is a little too ambiguous and I do not know the exact meaning of "interior oxygen". [Mengxi Wu, United States of America]	Figure changed
21717	5	33	29	33	32	It may be better to indicate in the figure caption that all the variables used are annual-means because "the year of emergence" was used instead of "the time of emergence." [Government of Republic of Korea, Republic of Korea]	Figure changed
27801	5	33	29	33	32	Which scenario(s) does this figure refer to? [Momme Butenschön, Italy]	Text edited
20491	5	33	35	33	39	The changes may not alter the natural variability of a key condition, especilly in coastal ocean, but just lengthen the period where the environment represents harsh conditions for the biota within the natural variation. For instance, the number of days above X temperature may increase in coastal areas causing the death of some macroalgae without changing the temperature range of this particular area (DOI: 10.1080/09670262.2011.617840). [APECS Group Review, Germany]	Taken into account
25331	5	33	35	34	31	ToE and the concepts of the exposure to hard and vulnerability of biota. I would mention the combined effects of multiple climate drivers (=multiple hazards) which can exacerbate the effects of single stressors in the habitat and thus on the biota. Also, fishes are an example, but it worth mentioning more clearly the benthic organisms (not only corals) which live in association with the substrates, thus are not able to move and 'escape' the changes occurring in the habitat. [Chiara Lombardi, Italy]	Taken into account
20371	5	33	40	33	41	E1a: The species Atlantic cod and Skipjack Tuna are introduced, but no scientific name is specified. This happens later on (several times), but should be specified here. Then later on, it is unnecessary to mention the scientific names again and again. [APECS Group Review, Germany]	Figure deleted
7113	5	33	42	0		Suggest insert "a" before "large"; remove "with" and replace with "in" [Nina Hunter, South Africa]	Text edited
26461	5	34	0	34		Box. 5.1. Fig 2. - There are several issues with this figure, so I will make several entries: 1) where is it published? It is not in Frolicher et al or Deutsch et al, the two references used. If it is new it should be stated it is not published? 2) the legend refers to c and d "time of emergence of changes" but in my view it shows "habitat suitability area". If i am not right then the figure needs further explanation [Florence Poulain, Italy]	Figure deleted

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
26463	5	34	0	34		Continuing with Box 5.1. Fig 2. 3) The figure seems to indicate skipjack will run out of habitat by 2090. This seems in contradiction with Bell et al. (2018), Lehodey et al (2013) and Yen et al. (2016), all published papers which indicate significant changes in distribution of skipjack but not a disappearance of habitat. Skipjack is the third largest contributor to fish catches and one has to be very sure before predicting it would disappear (no habitat) by 2090, especially when it is not clear the figure has been published and other published papers are not mentioned. [Florence Poulain, Italy]	Figure deleted
26465	5	34	0	34		Continuing with Box 5.1. Fig 2. 4) Atlantic cod has many different stocks, but according to this figure habitat increased 2000-2010 and declines from 2010 to 2020. So far, FAO landings and ICES data suggest cod has actually gone in the opposite direction: declining from 2000 to 2010 and recovering since then to now. How does one reconcile the real data with this habitat assessment? Surely it is at least worth noting that habitat maps do not always fit well with observations? [Florence Poulain, Italy]	Figure deleted
20493	5	34	4	34	13	The entire paragraph lacks of any term about the confidence or likelihood of the assertions and including them would be very helpful for the readers. [APECS Group Review, Germany]	Text edited
32161	5	34	4	34	13	It is probably worth also mentioning the threat emerging from multiple stressors [Nicolas Gruber, Switzerland]	Taken into account
9733	5	34	4	34	6	Given the timescales involved, 'adapt' would be more appropriate than 'evolve'. [Government of France, France]	Text edited

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
11323	5	34	6	34	12	Following my comments on Chapter 1, the text on evolutionary adaptation within this paragraph would benefit from more recent references and clarification and updating regarding evidence for potential evolutionary adaptation. Specifically I recommend that the second and third sentences (lines 6-12; "However, evidence on evolutionary adaptation... cod and tunas (Deutsch et al., 2015; Box 5.1, Figure 2). ") be replaced with the following: Although evidence on evolutionary adaptation to climate drivers is just beginning to accumulate, scope for its occurrence has been described in oceanic (Pespini et al. 2013, Hinnens et al. 2017, Bay et al. 2017), riverine (Kovach et al. 2012, Manhard et al. 2017) and terrestrial species (Diamond et al. 2017, Mills et al. 2018). Successful evolutionary adaptation will certainly have limits, where changes in ocean variables will exceed the scope for adaptation. For example, species-specific thresholds of changes may exceed biological limits, such as warming threshold for coral bleaching (Pendleton et al., 2016) and temperature and oxygen threshold for fishes such as Atlantic cod and tunas (Deutsch et al., 2015; Box 5.1, Figure 2). [L. Scott Mills, United States of America]	Taken into consideration
28793	5	34	9	0		Insert the word Section before (5.2.3.1) : "(Section 5.2.3.1)" [Government of Brazil, Brazil]	Text edited
9735	5	34	9	34	12	We suggest to add that some of these species-specific thresholds are hardly known for phyto and zooplankton. [Government of France, France]	Text edited
32159	5	34	12	34	13	This is an important statement, but the use of absolute thresholds compared to the relative ones, i.e., those based on the variance of the past, can lead to both an earlier or later ToE. It is just a very different concept. [Nicolas Gruber, Switzerland]	Text edited
1729	5	34	14	34	20	Define in the figure caption what habitat suitability of 0 vs. 1 means. Add a title to the area plots to make it clear what is being shown in c and d. [Nora Richter, United States of America]	Figure deleted
32437	5	34	15	34	15	Box 5.1, Figure 2: The figure is very interesting, but it is hard to understand why the suitable area for the tw species are almost zero in both 1970 and 2100. Or is it another area? Furthermore you may consider to present a magnified figure for the atlantic area for cod since the changes are in this area and as it is now hard to see. [Government of Norway, Norway]	Figure deleted
32497	5	34	16	34	20	Please consider to improve the figure cation in order to make it more understandable e.g. the suitable area part is not explained. [Government of Norway, Norway]	Figure deleted

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
27631	5	34	18	34	18	Typo - Gadus morhua not morhus. [Government of Norway, Norway]	Text edited
13047	5	34	20	34	20	(a,b) should be (c,d)? Caption is not clear. [Government of Germany, Germany]	Text edited
28795	5	34	24	0		Insert the see section before 5.4.2, 5.4.3 : "(see section 5.4.2, 5.4.3)" [Government of Brazil, Brazil]	Text revised
29211	5	34	24	34	29	Challenges for international and regional policies see ref: Ziveri P, Delpiazzi E, Bosello F, Eboli F, van den Bergh J (2017) Adaptation policies and strategies as a response to ocean acidification and warming in the Mediterranean Sea, In: Handbook on the Economics and Management for Sustainable Oceans, Editors: Lisa Emelia Svansson, Paulo A.L.D. Nunes, Pushpam Kumar and Anil Markandya: 339-352 [Patrizia Ziveri, Spain]	Taken into consideration
7115	5	34	26	0		Suggest change "sensitivity" to "sensitive" [Nina Hunter, South Africa]	Text edited
7117	5	34	27	0		Suggest change "post" to "pose"; change "their" to "they" [Nina Hunter, South Africa]	Text edited
26467	5	34	27	34	29	The text indicates[impacts] "may post challenges for international and regional policies as they often require multiple decades...". This is theoretically correct, but disregard the fact that cod (ICES+ NEAFC and EC) and skipjack (Tuna Commissions) already have policies in place. In fact it is surprising the role of regional fisheries management organizations is not mentioned when one of the main issues in relation to CC and fisheries are distributional shifts. [Florence Poulain, Italy]	This is discussed in 5.5.2.
28797	5	34	29	0		Insert the word Section before (5.5.2) : "(Section 5.5.2)" [Government of Brazil, Brazil]	Consistency with IPCC style checked and corrected.
7119	5	34	30	34	31	Suggest rephrase so that sentence makes sense: "that are expected to emergence of stressors and impacts at different time frame" [Nina Hunter, South Africa]	Text edited
20331	5	35	1	35	10	You should also explain what epipelagic, mesopelagic etc is. It has not been done in the corresponding paragraphs. I would do it in this paragraph, because it is easier to understand if it is mentioned all in one, but maybe in each following paragraph you can repeat it shortly in brackets (as you also have done for e.g. ectotherms). Doing so, you could also refer to Figure 5.11 [APECS Group Review, Germany]	Done
32165	5	35	1	45	1	Section 5.2.3 needs a lot of work. First, it is way too long. Second, it is too assertive, i.e., making statements about detection and attribution that are NOT supported by the available literature. [Nicolas Gruber, Switzerland]	All the section has been rewritten

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
32411	5	35	2	35	4	This sentence is based on one study only. It would be good to have more evidence, other citations. The performance of fish and crustaceans will decrease at combined effects of temperature and CO2, especially at their thermal limits [Daniela Storch, Germany]	accepted
14237	5	35	3	35	10	It is worth noting here that, despite shared drivers, responses are highly localised and species-specific; this was one of the key points in AR5. [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	accepted
14247	5	35	3	46	3	This section is hard to follow as the sub-sections are arranged by bathyl depth, then discuss the impacts of various drivers on microorganisms, phytoplankton, zooplankton, fish and so on, scaling up through body size. The lack of subheadings makes the structure unclear to the reader and it seems to jump back and forth from similar impacts of similar drivers on different organisms. This makes the section feel repetitive and dis-jointed. The section could be tightened up considerably by restructuring with sub-headings by climate driver. [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	All the section has been rewritten, now with subheadings
14249	5	35	3	46	3	Where information is providing an update on the AR5 summary this needs to be noted. In some parts of the section, eg, page 37, line 1- page 37 line 8, the text is well referenced but with old citations. I assume that this is providing the useful narrative that the reader needs to know but there have been no major updates to the understanding of this topic since the AR5? If this is the case, it should be clearly stated. Conversely, there are sections sparsely referenced but with very recent citations, e.g., page 36, line 2 - page 36, line 28, where I assume the text is providing update to the AR5, in which case, this need to be more explicit. [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	All the section has been rewritten, now with subheadings and referred to AR5 and S15
20421	5	35	4	35	4	(...) the multiple interacting effects of a changing climate (...). [APECS Group Review, Germany]	text revised
9737	5	35	5	35	7	We suggest to replace « marine microbes » by « plankton and viruses ». [Government of France, France]	removed "marine microbes". Text revised
21407	5	35	6	0		There is no much information about microbes in this section, actually. [Rui Zhang, Canada]	removed "marine microbes". Text revised
28799	5	35	7	0		Please, remove () from 2017, add comma in al. [Government of Brazil, Brazil]	text revised
20325	5	35	7	35	10	The term „predictably“ is not clear. Do you mean some kind of likelihood/confidence? If thats the case, use the dedicated terms. The term predictably is quite obscure since it is not part of the terms normally used to deal with uncertainties so I suggest change it to one include within the guidance for consistent treatment of uncertainties [APECS Group Review, Germany]	removed. text revised

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20327	5	35	7	35	10	The sentence in total is not easy to understand. Is there a break (comma, end of sentence) after „performance“ possible? [APECS Group Review, Germany]	accepted
20423	5	35	9	35	9	I think the word "functions" is obsolete here. [APECS Group Review, Germany]	text revised
10265	5	35	10	35	10	some texts inside of the figure 5.9 seem to be too small for proper readability [Jinsoon Park, Republic of Korea]	accepted
21719	5	35	10	35	10	some texts inside of the figure 5.9 seem to be too small for proper readability [Government of Republic of Korea, Republic of Korea]	accepted
14239	5	35	19	35	22	Suggest that the idea of how using time series links to the statements is introduced in the previous paragraph as currently it feels like a big jump between the two paragraphs. [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	text revised
20303	5	35	19	35	22	Our findings for the Baltic Sea suggest that the state of the AMO should be considered when discussing the state of a coastal ocean. (AMO in the North Atlantic has a periodicity of 60-90 years). Börgel, F., Frauen, C., Neumann, T., Schimanke, S., & Meier, H. E. M. (2018). Impact of the Atlantic Multidecadal Oscillation on Baltic Sea variability. Geophysical Research Letters, 45. https://doi.org/10.1029/2018GL078943 [APECS Group Review, Germany]	text revised
28801	5	35	23	0		Please, change – and - , to commas: "evidence, ranging from experiments to models and field observations," [Government of Brazil, Brazil]	text revised
14241	5	35	25	35	27	A diagram would be useful to illustrate the different depth classifications here. [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	rejected
28803	5	35	27	0		change – to - [Government of Brazil, Brazil]	text revised
15735	5	35	29	35	29	Comment for the whole Epipelagic Ocean section: will biodiversity metrics respond? Any discussion on this? Focus is on single species physiological responses. What about food web and community effects? [EUCE, Belgium]	Suggestion considered. text revised

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
15737	5	35	29	35	29	<p>Comment for whole section. The relative changes in phenologies is not covered well in the chapter. The phasing of predators and prey is likely to become desynchronized due to species specific responses to changes in abiotic factors such as temperature. A mechanistic example of the close coupling between fish larvae and their prey has now been recently demonstrated using field observations at the macroecological scale for a widespread commercially important species, cod. A key element to the coupling is how the species have adapted to long term local temperature conditions; climate induced changes to those temperatures will likely uncouple these links, leading to either changes in larval survival. This could be a mechanism driving species distribution shifts and productivity changes. See Neuheimer et al. 2018 for details. Neuheimer, A. B., MacKenzie, B. R., Payne, M. R. Temperature-dependent adaptation allows fish to meet their food across their species' range. Sci. Advances 4(7): eaar4349 (p. 1-8); DOI: 10.1126/sciadv.aar4349 [EUCE, Belgium]</p>	Accepted. Text revised and citation included
15739	5	35	29	35	29	<p>General comment for Epipelagic section. Emphasis is on physiological and individual level responses to climate change. it would be beneficial to show some population and demographic evidence of changes in order to quantify the magnitude of the impacts at higher levels of biological organisation. it is suggested to put more emphasis on some of the large fish stocks that account for large shares of the world's food and fishmeal/oil production since these are ones supporting much food security and employment. [EUCE, Belgium]</p>	Accepted. Text revised

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Comment id	Chapter	From page	From line	To page	To line	Comment	
31991	5	35	29	44	37	The chapter structure according to biomes is an appealing systematic approach at first sight but does not allow developing a clear picture from mechanisms of effect which may be unifying across or within groups of organisms to their impacts which would reflect mode of life and habitat characteristics. The distinction between climate drivers and their specific expression in different regions as well as their combined (or not) impact on organisms is not clearly developed. In other words, if such systematic is maintained it may be useful to do an update on drivers and their mechanisms of impact and interactions first, then move into the different biomes, talk about their climate characteristics and discuss, explain and project the biome specific phenomena in a comparative way. [Hans-Otto Poertner and WGII TSU, Germany]	All the section has been revised considering these an other suggestions
14245	5	35	31	40	33	This section on observed effects on pelagic ecosystems does not address deoxygenation at all. It is briefly mentioned in the 'Future changes' section but is not given due discussion throughout the section. Considering it's identified in the introduction as one of the major threats to the marine ecosystem and that section 5.2.4, fig 5.7 a shows large decreases in surface oxygen in open oceans, including more detail on this topic is recommended. [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	We have considered it now in multiple climate drivers and future projections, particularly in fishes
20425	5	35	32	35	32	(...), epipelagic ecosystem, build on observations, experimental and modelling studies. [APECS Group Review, Germany]	Text revised
13049	5	35	34	35	46	"The following assessments include the interactions between multiple climate and non-climate stressors, instead of the effects of individual drivers; the latter was solidly established in AR5." That individual climate drivers of ocean ecosystem variability have been studied satisfactorily enough seems to me an overstatement. This sentence is obviously based on studies with ESMs, but I think there is still much to learn about the drivers of habitat changes in the context of climate change, not with models, but with observations! I suggest to tone down, i.e., not writing "solidly established" but rather "widely discussed in AR5 from outputs of ESMs". [Government of Germany, Germany]	Accepted. Text revised
7121	5	35	37	0		Suggest insert "a" before "more" [Nina Hunter, South Africa]	accepted
11937	5	35	41	36	28	Some of the statements are not specific to the epipelagic ocean. Please provide an overview of general concepts (physiological responses) separately. [Wolfgang Kiessling, Germany]	Accepted. Text revised

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
16607	5	35	41	44	37	<p>Additional publications addressing the 2014-2016 multi-year warming event which covered much of the northeast Pacific may be useful for assessing potential ecosystem changes under a warming and/or stratifying ocean. Cavole et al. 2016 and McCabe et al. 2016 are already referenced, but other publications such as Pena et al. 2018 (doi: 10.1002/lno.11056) (phytoplankton); Yang et al., 2018 (doi:10.5194/bg-15-6747-2018) (phytoplankton); Chandler et al. 2014; 2015; 2016 (http://www.dfo-mpo.gc.ca/oceans/publications/soto-rceo/2014/index-eng.html; http://www.dfo-mpo.gc.ca/oceans/publications/soto-rceo/2015/index-eng.html; http://www.dfo-mpo.gc.ca/oceans/publications/soto-rceo/2016/index-eng.html) (multiple aspects of the ecosystem); Bond et al., 2015 (doi: 10.1002/2015GL063306) (causes and brief ecosystem impacts); Di Lorenzo & Mantua, 2016 (doi:10.1038/nclimate3082) (causes of the anomaly, and projected increase in such events with climate change) would give a more complete picture. These references could fit generally into this section, could be added to the discussion of this warm water anomaly on p. 40 lines 15-18, or could fit with the discussion of future changes in the epipelagic ocean (section 5.2.3.1.2, beginning on p.40). [David Janssen, Switzerland]</p>	Rejected, due o shortening of the section

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
26771	5	35	42	35	50	The statement does not reflect the scientific consensus about the dominance and validity of the hypothesis that oxygen is limiting temperature tolerance. Although oxygen limitation has been shown to contribute to setting tolerance limits in some cases (Portner et al., 2017) a number of studies directly testing the hypothesis were not able to confirm it (Jutfelt et al., 2018). Of even greater concern is the fact that Portner et al. neglected to cite and reference any of these studies (Jutfelt et al., 2018). The critical comments by twenty-nine ecophysiologicalists (Jutfelt et al., 2018) in response to a review by Portner et al. (2017), provide a strong statement about the lack of dominance of solely focusing on one factor limiting temperature tolerance. Several recent reviews have pointed out that the underlying mechanisms of thermal tolerance are far from settled (Schulte, 2015; Sokolova et al., 2012; Somero et al., 2017). It is necessary to represent a broader body of the literature on the biochemical and physiological mechanisms of stress tolerance to reflect more accurately the current state of the field. My suggestion for rewriting these sentences is: "Recent evidence from mechanisticsupport the effects of changing temperature and other environmental variables on pelagic marine ectotherms (...). The underlying mechanisms of temperature and stress tolerance in general are likely to be systemic at all levels of biological organization, from cells to whole organisms, but a comprehensive integration of these mechanisms across levels of biological organization is still lacking but is the focus of current research in ecophysiology (Portner et al., 2017; Schulte, 2015; Sokolova et al., 2012; Somero et al., 2017; Tomanek, 2010). Despite the underlying complexity of factors contributing to stress tolerance, the conclusion that biological functions are impacted by warming beyond species' thermal preferences and tolerances remain robust with high agreement of evidence." References not yet included in the report: Jutfelt, F., T. Norin, R. Ern, et al., 2018: Oxygen- and capacity-limited thermal tolerance: blurring ecology and physiology. Journal of Experimental Biology 221, jeb169615. Schulte, P. M., 2015: The effects of temperature on aerobic metabolism: towards a mechanistic understanding of the responses of ectotherms to a changing environment. Journal of Experimental Biology 218, 1856-1866. doi:10.1242/jeb.118851. Sokolova, I. M., M. Fredrich, R. Bagwe, G. Lannig and A. A. Sukhotin, 2012: Energy homeostasis as an integrative tool for assessing limits of environmental stress tolerance in aquatic invertebrates. Marine Environmental Research 79, 1-15. Somero, G. N., B. Lockwood and L. Tomanek, 2017. Biochemical Adaptation: Responses to Environmental Challenges from	Considered. Text revised and shortened
11231	5	35	45	35	47	This conclusion needs a statement that this is only valid for non-photosynthetic organisms [Inka Bartsch, Germany]	text revised
24045	5	35	45	36	6	This description of the hypothesis for the interactive effects of warming and acidification is general and not limited to the epipelagic. Placing the description here (5.2.3.1.1) may give the erroneous impression that these effects are restricted to the epipelagic. It is therefore misplaced and should be moved up to the general description of effects on marine ecosystems. [Peter Thor, Sweden]	text revised
20427	5	35	46	35	47	It would be easier for the reader to follow the line of thoughts if the physiological mechanisms of what were defined within the sentence: The dominant hypothesis explaining the physiological mechanisms of temperature sensitivity is the (...). [APECS Group Review, Germany]	Agreed. Text revised

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
29213	5	35	47	34	50	Regarding warmig affecting the physiology of calcifying phytoplankton: Rosas-Navarro A, Langer G, Ziveri P (2018) 'Temperature affects the morphology and calcification of Emiliana huxleyi strains', PLoS ONE, 13, 3, e0194386. [Patrizia Ziveri, Spain]	text revised. Citation included
20429	5	35	50	35	50	Anoxic conditions hinder marine life that depends on oxygen ... [APECS Group Review, Germany]	text revised
7123	5	35	50	35	51	Please define "anoxic" and "hypoxic" conditions briefly in parentheses [Nina Hunter, South Africa]	these terms are defined in the glossary; nevertheless, the text has been revised
14243	5	35	50	35	52	Please explain the difference between hypoxic and anoxic here. [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	these terms are defined in the glossary; nevertheless, the text has been revised
20495	5	35	52	35	57	There is also some literature that yielded the opposite results, not a significant effect from ocean acidification or effects that disappear in a few generations (e.g. some articles within https://doi.org/10.1093/icesjms/fsx073) so it would be worth mentioning these kind of articles also and stating the current agreement and robustness of these assertions made here. [APECS Group Review, Germany]	text revised
4193	5	35	53	35	57	The quoted references only encompass studies with fish and coccolitophores. Maybe other metadata studies could be included here such as Kroeker, K.J., Kordas, R.L., Crim, R., Hendriks, I.E., Ramajo, L., Singh, G.S., Duarte, C.M., Gattuso, J.-P., 2013. Impacts of ocean acidification on marine organisms: quantifying sensitivities and interaction with warming. Global Change Biology 19, 1884–1896. [Carles Pelejero, Spain]	text revised. Citation included
4195	5	36	2	36	4	I don't think Boyd and Bressac 2016 and Breitburg et al., 2018 are good references here. Maybe just cite Poloczanska et al 2013, as in Fig. 5.9? [Carles Pelejero, Spain]	accepted
20431	5	36	3	36	3	I think it would be better to say "laboratory and field studies" or "laboratory experiments and observational field studies". [APECS Group Review, Germany]	text revised
11941	5	36	3	36	4	Boyd and Bressac (2016) describe geoengineering and iron geochemistry, which is not related to Fig. 5.9. Do you mean 1. P. W. Boyd et al., Biological responses to environmental heterogeneity under future ocean conditions. Global Change Biology 22, 2633-2650 (2016).? References for Fig. 5.9 should be adequate. [Wolfgang Kiessling, Germany]	text revised
20497	5	36	4	36	14	The likelihood or confidence of all these assertions is missing and it would be helpful for readers so they are able to evaluate the relative importance of these findings. [APECS Group Review, Germany]	done
20433	5	36	6	36	6	I think it would be helpful to specify the direction of effects of acidification (i.e. positive or negative). [APECS Group Review, Germany]	text revised

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
20375	5	36	7	36	8	E1a: The part on phytoplankton breaks the flow. The author could write this as an example? [APECS Group Review, Germany]	text revised
11939	5	36	8	0		omit "recent". 2015 is not recent by IPCC standards [Wolfgang Kiessling, Germany]	Accepted. Text revised
334	5	36	8	36	8	change "phyoplankton" to "phytoplankton" [Guillem Chust, Spain]	Accepted. Text revised
336	5	36	11	36	11	remove "by" before "and" [Guillem Chust, Spain]	Accepted. Text revised
20435	5	36	14	36	14	I would specify at the very beginning of the sentence that this is in carnivores (assuming that this is what the sentence is about, it was not totally clear to me). [APECS Group Review, Germany]	text revised
7131	5	36	18	0		Suggest change full stop to comma [Nina Hunter, South Africa]	Accepted. Text revised
28805	5	36	19	0		Remove Maud: "(Ferrari et al., 2014)," [Government of Brazil, Brazil]	Accepted
20305	5	36	19	36	19	Possibly Ferrai Maud et al., 2014 is wrongly cited. It should be Ferrari, Maud et al. And is the year 2015? Ferrari, M. C., Munday, P. L., Rummer, J. L., McCormick, M. I., Corkill, K. , Watson, S. , Allan, B. J., Meekan, M. G. and Chivers, D. P. (2015), Interactive effects of ocean acidification and rising sea temperatures alter predation rate and predator selectivity in reef fish communities. Glob Change Biol, 21: 1848-1855. doi:10.1111/gcb.12818 [APECS Group Review, Germany]	Accepted
23743	5	36	19	36	20	Reef fish are not part of the epipelagic ecosystem, rather they belong the reef ecosystem and the reference to these in the description of effect on the epipelagic seems misplaced. [Government of Sweden, Sweden]	Accepted. Text revised
24043	5	36	19	36	20	Reef fishes are not part of the epipelagic ecosystem, rather they belong the reef ecosystem and the reference to these in the description of effect on the epipelagic seems misplaced [Peter Thor, Sweden]	Accepted. Text revised
29215	5	36	23	36	25	Limitation of food availability and warming impacting foraminifera see: Mallo M, Ziveri P, Mortyn G, Schiebel R, Grelaud M (2017) Low planktic foraminiferal diversity and abundance observed in a 2013 West-East Mediterranean Sea transect, Biogeosciences, 14, 2245-2266. [Patrizia Ziveri, Spain]	rejected. Text was revised and shortened
7133	5	36	25	0		Suggest change "affect" to "affects" [Nina Hunter, South Africa]	Accepted
20437	5	36	27	36	27	(...) changing environmental conditions and changes in trophic interactions. [APECS Group Review, Germany]	Accepted
11237	5	36	30	36	30	past tense! [Inka Bartsch, Germany]	Accepted
20499	5	36	30	36	35	Since this paragraph summarizes what is said above it may be a good idea to place it before as a general background and lay down afterwards the specific cases shown in the previous paragraph. It would ease the reading for non-expert readers going from the general and more important to the particular. [APECS Group Review, Germany]	text revised

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
14251	5	36	30	38	57	This section seems to wander and could do with tightening up. Paragraph commencing line 37, page 36 discussed range shifts and then ends by explaining phenology. The following paragraph goes back to discussing range shifts and introduces field results from the CPR. The next paragraph follows well, illustrating the changes that have been observed in zooplankton and fish. It then brings back one sentence about phenology with an old reference to a 2006 study in the CCS, before talking about OA. Paragraph commencing line 4, page 38 then circles back round to discussing warming effects. It may be better to separate phenology and address separately. Are there more up to date examples of phenological changes in the pelagic ecosystem, published since the AR5? [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	All the section has been revised considering these and other suggestions
7135	5	36	33	0		Suggest change "organism" to plural [Nina Hunter, South Africa]	Accepted
14253	5	36	37	36	45	The figure 5.9 is not properly discussed in this paragraph. There is no indication of why some groups are not meeting expectations. This figure is also the first mention that body size might change, the text does not mention it and there is no explanation of why. [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	Figure (now Figure 5.13) has been modified and better referred to now in the text
20501	5	36	37	36	45	The likelihood or confidence of all these assertions is missing and it would be helpful for readers so they are able to evaluate the relative importance of these findings. [APECS Group Review, Germany]	Accepted. Text revised
17365	5	36	37	36	55	There is a limit to poleward displacement of marine species at high latitudes. Here, at the highest latitudes, i.e. poleward of a "critical latitude" 64-66 degrees, this can only happen if invasive planktivorous species from lower latitudes are able to change their life cycle by increasing the lipid content during spring/summer enough to sustain life during the winter without enough primary production. This fact has not been considered in present climate change predictions, but the idea has been outlined by Sundby et al. (2016) (Sundby, S., Drinkwater, K. and Kjesbu, O.S. 2016. The North Atlantic spring-bloom system - where the changing climate meets the winter dark. Frontiers in Marine Science 3:28. doi: 10.3389/fmars.2016.00028) where critical latitudes are defined polewards of 64 to 66 degrees. In summary, it is a limit how much new planktivorous species will be found in the Arctic and Antarctic marine ecosystems. [Svein Sundby, Norway]	Accepted. Text revised and citation included

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
32167	5	36	37	36	55	A very substantial part of these rather strong statements build on the metaanalysis of Poloczanska et al. (2016). As I wrote already in the general comments about this chapter, I could not find the level of confidence in that study that is asserted here. This applies to both the question of detection, i.e., whether the data truly support a (forced) trend, to the question whether the trends are actually caused by climate change. When reading Poloczanska et al.'s assessment, I got a much more nuanced impression than when I read this text here. I also think it is necessary to be more specific about the taxa that a certain statement applies to. For example, I don't think we have much widespread evidence for the range/phenological shifts in phyto- and zooplankton [Nicolas Gruber, Switzerland]	All the section has been revised considering these and other suggestions
7137	5	36	38	0		Was a comma intended between "phytoplankton" and "zooplankton"? ; change "understanding" to plural? [Nina Hunter, South Africa]	accepted
21409	5	36	38	0		A very important pico-phytoplankton, cyanobacteria, should be highlighted since they are major primary producer in the open ocean. [Rui Zhang, Canada]	rejected. Text was revised and shortened
7139	5	36	42	0		Suggest insert "the" before "leading edge" and before "trailing edge"? [Nina Hunter, South Africa]	Accepted. Text revised
20439	5	36	42	36	42	I am not sure if leading edge and trailing edge should maybe be better defined. [APECS Group Review, Germany]	they are better explained now
344	5	36	45	36	45	Add the following sentence and references at the end of the paragraph "In fishes, both poleward shifts and earliness of biological events are expected to be more prominent in main life phases such as spawning (Bruge et al. 2016, Erauskin-Extramiana et al. In Press)" References: Bruge, A., Alvarez, P., Fontán, A., Cotano, U. and Chust, G. (2016) Thermal Niche Tracking and Future Distribution of Atlantic Mackerel Spawning in response to Ocean Warming. <i>Frontiers in Marine Science</i> , 3, 86. Erauskin-Extramiana, M., P. Alvarez, H. Arrizabalaga, L. Ibaibarriaga, A. Uriarte, U. Cotano, M. Santos, L. Ferrer, A. Cabré, X. Irigoyen and G. Chust. Historical trends and future distribution of anchovy spawning in the Bay of Biscay. <i>Deep Sea Research II: Topical Studies in Oceanography</i> . (In press). https://doi.org/10.1016/j.dsr2.2018.07.007 . [Guillem Chust, Spain]	text revised. Citation included
20307	5	36	47	36	47	The shift of marine biota? I would add this to the sentence, since it increases readability [APECS Group Review, Germany]	text revised

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
20329	5	36	47	36	50	The sentence is hard to understand. You should specify who/what is shifting in geographic range, then the sentence becomes understandable from the first reading. [APECS Group Review, Germany]	text revised
25487	5	36	48	36	49	REDUNDANT? [Christophe Deissenberg, Luxembourg]	text revised
7141	5	36	53	0		Suggest change "its distribution seems to be primary" to "their distribution seems to be primarily" [Nina Hunter, South Africa]	text revised
1507	5	37	0	0		Improve clarity, larger font size needed [Chandani APPADOO, Mauritius]	done
28809	5	37	0	0		editing: label in x axis (pannels c and d) are too small. [Government of Brazil, Brazil]	modified
28807	5	37	1	0		remove space between nunbers and \pm [Government of Brazil, Brazil]	accepted
338	5	37	1	37	1	the following sentence seems incorrect: "zooplankton are advancing northwards by 11.6 +- 2.9 days per decade". I guess "days" should be changed to "km". [Guillem Chust, Spain]	modified
26469	5	37	1	37	1	Are you sure zooplankton is "advancing northwards" as oposed to "populations in the leading edge being more productive than near the trailing edge" or "populations in northward regions being more productive than populations closer to the tropics"? What does advancing by 12 days faster than other marine groups actually means? Does it not reflect productivity changes for a very fast turnover group? The language to me is confusing [Florence Poulain, Italy]	text revised
20441	5	37	1	37	2	It seems strange that the northward advancement is given in days (rather than a distance). Maybe this could be explained a little more detailed. Thus, It is unclear if zooplankton is moving northwards or peaking earlier because the text and the units do not match one another. [APECS Group Review, Germany]	text revised
20443	5	37	2	37	4	Is it the abundance of these species which is peaking earlier? If yes, I would define it as such. [APECS Group Review, Germany]	text revised
22827	5	37	8	37	8	I'm pretty sure that's the wrong reference--Behrenfeld is discussing biomass and NPP. At best they reference a paper talking about the impact on larvae of demersal fish [Raphael Kudela, United States of America]	removed. text revised
31693	5	37	10	0		Figure 5.9. The caption for panel A refers to [-] antagonistic, but this doesnt appear in the figure itself. [Hans-Otto Poertner and WGII TSU, Germany]	modified
31695	5	37	10	0		Figure 5.9. The layout in terms of bounding boxes and title/subtitle may be reworked in order to allow the reader an easier and quicker understanding of these ivisions. For example, the placement of " population level" in the middle of panels B and D doesnt become obvious at first sight. [Hans-Otto Poertner and WGII TSU, Germany]	the figure has been modified

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
31697	5	37	10	0		Figure 5.9. The elements in the legend could be reduced in size. This would help for the reader to focus on the data, and not to be overwhelmed at first sight - as it is now, the first impression is that the legend is part of the dataset. You could make it much smaller and also leave it without a bounding box. [Hans-Otto Poertner and WGII TSU, Germany]	the figure has been modified
31699	5	37	10	0		Figure 5.9. Axis labels for panels C and D need to be enlarged. [Hans-Otto Poertner and WGII TSU, Germany]	the figure has been modified
14257	5	37	10	37	10	This figure takes a long time to digest, suggest replacing the initials for the groups with icons/pictures which are quick and easy to identify. Change the arrangement of the boxes to a sequential one to illustrate the a-d represents a scaling up from the cellular level through to the population level. Text on the graph axis in c-d should be larger to make clear. Colours look different on the graphs: c. F, d. Z and d.O. I would use different colours to denote consistency as red and blue are instinctively interpreted as warmer and colder, which is confusing on a figure that also deals with temperature. [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	the figure has been modified
20379	5	37	10	37	11	E1a: Description axes figure c and d very small. [APECS Group Review, Germany]	the figure has been modified
11915	5	37	10	37	14	The legend of Fig 5.9 (a) describes "(-) antagonistic", but, this isn't shown in the Fig.5.9(a) [Jun Sun, China]	the figure has been modified
11923	5	37	10	37	14	The legend of Fig 5.9 (a) describes "(-) antagonistic", but, this isn't shown in the Fig.5.9(a) [Jun Sun, China]	the figure has been modified
25333	5	37	10	38	3	The paragraph 5.2.3 is presenting Pelagic Ecosystem. The figure 5.9- paragraph 5.2.3.1 is reporting data about 'benthic organisms' which is a bit unclear to me. Benthic organisms are not the focus of this section, centered on plankton, fishes, mammals and seabirds, but there are data on Physiological impacts, range shift and change in body size. I would specify in the table and in the text what are the benthic invertebrates considered in these analyses. [Chiara Lombardi, Italy]	the figure and the legend have been modified
11943	5	37	11	38	3	Fig. 5.9: Panels a and b are insufficiently referenced. Neither from the figure caption nor the text referring to this figure are the sources fully evident. [Wolfgang Kiessling, Germany]	the figure and the legend have been modified
11233	5	37	12	0		unclear why this figure does not contain more organism groups where multiple driver experiments have been performed? There is more than Poloczanska et al; or delete benthic invertebrates to make it better fit to the chapter? [Inka Bartsch, Germany]	the figure and the legend have been modified. New information is provided in the text about the data

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
14255	5	37	12	14	37	Non-specialist readers may need reminding of the difference between additive, antagonistic and synergistic stressors. [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	the figure and the legend have been modified
11239	5	37	12	37	12	unclear why this figure does not contain more organism groups where multiple driver experiments have been performed? There is more than Poloczanska et al; or delete benthic invertebrates to make it better fit to the chapter? [Inka Bartsch, Germany]	the figure and the legend have been modified
28811	5	38	2	38	3	change – to - [Government of Brazil, Brazil]	Accepted
20503	5	38	6	38	15	The likelihood or confidence of all these assertions is missing and it would be helpful for readers so they are able to evaluate the relative importance of these findings. [APECS Group Review, Germany]	Accepted. Text revised
26773	5	38	13	38	13	Insert after sentence: "Marine invertebrates and fish from both highly variable and stable thermal environments are more sensitive to extreme temperature exposures than animals from moderately variable thermal environments due to their current temperature range of responding to thermal stress (Stillman, 2003; Tomanek, 2010; Tomanek and Somoero, 1999)." References not yet included in the report: Stillman, J. H., 2003: Acclimation capacity underlies susceptibility to climate change. Science 301: 65. Tomanek, L., 2010: Variation in the heat shock response and its implication for predicting the effect of global climate change on species' biogeographical distribution ranges and metabolic costs. Journal of Experimental Biology 213, 971-979. Tomanek, L., and G. N. Somero, 1999: Evolutionary and acclimation-induced variation in the heat-shock responses of congeneric marine snails (Genus Tegula) from different thermal habitats: implications for limits of thermotolerance and biogeography. Journal of Experimental Biology 202, 2925-2936. [Lars Tomanek, United States of America]	text has been thoroughly revised and shortened, so not all references can be included
7143	5	38	14	0		Suggest change "successfulness" to "success" [Nina Hunter, South Africa]	Accepted
5049	5	38	17	38	19	This seems like an incomplete sentence. [Debra Roberts and Durban Team, South Africa]	text revised
20309	5	38	17	38	19	Verb is missing and the sentence feels incomplete. I am missing the conclusion. [APECS Group Review, Germany]	text revised
20445	5	38	17	38	19	This sentence needs to mention that these are the effects of climate change: (...) of marine organisms in the epipelagic system is affected by the interacting effects of climate change, with (...) [APECS Group Review, Germany]	text revised

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20505	5	38	17	38	19	The timing and biogeography part of this sentence includes the type of change (earlier and poleward expansion), but there is nothing about the shift in biomass. If biomass is going to increase or diminish is uncertain. [APECS Group Review, Germany]	text revised. We discuss now changes in biomass in future projections
17367	5	38	17	38	23	Same comment as No 13 above [Svein Sundby, Norway]	text revised
32169	5	38	17	38	23	This seems overconfident to me. And I also think that the authors need to be much more cautious about the implied attribution statement (consistent with) and then on line 23 "do not undermine the attribution of biological impacts to warming". I don't see the truly convincing evidence for the epibelagic ocean that allows us to make such bold statements. I think it behooves the authors well to be more critical about the evidence and to better assess the uncertainties inherent in the studies. This is particularly important if the assessment is based on a meta analysis of the published literature, as this (i) tends to lose the uncertainties associated with each study, and (ii) is very prone to serious biases associated with space/time and the well know publication bias, i.e., results are published when a range shift was found, and are much less likely to be published if no change is found. [Nicolas Gruber, Switzerland]	text and assesments revised and toned down
26471	5	38	21	38	23	Uncertainties in the physiological changes driving macroecological changes may not affect attribution, but they affect the certainty of quantative projections, and this is not acknowledged [Florence Poulain, Italy]	text revised
20381	5	38	22	38	23	C1: Does the author mean attribution of warming to biological impacts? [APECS Group Review, Germany]	modified
20507	5	38	25	38	25	If robustly is refering to uncertanty it should be in italics, if not I suggest changing the term to avoid potential confussion. [APECS Group Review, Germany]	Accepted
7145	5	38	27	0		Change "suggested" to "suggest" [Nina Hunter, South Africa]	Accepted
14259	5	38	27	38	28	Please make clear that the study was undertaken in one of the more highly saturated basins, the Mediterranean; this does not necessarily mean that the effects of OA can't be observed elsewhere, but rather that the local conditions will have an effect on the local populations. [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	text revised
29219	5	38	28	38	34	Coccolithophore response to acidification is confusing at page 38 is written that are resilient or even favourite by OA but at page 41 lines 8-9 is stated that they are the only phytoplankton class known to respond negatively to OA. [Patrizia Ziveri, Spain]	text revised
7147	5	38	30	0		Remove bracket before "Rivero" and insert before "2015" [Nina Hunter, South Africa]	accepted

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20447	5	38	31	38	32	(...) have increased by by 20% over the last five decades (...) [APECS Group Review, Germany]	accepted
7149	5	38	33	0		Suggest change "other" to "another" [Nina Hunter, South Africa]	accepted
7151	5	38	33	38	34	Where is the reference for this study? [Nina Hunter, South Africa]	accepted
20449	5	38	34	38	38	Compared to the rest of the chapter, this sentence seems to go into a lot of detail of one specific study, which seems unnecessary. [APECS Group Review, Germany]	text revised
32171	5	38	34	38	38	The meaning of this statement about Takahashi versus Moana Loa pCO ₂ is unclear. Over multi-decadal timescales, the surface ocean pCO ₂ is tracking the atmospheric CO ₂ very closely. Thus, there is no difference in the trend (see e.g. McKinley et al. (2011) (doi:10.1038/ngeo1193) and her subsequent global studies. [Nicolas Gruber, Switzerland]	removed. text revised
7153	5	38	35	0		Remove bracket before "Rivero" and insert before "2015" [Nina Hunter, South Africa]	accepted
20311	5	38	36	38	37	Add that the AMO is a mode of natural variability. [APECS Group Review, Germany]	text revised
7155	5	38	40	0		Suggest insert "the" before "abundance" and "been" before "observed" [Nina Hunter, South Africa]	accepted
33693	5	38	40	0		"califying" should be "calcifying". [Government of United States of America, United States of America]	accepted
20451	5	38	40	38	40	Have been observed [APECS Group Review, Germany]	accepted

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
11557	5	38	40	38	42	<p>" This report notes "AR5 concluded that there had been limited field observations that robustly demonstrate biotic responses attributable to anthropogenic ocean acidification, partly because of the large natural variability (Pörtner et al. 2014). More recent evidence since AR5 continues to suggested mixed results on whether impacts of ocean acidification on calcifying zooplankton are already observable (Howes et al., 2015)."</p> <p>This passage should note several studies suggesting there have already been detectable responses to ocean acidificaiton</p> <p>There have been some field observations demonstrating biotic response to ocean acidification:</p> <p>Cooper, T. F., G. De'Ath, K. E. Fabricius, and J. M. Lough (2008), Declining coral calcification in massive Porites in two nearshore regions of the northern Great Barrier Reef, Global Change Biology, 14, 529-538, doi:10.1111/j.1365-2486.2007.01520.x.</p> <p>Silverman, J., K. Schneider, D. I. Kline, T. Rivlin, A. Rivlin, S. Hamylton, B. Lazar, J. Erez, and K. Caldeira (2014), Community calcification in Lizard Island, Great Barrier Reef: A 33 year perspective, Geochim. Cosmochim. Acta, 144, 72-81, doi:10.1016/j.gca.2014.09.011.</p> <p>De'ath, G., J. M. Lough, and K. E. Fabricius (2009), Declining Coral Calcification on the Great Barrier Reef, Science, 323(5910), 116-119, doi:10.1126/science.1165283.</p> <p>Moy, A. D., W. R. Howard, S. G. Bray, and T. W. Trull (2009), Reduced calcification in modern Southern Ocean planktonic foraminifera, Nat. Geosci., 2, 276-280, doi:10.1038/ngeo460.</p> <p>de Moel, H., G. M. Ganssen, F. J. C. Peeters, S. J. A. Jung, D. Kroon, G. J. A. Brummer, and R. E. Zeebe (2009), Planktic foraminiferal shell thinning in the Arabian Sea due to anthropogenic ocean acidification?, Biogeosciences, 6(9), 1917-1925.</p> <p>Just a few I'm aware of. two on planktic foraminifera. three others on coral and/or</p>	text has been thoroughly revised an shortened, so not all references can be included
20509	5	38	40	38	42	<p>Some references should be included here so readers can track who and where have detected these changes. [APECS Group Review, Germany]</p>	text revised. Citations included

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22549	5	38	40	38	42	<p>Suggest this passage note the several studies which suggest there have already been detectable responses to ocean acidification. For example, there have been some field observations demonstrating biotic response to ocean acidification:</p> <p>Cooper, T. F., G. De'Ath, K. E. Fabricius, and J. M. Lough (2008), Declining coral calcification in massive Porites in two nearshore regions of the northern Great Barrier Reef, <i>Global Change Biology</i>, 14, 529-538, doi:10.1111/j.1365-2486.2007.01520.x.</p> <p>Silverman, J., K. Schneider, D. I. Kline, T. Rivlin, A. Rivlin, S. Hamylton, B. Lazar, J. Erez, and K. Caldeira (2014), Community calcification in Lizard Island, Great Barrier Reef: A 33 year perspective, <i>Geochim. Cosmochim. Acta</i>, 144, 72-81, doi:10.1016/j.gca.2014.09.011.</p> <p>De'ath, G., J. M. Lough, and K. E. Fabricius (2009), Declining Coral Calcification on the Great Barrier Reef, <i>Science</i>, 323(5910), 116-119, doi:10.1126/science.1165283.</p> <p>Moy, A. D., W. R. Howard, S. G. Bray, and T. W. Trull (2009), Reduced calcification in modern Southern Ocean planktonic foraminifera, <i>Nat. Geosci.</i>, 2, 276-280, doi:10.1038/ngeo460.</p> <p>de Moel, H., G. M. Ganssen, F. J. C. Peeters, S. J. A. Jung, D. Kroon, G. J. A. Brummer, and R. E. Zeebe (2009), Planktic foraminiferal shell thinning in the Arabian Sea due to anthropogenic ocean acidification?, <i>Biogeosciences</i>, 6(9), 1917-1925.</p> <p>We acknowledge in some cases it's not possible to uniquely attribute the detected changes in calcification to ocean acidification, however, we note the language in other parts of the chapter using "consistent with" language in lieu of unambiguous unique attribution. [Government of Australia, Australia]</p>	text has been thoroughly revised an shortened, so not all references can be included
11241	5	38	40	38	43	shouldn't confidence statements be supported by references? [Inka Bartsch, Germany]	Agreed. Text revised
20453	5	38	41	38	42	The second part of this sentence is not very clear. I would rephrase it to something like (...), but increased ocean acidification caused by climate change might not be the dominant driver of these changes in all regions. [APECS Group Review, Germany]	text revised
7157	5	38	44	0		Suggest rephrase: "differences in rate of responses warming" [Nina Hunter, South Africa]	accepted. Text revised
32173	5	38	44	38	57	This text about the changes in NPP needs to be made consistent with the previous section. For example, the 10fold drop in biomass mentioned here is not tenable. Also, it neglects the role of grazing. [Nicolas Gruber, Switzerland]	text revised

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20313	5	38	44	39	2	The authors should include here likelihood and confidence terms, especially since afterwards they include a counter example of what is said here. [APECS Group Review, Germany]	agreed. Text revised
7159	5	38	45	0		Suggest insert "the" before "increasing" and "potential" [Nina Hunter, South Africa]	accepted
7161	5	38	50	0		Suggest insert "in" before "biomass" [Nina Hunter, South Africa]	accepted
20455	5	38	51	38	51	I think it is a little broad to just talk about "polar regions", given that drivers of productivity and climate change induced changes are very very different on the Arctic and Southern Ocean. [APECS Group Review, Germany]	accepted
20457	5	38	52	38	54	I feel like this sentence should have a reference. [APECS Group Review, Germany]	accepted
28159	5	38	52	38	54	Can a reference be given to support this statement. [Hilary Kennedy, United Kingdom (of Great Britain and Northern Ireland)]	text revised
15741	5	38	53	38	54	Plese, add a reference of the study which did this analysis. It is not clear from the text who did it. [EUCE, Belgium]	text revised
31989	5	39	2	0	4	The wording when comparing endotherms and ectotherms with respect to regulation of body temperature and exposure to ambient changes and extremes needs to be adjusted to fully reflect physiological knowledge. At the moment is reads like a comparison of apples and oranges: first the assumed buffering of body temperature upon exposure to extremes for endotherms, secondly the need for external heat for increasing body temperature in ectotherms.... The text here and elsewhere is not fully up to speed with respect to physiological concepts and language used. [Hans-Otto Poertner and WGII TSU, Germany]	text revised
20459	5	39	4	39	14	Given that the section is about the pelagic ocean, I was alittle surprised that the effect of temperature on nest sites of turtles is discussed. [APECS Group Review, Germany]	it addresses also reptiles, seabirds and mammals whose life cycles are linked to the epipelagic ocean
14261	5	39	4	40	8	These sections are much better referenced than the rest of section 5.2.3. There seem to be inconsistencies with the levels of referencing throughout, giving an incorrect impression of the body of evidence. Please either aim to provide a consistent level of referencing throughout this section or be explicit in the text where knowledge gaps exist. [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	section thoroughly revised
22829	5	39	4	40	8	I imagine it's because different people wrote different sections but there is a dramatic increase in the number of references cited for the marine bird and mammal section compared to most other sections of this chapter [Raphael Kudela, United States of America]	section thoroughly revised
4881	5	39	6	0		"effects" should be "affects" [Debra Roberts and Durban Team, South Africa]	Accepted
4883	5	39	22	0		"Effecting" should be "affecting" [Debra Roberts and Durban Team, South Africa]	Accepted
7163	5	39	22	0		Suggest change "effecting" to "affecting" [Nina Hunter, South Africa]	Accepted

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20383	5	39	26	39	27	E1a: For consistency, scientific names between brackets. [APECS Group Review, Germany]	will be modified at a later stage
15743	5	39	45	39	46	Agree that there will be winners and losers among the marine megafauna, but this will also be the case for nearly all widespread species, including local populations within species. E.g., recruitment and maximum population growth rates for local stocks within ranges of cod, salmon and sprat are higher when temperatures increase in cold northern parts of ranges but decrease in warm, southern parts of the range (Planque and Fredou 1999; Mantzouni et al. 2010, Meuter et al. 2002, MacKenzie and Koster 2004). This could drive range shifts and expansions. [EUCE, Belgium]	text has been thoroughly revised and shortened, so not all references can be included
25489	5	39	45	55	31	POSSIBLY BECAUSE ON THE EMPHASIS ON THE COEXISTENCE OF WINNERS AND LOSERS, THE TEXT MAY GIVE TOO STRONG AN IMPRESSION THAT ON THE AVERAGE WE ARE NOT LOSING MUCH. MOREOVER: HOW CERTAIN CAN ONE BE THAT THE WINNERS WILL REMAIN WINNERS IN THE LONG RUN, EVEN IF THE PHYSICAL ENVIRONMENT REMAIN UNCHANGED? OR, PUT ALTERNATIVELY; IN A HIGHLY INTERCONNECTED, NON-LINEAR WORLD, CAN ONE EXCLUDE THE POSSIBILITY THAT ALL HIGHER SPECIES BECOME LOSERS ON THE LONG TERM? [Christophe Deissenberg, Luxembourg]	text revised
7165	5	40	2	0		Suggest change "latitudes" to singular [Nina Hunter, South Africa]	Accepted
20315	5	40	4	40	4	I looked at the table of the uncertainty guidance and did not find highly likely. Is this correctly used here? [APECS Group Review, Germany]	modified
20333	5	40	4	40	4	Does „highly likely“ exist as a likelihood defined in the IPCC? I think it is „Extremely likely“ oder „virtually certain“. The same on p.48 in I- 21 and I. 36 [APECS Group Review, Germany]	text revised
20317	5	40	5	40	5	The paragraph starts with frequency and intensity of storms. I guess everyone has idea on what time scales storms happen, but what about this warm-water anomaly? Is the frequency also increasing due to climate change? For how long was this warm-water anomaly present? [APECS Group Review, Germany]	text revised
15745	5	40	10	40	12	Should generalize the example list of responses to extreme events to other taxa and not just the mammals and birds. [EUCE, Belgium]	text revised
31807	5	40	10	40	14	Here you talk about coccolithophore vulnerability to pH citing a paper from 2014, and the next sentence starts with “However, new evidence, ...” with a paper from 2013 (i.e. older than the previous one) given as reference. I suggest removing the “new evidence”. [Hans-Otto Poertner and WGII TSU, Germany]	text revised

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31809	5	40	14	40	15	Is this medium to high confidence based on this single publication? Wouldn't make sense unless it is a meta study. [Hans-Otto Poertner and WGII TSU, Germany]	text revised
31811	5	40	24	40	26	I wouldn't say that 2012 is "recent". [Hans-Otto Poertner and WGII TSU, Germany]	agreed. Text revised
31805	5	40	25	40	26	Is the vulnerability of specialist/generalist species really shown in Fig 5.9? [Hans-Otto Poertner and WGII TSU, Germany]	text revised
20461	5	40	28	40	28	Personally, I think the term "quite precarious" sticks out here as pretty vague. In particular if you then give a level of confidence for it. [APECS Group Review, Germany]	text revised
4885	5	40	31	0		The phrase "winners and losers" is problematic as it suggests an acceptable accounting balance between positive and negative effects. However, "that will lose species are about six times more prevalent than areas gaining species" (p105-29). If there is one winner for every six losers, the phrase is misleading. Further, "losers" could mean permanent extinction, and the benefit to "winners" could be temporary, depending on where the system stabilises, whether dangerous tipping points are crossed. The net effect is often a loss of biodiversity and ecosystem complexity. This all gets discussed well later in this chapter. So the phrase "winners and losers" conveys a potentially dangerous message. Please consider avoiding it entirely. It should definitely not appear in the Exec Summ, or SPM, as it can easily be misconstrued. There are other instances of this phrase in the chapter, eg 43-13, 39-46, 55-31 (especially here in this concluding paragraph), 72-48, Table 5-8. [Debra Roberts and Durban Team, South Africa]	we are still keeping these terms, because there are used in other sections, but have toned down the arguments
21411	5	40	33	0		Cyanobacterial Prochlorococcus and Synechococcus should be included. [Rui Zhang, Canada]	agreed. They are included in future projections
11243	5	40	33	40	33	Wouldn't it be better to combine all 'Future changes' subchapters of the Ecosystems into one heading so that the reader gets an integrated overview? Some of the expectations, such as epigenetic mechanisms, trans-generational adaptation etc will be valid for many organisms and ecosystems and thus could/should be presented in an integrative way. This will also reduce redundancy in the description of the general mechanisms [Inka Bartsch, Germany]	the section and subsections have been reorganized with different headings
32175	5	40	33	44	34	In my opinion, this section could be strengthened by focusing more on the assessment rather than just being a summary of the recent literature. [Nicolas Gruber, Switzerland]	agreed. Hopefully we have done it
7167	5	40	35	0		Should "foodweb" be plural? [Nina Hunter, South Africa]	accepted

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20511	5	40	39	40	40	This has been said previously in page 34 lines 4 - 13 so there is no need to re-introduce it. Authors can include it in the next sentence "Microbes are expected to adapt quickly to rapidly rising of CO2 or warming due to their short turnover times, partly compensating for the negative effects (Schaum and Collins, 2014)." [APECS Group Review, Germany]	text revised
20463	5	40	40	40	40	I think "would" should be replaced by "are likely to" or simply "will", as this is a fact that is stated here. [APECS Group Review, Germany]	text revised
7169	5	40	41	0		Suggest remove "of"? [Nina Hunter, South Africa]	accepted
20335	5	40	45	40	47	What does it mean that the shift in microbial communities are associated with invertebrate hosts? Are the invertebrate hosts also change? How? [APECS Group Review, Germany]	text revised
9739	5	40	47	40	49	This is too preliminary to be mentioned. [Government of France, France]	text revised
7171	5	40	49	0		Is "pCO2" intended? Perhaps define what this is. [Nina Hunter, South Africa]	text revised
20385	5	40	49	0		C1: pCO2 maybe needs clarification, as it is the first time used. [APECS Group Review, Germany]	text revised
20337	5	40	51	40	51	First, you write N2 and later nitrogen. Write nitrogen first and mention in brackets that it will be referred to as N2. [APECS Group Review, Germany]	text revised
20339	5	40	51	40	53	Here is a reference missing for this sentence. [APECS Group Review, Germany]	text revised
20343	5	41	4	42	6	Due to many specific words for different kinds of plankton etc the text is hardly readable for non-specialists. You should at least give general information, if they are specifically important or that other kinds react differently or if all kinds react similar and what all that means for the whole marine biota. E.g the paragraphs on page 43 (l. 1-29) are well understandable. [APECS Group Review, Germany]	text revised
28813	5	41	6	0		a should be in italic : "(chlorophyll a)" [Government of Brazil, Brazil]	accepted
28815	5	41	7	0		font color seems grey. [Government of Brazil, Brazil]	modified
20341	5	41	8	41	17	First you write that Haptophytes are the only phytoplankton responding negative (l. 7-8) and later there is also planktonic foraminifera which is also responding negatively (l. 14-17). So Haptophytes are not the only ones? [APECS Group Review, Germany]	text revised
11945	5	41	8	41	9	Haptophytes are considered a phylum rather than a class (replace class with group) [Wolfgang Kiessling, Germany]	text revised
4197	5	41	11	41	14	Khanna et al 2013 is not an appropriate reference here. The right one is Sett et al., 2014. Seems to me that references have been moved somehow in this paragraph since, in the following lines, Khanna et al 2013 should go instead of Roy et al., 2015, and this one instead of Brussard et al., 2013, and this one instead of Garzke et al, 2016.... [Carles Pelejero, Spain]	Agreed. Text revised

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26473	5	41	14	41	15	Note that Roy et al. 2015 concludes that "...the environmental controls on calcite production by Foraminifera are still poorly understood...quantitative assessment of the impact of acidification on the foraminiferal carbonate flux can be made with confidence only once these complexities have been taken into account". How can such a reference be used to catalogue the statement as medium to high confidence? [Florence Poulain, Italy]	agreed. Text revised
14263	5	41	14	41	17	This section seems to be under-referenced; the statement is given medium to high confidence and cites only one study. If this is just the one study that has been published since the AR5 but is adding to an already significant weight of evidence or tipping the confidence scales over to med/high from med, please state that here. [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	text revised
33695	5	41	15	41	15	"(medium to high confidence)" make it one or the other. [Government of United States of America, United States of America]	text revised
14265	5	41	19	41	19	These references are all very recent, so if these studies have been all that has been published since AR5 that should be made clear, as currently it reads as if they are the only evidence. [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	text revised
20465	5	41	23	41	24	This sentence sounds silly to me. Of course when food is completely absent, the zooplankton will not do very well. I think the way it is written now, it does not add to the overall context of the section. [APECS Group Review, Germany]	text revised
7173	5	41	24	0		Should "and or" not be written "and/or"? [Nina Hunter, South Africa]	text revised
28817	5	41	24	0		missing an o in mesocosm : "mesocosm" [Government of Brazil, Brazil]	text revised
21919	5	41	24	41	26	Is 2012 that "recent"? Since this is supposed to be an update on AR5, I would consider only work published subsequently to its release "recent"? [David Schoeman, Australia]	agreed. Text revised
20387	5	41	33	0		C1: The author refers to realistic ocean acidification scenarios, but are there also unrealistic scenarios? And what are those scenarios then? [APECS Group Review, Germany]	text revised
13197	5	41	38	41	45	Alguero-Muniz et al., 2017 is not a correct reference here, shall dissolution has been cited as an effect as early as 2005 (Orr et al., 2005; Fabry et al., 2008). Also, Alguero-Muniz et al., 2017 not the best reference for the benthic communities, there are much more specific ones. The same goes for the mesocosm results. Expand with supporting references. [NINA BEDNARSEK, United States of America]	accepted. Text and citations revised
21413	5	41	47	0		Without a section introducing marine carbon cycling including biological pump, microbiological pump, carbonate pump, readers are confused here. [Rui Zhang, Canada]	Rejected, due to shortening of the section

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21415	5	41	49	0		Actually, this chapter really need to put much more efforts to show how marine carbon pumps response to climate change since their response directly impact the carbon pool and carbon flux in the future ocean. [Rui Zhang, Canada]	Rejected, due to shortening of the section
21721	5	42	0	0		In Table 5.1. ~100% Faster (nutrient-replete), no change (nutrient-deplete) [Government of Republic of Korea, Republic of Korea]	it is 10% (see Boyd et al., 2015)
21417	5	42	9	0		Other pumps are to be included. such as MCP. Jiao N, Herndl GJ, Hansell DA, Benner R, Kattner G, Wilhelm SW, Kirchman DL, Weinbauer MG, Luo T & Chen F (2010) Microbial production of recalcitrant dissolved organic matter: long-term carbon storage in the global ocean. Nature Reviews Microbiology 8: 593-599. Kim JM, Lee K, Shin K, Yang EJ, Engel A, Karl DM & Kim HC (2011) Shifts in biogenic carbon flow from particulate to dissolved forms under high carbon dioxide and warm ocean conditions. Geophysical Research Letters 38: L08612. Legendre L, Rivkin RB, Weinbauer MG, Guidi L & Uitz J (2015) The microbial carbon pump concept: Potential biogeochemical significance in the globally changing ocean. Progress in Oceanography 134: 432-450. Jiao N, Robinson C, Azam F, Thomas H, Baltar F, Dang H, Hardman-Mountford N, Johnson M, Kirchman D & Koch B (2014) Mechanisms of microbial carbon sequestration in the ocean–future research directions. Biogeosciences 11: 5285-5306. [Rui Zhang, Canada]	Rejected, due to shortening of the section.No need to include the MCP
29209	5	42	11	41	17	About modulation of OA impacat by temperature see : Milner, S, Langer, G, Grelaud, M, *Ziveri, P (2016) Ocean warming modulates the effects of acidification on <i>Emiliana huxleyi</i> calcification and sinking, Limnology & Oceanography, 61, 1322–1336. Also teh effects of warming and OA on the sinking capacity of coccolithophores is not mentioned (see: Rosas-Navarro A, Langer G, Ziveri P (2018) 'Temperature affects the morphology and calcification of <i>Emiliana huxleyi</i> strains', PLoS ONE, 13, 3, e0194386. [Patrizia Ziveri, Spain]	text revised. Citation included
7175	5	42	12	0		"it has been indiated the sign of the projected change on export" - please rephrase so that meaning is clear [Nina Hunter, South Africa]	modified

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33697	5	42	16	42	16	"in the 1990/2000 period being characterized by an exceptionally weak global net uptake of only about 0.8 ± 0.5 Pg C yr ⁻¹ ." This is incorrect. The average net uptake over the 10-year period is 1.2 Pg C (Landschutzer see LeQuere et al. 2018, supplementary excel spreadsheet). [Government of United States of America, United States of America]	this comment is wrongly placed
14267	5	42	17	42	17	Make the annotations & ? *, clearer as they are very hard to spot in a table that is already full of text [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	done
340	5	42	17	42	18	In Table 5.1 add a row in Epipelagic Oean, where the component: "Food web amplification"; Driver: "Warming"; Proj Change 2100: "Zooplankton negatively amplify the climate change signal that propagates up from phytoplankton in oligotrophic tropical regions, and positively amplify in polar regions"; Confidence: Medium; References: Chust et al. 2014; Stock et al. 2014 [Chust, G., J. I. Allen, L. Bopp, C. Schrum, J. Holt, K. Tsias, M. Zavatarelli, M. Chifflet, H. Cannaby, I. Dadou, U. Daewel, S. L. Wakelin, E. Machu, D. Pushpadas, M. Butenschon, Y. Artioli, G. Petihakis, C. Smith, V. Garçon, K. Goubanova, B. Le Vu, B. A. Fach, B. Salihoglu, E. Clementi, and X. Irigoien. 2014. [Guillem Chust, Spain]	Agreed and included, but the confidence is "low" (see the text)
20513	5	42	17	42	18	The reference Isala 2008 within the Table should be experimental [E] instead of observational [O] [APECS Group Review, Germany]	corrected
22831	5	42	17	42	18	I know there are always more papers that could be cited, but (a) Sett et al. 2018 is not in the references, and (b) you might consider including Dutkiewicz et al. 2013 (GBC https://doi.org/10.1002/gbc.20042), and Treguer et al. 2018 (Nature Geoscience11, 27-37). The latter is a review so particularly relevant to the table and text [Raphael Kudela, United States of America]	considered. Added citations
26475	5	42	21	42	21	do microorganisms migrate? [Florence Poulain, Italy]	text revised
21419	5	42	22	0		Flombaum P, Gallegos JL, Gordillo RA, Rincón J, Zabala LL, Jiao N, Karl DM, Li WK, Lomas MW & Veneziano D (2013) Present and future global distributions of the marine Cyanobacteria Prochlorococcus and Synechococcus. Proceedings of the National Academy of Sciences of the United States of America 110: 9824-9829. [Rui Zhang, Canada]	reference included

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88	5	42	26	42	27	<p>I think the reference on line 27 here (Stock et al., 2014) is incorrect. Stock et al., 2014 only includes one model. The correct reference here is (Kwiatkowski et al., 2018), which includes 12 CMIP5 models, not 11 as quoted in the text. To the best of my knowledge this is the only publication that assesses projected zooplankton biomass declines across the CMIP5 ensemble (or any Earth System Model ensemble):</p> <p>Reference:</p> <p>Kwiatkowski, L., Aumont, O., Bopp, L., 2018. Consistent trophic amplification of marine biomass declines under climate change. Global Change Biology, doi:10.1111/gcb.14468. [Lester Kwiatkowski, France]</p>	agreed.modified
20515	5	42	26	42	29	<p>This sentence changes from what seems to be observations (between 1951-2000) to what seems to be model projections (2051-2100) without any explanation of what is what and how these different thongs were assessed. If the study Stock et al. 2014 is based only on models it should be stated within the sentence "similar to toher modellins studies..." and if not, more context of these findings are necessary for the readers. [APECS Group Review, Germany]</p>	text revised

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
90	5	42	26	42	32	<p>There are some errors and inaccuracies in the text here. Specifically, the Stock et al., 2014 projected 7.9% decline is in relation to mesozooplankton production not zooplankton biomass which, although related, are not the same. In addition I don't think this paper included projections under SRES A1B, only RCP8.5, so I think a different reference is needed for the 11% figure. In addition, a number of the CMIP5 models project greater negative trophic amplification between phytoplankton and zooplankton biomass than the 100% (Lewandowska et al., 2014) figure given on line 32. It is probably also worth mentioning that negative trophic amplification of plankton biomass declines is driven by the low latitude oceans across the CMIP5 ensemble whereas in the higher latitudes relative changes in projected phytoplankton and zooplankton biomass are largely proportional. I recommend changing the text here to something like the following:</p> <p>"All 12 CMIP5 Earth System Models in a recent study project declines in zooplankton biomass in the twenty-first century (Kwiatkowski et al., 2018), similar to other studies that report global mesozooplankton production declines of 7.9% between 1951-2000 and 2051-2100 under RCP8.5 (Stock et al., 2014). Some regions could experience >50% declines in biomass in these scenarios (Woodworth-Jefcoats et al., 2017). These same models show that the impact of climate change on zooplankton biomass is amplified relative to phytoplankton by $38\pm 2\%$ to $385\pm 15\%$ (Kwiatkowski et al., 2018). This trophic amplification of declines in plankton biomass is driven by the low-latitude oceans (Chust et al., 2014; Stock et al., 2014; Kwiatkowski et al., 2018).</p> <p>References:</p> <p>Chust, G., Allen, J.I., Bopp, L., Schrum, C., Holt, J., Tsiaras, K., Zavatarelli, M., Chifflet, M., Cannaby, H., Dadou, I. and Daewel, U., 2014. Biomass changes and trophic amplification of plankton in a warmer ocean. <i>Global Change Biology</i>, 20(7), 2124-2139.</p> <p>Kwiatkowski, L., Aumont, O., Bopp, L., 2018. Consistent trophic amplification of marine biomass declines under climate change. <i>Global Change Biology</i>, doi:10.1111/gcb.14468. [Lester Kwiatkowski, France]</p>	text revised. Citations included
14269	5	42	26	42	32	<p>This section is unclear and confusing for the reader; recommend it is clarified what the RCP/SRES scenarios correspond to (i.e. high or low emission scenario) and make clear under which scenarios >50% biomass declines could occur. [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]</p>	text revised. Citations included
20467	5	42	30	42	30	<p>In order not to confuse the reader, I think it should be specified that it is zooplankton biomass. [APECS Group Review, Germany]</p>	text revised

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
342	5	42	32	42	32	add the following sentence and reference after "(Lewandowska et al., 2014).": "Zooplankton negatively amplify the climate change signal that propagates up from phytoplankton in oligotrophic tropical regions, and positively amplify in polar regions (Chust et al. 2014)". Reference: [Chust, G., J. I. Allen, L. Bopp, C. Schrum, J. Holt, K. Tsiaras, M. Zavatarelli, M. Chifflet, H. Cannaby, I. Dadou, U. Daewel, S. L. Wakelin, E. Machu, D. Pushpadas, M. Butenschon, Y. Artioli, G. Petihakis, C. Smith, V. Garçon, K. Goubanova, B. Le Vu, B. A. Fach, B. Salihoglu, E. Clementi, and X. Irigoien. 2014. [Guillem Chust, Spain]	text revised. Citations included
26479	5	42	32	42	32	Lewandowska's paper is based on a reduction of nutrients to the photic zone of 40% by 2100 which is not consistent with Stock et al or Woodworth et al., and based on the results of a 6-week mesocosm study. Surely their conclusion of a 100% amplification of the climate signal should be tempered by these facts? Is this a reliable study? [Florence Poulain, Italy]	text revised
20517	5	42	32	42	33	The authors should include here likelihood and confidence terms of this statement. [APECS Group Review, Germany]	text revised
4889	5	43	0	0		Figure 5.10 Consider using a colour palette other than blue or red for c, d, e, f (which show variability and agreement) to avoid confusion with a and b (which show mean model prediction. It would help to illustrate what to do with c and d, e.g. in the arctic ocean the mean value is 50% increase, and the variability is also 50. Does that mean the prediction is 50% +-50? How does the scale 0-50 relate to 'one inter-model standard deviation' as per legend? [Debra Roberts and Durban Team, South Africa]	Figure revised to clarify the points suggested
7177	5	43	2	0		Suggest insert "is" before "projected" [Nina Hunter, South Africa]	Grammatical error has now been corrected
13051	5	43	2	43	4	"Decrease in oxygen content under warming projected to ... contraction of suitable environmental conditions for fishes (Munday, 2014)": Are you sure Munday, 2014 ("Transgenerational acclimation of fishes to climate change and ocean acidification") is the correct quote for such a statement? Shouldn't you quote here a paper of Stramma rather (Stramma et al., 2008; Stramma et al., 2010)? And why there is no confidence term (high confidence? low confidence?) associated to this statement? [Government of Germany, Germany]	Reference revised. Confidence is assessment statement is now given (at the end of the paragraph).
7179	5	43	4	0		Suggest insert "the" before "ocean" [Nina Hunter, South Africa]	Grammatical error has now been corrected

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
25335	5	43	6	43	11	In this part of the paragraph are mentioned calcifying invertebrates, which belong to coastal system and not to pelagic realm (Kroecker et al. 2013). So, it is not very clear while mentioning them here. If related to the food chain (as food-consumer, see paragraph below) that should be specified. Also, a reference of the dedicated paragraph in coastal and shelf system (below) should be added. [Chiara Lombardi, Italy]	Revised
4199	5	43	6	43	9	Alava et al 2017 is not an appropriate reference here, Kroecker et al., 2013 would be enough. [Carles Pelejero, Spain]	Revised
20469	5	43	8	43	8	The paragraph appears to start with fish only, crustaceans and calcifying molluscs appear very suddenly. It might be helpful to have one more general sentence in the beginning to point out that this paragraph moves to the next step of the food web. [APECS Group Review, Germany]	Revised
7181	5	43	9	0		Suggest change "sensitivity" to "sensitive" [Nina Hunter, South Africa]	Grammatical error has now been corrected
31813	5	43	9	43	11	Provide references for these statements regarding sensitivity of early life stages and synergistic effects [Hans-Otto Poertner and WGII TSU, Germany]	Text edited. Comments no longer applicable.
14271	5	43	9	43	14	Please provide references for the statements in this section, currently there are none. [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	Text edited. Comments no longer applicable.
21921	5	43	11	43	12	The sentence, as written, suggests that acidification will decrease...with high confidence...? [David Schoeman, Australia]	Text edited. Comments no longer applicable.
31815	5	43	11	43	14	It is not clear on which references these assessments of high confidence are based. Please ensure traceability. And who are the "winners" among fish? Please also revise confidence language, this mixture of confidence and agreement is strange (check guidelines for the correct use of confidence language) [Hans-Otto Poertner and WGII TSU, Germany]	Text revised.
26477	5	43	13	43	13	As the text says (high agreement, high confidence) there will be winners and losers, but I fail to see any reference to winners in the text. Why is that? [Florence Poulain, Italy]	Text revised.
31817	5	43	14	43	15	Is this assessment of "high confidence" based on a single publication? [Hans-Otto Poertner and WGII TSU, Germany]	Traceable references to support confidence level added.
13053	5	43	17	43	17	"Based on outputs from an ensemble of marine ecosystem and fisheries models...": I think it is important to mention that these models are global, i.e., "Based on outputs from an ensemble of *global* marine ecosystem and fisheries models...". And shouldn't you quote Lotze et al immediately after the sentence (i.e., Figure 5.10, Lotze et al) or perhaps in the caption to Figure 5.10? Or where are these results coming from? [Government of Germany, Germany]	The references to global model and Lotze et al. 2019 are now added.
9741	5	43	17	43	20	Ref. is missing. It should be: Lotze et al. 2018. [Government of France, France]	The reference to Lotze et al. 2019 is now added.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
31819	5	43	17	43	20	Would it be possible to also provide absolute numbers for these decreases? [Hans-Otto Poertner and WGII TSU, Germany]	The different models have different baseline biomass because of their different in structure. Therefore, we do not provide absolute numbers.
26481	5	43	17	43	25	This section is somewhat problematic. It is based on an unpublished paper with statements largely labelled as likely (>66%). Yet, a major FAO report on the impacts of climate change on fisheries, at global, regional and EEZ level, written by over 100 experts, is largely ignored, even though it provides much more synthetic, tested and published evidence than the Lotze et al paper. [Florence Poulain, Italy]	The paper is now accepted for publication. The projections that are presented in the FAO report are used in Section 5.4.
15791	5	43	17	43	29	This whole statement about potential changes in global fish biomass is based on one unpublished paper but is rated as 'likely'. I guess the trajectory of the ecological system (specially when speaking about high trophic levels) is going to be highly uncertain and region-specific. [EUCE, Belgium]	The paper is now published. The uncertainties of the region-specific projections are highlighted.
31823	5	43	17	43	34	Based on which literature have all the assessments of likelihood been made? Where are the references for the statements in this paragraph? Where does the data come from? Make sure that each statement/assessment can be traced back to the literature. [Hans-Otto Poertner and WGII TSU, Germany]	Text revised.
31821	5	43	20	43	20	"large-bodied animals" means "large fish and/or squid"? then please say so. [Hans-Otto Poertner and WGII TSU, Germany]	Text revised.
20519	5	43	22	43	29	According to the figure below this paragraph (Fig. 5.10 e & f panels), the level of agreement among models is similar between the Arctic and the Southern Ocean. However, the authors only reflect this for the Arctic (as likely as not and in lines 24-26). At least authors should include some term of confidence for the assertions in lines 26-29 regarding the Southern Ocean or deal with the uncertainties similarly to what they did for the Arctic. [APECS Group Review, Germany]	Text revised. Assessment to polar region is also referred to Ch 3.
4887	5	43	23	0		"increases": since it is 'as likely as not', rather say "may or may not increase" [Debra Roberts and Durban Team, South Africa]	Text revised
20345	5	43	23	43	23	If an increase in one parameter is „as likely as not“ it is not significant at all and you cannot say anything about whether it is increasing or decreasing. [APECS Group Review, Germany]	Text revised
7183	5	43	24	0		Suggest change "represent" to plural [Nina Hunter, South Africa]	Grammatical error has now been corrected
20471	5	43	24	43	26	In my opinion, this sentence is almost impossible to follow, unless you are a specialist in this kind of modelling. Additionally, I think that the bad performance of the model in the Arctic Ocean is surely also simply related to data scarcity in this region. [APECS Group Review, Germany]	Text revised

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
14273	5	43	30	43	30	Colours should be changed, blue and red naturally make the reader think of warming and cooling. [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	Figure revised.
31825	5	43	30	43	34	Indicate source of figure or source(s) of the data on which this figure is based [Hans-Otto Poertner and WGII TSU, Germany]	Reference added.
9743	5	43	32	44	2	Same ref. is missing in the Footnotes : Lotze et al. 2018 [Government of France, France]	Reference added.
13055	5	43	33	43	33	I would insert a link to the FISH-MIP webpage, either here in the caption or in the literature reference list. [Government of Germany, Germany]	URL added
28819	5	43	34	0		Please, remove) after fishing in legend of Figure 5.10 [Government of Brazil, Brazil]	Grammatical error has now been corrected
17369	5	44	5	44	10	Same comment as No 13 above [Svein Sundby, Norway]	Revised
31827	5	44	5	44	13	This is not only true for pelagic open ocean fish, but also for demersal fish and in coastal seas [Hans-Otto Poertner and WGII TSU, Germany]	Cross-references from the coastal ecosystems to this sections are made.
15747	5	44	5	44	7	How much of the shift on average is due separately to T and NPP? How is the link to NPP made? E.g., in statistical correlative way, or mechanistically via a foodweb modelling approach? [EUCE, Belgium]	There is not literature to synthesize such contribution by all the models included.
9745	5	44	5	44	9	Specify here that the sentence refers to a "polarwards" range shift (otherwise, it could be difficult to understand). [Government of France, France]	Text revised
9747	5	44	5	44	9	The values mentioned here are averages. Please specify that a large species-specific variability does exist around the mean. [Government of France, France]	Text revised
31997	5	44	15	0	31	This text is full of speculation about physiological background which is not substantiated by evidence. Please focus on studies that actually identified constraining processes, by providing the respective data. Otherwise I suggest condensing and referring to AR5. [Hans-Otto Poertner and WGII TSU, Germany]	text revised
20521	5	44	15	44	31	The entire paragraph lacks of any term about the confidence or likelihood of the assertions. [APECS Group Review, Germany]	text revised
7185	5	44	18	0		Suggest change "demonstrate" to "demonstrates" [Nina Hunter, South Africa]	text revised
21923	5	44	18	44	18	"...less complex organisms..." This is a bit colloquial. Could it be written in a more defensible manner? [David Schoeman, Australia]	text revised
11325	5	44	23	44	26	The sentence beginning with "Although scope for acclimatizing..." is not correct as stated. Responses in recent decades do not provide evidence that acclimatizing or adapting to future climate change impacts will be ineffective. It's true of course that there must be limits to the rate and scope of successful phenotypic change through acclimatizing or adapting, but we do not know what those limits are under different management scenarios. [L. Scott Mills, United States of America]	text revised
7187	5	44	25	0		Suggest insert "the" before "ocean" [Nina Hunter, South Africa]	accepted

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23747	5	44	26	44	27	One study showing adaptation potential in zooplankton can be found in: Thor and Dupont (2015) Transgenerational effects alleviate severe fecundity loss during ocean acidification in a ubiquitous planktonic copepod. Glob. Change Biol. 21:2261-2271 and De Wit et al (2015) Selection on oxidative phosphorylation and ribosomal structure as a multigenerational response to ocean acidification in the common copepod Pseudocalanus acuspes. Evol. Appl. 9: 1112-1123. [Government of Sweden, Sweden]	Rejected, due to shortening of the section
24047	5	44	26	44	27	The most prominent study showing adaptation potential in zooplankton can be found in: Thor and Dupont (2015) Transgenerational effects alleviate severe fecundity loss during ocean acidification in a ubiquitous planktonic copepod. Glob. Change Biol. 21:2261-2271 and De Wit et al (2015) Selection on oxidative phosphorylation and ribosomal structure as a multigenerational response to ocean acidification in the common copepod Pseudocalanus acuspes. Evol. Appl. 9: 1112-1123. [Peter Thor, Sweden]	text revised
11327	5	44	26	44	29	As I have noted in previous sections, recent publications lead to a different conclusion than this sentence implies. The potential for rapid climate-mediated adaptation (to a limit of course) has been demonstrated in oceanic (Pespini et al. 2013, Hinnert et al. 2017, Bay et al. 2017), riverine (Kovach et al. 2012, Manhard et al. 2017) and terrestrial species (Diamond et al. 2017, Mills et al. 2018). [REFERENCES ARE GIVEN IN MY COMMENTS ABOVE ABOUT THE ENTIRE DOCUMENT] [L. Scott Mills, United States of America]	text has been thoroughly revised and shortened, so not all references can be included
20347	5	44	33	44	37	If it should be a summary of the whole paragraph 5.2.3.2 it is not sufficient in my point of view. What about all the plankton paragraphs? In the chapter before, the summary was more general, more like a conclusion. This would be very useful here, too. [APECS Group Review, Germany]	text revised
20523	5	44	33	44	37	Since this paragraph summarizes what is said above it may be a good idea to place it before as a general background and lay down afterwards the specific cases shown in the previous paragraph. It would ease the reading for non-expert readers going from the general and more important to the particular. [APECS Group Review, Germany]	the section and subsections have been reorganized with different headings
31993	5	44	35	0	37	Precisioning of the language is needed. Do you know of examples where adaptation was effective to keep organisms in place? [Hans-Otto Poertner and WGII TSU, Germany]	text revised
31829	5	44	35	44	37	Provide reference(s) for this statement. [Hans-Otto Poertner and WGII TSU, Germany]	text revised

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
31831	5	44	42	44	44	This general sentence on understanding of impacts would be more appropriate in the intro section, but not here. [Hans-Otto Poertner and WGII TSU, Germany]	text revised
7189	5	44	43	0		Suggest remove "their" and insert "the", then insert "of this realm" after "ecosystems" [Nina Hunter, South Africa]	text revised
21925	5	44	46	44	48	This sentence seems to imply that the bathypelagic might warm by 1.5°C by the end of the century. I don't think that this is correct? [David Schoeman, Australia]	text revised
31833	5	44	47	44	47	Figure 5.5 (to which you are referring here) shows observations from the past, but not a future projection. Please check. [Hans-Otto Poertner and WGII TSU, Germany]	checked. Text revised
33699	5	44	47	44	47	Incorrect figure reference. It should be Figure 5.2, but Figure 5.2 only shows RCP8.5. Also, the number listed appears much too high for the bathypelagic (> 1000m) "Global ocean warming between 0.5DegreesC (RCP2.6) and 1.5DegreesC (RCP8.5) is expected to reach the bathypelagic". [Government of United States of America, United States of America]	corrected
7191	5	44	48	0		Please check parentheses - need amending [Nina Hunter, South Africa]	checked. Text revised
12969	5	44	48	44	48	typo in cited references (extra parentheses) [Roberta Hansman, France]	corrected
25337	5	44	48	44	48	"...Claus, 2014); Roemmich et al. (2015)." should be "...Claus, 2014; Roemmich et al. 2015)". [Chiara Lombardi, Italy]	corrected
20525	5	44	50	44	54	Somewhere else in the chapter is said that primary productivity may increase in certain areas (e.g. polar or high latitude) so this statement is unclear. If there is some regional differences for these changes the authors should include them here in order to keep the consistency of the chapter. [APECS Group Review, Germany]	text revised. Now refers to section 5.2.2
31837	5	45	0	46	6	This section 5.2.4 on "deep sea floor systems" starts with a definition of the deep sea in general, which doesn't make any sense. The term "deep sea" includes the deep sea floor, but also the mesopelagic and bathypelagic zones which have both already been discussed in the previous section 5.2.3 "impacts on pelagic ecosystems" (5.2.3.2). This definition should move up. Same for the subsection 5.2.4.2, all what is written here applies to the deep sea floor as well as deep pelagic zone. Separation between the sections is not clear. [Hans-Otto Poertner and WGII TSU, Germany]	modified
7193	5	45	3	0		Suggest change "on" to "in" [Nina Hunter, South Africa]	accepted
21421	5	45	3	45	6	I am happy to see this but it seems authors of previous section did not notice this. Again, strongly suggest a section to introduce organic carbon and the other section to introduce all carbon pumps in the ocean. [Rui Zhang, Canada]	Rejected, due to shortening of the section
7195	5	45	8	0		Suggest change "from" to "for" [Nina Hunter, South Africa]	accepted

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20527	5	45	11	45	13	This statement is categorized as low confidence and above is said that primary production and POC fluxes may likely be reduced in the future. Therefore, this assertion feels kind of counterintuitive since according previous lines, there will be less energy available for animals living at the DSL. The shallowing of the DSL will reduce energetic costs for swimming to surface waters, but it may not be enough if the energy available is reduced. Since the sentence is categorized as low confidence and it is not necessary to present the rest of the paragraph my suggestion is to eliminate it. [APECS Group Review, Germany]	POC Flux might decrease, but the active flux might increase. In any case, there are low confidence in both assessments
31835	5	45	14	45	14	Provide reference for IPCC AR5 WGI Chapter 3 [Hans-Otto Poertner and WGII TSU, Germany]	Agreed. Text revised
31999	5	45	19	0	20	Humboldt squid show large oscillations in population size which are not necessarily related with hypoxia. Does the literature really support such a generalizing statement? [Hans-Otto Poertner and WGII TSU, Germany]	We have modified the text to describe better why the Humboldt squid may indirectly benefit from OMZ expansions.
32177	5	45	30	54	42	The whole section 5.2.4 can be strongly shortened. A substantial part of this section is purely a review of the different habitats. Instead the whole section should focus on the assessment of the changes. In addition, one needs to balance the length of this text also against the length of the text for the other ecosystems. Deep floor communities are clearly important, but I don't see the immediate argument why they should be more important than other ecosystems. [Nicolas Gruber, Switzerland]	Taken into account - section shortened by approximately 50% and habitat discussions grouped into fewer sections.
17371	5	45	32	45	57	Defining the ocean below 200 m as "the deep sea" is challenging the accepted scientific definitions, and I cannot find that the references cited in this paragraph are giving any support to this definition. The mesopelagic and bathypelagic layers deeper than the epipelagic layer have each their distinct distributions of species, particularly of zooplankton and fish that makes it meaningful in terms of marine ecosystem description. [Svein Sundby, Norway]	Taken into account - have made reference to the ocean bottom > 200 m at the start of the section
21927	5	45	34	45	36	Similarly to my earlier query on the definition for open ocean, I find the wording of this definitin a little ambiguous...there are surface waters that are > 200 m deep. [David Schoeman, Australia]	Taken into account - two hundred meters is a working definition for deep, now refer to ocean bottom.

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14275	5	45	34	45	41	The sections start by explaining the current and previous definitions of the deep, I would suggest expanding on why the authors have used this current definition of the deep and not continue to use the previous one. The text reads like an apology and if the research has improved and further evidence is available to modify slightly the definition and the work, then efforts should concentrate on these new definitions to strengthen the chapter. The next section is repetitive as it continues to be dwell on the need to define the deep as 200m... [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	Taken into account - no space available. Have had to shorten discussion of deep definition (which now resides in an earlier section).
20473	5	45	34	45	41	This section left me wondering why the section heading is deep sea floor systems. I am not an expert on anything below the euphotic zone, so I had to go back and forth a lot between the previous section and this to figure out what the difference between the deep pelagic and the deep sea is. It might be useful to the reader to define this difference. Or define the deep pelagic better in the previous section. It would also really help to make reference to the figure 5.11 in the text, to help the reader distinguishing the different regions. [APECS Group Review, Germany]	Taken into account. The deep sea floor ecosystems are depicted in Fig. 5_11 and referred to in the text.
23745	5	45	35	6	36	This description of the hypothesis for the interactive effects of warming and acidification is general and not limited to the epipelagic. Placing the description here (5.2.3.1.1) may give the erroneous impression that these effects are restricted to the epipelagic. It is therefore misplaced and should be moved up to the general description of effects on marine ecosystems. [Government of Sweden, Sweden]	wrong page numbers?
14277	5	45	45	45	47	Suggest to reframe this section and start with a positive argument, explaining the need to study these systems, the lack of available information and the need to have time-series observations to fully document and understand expected changes across these habitats types [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	Section omitted in response to required shortening of text
14279	5	45	49	45	49	The authors refers to paleo records and how important this information is to support current research, I would suggest that a reference is added to support this. [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	Section omitted in response to required shortening of text
11947	5	45	49	45	51	Reference to paleo record comes out of the blue and nothing in made of it. Sentence can be deleted. [Wolfgang Kiessling, Germany]	taken into account - Section omitted in response to required shortening of text
31839	5	45	56	45	56	Check and revise reference to section [Hans-Otto Poertner and WGII TSU, Germany]	Section omitted in response to required shortening of text
23231	5	46	0	46		Illustrative figure but does not convey a sense of an assessment : level of scientific understanding, confidence...? [Valerie Masson-Delmotte, France]	taken into account - Figure redrawn to reflect assessment of impacts

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14281	5	46	1	46	1	This final paragraph emphasises the importance of combining different sources of information. Suggest that the last line is rephrased to make a statement which reinforces the need to combine several sources of evidence to study deep-water ecosystems. [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	Section omitted in response to required shortening of text
10267	5	46	3	46	3	Fig. 5.11 better be far enlarged for proper readability of texts/labels [Jinsoon Park, Republic of Korea]	Taken into account
21723	5	46	3	46	3	Fig. 5.11 better be far enlarged for proper readability of texts/labels [Government of Republic of Korea, Republic of Korea]	Taken into account
24035	5	46	3	46	6	In Figure 5.11 the OMZ is drawn overlapping with the green productivity zone (I guess the green color indicated primary production).It is misleading to have OMZ overlapping with the productivity zone. OMZ is the result of decomposition of sedimenting organic material/respiration of phytoplankton. OMZ should be drawn below the green layer. [Svein Sundby, Norway]	Taken into account
20389	5	46	4	46	6	E1a: The quality of the figure is not good. [APECS Group Review, Germany]	Taken into account - figure redrawn
2629	5	46	9	17	6	This section, 5.2.4.3, frames its findings and analysis of deep sea changes around RFMO jurisdictions. It is not clear to me why RFMO jurisdictions or boundaries are required to do this, or how RFMO boundaries are helpful. Other subsections of 5.2, and the other sections detailing biophysical impacts of climate change on the marine environment, do not delineate their attempts to understand climate change impacts around social and legal barriers, so this subsection is in contrast to other (sub)sections. The impacts the subsection describes would probably be more clearly articulated just by using geographic descriptions of their findings (i.e. northwest Atlantic) rather than overlaying RFMO competencies. [Brian Pentz, Canada]	Taken into account - section omitted
26591	5	46	9	46	12	The current text is misleading in that it doesn't note that these particular 7 RFMOs (out of over 50) are for deep-seas areas. Suggest that the text be revised along the lines of "For all deep-sea waters of both the high seas and those subject to management by regional fisheries management organizations (RFMOs),..." [Florence Poulain, Italy]	Section omitted in response to required shortening of text

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
11245	5	46	9	46	9	I really wonder whether no results of AWI deep Sea ecology group has been cited despite some possible relevance? See eg: Soltwedel, T. , Bauerfeind, E. , Bergmann, M. , Bracher, A. , Budaeva, N. , Busch, K. , Cherkasheva, A. , Fahl, K. , Grzelak, K. , Hasemann, C. , Jacob, M. , Kraft, A. , Lalande, C. , Metfies, K. , Nöthig, E. M. , Meyer, K. , Quéric, N. V. , Schewe, I. , Wlodarska-Kowalczyk, M. and Klages, M. (2016): Natural variability or anthropogenically-induced variation? Insights from 15 years of multidisciplinary observations at the arctic open-ocean LTER site HAUSGARTEN , Ecological Indicators, 65 , pp. 89-102 [Inka Bartsch, Germany]	Taken into account. - Soltwedel is now cited.
32001	5	46	9	47	6	The following does not read like an assessment but a detailed summary of one individual study. This is not what is needed. [Hans-Otto Poertner and WGII TSU, Germany]	Taken into account and section deleted.
32003	5	46	9	54	42	This section in comparison to others indicates that the treatment according to habitats or biomes come with high risk of redundancy and overlap. This emphasizes the suggestion made earlier to address the principles first and then compare the systems with respect to climate drivers, impacts and adaptation in a concise way. The same approach may work for ecosystem services p. 75 onward. [Hans-Otto Poertner and WGII TSU, Germany]	Taken into account, sections condensed with attention to assessment
2631	5	46	11	46	11	Subsection 5.2.4.3 specifically defines its area of interest as the high sea. Why is this? Are there no changes to the deep-sea floor expected in domestic jurisdictions? Why not? Why restrict this subsection to international waters? [Brian Pentz, Canada]	Taken into account - now not restricted to high seas, most text deleted
14283	5	46	11	46	11	This section refers to regional management mechanisms, my suggestion will be here to add 1-2 lines and introduce what it is and how it works, as background context. [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	Text omitted in response to required shortening of text
31841	5	46	11	47	6	Please remove all the redundant acronyms in these paragraphs. [Hans-Otto Poertner and WGII TSU, Germany]	Text omitted in response to required shortening of text
7197	5	46	14	0		Insert comma before "c)" [Nina Hunter, South Africa]	Text omitted in response to required shortening of text
28821	5	46	15	0		change – to - [Government of Brazil, Brazil]	Text omitted in response to required shortening of text
21929	5	46	15	46	16	This isn't the definition of time of emergence used elsewhere, as far as I can tell? [David Schoeman, Australia]	Taken into account - Text omitted in response to required shortening of text
2627	5	46	17	46	17	This line refers to 'each of the 7 RFMOs'. Depending on the definition used, there are about 17-18 RFMOs. How were these seven selected? How are they defined? What % of the deep-sea floor do these 7 RFMOs account for? What areas are omitted? Does the way RFMOs are defined here influence the results or the broader points of this subsection (5.2.4.3)? [Brian Pentz, Canada]	Text omitted in response to required shortening of text so no longer relevant

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
14285	5	46	20	46	20	There last line refers to changes in current metrics. Please include a brief explanation of what these metrics are helping to characterise across areas rather than solely citing another section. [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	Text omitted in response to required shortening of text
14287	5	46	23	46	23	This section covers several temperature changes happening across several regions. Some of these changes are well documented; please cite the relevant literature to support the statements made. [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	Text omitted in response to required shortening of text
20319	5	46	23	46	31	I feel that the abbreviations in this paragraph are not necessary since they are not used again? Since they are also not very intuitive it makes this paragraph harder to read. Otherwise, a Table as supplementary material or an annexes explaining this would be helpful. [APECS Group Review, Germany]	Text omitted in response to required shortening of text
7199	5	46	26	0		Suggest write "N." in full [Nina Hunter, South Africa]	Text omitted in response to required shortening of text
14289	5	47	1	47	1	There is reference to cumulative effects. Currently this section is very broad and would benefit from adding specific details to document fully the issues and sources resulting from cumulative effects and across which areas, and magnitude, several stressors are acting upon. [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	Text omitted in response to required shortening of text
20475	5	47	6	47	6	It might not be immediately clear to a non expert reader what the Martin Curve is. Maybe this could be defined briefly, or a reference could be given. [APECS Group Review, Germany]	Text omitted in response to required shortening of text
10651	5	47	8	0		I would recommend using "drivers" rather than "stressors" because some species benefit from the changes [Jean-Pierre Gattuso, France]	This section has been removed
31843	5	47	8	48	13	There is lots of overlap among sections; most of all this is (a) general information that applies to benthic and pelagic realm, and (b) has been already previously discussed. [Hans-Otto Poertner and WGII TSU, Germany]	This section has been removed
26775	5	47	12	47	13	Rewrite the sentence to: "The underlying mechanisms involve a number of biochemical and physiological processes that can not be reduced to a single factor (Portner, 2012; Schulte, 2015; Somero et al., 2017)." A broader statement more accurately represents the state of the field. The reduction to a single explanation, i.e. oxygen limitation, as setting thermal tolerance is not supported empirically (see the comment by Jutfelt et al. (2018) cited and referenced above. [Lars Tomanek, United States of America]	This section has been removed
28823	5	47	17	0		change – to - [Government of Brazil, Brazil]	This section has been removed

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
17373	5	47	20	47	21	As far as I can understand this is not quite what Levin (2018) says, or at least this can be misunderstood. The direct effect of temperature on solubility of oxygen is 10 - 20 % of the reduction (as stated elsewhere in this chapter). The rest of O2 reduction is indirect effects temperature and of climate change impacts that are not necessarily linked to temperature but to processes like circulation, stratification and changing in primary production. [Svein Sundby, Norway]	This section has been removed
20477	5	47	21	47	23	I would suggest to define the time-scales on which these changes in O2 occur be defined. [APECS Group Review, Germany]	This section has been removed
7201	5	47	24	0		Is it possible to define "extremophile"?; is a word intended after second "extremophile"? [Nina Hunter, South Africa]	This section has been removed
20391	5	47	24	0		C1: Extremophile needs explanation. The sentence is also not complete. [APECS Group Review, Germany]	This section has been removed
28825	5	47	24	0		Query: is that right ? "extremophile invertebrates and eventually to extremophile" [Government of Brazil, Brazil]	This section has been removed
12687	5	47	24	47	25	This sentence is unclear. Review. [Noureddine Benkeblia, Jamaica]	This section has been removed
7203	5	47	32	0		Was the word "tests" intended here? [Nina Hunter, South Africa]	This section has been removed
7205	5	47	34	0		Suggest change "to influence" to "as influencing" [Nina Hunter, South Africa]	This section has been removed
7207	5	47	36	0		Suggest remove bracket after "2014" [Nina Hunter, South Africa]	This section has been removed
28827	5	47	38	0		p should be in italic : "pCO2" [Government of Brazil, Brazil]	This section has been removed
32179	5	47	44	47	47	This text needs to be made consistent with the previous section on NPP changes. There are potentially substantial regional differences to this general pattern. The best exception are likely the Eastern Boundary Upwelling regions. (see box). Given their high productivity, these changes have a huge impact on benthic communities in the deep ocean, particularly since a substantial fraction of the organic matter gets laterally exported (see e.g. Frischknecht et al. (2018) (doi: 10.1029/2018JC013934) [Nicolas Gruber, Switzerland]	Taken into account. Frischknecht et al. now cited
20393	5	47	51	47	53	C1: Will it be clear what export production means? [APECS Group Review, Germany]	Taken into account - now defined
31845	5	47	51	48	14	check IPCC guidelines and revise uncertainty language in these paragraphs. [Hans-Otto Poertner and WGII TSU, Germany]	This section has been removed
28829	5	47	53	47	55	change – to - [Government of Brazil, Brazil]	Accepted
25491	5	47	55	47	55	CHECK THE CONSISTENCY IN THE USE OF MINUS SIGNS [Christophe Deissenberg, Luxembourg]	Accepted
29217	5	48	8	48	10	Gambi et al., 2017, the deep-sea biota efficiency is both from mesotrophic and ultra-oligotrophic conditions of the deep Mediterranean Sea. [Patrizia Ziveri, Spain]	Taken into account - text now says thus in mesotrophic and ultra-oligotrophic settings

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
9749	5	48	10	48	43	At the end of the sentence add "and wood falls". references : - D. Kalenitchenko, E. Péru, L. Contreira Pereira, C. Petetin, P. E. Galand & N. Le Bris (2018). The early conversion of deep-sea wood falls into chemosynthetic hotspots revealed by in situ monitoring, Scientific reports (2018) 8:907 DOI:10.1038/s41598-017-17463-2 - Thubaut, J., Puillandre, N., Faure, B., Cruaud, C., and Samadi, S. (2013). The contrasted evolutionary fates of deep-sea chemosynthetic mussels (Bivalvia, Bathymodiolinae). Ecology and Evolution 3, 4748–4766. doi:10.1002/ece3.749. - Laming, S. R., Szafranski, K. M., Rodrigues, C. F., Gaudron, S. M., Cunha, M. R., Hilário, A., et al. (2015). Fickle or faithful: the roles of host and environmental context in determining symbiont composition in two Bathymodiolina mussels. PloS one 10, e0144307. [Government of France, France]	Rejected - this discussion is now in the abyssal plain section and the sentence refers to the influence of the nekton and zooplankton on organic matter flux , so wood falls are not relevant.
4891	5	48	12	0		What are "diel vertical migrations, ontogenetic migrations"? [Debra Roberts and Durban Team, South Africa]	Taken into account- now defined.
20395	5	48	14	0		E1a: Reference to section is not complete. [APECS Group Review, Germany]	Text removed so no longer necessary
12981	5	48	16	48	38	additional results from Smith et al., 2018 (Episodic organic carbon fluxes from surface ocean to abyssal depths during long-term monitoring in NE Pacific; PNAS) should be incorporated here [Roberta Hansman, France]	Taken into account. Smith et al. 2018 now cited
31849	5	48	16	50	45	Carefully check IPCC guidelines and revise uncertainty language thoroughly. [Hans-Otto Poertner and WGII TSU, Germany]	Taken into account - uncertainty language reviewed and revised.
20479	5	48	19	48	19	The "will" seems very strong and definite here, after the uncertainty associated with predictions in primary productivity have been discussed at length just a few sections ago. I would suggest to change it to something like "are predicted to" and also reference the section on primary productivity. [APECS Group Review, Germany]	Accepted

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
4893	5	48	22	0		It is probably better to reflect levels of certainty in the choice of words. "will experience" should rather read "are projected to experience" or "may experience", especially since "medium confidence" refers to model results, and as we heard, the deep ocean is "difficult to access and expensive to study..." so the models probably still lack accuracy. It may be worth doing a search on the word "will" and checking the wording. For the same reason it would be good if any hard evidence could be elevated - e.g. to a figure or table, where relevant. The few time series we have - what do they show? It would be really great to see a figure for example, with one X-axis for time and a long Y-axis with different line graphs for a range of variables for which time series data are available, arranged one above each other, each with their own section of Y-axis labels. [Debra Roberts and Durban Team, South Africa]	Taken into account. 'will' has been replaced by ore appropriate terminology. There are not sufficient time series to document in a figure.
28831	5	48	22	48	23	change – to - [Government of Brazil, Brazil]	Accepted
7209	5	48	25	0		Suggest write "NE" in full [Nina Hunter, South Africa]	Accepted
31847	5	48	27	48	29	On which literature is this assessment of medium confidence based? Please ensure traceability. [Hans-Otto Poertner and WGII TSU, Germany]	Taken into account - now cite AR5 Chapter 30.5.7
21931	5	48	31	48	32	The last part of this sentence just doesn't seem to make any sense, whatsoever. [David Schoeman, Australia]	Taken into account - sentence split in two and latter part now states Changes in size and associated production efficiency and energy transfer are expected to be largest for macrofauna and lesser for megafauna and meiofauna (Jones et al., 2014)
25493	5	48	32	48	32	WHAT DO YOU MEAN? " and similar" [Christophe Deissenberg, Luxembourg]	Taken into account - sentence split in two and rewritten. (and similar removed).
20481	5	48	40	49	52	Throughout this section I would always refer to continental margins instead of just margins. For all the different regions discussed, it would also be good to refer to figure 5.11 when each region is introduced and defined. [APECS Group Review, Germany]	Accepted
30441	5	48	48	48	49	This statement generates the impression that upwelling systems may increase in general across eastern boundary current systems, which is not correct - more careful phrasing is needed here. [Francois Engelbrecht, South Africa]	Taken into account - text removed during shortening of chapter
7211	5	49	2	0		"and but" - suggest remove "and" [Nina Hunter, South Africa]	Accepted
31851	5	49	2	49	2	Provide literature on which this likelihood "virtually certain" is based. [Hans-Otto Poertner and WGII TSU, Germany]	taken into account - references added
20353	5	49	9	49	47	Again, there are too many specific words. For non-biologists it is very hard to follow. E.g in l. 10-11, I do not know, to which species Ammonia spp., etc belong to. [APECS Group Review, Germany]	Taken into account - have simplified, condensed and removed species names.
21933	5	49	9	49	52	There is a sharp shift here, from broad, general statements to far more specific (species-specific) statements. Also, it seems more like a group of disparate ideas than a synthesis. [David Schoeman, Australia]	Taken into account - have simplified, condensed and removed species names.

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7213	5	49	10	0		Suggest change "showed" to "shown" [Nina Hunter, South Africa]	Taken into account - text altered
28833	5	49	24	0		superscript ° in 0.4°C [Government of Brazil, Brazil]	text removed so no longer necessary
20483	5	49	27	49	29	I think the link between ice shelf collaps and rising temperature should be explicitly made. [APECS Group Review, Germany]	Text removed as polar settings are treated in another chapter
31853	5	49	27	49	29	This should be part of chapter 3, as Antarctic benthos is assessed there. [Hans-Otto Poertner and WGII TSU, Germany]	Taken into account - Text removed.
28835	5	49	41	49	42	Remove) after 2016 and 2017 [Government of Brazil, Brazil]	Text removed so no longer necessary
7215	5	49	45	0		Suggest remove "to" [Nina Hunter, South Africa]	Accepted
7217	5	49	56	0		Suggest insert "the" before "effects" [Nina Hunter, South Africa]	Text removed so no longer necessary
31855	5	50	7	50	13	Once again the distinction between benthic and pelagic realms is suspended here. Shouldn't this be part of 5.2.3 (pelagic systems)? [Hans-Otto Poertner and WGII TSU, Germany]	Rejected - key point is vulnerability of the seafloor ecosystem and discussion among section authors places this in 5.2.4
28837	5	50	11	0		Remove the) after 2014, add comma in al. [Government of Brazil, Brazil]	Accepted
20529	5	50	15	50	16	It is unclear what kind of changes and climate drivers the authors are referring to here so the sentence is quite obscure in its current form. [APECS Group Review, Germany]	Taken into account - sentence removed
4895	5	50	21	0		"regionally increase biodiversity" - this phrase is problematic. It comes from the notion that changing conditions allow additional species to join an ecosystem where before they did not exist. However what we know about ecology suggests that systems are always a lot more complex than they seem, and that the addition of one species can easily upset the balance and lead to the demise of 10 others. Besides, biodiversity of species cannot increase (at least not at scales or time frames relevant to this discussion). "increase in biodiversity" is a very dubious idea, even with the qualifier 'regional' or 'local', and it would be better not to use those words. It gets abused too easily. "Shift in species composition" would be more accurate. [Debra Roberts and Durban Team, South Africa]	Accepted, this discussion removed..
25495	5	50	21	50	21	1. "and either locally decrease or regionally increase biodiversity" YOU MIGHT WANT TO DEFINE LOCAL VS REGIONAL AND EXPLAIN A BIT [Christophe Deissenberg, Luxembourg]	Taken into account - this discussion now removed
14291	5	50	33	50	33	The section covering biodiversity changes on mussel beds could be supported with other relevant references. There are several papers looking at the impacts of climate change driven effects on oysters, and modiolus beds that could be added in this section. See specific work by Lemasson A.J., Fletcher S., Hall-Spencer J.M. and Knights A.M. (2017). Linking the biological impacts of ocean acidification on oysters to changes in ecosystem services: A review. Journal of Experimental Marine Biology and Ecology. doi.org/10.1016/j.jembe.2017.01.019; [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	Taken into account - suggested reference is a shallow water paper and it will be passed to the appropriate section (5.3).
31857	5	50	33	50	34	Provide reference [Hans-Otto Poertner and WGII TSU, Germany]	Accepted - reference provided

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
20377	5	50	36	52	36	C1: How many years are tracked by the plankton recorder? This is important if you want to make assumptions on the effects of climate change. [APECS Group Review, Germany]	Not page 50? Refer to section below?
7219	5	50	50	0		Would "occurs" be useful after "masses"? [Nina Hunter, South Africa]	Accepted
5403	5	51	1	51	1	To further support the statement, suggest adding the following two references at the end of the sentence that ends with "food supply.": De Leo, F.C., Bruno Ogata, B., Akash, R., Sastri, A.R., Heesemann, M., Mihály, S., Galbraith, M., Morley, M.G., (2018) High-frequency observations from a deep-sea cabled observatory reveal seasonal overwintering of Neocalanus spp. in Barkley Canyon, NE Pacific: Insights into particulate organic carbon flux. Progr. Oceanogr. 169, 120-137. Thomsen, L., Aguzzi, J., Costa, C., De Leo, F.C., Ogston, A., Purser, A., (2017). The oceanic biological pump: rapid carbon transfer to depth at continental margins during winter. Sci. Reports 7, 10763. https://doi.org/10.1038/s41598-017-11075-6 . [Kate Moran, Canada]	Accepted - incorporated into rewritten sentences.
20531	5	51	1	51	3	It is not clear if the downwelling processes are going to increase or diminish their frequency and intensity and it is important because if frequency or intensity increase (e.g. more often storms) it could enhance vertical transport of POC. [APECS Group Review, Germany]	Taken into account - wording changed.
28305	5	51	2	0	6	This sentence is too long. I suggest that it should be broken into two sentences thus; "It can also ... (Hennige et al., 2015; Büscher et al., 2017). However, acidification ... (low confidence) (Hennige et al., 2015). [Nsikak Benson, Nigeria]	Text rewritten (was page 52)
31859	5	51	11	51	11	Is this "high confidence" based on that single study? [Hans-Otto Poertner and WGII TSU, Germany]	Taken into account - Gallo and Levin is a review paper - not sure if necessary to cite all the papers within
7221	5	51	13	0		Suggest "as hosting" to replace "to host" [Nina Hunter, South Africa]	Accepted
20355	5	51	17	51	33	There are no climate-impacts on seamounts listed. I suppose that the conditions at seamounts are too extreme so that climate change impacts are relatively small, but still I would discuss it if it is so. [APECS Group Review, Germany]	Taken into account - there is discussion of changing exposures on seamounts and consequences in context of cold water corals (box), as well as reproductive sites for skates. Little assessment level information is available
12689	5	51	18	0		It might be useful to give an idea about the percentage of the ACTIVE volcanic seamounts and where they are located. [Noureddine Benkeblia, Jamaica]	Rejected - this information is not readily available and discussion refers to communities associated with non-active seamounts.
20533	5	51	18	51	33	The entire paragraph lacks of any term about the confidence or likelihood of the assertions. [APECS Group Review, Germany]	Accepted - Confidence now added
26593	5	51	19	51	24	Seamount flanks are not subject to bottom trawling. [Florence Poulain, Italy]	text was removed
20485	5	51	22	51	22	"Flows" should be defined. (flows of what?) [APECS Group Review, Germany]	Accepted - now water flow
20487	5	51	32	51	32	"far-reaching" consequences seems a little vague. I think at least far-reaching in terms of what should be defined. [APECS Group Review, Germany]	Taken into account - term removed.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
31861	5	51	35	53	30	Is this subsection really a part of "5.2.4 impacts on deep sea floor systems"? Seems more like a section on corals in general. Doesn't make much sense to have this under deep sea floor systems. [Hans-Otto Poertner and WGII TSU, Germany]	Taken into account - Section is converted into a box on cold-water corals and sponges highlighting deep-ocean species
11247	5	51	35	53	49	Rather long; combine both chapters in one sub-chapter? This way quite unbalanced [Inka Bartsch, Germany]	Taken into account - this is substantially shortened by creating a box and converting some material to an appendix table.
11027	5	51	53	51	53	Extra reference to the fact that aragonite shoaling needs to be taken into account when planning deep-water corall reef protection. Jackson EL, Davies A, Howell KL, Kershaw PJ, Hall-Spencer JM (2014) Future-proofing Marine Protected Area networks for cold water coral reefs. ICES Journal of Marine Science 71, 2621-2629. [Jason Hall-Spencer, United Kingdom (of Great Britain and Northern Ireland)]	Taken into account- Jackson et al. now cited regarding shoaling ASH but but discussion of proections is removed as it is prescriptive
20535	5	51	55	53	30	Lophelia petrusa is no longer a valid name. The currently accepted name is Desmophyllum petrusum http://www.marinespecies.org/aphia.php?p=taxdetails&id=135161 [APECS Group Review, Germany]	Taken into account - decision made to use names as published by authors; will note in text.
14293	5	52	6	52	7	The text refers to the importance of bioerosion and how this process may exacerbate bio dissolution. The next paragraph discusses how bioerosion and dissolution processes have been overlooked in cold-water coral response under future under climate change conditions. Suggestion to combine the final lines of 1st para with 2nd para to continue this topic. [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	Taken into account - text rewrittent
31863	5	52	8	52	8	Why not using confidence (instead of likelihood), here? [Hans-Otto Poertner and WGII TSU, Germany]	Accepted
14295	5	52	11	52	11	The text refers to the importance of the coral framework for enhancing coral growth and supporting biodiversity in these habitats - please add a reference to support this statement. [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	Taken into account - text ommitted in shortening section
7223	5	52	13	0		Suggest insert "a" before "live" [Nina Hunter, South Africa]	Taken into account - text ommitted in shortening section
31865	5	52	14	52	16	This statement is actually identical with the statement in line 8 above, but with different confidence level/likelihood. So which one is valid? Please remove one of these duplicates and verify confidence/likelihood. [Hans-Otto Poertner and WGII TSU, Germany]	Taken into account - text rewrittent
20357	5	52	22	52	23	Do you mean „positive trends in calcification rates“ instead of „positive rates under warming“, I suppose they are always positive. [APECS Group Review, Germany]	Taken into account - text rewrittent to say can continue to calcify
7225	5	52	26	0		Suggest change "decrease" to past tense, in line with "became" in next row [Nina Hunter, South Africa]	Accepted
20321	5	52	26	52	26	Was the omega symbol previously introduced? [APECS Group Review, Germany]	Need to check if Ω is introduced earlier in chapter
28839	5	52	29	0		add comma "single study," [Government of Brazil, Brazil]	Taken into account - text ommitted in shortening section
20359	5	52	30	52	30	Hypoxia occurs already at values below 2ml/l, not only below 1.5 ml/l. [APECS Group Review, Germany]	Taken into account - text ommitted in shortening section
28841	5	52	31	0		remove the acronym NAO [Government of Brazil, Brazil]	cannot find this

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11949	5	52	36	0		Lophelia and Desmophyllum were recently merged. OK to keep the name for this report but this paper should perhaps be cited: Addamo AM, Vertino A, Stolarski J, García-Jiménez R, Taviani M, Machordom A (2016) Merging scleractinian genera: the overwhelming genetic similarity between solitary Desmophyllum and colonial Lophelia. BMC evolutionary biology 16:108-108 [Wolfgang Kiessling, Germany]	Accepted -
4201	5	52	36	52	36	After the assertion "The solitary coral Desmophyllum dianthus, a species closely related to L. Pertusa" it would be good to cite Addamo, A.M., Vertino, A., Stolarski, J., García-Jiménez, R., Taviani, M., Machordom, A., 2016. Merging scleractinian genera: the overwhelming genetic similarity between solitary Desmophyllum and colonial Lophelia. BMC Evolutionary Biology 16, 1-17. [Carles Pelejero, Spain]	Accepted
25339	5	52	36	52	48	"The solitary coral...(low confidence)". Please check the font of the text, it does seem different from the rest of the report. [Chiara Lombardi, Italy]	Checked, but text now removed
7227	5	52	39	0		Suggest unitalicize "in" [Nina Hunter, South Africa]	Accepted
7229	5	52	44	0		Suggest write out in full: N. Atlantic and SW Pacific Oceans [Nina Hunter, South Africa]	Accepted - in annex table
9751	5	52	50	52	52	This insight is particularly important and it should be mentioned in p.4, l.45-52 to underline the adaptation capacity of coral reef systems. [Government of France, France]	???
4413	5	52	54	52	54	Clarify that water temperature is meant here [The UBern Team Group Review, Switzerland]	Accepted
4203	5	52	54	52	56	Reference needed at the end of this phrase. [Carles Pelejero, Spain]	Taken into account in revision
20537	5	52	54	52	56	The reference of the study where this was proved is lacking (Gori et al., 2016) [APECS Group Review, Germany]	Taken into account in revision
31867	5	52	54	52	56	Provide reference(s) for this statement. [Hans-Otto Poertner and WGII TSU, Germany]	Taken into account in revision
20539	5	52	56	53	1	The reference of the study where this was proved is lacking [APECS Group Review, Germany]	References provided in the revised version
4205	5	52	56	53	3	Reference needed at the end of this phrase. [Carles Pelejero, Spain]	References provided in the revised version
4207	5	53	7	53	17	The whole paragraph needs better substantiation with citations. Morato et al 2006 is not an appropriate reference here. [Carles Pelejero, Spain]	References provided in the revised version
20541	5	53	7	53	9	The reference of the study where this was proved is lacking [APECS Group Review, Germany]	References provided in the revised version
21935	5	53	8	53	8	What is T, here? [David Schoeman, Australia]	No longer in text

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
20543	5	53	9	53	13	It is worth mentioning that there is a growing body of literature that points out to zooplankton as the main component of the diet of some cold-water corals (e.g. <i>Desmophyllon dianthus</i>) and therefore the food supply should not be considered as the POC flux, at least not solely. Experiments showing this here (PeerJ 6:e5872; DOI 10.7717/peerj.5872) and stable isotopes analysis here (DOI 10.3354/meps277013 DOI 10.3354/meps08361 & DOI 10.3354/meps09015). Therefore, changes in POC fluxes may play a less important role than expected, while changes in zooplankton abundance and composition may be more important than expected for cold-water corals (at least for some species within <i>Desmophyllum</i> spp.) [APECS Group Review, Germany]	Taken into account and the point is introduced in text.
28843	5	53	16	0		Qarag remove arag here, OR insert it in page 52 line 26. [Government of Brazil, Brazil]	Accepted
20361	5	53	19	53	30	I would suggest, first to say that the NAO has impact on biota etc and how the NAO is supposed to be changing in the future and then say, how it is affecting specific species. At least the first sentence should be changed, because it sounds like the NAO is shifting somehow („Future mean NAO state“), which is not the case. The NAO in general (not only in the future) is affecting cold-water corals. [APECS Group Review, Germany]	Information moved to annex table. No longer part of chapter text
31869	5	53	32	55	31	Carefully check IPCC guidelines and revise uncertainty language thoroughly. [Hans-Otto Poertner and WGII TSU, Germany]	Taken into account and revised
9753	5	53	33	53	36	Specify in vivo or ex situ experimentation. [Government of France, France]	Taken into account - now clarified in text as laboratory experiments
31871	5	53	38	53	41	I wouldn't call a holothurian a biogenic structure. [Hans-Otto Poertner and WGII TSU, Germany]	Accepted - text removed from this section
20545	5	53	41	53	43	Include a confidence or likelihood term within the sentence. [APECS Group Review, Germany]	Taken into account - text no longer in chapter
7231	5	53	42	0		Suggest change "suggests" to singular; remove comma and insert "and" [Nina Hunter, South Africa]	Accepted
11951	5	53	44	0		Cited reference (Schulz et al. 2013) is on a different topic. Perhaps cite this paper in the context of sponge tolerance: Bennett HM, Altenrath C, Woods L, Davy SK, Webster NS, Bell JJ (2017) Interactive effects of temperature and pCO ₂ on sponges: from the cradle to the grave. <i>Global Change Biology</i> 23:2031-2046 [Wolfgang Kiessling, Germany]	Accepted
20547	5	53	46	53	49	The authors should include likelihood and confidence terms of this statement. [APECS Group Review, Germany]	Xenophyophore text moved and statement given confidence.
7233	5	53	54	0		Suggest insert "the" before "limited" [Nina Hunter, South Africa]	Section omitted in response to required shortening of text

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
5397	5	53	54	53	54	suggested that this text be inserted after the word "studies": Continuous, high-resolution observations at fixed ocean observatories are providing information on the scope and scale of seasonal and inter-annual variability in deep-sea ecosystems (Chauvet P, Metaxas A, Hay A, et al. (2018) Annual and seasonal dynamics of deep-sea megafaunal epibenthic communities in Barkley Canyon (British Columbia, Canada): A response to climatology, surface productivity and benthic boundary layer variation. Progress in Oceanography, 1-12-2018 DOI: 10.1016/j.pocean.2018.04.002; Juniper, SK, M. Matabos, S. Mihaly, R.S. Ajayamohan, F. Gervais, & A.O.V. Bui (2013) A year in Barkley Canyon: A time-series observatory study of mid-slope benthos and habitat dynamics using the NEPTUNE Canada network. Deep-Sea Research Part II 92, 114-123. doi.org/10.1016/j.dsr2.2013.03.038; Lelièvre, Yann; Legendre, Pierre; Matabos, Marjolaine; Mihály, Steve; Lee, Raymond W.; Sarrazin, Pierre-Marie; Arango, Claudia P.; Sarrazin, Jozée (2017) Astronomical and atmospheric impacts on deep-sea hydrothermal vent invertebrates. Proceedings of the Royal Society B: Biological Sciences 284. DOI: 10.1098/rspb.2016.2123; Cuvelier, Daphne; Legendre, Pierre; Lais-Huon, Agathe; Sarrazin, Pierre-Marie; Sarrazin, Jozée (2017) Biological and environmental rhythms in (dark) deep-sea hydrothermal ecosystems. Biogeosciences 14, DOI: 10.5194/bg-14-2955-2017). Such information is critical to establishing baselines for detecting long-term change. [Kate Moran, Canada]	Section omitted in response to required shortening of text
7235	5	53	55	0		"Most such studies examine on single species and on single climate drivers" - suggest remove "on" [Nina Hunter, South Africa]	Section omitted in response to required shortening of text
4415	5	54	1	54	1	rewrite to 300 Ma or 300 myr [The UBern Team Group Review, Switzerland]	Section omitted in response to required shortening of text
11953	5	54	1	54	4	Another half-harted reference to the paleo record, which may better be deleted. Note that the geological record on earth is actually more than 4 billion years long and simulateneous changes of variables can be traced at least 500 myr. Certian --> certain. Although split this extremely long sentence (continuing to line 7, although upper case M in Modern suggests otherwise) at least into two [Wolfgang Kiessling, Germany]	Section omitted in response to required shortening of text
7237	5	54	3	0		Change "certian" to "certain" [Nina Hunter, South Africa]	Section omitted in response to required shortening of text
7239	5	54	4	0		Suggest insert "of" after "scales"; remove comma and replace with fullstop [Nina Hunter, South Africa]	Section omitted in response to required shortening of text
28845	5	54	4	0		change , to . After years [Government of Brazil, Brazil]	Section omitted in response to required shortening of text

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
7241	5	54	5	0		Suggest replace "assessment" with "assessments" [Nina Hunter, South Africa]	Section omitted in response to required shortening of text
7243	5	54	9	0		Suggest insert "the" before "response" [Nina Hunter, South Africa]	Section omitted in response to required shortening of text
5405	5	54	10	54	10	<p>add these two additional references along with the current references to Danovaro et al. and Sweetman et al.: De Leo, F.C., Bruno Ogata, B., Akash, R., Sastri, A.R., Heesemann, M., Mihály, S., Galbraith, M., Morley, M.G., (2018) High-frequency observations from a deep-sea cabled observatory reveal seasonal overwintering of Neocalanus spp. in Barkley Canyon, NE Pacific: Insights into particulate organic carbon flux. Progr. Oceanogr. 169, 120-137.</p> <p>Thomsen, L., Aguzzi, J., Costa, C., De Leo, F.C., Ogston, A., Purser, A., (2017). The oceanic biological pump: rapid carbon transfer to depth at continental margins during winter. Sci. Reports 7, 10763. https://doi.org/10.1038/s41598-017-11075-6. [Kate Moran, Canada]</p>	Section omitted in response to required shortening of text, Thompson et al. is cited elsewhere.
20397	5	54	14	54	16	C1: The part on labile C (write carbon) feels out of place. Integrate it by giving it as an example. [APECS Group Review, Germany]	Section omitted in response to required shortening of text
20351	5	54	21	54	21	The caption indicates the summary of the deep PELAGIC ocean, but the deep pelagic ocean was under 5.2.3.2. This chapter was the deep sea floor with number 5.2.4. I am not that familiar with the labelling, but if it is right like that, the part about the deep pelagic ocean (5.2.3.2) should be part of this chapter (5.2.4). [APECS Group Review, Germany]	Taken into account - this should have said deep sea floor and has been corrected.
15749	5	54	44	54	44	Section 5.2.5 Risk assessment of open ocean ecosystems. Lacks mention of tipping elements and risks due to crossing tipping points in their variability. Should refer to ch. 6 here. [EUCE, Belgium]	Text re-written
20399	5	54	46	0		C4: The deep sea was considered >200 m and now the upper ocean is defined as everything between 0-700 m. [APECS Group Review, Germany]	Text re-written
28847	5	54	46	0		change – to - [Government of Brazil, Brazil]	Text re-written
17375	5	54	46	54	47	Definition of depth layers contradicting the earlier definition at page 45 and commented in No 16 [Svein Sundby, Norway]	Text re-written
20549	5	54	46	55	3	Some references should be included so readers are able to track the origin and confidence of the assertions. [APECS Group Review, Germany]	Text re-written
14297	5	54	49	54	49	What does 'lighter' mean in this context - please define [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	Text re-written
7245	5	55	3	0		Suggest change "changes" to "changing" [Nina Hunter, South Africa]	Text re-written
32005	5	55	5	0	6	The wording is odd. Suggestion: The ecophysiological responses of organisms (plankton to mammals) to novel ocean conditions are driving changes in biogeography, ecology and biodiversity. [Hans-Otto Poertner and WGII TSU, Germany]	Text re-written

SROCC Second Order Draft Government and Expert Review Compiled Comments - Chapter 5							
Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
9755	5	55	10	55	10	What is OA, acronyms should be defined. [Government of France, France]	Text re-written
20323	5	55	10	55	10	The abbreviation 'OA' should be changed to ocean acidification [APECS Group Review, Germany]	Text re-written
7247	5	55	11	0		Suggest unitalicize "is" ; suggest insert "it" before "is" [Nina Hunter, South Africa]	Text re-written
15751	5	55	15	55	19	These are important conclusions regarding C cycling and biogeochemical fluxes and role of oceans in global C budgets. This means there are still large uncertainties and new investigations and monitoring is needed. [EUCE, Belgium]	Text re-written
7249	5	55	17	0		Suggest change "on" to "in" [Nina Hunter, South Africa]	Text re-written
15753	5	55	21	55	24	Yes, and also effects on the fish communities in benthic and pelagic systems that support fishery yields. [EUCE, Belgium]	Text re-written
20401	5	55	26	0		C1: What does 'they' refer to? [APECS Group Review, Germany]	Text re-written
25497	5	55	26	55	26	lowers their sensitivity SPECIFY WHO IS "their" [Christophe Deissenberg, Luxembourg]	Text re-written
20489	5	55	26	55	31	This summarizing paragraph is very important I think. It needs to be revised to fit in better with the above section and be more logical in itself. [APECS Group Review, Germany]	Text re-written
31873	5	55	29	55	31	This extremely general and vague statements about "there will be winners and losers" is made several times. I think it is not very helpful for the assessment. [Hans-Otto Poertner and WGII TSU, Germany]	Text re-written
21937	5	55	30	55	30	"...observed changess...will occur..." Observations are from the past...not in the future? [David Schoeman, Australia]	Text re-written
15755	5	55	31	55	31	Section on coastal ecology and cc impacts. The recent paper by Reusch et al 2018 Sci. Adv. showing how the Baltic Sea and its monitoring and governance frameworks could be a time machine for future multi-driver change and policy development in other coastal systems is relevant to the context and background here. [EUCE, Belgium]	Taken into account in 5.3
20551	5	55	34	75	25	There is a good balance between section lengths [APECS Group Review, Germany]	Noted
20553	5	55	34	75	25	Multiple climate drivers were profusely explored, but others, such as ultraviolet radiation or pollution, were barely explored despite their significant impact. Please consider adding some discussion of these drivers to this section [APECS Group Review, Germany]	Taken into account. Pollution has been addressed when oportune in some coastal ecosystems but no UV due to lack of clear assessment.
20555	5	55	34	75	25	There are discrepancies in the amount of confidence levels between sections (i.e. coral reefs with lots of references, while few in estuaries). Is it because there is not such amount of confidence or because authors did not include this information? Please make the use of confidence level language consistant across sections [APECS Group Review, Germany]	Taken into account. The confidence levels have been revised for consistency across the whole section.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
20557	5	55	34	75	25	Authors mention that coastal ecosystems are under stress from the combination of climate change impacts as well as non-climatic human activities (e.g., pollution, eutrophication, aquaculture, urbanization). However, these human activities were not as deeply explored as climate drivers. A discussion, or at least reference to, human activities is needed to improve the completeness of this section [APECS Group Review, Germany]	Taken into account. The text has been modified accordingly.
14301	5	55	38	55	40	This text needs to be supported by a reference to demonstrate evidence. [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	Rejected- this is a general statement.
8689	5	55	38	55	53	it maybe consider dis reference : Ismail Dodanje, Saeed Soltani, Ali Sarhaddi,2010,Investigating the effect of climate change on the process of limiting the flow (minimum flow and flood) in the white water basin of the dam,Fourth Regional Climate Change Conference,IRAN, [Government of Iran, Iran]	Rejected. More recent literature has been considered.
29837	5	55	40	55	40	Please add "seagrass meadows" [Dorte Krause-Jensen, Denmark]	Rejected. Some examples are mentioned here, then all types of coastal ecosystems, including seagrass meadows, are assessed in the following subsections.
20635	5	55	41	0		It may be helpful to ad a map illustrating the distribution of "coastal seas" [APECS Group Review, Germany]	Rejected. Due to space constrains in the final draft,coastal seas have not been assessed. Section 5.3 has been rewritten and reorganized focused on coastal ecosystems.
14299	5	55	41	55	41	What are these percentages? Are they by area or volume - please clarify. [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	Rejected. They refer to area and total global marine PP
17377	5	55	43	55	43	Not correct. The coastal and shelf seas do not harbor 90 % of the world's fish catches. See for example Hoegh-Guldberg et al (2014) IPCC WG2 Chapter 30. [Svein Sundby, Norway]	Accepted. This text has been removed.
29839	5	55	45	55	48	I suggest modifying to e.g. "These marine environments include several frontal and upwelling areas (Box 5.2) that support high plankton productivity and fisheries yields (Scales et al., 2014) as well as highly productive kelp forests (ref). Moreover, coastal ecosystems such as mangrove forests, seagrass meadows and kelp forests form important habitats stimulating biodiversity while also supporting climate change mitigation and adaptation (Duarte et al. 2013. Nature Climate Change), with mangrove forest e.g. providing physical protection against extreme events such as storms and floods (Kelleway et al., 2017a)." [Dorte Krause-Jensen, Denmark]	Accepted, the text has been modified according to the suggestion.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
17379	5	55	47	55	47	This is generally not correct according to IPCC WG1 2013. The highest warming is in open-ocean high latitudes. Sea-surface warming is generally high i coastal waters because of stratification induced by runoff/low-saline surface waters.. [Svein Sundby, Norway]	Rejected - Due to space constraints in the final draft, this section of oceanographic drivers in the coastal seas has been removed.
14303	5	55	51	55	53	Please define the concept of 'mesoscale processes' to help guide the reader. [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	Rejected - Due to space constraints in the final draft, this text has been removed.
3967	5	55	55	56	1	Sentence is too long, could be broken into two simpler sentences [Aakash Sane, United States of America]	Accepted. This text has been rewritten according to reviewer comment.
33701	5	56	1	0		Section should include FOG that is created by land-sea temperature connection and has a large effect on coastal temperatures and ecosystems. [Government of United States of America, United States of America]	Rejected, no celar assessment on FOG on coastal ecosystems.
14307	5	56	1	56	3	Recommend that 'non-climate' is replaced by 'anthropogenic driven disturbances' to clarify meaning. [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	Accepted.
20637	5	56	1	56	3	Replace "non-climatic distrubances" with "human impacts" so that it is clear these are the impacts referenced in line 1 [APECS Group Review, Germany]	Accepted.
14309	5	56	1	56	4	Recommend 'threats' is replaced with 'climate-driven effects' for clarity. [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	Accepted
20639	5	56	2	56	4	Please a reference to support this assertion. [APECS Group Review, Germany]	Accepted
14305	5	56	3	56	3	Nutrient loads is not necessarily a disturbance and does not necessarily lead to eutrophication - please acknowledge this here. [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	Accepted-the text has been modified accordingly.
4897	5	56	5	0		Suggest removing the words "goods and services". [Debra Roberts and Durban Team, South Africa]	Accepted
3969	5	56	5	56	7	I think the sentence should be, " For example, cumulative exposure to eutrophication increases the likelihood of harmful algal blooms excacerbating the vulnearibility of coastal ecosystems to warming and deoxygenation..." [Aakash Sane, United States of America]	Rejected - Due to space constraints in the final draft, this text has been removed.
33703	5	56	5	56	7	Explain how eutrophication exacerbates vulnerability to warming. [Government of United States of America, United States of America]	Rejected - Due to space constraints in the final draft, this text has been removed.
7251	5	56	6	0		Vulnerability spelt incorrectly [Nina Hunter, South Africa]	Accepted
14311	5	56	9	56	12	Please add clear explanations to the text regarding the different types of scales in which these process operate [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	Accepted
28849	5	56	12	0		Add (ToE) after The so-called 'time of emergence' : "The so-called 'time of emergence' (ToE)" [Government of Brazil, Brazil]	Accepted

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
32413	5	56	15	56	16	Sentence should indicate that the underlying mechanisms for animals involve oxygen and capacity limited thermal tolerance. The citation "Brown & Thatje, 2014" should be moved to the end of the sentence "Pressure tolerance may also be limited by availability of oxygen [Daniela Storch, Germany]"	I couldn't find the link to this comment
31875	5	56	17	56	17	Provide proper citations for these AR5 Chapters [Hans-Otto Poertner and WGII TSU, Germany]	Rejected. This text has been removed.
33705	5	56	17	56	18	This is confusing. The previous paragraph indicated that changes at the coast are a combination of climate change and local anthropogenic changes (e.g., land use). This seems to contradict that previous statement. Even if no climate change, land use changes at the coast causes problems and modifies the local sediment budget and urban hydrology. Clarify these issues here. [Government of United States of America, United States of America]	Taken into account. This text has been removed/reorganized.
26597	5	56	18	56	19	The statement that coastal ecosystems are in "close proximity to human populations" is a very peculiar one. These ecosystems cannot relocate; humans relocate. Suggest rewriting to note that "...because of the close proximity of human populations to coastal ecosystems." [Florence Poulain, Italy]	Taken into account. The text has been removed/reorganized.
28851	5	56	21	0		add ocean before acidification : "ocean acidification" [Government of Brazil, Brazil]	Accepted.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
24635	5	56	29	0		This section outlines drivers specific/more pronounced in coastal ecosystems. One driver that is not mentioned here, is the increase in terrestrial dissolved organic matter (termed browning) that is released in the catchments and transported to lakes and ultimately coastal ecosystems, which is forced by a wetter climate, reduced sulfate deposition (ie. acid rain) and land-use changes (e.g. de Wit et al. 2016, DOI: 10.1021/acs.estlett.6b00396). This dissolved organic material undergoes substansial transformations along the aquatic continuum, also in coastal waters and estuaries (e.g. Massicotte et al., 2017, https://doi.org/10.1016/j.scitotenv.2017.07.076). The suspended dissolved and particulate organic mater in coastal systems has been shown to be increasing, which has been connected to the increase in dissolved organic matter being released and transported from land, with implications for aquatic productivity and optical conditions (e.g. Aksnes et al., 2009, https://doi.org/10.3354/meps08120 , Frigstad et al., 2013, https://doi.org/10.1016/j.pocean.2013.01.006 , Wikner & Andersson, 2012, https://doi.org/10.1111/j.1365-2486.2012.02718.x). [frigstad helene, Norway]	Rejected. Due to space constrains in the final draft,coastal seas have not been assessed and the whole section "5.3.2 Oceanographic drivers" has been removed and the text and references relocated in the coastal ecosystems, when appropriated.
32415	5	56	29	56	29	oxygen loss also includes the shift from communities with complex organisms such as multicellular Eukarya to less compley organisms such as unicellular Eukarya, Bacteria and Archaea (Storch et al. 2014). [Daniela Storch, Germany]	Rejected. Due to space constrains in the final draft,coastal seas have not been assessed and the whole section "5.3.2 Oceanographic drivers" has been removed and the text and references relocated in the coastal ecosystems, when appropriated.
31877	5	56	29	56	46	I am not sure whether I would call freshwater and river nutrient input "oceanographic" drivers. May be you with to think about rewording. [Hans-Otto Poertner and WGII TSU, Germany]	Rejected. Due to space constrains in the final draft,coastal seas have not been assessed and the whole section "5.3.2 Oceanographic drivers" has been removed and the text and references relocated in the coastal ecosystems, when appropriated.
776	5	56	29	57	12	This subsection about physical and chemical changes seems much shorter than its counterpart for the open ocean. I think the content (so many "e.g.") can be expanded a little. [Mengxi Wu, United States of America]	Rejected. Due to space constrains in the final draft,coastal seas have not been assessed and the whole section "5.3.2 Oceanographic drivers" has been removed and the text and references relocated in the coastal ecosystems, when appropriated.
9757	5	56	31	56	32	Physico-chemical drivers also include changes due to pollutants and plastics. They should be added. [Government of France, France]	Rejected. Due to space constrains in the final draft,coastal seas have not been assessed and the whole section "5.3.2 Oceanographic drivers" has been removed and the text and references relocated in the coastal ecosystems, when appropriated.
20583	5	56	31	56	32	Replace "These include" with "These include the following: [APECS Group Review, Germany]	Rejected. The text has been removed.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
1839	5	56	31	56	57	Ocean acidification is missing from this list. Coastal ocean acidification rates can also be more pronounced in coastal areas due to drivers other than anthropogenic CO ₂ : (1) Feely, R. A., Alin, S. R., Newton, J., Sabine, C. L., Warner, M., Devol, A., Krembs, C., and Maloy, C.: The combined effects of ocean acidification, mixing, and respiration on pH and carbonate saturation in an urbanized estuary, <i>Estuar. Coast. Shelf Sci.</i> , 88, 442–449, 10.1016/j.ecss.2010.05.004, 2010. (2) Wootton, J. T., and Pfister, C. A.: Carbon system measurements and potential climatic drivers at a site of rapidly declining ocean pH, <i>PLoS One</i> , 7, e53396, 10.1371/journal.pone.0053396, 2012. (3) Kapsenberg, L., Alliouane, S., Gazeau, F., Mousseau, L., and Gattuso, J. P.: Coastal ocean acidification and increasing total alkalinity in the northwestern Mediterranean Sea, <i>Ocean Sci.</i> , 13, 411–426, 10.5194/os-13-411-2017, 2017. [Lydia Kapsenberg, Spain]	Rejected. Due to space constraints in the final draft, coastal seas have not been assessed and the whole section "5.3.2 Oceanographic drivers" has been removed and the text and references relocated in the coastal ecosystems, when appropriated.
14313	5	56	31	57	12	An omission is a discussion of large scale circulation changes (especially the AMOC). This is discussed in Chapter 6, and this may reflect the expertise of the different chapter author teams, but from a user's perspective it's unhelpful to have information about large scale ocean changes distributed across the report. While abrupt AMOC change is an important topic and belongs in Chapter 6, all sorts of other variability in the AMOC are important and need to be discussed in Chapter 5 to give the full picture. It may be too late to change the overall distribution of material between chapters but there should be somewhere where a reader can pick up an integrated view of ocean changes. This could be achieved by adding a paragraph on ocean circulation (including AMOC) to the Executive Summary of Chapter 5 – obviously consistent with the conclusions of Chapter 6. [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	Rejected. We acknowledge the comment of the reviewers, but unfortunately, due to space constraints in the final draft, coastal seas and large scale circulation changes have not been assessed here. The whole section "5.3.2 Oceanographic drivers" has been removed and the text and references relocated in the coastal ecosystems, when appropriated.
7253	5	56	34	0		Suggest change "affecting" to "affect" [Nina Hunter, South Africa]	This text has been removed.
20559	5	56	34	56	34	Please replace "affecting" with "affect" [APECS Group Review, Germany]	This text has been removed.
33707	5	56	34	56	41	Acidification via freshening and organic nutrients should be mentioned here. [Government of United States of America, United States of America]	Rejected. Due to space constraints in the final draft, coastal seas have not been assessed and the whole section "5.3.2 Oceanographic drivers" has been removed and the text and references relocated in the coastal ecosystems, when appropriated.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
3663	5	56	34	57	6	Two of missing references here are Takeshita et al. (2015, Biogeosciences) and Frieder et al. (2012, Biogeosciences). These papers raised the possibility that the benthic communities on an upwelling shelf are currently acclimatized and adapted to natural, variable, and low dissolved oxygen and pH, projecting anthropogenic acidification trajectories by combining high-temporal-resolution sensor data, hydrographic surveys for source water characterization, empirical relationships of the CO2 system, and the atmospheric CO2 record. [Nam SungHyun, Republic of Korea]	Rejected. Due to space constrains in the final draft,coastal seas have not been assessed and the whole section "5.3.2 Oceanographic drivers" has been removed and the text and references relocated in the coastal ecosystems, when appropriated.
21725	5	56	34	57	6	Two of missing references here are Takeshita et al. (2015, Biogeosciences) and Frieder et al. (2012, Biogeosciences). These papers raised the possibility that the benthic communities on an upwelling shelf are currently acclimatized and adapted to natural, variable, and low dissolved oxygen and pH, projecting anthropogenic acidification trajectories by combining high-temporal-resolution sensor data, hydrographic surveys for source water characterization, empirical relationships of the CO2 system, and the atmospheric CO2 record. [Government of Republic of Korea, Republic of Korea]	Rejected. Due to space constrains in the final draft,coastal seas have not been assessed and the whole section "5.3.2 Oceanographic drivers" has been removed and the text and references relocated in the coastal ecosystems, when appropriated.
21939	5	56	34	57	6	Sudden switch to dot points is disconcerting. [David Schoeman, Australia]	This text has been removed.
15757	5	56	39	56	41	This is correct, and the interaction between the changes in salinity and other abiotic components should be stressed here. That is, species must adjust to changes in t, s and other variables and the responses will be more complex than in fully marine systems exposed to only changes in t, o or pH. Will affect the resident species (both marine, brackish and freshwater) and also the catadromous and diadromous ones. [EUCE, Belgium]	Taken into account. Due to space constrains in the final draft,coastal seas have not been assessed and the whole section "5.3.2 Oceanographic drivers" has been removed. The text and the references have been relocated in the coastal ecosystems, when appropriated.
21941	5	56	42	56	46	Another consequence is changing sediment load. [David Schoeman, Australia]	Taken into account. Due to space constrains in the final draft,coastal seas have not been assessed and the whole section "5.3.2 Oceanographic drivers" has been removed. The text and the references have been relocated in the coastal ecosystems, when appropriated.
9759	5	56	52	56	54	So far, we can just say that sea level rise has negligeable impacts on warm-water corals. [Government of France, France]	Taken into account. Due to space constrains in the final draft,coastal seas have not been assessed and the whole section "5.3.2 Oceanographic drivers" has been removed. The text and the references have been relocated in the coastal ecosystems, when appropriated.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
20585	5	56	55	56	57	Consider splitting the sentence into two shorter sentences: "Seasonal deoxygenation in coastal seas is likely to become more pronounced under warmer conditions (Laurent et al., 2018). It will also be indirectly affected by changes in primary production (and nutrient loads, both riverine and atmospheric) (Rabalais et al., 2014; Fennel and Testa, 2018; Irby et al., 2018)." [APECS Group Review, Germany]	Rejected. Due to space constraints in the final draft, coastal seas have not been assessed and the whole section "5.3.2 Oceanographic drivers" has been removed. The text and the references relocated in the coastal ecosystems, when appropriated.
12691	5	57	0	0		- Section 5.3.3: Some coastal ecosystems are converted to agrosystems (aquaculture zones), while few are sustainable ecosystems also called agroecosystems. [Noureddine Benkeblia, Jamaica]	Rejected. Due to space constraints in the final draft, this subsection has been merged with the general introduction 5.3 of coastal ecosystem. The text has been rewritten, reorganized and reduced.
25341	5	57	0	0		Section 5.3.3 Non-indigenous species (e.g. Biological invasions) are not mentioned in this section. I think it would be very important to dedicate a paragraph on the state of art on non-indigenous species in coastal ecosystems and the effects of climate change them (there are no many studies). It might be considered a dedicated box in Section 5.4.2 (see Harmful algal bloom and climate change) [Chiara Lombardi, Italy]	Taken into account. This subsection has been removed and the text reorganized. Biological invasions are considered in particular coastal ecosystems.
7255	5	57	2	0		Suggest insert "the" before "water" [Nina Hunter, South Africa]	Rejected, this subsection has been removed.
9761	5	57	2	57	6	Nothing is said about cumulative stress and plastic. [Government of France, France]	Rejected, this subsection has been removed.
14317	5	57	8	57	10	Changes influenced by coastal waters have been documented, please include a citation here. [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	Rejected. This subsection has been removed.
3665	5	57	8	57	12	Two of key missing references here are Send and Nam (2012, Journal of Geophysical Research - Ocean) and Nam et al. (2011, Journal of Geophysical Research - Ocean). The former highlights the roles of circulation patterns (altering shelf-edge currents and upwelling, and hence nutrient supplies) and width of the continental shelf in shaping physio-chemical oceanographic properties near the coast. The latter raises potentially important roles of near-bottom processes and turbulent mixing on physico-chemical properties of coastal water. [Nam SungHyun, Republic of Korea]	Rejected. This subsection has been removed.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
21727	5	57	8	57	12	Two of key missing references here are Send and Nam (2012, Journal of Geophysical Research - Ocean) and Nam et al. (2011, Journal of Geophysical Research - Ocean). The former highlights the roles of circulation patterns (altering shelf-edge currents and upwelling, and hence nutrient supplies) and width of the continental shelf in shaping physio-chemical oceanographic properties near the coast. The latter raises potentially important roles of near-bottom processes and turbulent mixing on physico-chemical properties of coastal water. [Government of Republic of Korea, Republic of Korea]	Rejected. This subsection has been removed.
24705	5	57	9	57	9	transport at multiple depths is also likley to change and controls nutrient supplies. cross shelf transport is missing from here. Suggest changing the sentence to say this e.g. update to say: '...altering shelf edge currents, upwelling and cross-shelf transport, and hence nutrient supplies). [Shutler Jamie, United Kingdom (of Great Britain and Northern Ireland)]	Rejected. This subsection has been removed and the text reorganized.
33709	5	57	12	57	12	"Spatial" should be extended to "spatio-temporal". [Government of United States of America, United States of America]	Rejected. This subsection has been removed.
11249	5	57	14	57	14	Subchapter 5.3.3. - too long - needs substantial shortening [Inka Bartsch, Germany]	Taken into account. The whole section has been substantially shortened and rewritten.
26595	5	57	14	57	14	The implications of the various changes explored in Section 5.3.3 Coastal Ecosystems seem to be premised on no policy changes; in short, a ceterus paribus sort of scenario and reduces the contribution of an otherwise highly relevant sub-section. [Florence Poulain, Italy]	Noted. This section assesses the climate change impacts on coastal ecosystems and the levels of risk for their biodiversity, structure and ecologcial functioning . Human risk reduction strategies -mitigation and adaptive responses- are not adressed here, but in the following sections of the Chapter.
21961	5	57	14	73	30	These sections on coastal ecosystems seem at the same time repetitive and inconsidetntly structured. This sounds contradictory, but I think the impression arises because there is not a coherent approach, almost as if the sections were wrtten by completely different people, and assembled without much thought to how they hang together. This could all be much tighter, with a simple summary of physical changes folowed by an assessment of the ecological responses, perhaps in the same order (warming, SLR, acidification, storms, etc.)? [David Schoeman, Australia]	Taken into account. The whole section 5.3 Coastal Ecosystems has been rewritten, reorganized and shortened.
32181	5	57	14	75	25	Coastal ecosystems are important, but the length of this section is out of proportion to the length allocated to the other oceanic ecosystems. This needs to be better balanced across all ecosystems [Nicolas Gruber, Switzerland]	Taken into account. The whole section 5.3 Coastal Ecosystems has been rewritten, reorganized and shortened.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
11677	5	57	16	57	16	What is the meaning of "diverse" in this line. Does it refer to the diversity of habitats, based on the geomorphological conditions? I do not think coastal ecosystems can be qualified as diverse in terms of biodiversity. For example, mangrove ecosystems only have ~70 different species which is very low when compared to other tropical forest ecosystems. Duke N. Chapter 2. Mangrove floristics and biogeography revisited: further deductions from biodiversity hot spots, ancestral discontinuities and common evolutionary processes. Mangrove ecosystems: a global biogeographic perspective structure, function and ecosystem services. Springer, New York, pp XX-XX 2017. I would suggest the author to precise the term of "diverse" or remove it. [Pierre Taillardat, Canada]	Taken into account. This subsection has been removed.
3971	5	57	16	57	17	I think a citation or a bit more explanation for this claim might be required [Aakash Sane, United States of America]	Rejected. This subsection has been removed.
20587	5	57	17	57	19	Remove "other" and replace "human drivers" by "anthropogenic drivers" as such: "They are also exposed to non-climatic anthropogenic drivers and their potential interactions with climate change because of their close proximity to human populations (...)". [APECS Group Review, Germany]	Rejected. This subsection has been removed.
11679	5	57	24	57	24	Is estuary an ecosystem? Perhaps habitat would be a more appropriated term [Pierre Taillardat, Canada]	Rejected. Estuaries are defined here as coastal ecosystems with particular biota and ecological and hydrological processes.
28853	5	57	27	0		add ocean before acidification : "ocean acidification" [Government of Brazil, Brazil]	Rejected. This subsection has been removed.
29841	5	57	27	55	30	This is not well-documented (the reference only considers coral reefs), and I think the lines could be better linked... Please rephrase. The last lines could e.g. be changed to "... are mostly threatened by warming and/or acidification, and are vulnerable to increased frequency of storms and heat-waves (ref). Coastal vegetated ecosystems have a disproportional high ecological value due to their roles as key habitats in combination with roles in climate change mitigation and adaptation (Duarte et al. 2013, Nature Climate Change), and coral reefs due to their stimulation of biodiversity in addition to protecting against erosion (Camp et al., 2016a)". It is not clear to me how coral reefs buffer warming, - if including this aspect, please explain. [Dorte Krause-Jensen, Denmark]	Taken into account. This subsection has been removed.
7257	5	57	28	0		Suggest change "disproportional" to "disproportionate" [Nina Hunter, South Africa]	Rejected. This subsection has been removed.
33711	5	57	29	57	30	Awkward phrasing makes this sentence unclear. [Government of United States of America, United States of America]	Rejected. This subsection has been removed.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
14319	5	57	32	57	34	Responses at the species-level differ, depending on the interactive effects of climate change. Please add references to support this section of the text. [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	Rejected. This subsection has been removed.
15759	5	57	32	57	34	Only partly correct. The big difference is that in many coastal systems salinity will also change. So a warming habitat might become suitable for new warmer adapted marine species but if the salinity falls, the immigrants will not be able to establish new thriving populations due to osmotic stress (or it will take many generations of natural selection to do so). This will be an issue for many estuaries in northern Europe (and maybe elsewhere?) where precipitation will likely increase. See also earlier comment re. Salinity changes. [EUCE, Belgium]	Taken into account. This subsection has been removed. Impacts on coastal biota due to changes in salinity have been assessed in the ecosystems subsections.
20561	5	57	32	57	34	Please provide additional support for this assertion. It seems unlikely that biological responses in both coastal and pelagic ecosystems can be similar (i.e., local extinctions may only be attributable to coastal ecosystems, or pollution impacting in a higher degree these ecosystems). [APECS Group Review, Germany]	Taken into account. This subsection has been removed.
14315	5	57	35	57	35	inland migration' of benthic infauna is perhaps misleading as it implies that animals are invading terrestrial habitats - suggest rephrasing to clarify, i.e. 'inland migration towards the coastal ocean'? [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	Taken into account. This subsection has been removed and the text reorganized.
33713	5	57	35	57	36	This is true not just for benthic fauna, but the whole community. [Government of United States of America, United States of America]	Taken into account. This section has been removed and the text reorganized.
7259	5	57	39	0		Suggest change "is" to "are" [Nina Hunter, South Africa]	Rejected. This subsection has been removed.
20641	5	57	40	57	40	Please add "hypoxic zones" to the glossary [APECS Group Review, Germany]	Taken into consideration
28855	5	57	44	0		add , since AR5, new understanding : "new understanding , since AR5, of ecological and functional ..." [Government of Brazil, Brazil]	Rejected. This subsection has been removed.
20589	5	57	45	57	45	Replace "human" by "anthropogenic" as such: "(...) ecosystems are experiencing related to multiple climate and non-climatic anthropogenic drivers, and their synergies." [APECS Group Review, Germany]	Rejected. This subsection has been removed.
15761	5	57	51	57	51	This section should include some lines about how species living in estuaries and brackish systems could face physiological challenges due to both changes in salinity and temperature. Depending on individual species' tolerances, the current and future temperatures and salinities, they could expand, contract or not change their distributions or productivities at all (due to counteracting or nonlinear/threshold responses to abiotic changes). See e.g., MacKenzie et al. 2007, Global Change Biology. [EUCE, Belgium]	Taken into account. The subsection has been rewritten and reorganized.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
15763	5	57	51	57	51	The Estuaries section seems a bit unbalanced towards the physical-chemical-geological impacts and misses some ecological context related to combined effects of changes in salinity with the other abiotic factors that could change (e.g. temperature, pH, nutrients, oxygen). For instance, there will be challenges to forecasting how species and foodwebs will be affected due to possible changes in salinity in addition to other variables. [EUCE, Belgium]	Taken into account. The subsection has been balanced.
20643	5	57	51	57	51	It may be helpful to explicitly state that beyond simply having high biodiversity, estuaries provide critical nursery/ early life history stage habitat for many commercially fished species and for emblematic species such as seahorses [APECS Group Review, Germany]	Taken into account.
20565	5	57	51	59	53	Most of the assumptions showed medium to low confidence, but the conclusions a high confidence. How is this sustained? [APECS Group Review, Germany]	Taken into account. The confidence levels have been revised.
28161	5	57	53	57	55	Many estuaries also support extensive stands of benthic plants in the saline region of the estuary and mangroves are adjacent to tropical estuaries. [Hilary Kennedy, United Kingdom (of Great Britain and Northern Ireland)]	Taken into account. Estuarine wetlands are considered.
21945	5	57	53	59	53	This section is not well written and needs a thorough edit for grammar, punctuation, sentence structure and clarity. [David Schoeman, Australia]	Taken into account.
20645	5	57	54	57	54	Please confirm that "ecotone" is in the glossary as indicated by the text in this line. [APECS Group Review, Germany]	Rejected. This term has been removed.
28307	5	57	57	0		Change "ml l-1" to "mL L-1" with a subscript [Nsikak Benson, Nigeria]	Rejected, this has been removed.
28309	5	58	1	0		Change "ml l-1" to "mL L-1" with a subscript [Nsikak Benson, Nigeria]	Rejected, this has been removed.
10293	5	58	2	58	3	Losses in ecosystem services due to land reclamation in coastal habitats have also been clearly demonstrated in a recent study of the Yellow Sea. I suggest the following literature to be cited - "Yim J., Kwon B.O., Nam J., Hwang J.H., Choi K., Kim J.S. 2018. Analysis of forty years long changes in coastal land use and land cover of the Yellow Sea: The gains or losses in ecosystem services. Environmental Pollution 241: 74-84." [Jinsoo Park, Republic of Korea]	Rejected. The text has been rewritten and ecosystem services are assessed in section 5.4.
21729	5	58	2	58	3	Losses in ecosystem services due to land reclamation in coastal habitats have also been clearly demonstrated in a recent study of the Yellow Sea. I suggest the following literature to be cited - "Yim J., Kwon B.O., Nam J., Hwang J.H., Choi K., Kim J.S. 2018. Analysis of forty years long changes in coastal land use and land cover of the Yellow Sea: The gains or losses in ecosystem services. Environmental Pollution 241: 74-84." [Government of Republic of Korea, Republic of Korea]	Rejected. The text has been rewritten and ecosystem services are assessed in section 5.4.
33715	5	58	3	58	5	Clarify the phrase starting with "which". [Government of United States of America, United States of America]	Rejected. The text has been rewritten.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
20563	5	58	4	58	10	Please use the confidence level language with these assertions. [APECS Group Review, Germany]	Taken into account. The text has been rewritten and the confidence language has been revised.
7261	5	58	5	0		Suggest replace comma after "estuaries" with colon [Nina Hunter, South Africa]	Rejected. The text has been rewritten.
14321	5	58	19	58	19	Please explain the terms 'meso and macro tidal estuaries' within the text. [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	Rejected.
25767	5	58	19	58	20	"Meso- and macrotidal estuaries are more resilient to global.....than microtidal estuaries , which" be changed as "Meso-and macrotidal estuaries with sediment-rich areas are more resilient to global.....than microtidal estuaries with sediment-starved areas, which" [Government of India, India]	Accepted
3973	5	58	23	58	26	I don't think there is a need to mention the Amazon River Basin. It looks redundant, it might be enough just to point the reader towards the reference or delete this sentence altogether. [Aakash Sane, United States of America]	Accepted.
7263	5	58	28	0		Suggest remove "on"; suggest insert "the" before "evaporation rate" [Nina Hunter, South Africa]	Rejected. The text has been rewritten.
20591	5	58	31	58	32	Replace "physical-chemical" by "physico-chemical" as such: "The cycling between periods of drought and flood over land in combination with warming will affect the 32 physico-chemical water gradients of ocean properties (...)" [APECS Group Review, Germany]	Rejected. This text has been removed.
5051	5	58	34	58	34	Drop "PSS" as the acronym was used only once in the chapter. [Debra Roberts and Durban Team, South Africa]	Rejected. This text has been removed.
21943	5	58	45	58	49	Here (as in several other places in this Chapter), two statements are woven together. The first has no confidence language, but the second does. The reader is left wondering whether the confidence language refers to the logical chain, or just the second sentence. This needs to be much clearer. [David Schoeman, Australia]	Taken into account. The confidence language has been revised.
20593	5	58	47	58	52	Maybe it is not necessary to cite Anderson et al. 2015 twice in such close proximity, when the second sentence seems to obviously be a continuation of the first. Perhaps it would be suitable to delete the first citation and retain the second. [APECS Group Review, Germany]	Accepted.
22833	5	58	52	58	52	Paerl 2016 is specifically addressing freshwater cyanobacteria. You might consider including Paerl et al. 2018 (ES&T 52: 5519-5529) which specifically addresses the link to the coastal ocean [Raphael Kudela, United States of America]	Accepted.
3975	5	58	56	58	56	Maybe the word 'detritus' should be added to the glossary? [Aakash Sane, United States of America]	Rejected.
14327	5	59	5	59	12	It is important to refer to the expected changes across shallow temperate estuaries; a reference is needed, especially if Rio de la Plata Estuary, Baltic Sea and Chesapeake Bay are cited as areas where these changes have been observed. [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	Taken into account. The reference is in the text Altieri and Gedan, 2015

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
16609	5	59	5	59	7	It might be useful to move this to coastal seas in general rather than putting it in the estuary section, since this sentence in general applies to coastal seas and is not directly geared toward estuaries. The Schunck et al. 2013 reference I suggested above could also fit in with this sentence as it discusses an anoxic & sulfidic region in the coastal ocean. [David Janssen, Switzerland]	Taken into account. This applies for general coastal seas, but desoxygenation is intensified in eutrophic estuaries. The coastal seas section has been removed. The text in estuaries has been rewritten accordingly.
20647	5	59	9	59	9	Why are arctic estuaries listed separately from "high latitude" estuaries? Are arctic estuaries not high latitude estuaries? Please explain the difference here or delete the reference to arctic estuaries. [APECS Group Review, Germany]	Accepted. The text has been revised.
28163	5	59	10	59	13	Warming also increases the extent and time of stratification, in addition increased rainfall can cause stronger stratification. The stratification aspect and consequent effects on hypoxia and surface water warming (+squeeze) should be included. Chesapeake bay is a good example. [Hilary Kennedy, United Kingdom (of Great Britain and Northern Ireland)]	Accepted. This has been added.
14323	5	59	15	59	18	The pteropod Limacina helicina is not an estuarine species so the sentence is out of place here; please remove or relocate to appropriate section. [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	Accepted. This has been removed.
33717	5	59	17	59	18	Pteropods are mainly open-ocean species so are not a good example here. [Government of United States of America, United States of America]	Accepted. This has been removed.
7265	5	59	20	0		Change "influence" to "influenced" [Nina Hunter, South Africa]	Accepted.
20649	5	59	20	59	41	Please be consistent with directional notation. This paragraph uses both initials (NW) and written out directions (northeast) [APECS Group Review, Germany]	Taken into account.
33719	5	59	20	59	41	Watch tense in examples. It is not consistent in this part of the document. [Government of United States of America, United States of America]	Taken into account.
7267	5	59	27	0		Change "causes" to "cause" [Nina Hunter, South Africa]	This text has been removed.
14329	5	59	30	59	31	The text refers to enhanced dredging practices that could have implications for water turbidity, please support this with a citation. [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	Taken into account. The text has been modified.
20595	5	59	30	59	31	To help understanding the direction of turbidity modification, I would reformulate as such: "In the temperate Bahía Blanca Estuary (SW Atlantic Ocean), warmer phases of ENSO mediate the emergence of high water turbidity (...)". [APECS Group Review, Germany]	Taken into account. The text has been modified.
9925	5	59	33	59	41	ENSO-driven drought is affecting coastal area, mangroves, etc. when groundwater with greater salt content is used to mitigate the drought. There is also missing a comment on the desalinisation plants in coastal areas and the return flow into the ocean affecting the whole physical-chemical composition of the coast and the ocean. [Úrsula Oswald Spring, Mexico]	Taken into account. ENSO is assessed when appropriated in each ecosystem subsection.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
28165	5	59	35	59	36	The concept of blue carbon needs to be defined [Hilary Kennedy, United Kingdom (of Great Britain and Northern Ireland)]	Rejected. This text has been removed from this section. Blue Carbon is assessed in section 5.4
7269	5	59	43	0		Should it not be "confers on"? [Nina Hunter, South Africa]	This text has been removed.
15765	5	59	43	59	53	The references to these attributions should be listed directly in the text, or as a table. It is currently difficult to see which papers supports these statements. [EUCE, Belgium]	Accepted. The text has been modified.
20567	5	59	44	59	45	How is it known that estuaries are resilient to short term environmental perturbations? How was this likelihood calculated? [APECS Group Review, Germany]	Taken into account. The text has been modified.
33721	5	59	44	59	45	More evidence should be provided here. Red tide blooms are caused in part by human impacts so the "likely" label seems somewhat suspect and may need additional caveats or references for support. [Government of United States of America, United States of America]	Taken into account. The harmful algal blooms are addressed in Box 5.3.
7271	5	59	48	0		Change "this" to "these" [Nina Hunter, South Africa]	Rejected. The text has been removed.
14331	5	59	51	59	53	Areas subjected to flooding will be the most vulnerable to changes in ecosystem functioning and services; please add a relevant citation. [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	Taken into account. The text has been modified.
14325	5	59	53	59	53	This section could also mention that climate change is impacting the ability of diadromous fish (e.g. salmon, eels etc) species to pass through estuaries. There is a sizeable literature on estuarine fish (especially salmon), that is not covered here. [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	Taken into account. Due to space constraints in the final draft, particular fish species could not be addressed in estuaries. Common changes in the estuarine biota distribution are considered in the text.
16761	5	59	55	59	55	Overall - This section is well written and includes all known stressors facing salt marshes in the future. It includes evidence from marshes all around the world. While the section mentions mangrove transgression into salt marshes, I do not see any mention of the potential for salt marsh expansion inland with SLR. Authors do mention barriers to this transgression, but do not mention recent work showing that, at least in some locations, salt marshes will expand with SLR. (See Matt Kirwan's work) (e.g., Kirwan, M.L., *Walters, D.C., Reay, W., and Carr, J.A. 2016. Sea level driven marsh expansion in a coupled model of marsh erosion and migration. Geophysical Research Letters 43, 4366-4373; and Kirwan, M.L., Temmerman, S., Skeeahan, E., Guntenspergen, G., and Fagherazzi, S. 2016. Overestimation of marsh vulnerability to sea level rise. Nature Climate Change 6, 253-260.) I am not disputing the claim that there is "high confidence" that salt marshes will continue to diminish in the future (P 61 L 46), especially because of barriers, just that this might not happen in all areas globally. [Carl Wepking, United States of America]	Taken into account. This section has been merged into coastal wetlands together with mangrove forests and seagrass meadows. The expansion inland is assessed for coastal vegetation (sediment reacomodation, soil accretion).

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
33723	5	59	55	61	54	Suggest that the organization of Section 5.3.3.2 be reconsidered so that information on the same topic is grouped. As it is now, the section seems scattered and meandering. [Government of United States of America, United States of America]	Accepted. This section has been merged into coastal wetlands together with mangrove forests and seagrass meadows. The text has been reorganized and rewritten.
28187	5	59	55	64	40	Miss any comment on improvements since AR5 [Hilary Kennedy, United Kingdom (of Great Britain and Northern Ireland)]	Accepted. The text has been rewritten accordingly.
20599	5	60	2	60	2	To improve clarity, please change "regimes" to "regions" [APECS Group Review, Germany]	Rejected. This text has been removed.
14333	5	60	5	60	6	Please explain the words 'forbs' and 'culms' - these will be unfamiliar to a non-specialist. [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	Rejected. This text has been removed.
11693	5	60	8	60	16	This part is related to the carbon sink ecosystem service saltmarshes provide. Some of the sentences used here are also present in 5.4.1.3.2. I would suggest remove this part from 5.3.3.2 and leave it in 5.4.1.3.2 [Pierre Taillardat, Canada]	Accepted.
14335	5	60	8	60	8	The text referring to burrowing and biodeposition needs to be supported by a citation. [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	Rejected. This text has been removed.
20597	5	60	8	60	8	Please delete the parantheses enclosing 2017b [APECS Group Review, Germany]	Accepted.
21947	5	60	11	60	12	Is confidence language required for non-climate-related statements? The answer through the rest of the Chapter seems to be NO? Consider consistency, throughout? [David Schoeman, Australia]	Taken into account. The onfidence language has been revised.
16763	5	60	12	60	12	p 60 L 12 - Can qualify low methane emissions as being due to sulfate availability. [Carl Wepking, United States of America]	Rejeted. No robust literature to adress this topic.
11681	5	60	14	60	14	You can also refer to Taillardat P, Friess DA, Lupascu M. Mangrove blue carbon strategies for climate change mitigation are most effective at the national scale. Biology Letters 2018; 14.for a more recent and up to date estimate of carbon burial in blue carbon ecosystems. [Pierre Taillardat, Canada]	Rejected. Blue carbon is not assessed in this section but in 5.4.
20601	5	60	14	60	16	Maybe it is not necessary to cite McLeod et al. 2011 twice in such close proximity, when the second sentence seems to obviously be a continuation of the first. Perhaps it would be suitable to delete the first citation and retain the second. [APECS Group Review, Germany]	Accepted. The text has been modified.
20603	5	60	18	60	21	Please insert the confidence level language, partiularly in regards to the statement that "Sea level rise is a major threat to salt marshes" [APECS Group Review, Germany]	Taken into account. The text has been modified and the confidence language has been revised.
33725	5	60	27	60	30	This seems too detailed and a mismatch from other paragraphs. [Government of United States of America, United States of America]	Accepted. The text has been removed.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
346	5	60	30	60	30	Add the following sentence at the end of the paragraph: "The study of dispersal limitation indicate that saltmarsh plant community in temperate estuaries are especially vulnerable to climate change, in comparison with other coastal communities such as macroinvertebrates (Chust et al. 2013)". Reference: Chust, G., Albaina, A., Aranburu, A., Borja, Á., Diekmann, O. E., Estonba, A., Franco, J., Garmendia, J. M., Iriondo, M., Muxika, I., Rendo, F., Rodríguez, J. G., Ruiz-Larrazaga, O., Serrão, E. A. and Valle, M. (2013) Connectivity, neutral theories and the assessment of species vulnerability to global change in temperate estuaries. Estuarine, Coastal and Shelf Science, 131, 52-63. [Guillem Chust, Spain]	Rejected. The text has been rewritten and reorganized and saltmarshes merged with mangroves and seagrasses into wetland section.
7273	5	60	32	0		Should it not be "rising sea level"? [Nina Hunter, South Africa]	Taken into account.
7275	5	60	33	0		Suggest change "have" to "has" [Nina Hunter, South Africa]	Rejected. The text has been removed.
33727	5	60	33	60	33	Change "have" to "has" [Government of United States of America, United States of America]	Rejected. The text has been removed.
14337	5	60	34	60	35	The text referring to structure and function of ecosystems needs to be supported by a citation. [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	Taken into account.
33729	5	60	35	60	36	Do you mean benefits of mangrove invasion or of increased saltmarsh area? [Government of United States of America, United States of America]	Benefits from mangrove invasion. The text has been modified.
16765	5	60	36	60	37	Need citations for this statement. (e.g., Carbon Cycling and Storage in Mangrove Forests Daniel M. Alongi Annual Review of Marine Science 2014 6:1, 195-219) [Carl Wepking, United States of America]	Rejected. The text has been rewritten and reorganized.
33731	5	60	40	60	40	"in situ" italicized here, but not in other places. [Government of United States of America, United States of America]	Taken into account.
3721	5	60	40	60	51	It seems pertinent to this discussion about salt marshes and sea level rise to discuss how dams and reservoirs have reduce sediment supply to salt marshes, which in turn reduces their ability to keep up with sea level rise. This is especially true for salt marshes in places like the Mississippi River Delta. [Trisha Atwood, United States of America]	Taken into account. This is considered in the new section of coastal wetlands.
16767	5	60	47	60	47	Needs citation, such as Enwright, N.M., Griffith, K.T., and Osland, M.J., 2016, Barriers to and opportunities for landward migration of coastal wetlands with sea-level rise: Frontiers in Ecology and the Environment, v. 14, p. 307-316. [Carl Wepking, United States of America]	Taken into account. This reference has been included.
33733	5	60	49	60	51	This sentence should go at the beginning of the paragraph and more attention should be paid to feedbacks that promote development. [Government of United States of America, United States of America]	Rejected. The text has been rewritten and reorganized.
33735	5	60	53	60	53	Specify what effects. [Government of United States of America, United States of America]	Rejected. Effects are specify in the the text.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
20569	5	61	5	61	6	Please specify the confidence for the assertion that increase decay rates in response to warming are a result of increase microbial and fungal activities. [APECS Group Review, Germany]	Taken into account. The confidence language has been revised.
14341	5	61	8	60	8	The text refers to the effects resulting from multiple stressors and their deterioration of saltmarshes, please add a citation to support this. [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	Taken into account. The text has been rewritten.
3717	5	61	8	61	10	Burrowing by crabs in New England Marshes were also found to increase erosion (Coverdale et al. 2014) which led to the loss of substantial carbon stocks (Atwood et al. 2015) Coverdale, T. C. et al. 2014 Indirect human impacts reverse centuries of carbon sequestration and salt marsh accretion. PLoS ONE 9, e93296. Atwood et al. 2015 Predators help protect carbon stocks in blue carbon ecosystems. Nature Climate Change 5: 1038-1045 [Trisha Atwood, United States of America]	Rejected. The text has been rewritten. Rencen literature is assessed related to climate-driven changes.
3719	5	61	15	61	20	The effects of nutrients on salt marsh sediment accumulation is less clear than what is being presented here. Other studies have found no effect of nutrient additions on elevation gain of salt marshes. See Reef et al. 2017. Global Change Biology 23:881-890. doi:10.1111/gcb.13396 [Trisha Atwood, United States of America]	Taken into account. The text has been rewritten.
20651	5	61	26	61	26	In this and several following paragraphs there is significant discussion about "C3"and "C4" plants. These terms are not defined in this section or elsewhere in the chapter. Please either give a breif definition here or add to the glossary [APECS Group Review, Germany]	Taken into account. This text has been removed.
25343	5	61	26	61	26	"C3" should have 3 subscript for being consistent with the rest of the text (see pg, 62 lines 32, 33) [Chiara Lombardi, Italy]	This text has been removed.
7277	5	61	27	0		Change "erradication" to "eradication" [Nina Hunter, South Africa]	This text has been removed.
33737	5	61	44	61	44	Cite the primary article, not the summary of it: Pacella, S. R., C. A. Brown, G. G. Waldbusser, R. G. Labiosa, and B. Hales. 2018. Seagrass habitat metabolism increases short-term extremes and long-term offset of CO2 under future ocean acidification. Proceedings of the National Academy of Sciences 115:3870-3875. [Government of United States of America, United States of America]	I couldnt find the link to this comment
14343	5	61	46	61	48	The text referring to the fact that saltmarshes will continue to reduce their area in response to SLR needs to be supported by a citation. [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	Taken into account. The text has been rewritten and references added.
20605	5	61	48	61	49	It may be understandable for more readers to use the phrase "locally extinct" instead of "locally extirpated" [APECS Group Review, Germany]	This text has been removed.
7279	5	61	52	0		Suggest insert "the" before "combined effects" [Nina Hunter, South Africa]	This text has been removed.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
14339	5	61	53	61	54	This section should probably mention saltmarshes as a habitat for juvenile fish. [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	Taken into account
33739	5	61	53	64	40	Would be good to add in something about the role of mangroves as a refugia to climate change and OA along the lines of : K.K Yates, C.S Rogers, J.J Herlan, G.R Brooks, N.A Smiley, R. A Larson. (2014). Diverse coral communities in mangrove habitats suggest a novel refuge from climate change. Biogeosciences. 11, 4321-4337. [Government of United States of America, United States of America]	Taken into account
23233	5	62	0	62		does not convey a sense of an assessment : level of scientific understanding, confidence...? [Valerie Masson-Delmotte, France]	Accpeted. The table has been removed.
20573	5	62	0	65		For consistency, Table 2 and table 3 should be formatted the same way [APECS Group Review, Germany]	Taken into account. Talbe 2 has beenremoved, Table 3 has beenmoved to the Appendix.
21949	5	62	1	62	46	There are a LOT of typos in this section. [David Schoeman, Australia]	Taken into account. This section has been rewritten and merged into coastal wetlands.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
25769	5	62	1	62	46	<p>Some additional points are relevant for mangroves and climate change: "The sea-level rise is a growing threat to mangroves. The most vulnerable mangroves to sealevel rise are located in the areas of small islands, lack of rivers, carbonate setting, tectonic movements, groundwater esxtraction, underground mining, coastal development, steep topography, microtidal and sediment-starved areas. The least vulnerable mangroves are situated in riverine areas, macrotidal and sediment-rich areas as well dense mangrove forests (Kathiresan, 2015; Mc Leod and Salm, 2006)." Another point to be discussed for mangroves is : "There is sufficient evidence that mangrove species have proliferated at or near their poleward limits at five continents over the past half a century. these changes are consistent with the poleward extension of temperature thresholds conciding with sealevel rise (Saintilan et al., 2014). One mroe point is : "Mangroves are among the most carbon-rich forests in the tropics. The carbon sequestration potential of mangroves is about four times greater than tropical terrestrial forests. This is because of high levels of below-ground biomass and considerable storage of organic carbon in mangrove sediment soils. Globally, mangroves accumulate up to 25.5 million tonnes of carbon annually and provide more than 10 percent of the organic carbon essential to the world's oceans. Globally, mangrove deforestation generates emissions of 0.02-0.12 picograms of carbon per year, up to 10 percent of total emissions from deforestation. Thus, failing to preserve mangrove forests can cause considerable carbon emissions and lead to climate change. Therefore, mangrove restoration could be a novel mitigation option against climate change (Ong, 1993; Dittmar et al., 2006; Donato et al., 2011).</p> <p>[Government of India, India]</p>	Taken into account. This section has been rewritten and merged into coastal wetlands.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
27269	5	62	1	62	46	Suggestion- Include data-information about carbono stock on mangrove florests – e.g.: ROCHA DE SOUZA PEREIRA, FRANCISCA ; KAMPEL, Milton ; Gomes Soares, Mário ; ESTRADA, GUSTAVO ; BENTZ, CRISTINA ; VINCENT, GREGOIRE . Reducing Uncertainty in Mapping of Mangrove Aboveground Biomass Using Airborne Discrete Return Lidar Data. Remote Sensing, v. 10, p. 637-658, 2018. ESTRADA, Gustavo Calderucio Duque ; SOARES, MÁRIO LUIZ GOMES . Global patterns of aboveground carbon stock and sequestration in mangroves. ANAIS DA ACADEMIA BRASILEIRA DE CIENCIAS, v. 89, p. 973-989, 2017. SOARES, MÁRIO LUIZ GOMES; CHAVES, Filipe de Oliveira ; ESTRADA, Gustavo Calderucio Duque ; FERNANDEZ, V. . Mangrove forests associated with salt flats: a case study from southeast Brazil. BRAZILIAN JOURNAL OF OCEANOGRAPHY, v. 65, p. 102-115, 2017. [Gleyci Moser, Brazil]	Taken into consideration
14345	5	62	4	62	4	Does the 'Atlantic East Pacific' include Caribbean mangrove forests? Please clarify in the text which areas this group includes? [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	Rejected. This text has been removed.
11683	5	62	6	62	6	You can refer to "Duke N. Chapter 2. Mangrove floristics and biogeography revisited: further deductions from biodiversity hot spots, ancestral discontinuities and common evolutionary processes. Mangrove ecosystems: a global biogeographic perspective structure, function and ecosystem services. Springer, New York, pp XX–XX 2017" for an edited version of this work. [Pierre Taillardat, Canada]	Rejected. This section has been rewritten and integrated with seagrassess and saltmarshes into coastal wetlands.
11685	5	62	8	62	10	This statement would benefit from a reference. I suggest for example "Richards DR, Friess DA. Rates and drivers of mangrove deforestation in Southeast Asia, 2000-2012. Proceedings of the National Academy of Sciences of the United States of America 2016; 113: 344-349." which identified aquaculture, oil palm and rice production to be the most important drivers of mangrove deforestation in SEA. [Pierre Taillardat, Canada]	Rejected. This text has been removed and rewritten.
7281	5	62	12	0		Suggest insert "an" before "important role" [Nina Hunter, South Africa]	Rejected. This text has been removed.
28171	5	62	12	62	13	The review provided by Krauss, KW et al., 2014 How mangrove forests adjust to rising sea level. nEW PHYTOLOGIST 202(1) 19-34 may be useful. [Hilary Kennedy, United Kingdom (of Great Britain and Northern Ireland)]	Taken into account.
7283	5	62	14	0		Separate "arepredicted" [Nina Hunter, South Africa]	noted
450	5	62	14	62	14	"arepredicted" be changed as "are predicted" [Kathiresan Kandasamy, India]	noted
17177	5	62	14	62	14	Space needed between "are predicted" [Shalini Singh, Fiji]	noted

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
28167	5	62	14	62	14	sense of sentence not clear [Hilary Kennedy, United Kingdom (of Great Britain and Northern Ireland)]	This text has been removed/rewritten.
33741	5	62	14	62	14	Add space separating words "are" and "predicted". Change "drawn" to "drown". [Government of United States of America, United States of America]	noted
7285	5	62	17	62	19	Suggest move "are the more vulnerable to sea level rise" to after "islands"; remove "the" before "more" [Nina Hunter, South Africa]	This text has been removed.
7287	5	62	19	0		Suggest change "mangroves" to "mangrove" [Nina Hunter, South Africa]	noted
14347	5	62	19	62	19	Why are mangrove systems only "initially resilient". Please explain why this is the case. [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	Taken into account.
20621	5	62	20	62	21	It would be helpful to add a little detail regarding what changes mid-century in the RCP8.5 scenario that ends the resiliency of mangrove ecosystems [APECS Group Review, Germany]	Taken into account.
33743	5	62	23	62	23	Explain how sea-level rise increases salinity. [Government of United States of America, United States of America]	Taken into account across coastal ecosysmtes.
28173	5	62	23	62	24	Climate change may increase aridity of existing mangrove locations reducing size, biomass and carbon storage. [Hilary Kennedy, United Kingdom (of Great Britain and Northern Ireland)]	Taken into account.
5553	5	62	23	63	1	it maybe consider this reference : "An overview of Iranian mangrove ecosystems, northern part of the Persian Gulf and Oman Sea"(MohammadAli Zahed-FatemehRouhani-SorayaMohajerla-Farshid Bateni-Leila Mohajeri) August 2010, DOI: 10.1016/j.chnaes.2010.03.013 Iranian mangrove forests occur between 25° 11 to 27° 25, in the north part of the Persian Gulf and Oman Sea. The areas of Iranian mangrove forests are almost 10700 ha which maximum area 67.5 km ² occurs between Khamir Port and northwest of Qeshm Island, and minimum area 0.01 km ² in Bardestan estuary. Only two species of mangrove include Avicennia marina from Avicenniaceae and Rhizophora macrunata from Rhizophoraceae are found in the Persian Gulf. A. marina specie is dominant specie in these forests and Rh. macrunata specie just is found in Sirik region. Overexploitation of mangrove leaves and oil pollution are the main destruction factors in this region Persian Gulf has high salinity, with a salt content of 38 – 50 g/L (Parvaresh et al., 2011). Petroleum hydrocarbons are detected in proximity (Zahed et al., 2010). The range of surface temperatures of water in the Sirik mangrove forest on the shore of the Gulf of Oman, varies from 23 °C in winter to 32 °C in the summer. [Government of Iran, Iran]	Taken into accpunt.
452	5	62	26	62	26	"treats" be changed as "traits" [Kathiresan Kandasamy, India]	noted
17179	5	62	26	62	26	Mis-spelled word "treats" should be "threats" [Shalini Singh, Fiji]	noted

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
20623	5	62	26	62	26	Perhaps the word "treats" is supposed to be "traits". However, there is not a discussion of physiological traits in the sentence prior, so it is challenging to understand the meaning. [APECS Group Review, Germany]	noted
33745	5	62	26	62	26	Change "treats" to "traits". [Government of United States of America, United States of America]	noted
7289	5	62	27	0		Suggest change "patters" to "patterns" [Nina Hunter, South Africa]	noted
454	5	62	27	62	27	"patters" be changed as "patterns" [Kathiresan Kandasamy, India]	noted
33747	5	62	27	62	27	Change "patters" to "patterns". [Government of United States of America, United States of America]	noted
28169	5	62	27	62	30	Include reference to Doughty, CL et al., 2016 Mangrove Range Expansion Rapidly Increases Coastal Wetland Carbon Storage ESTUARIES AND COASTS 39(2) 385-396 [Hilary Kennedy, United Kingdom (of Great Britain and Northern Ireland)]	Taken into account.
456	5	62	36	62	36	"exposed" be changed as "of exposure" [Kathiresan Kandasamy, India]	noted
33749	5	62	39	62	39	"Despite" or "in spite of"? [Government of United States of America, United States of America]	noted
33751	5	62	39	62	41	Rewrite sentence for clarity. [Government of United States of America, United States of America]	Accepted.
14349	5	62	43	62	44	The sentence about 'Mangrove forestry activities' seems out of place here; suggest this could be deleted. [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	Accepted
11251	5	62	49	62	49	Tabel 5.2: similar table could be designed for all sub-chapters; best in an integrative way, as some factors will influence similar processes in the other ecosystems: might not be easy and work but would be ideal [Inka Bartsch, Germany]	Rejected. The sections for each type of coastal ecosystems have been rewritten with a consistent structure of drivers-impacts-risks. Table 2 has been removed.
4417	5	62	49	63	1	Reading the references, it doesn't look like there has been much recent research on it. Maybe skip the entire table if there is some lenght constrain [The UBern Team Group Review, Switzerland]	Accepted.
20607	5	62	49	63	1	In table 5.2, one of the listed impacts of increased rainfall is decreased groundwater. This is counterintuitive. It would be helpful to include something in the main text explaining this phenomenon. [APECS Group Review, Germany]	The table has been removed.
20653	5	62	49	63	1	Table 5-2 is challenging to understand. The material has been so summarized that the menaing mayb have ben lost. For example recruitment is a process that is impacted many different ways, but it is likely that there are broad difference in impact with animal and plant recruitment responding much differently to stressors. [APECS Group Review, Germany]	The table has been removed.
21951	5	62	49	63	1	SROCC, in my understanding is supposed to build from AR5, but none of the references in this table are from after 2014. Was this information simply not included in AR5? [David Schoeman, Australia]	The table has been removed.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
25771	5	63	0	63		in the Table 5.2, under factor column "increased rainfall" be changed as "erratic rainfall" or "rainfall" [Government of India, India]	The table has been removed.
33753	5	63	1	0		Add non-native invasive species that may perform better under changing climate and affect seagrasses. Example of didenum growth on zostra. [Government of United States of America, United States of America]	Taken into account. This section has been merged into coastal wetlands, rewritten and restructured.
14351	5	63	5	63	5	Suggest an addition to explain that seagrasses deliver essential ecological functions but they are very limited in spatial extent world wide (please provide an estimate if possible). [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	Rejected. This section has been merged into coastal wetlands, rewritten and restructured.
14355	5	63	5	63	5	The importance of seagrasses to deliver ecosystem functions and services is well acknowledged, please add a citation to support this. [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	Rejected. This section has been merged into coastal wetlands, rewritten and restructured.
29843	5	63	5	63	9	I suggest changing to e.g. "Seagrass-dominated meadows deliver essential ecological functions and services, including carbon storage and wave attenuation (e.g. Duarte et al. 2013. Nature Climate Change - and provide reference to section XX on Blue Carbon)." Seagrass meadows of Posidonia spp. e.g. form highly refractory carbon deposits that can be stored over thousands of years within sediments (Pergent et al., 2014; Hyndes et al., 2016; York et al., 2017).Seagrasses also offer protection to neighbouring coral reefs by their buffering ability against ocean acidification (Camp et al., 2016b). [Dorte Krause-Jensen, Denmark]	Rejected. This section has been merged into coastal wetlands, rewritten and restructured. Ecosystem services are considered in 5.4
7291	5	63	6	0		Suggest replace "with" with "to" [Nina Hunter, South Africa]	This text has been removed.
33755	5	63	6	63	7	This finding is not confirmed enough to be applied in a general way. [Government of United States of America, United States of America]	Taken into account. This text has been removed.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
1841	5	63	6	63	8	<p>This is not at all what that paper (Camp et al 2016b) shows. Camp et al 2016b found:</p> <p>“Calcification rates per coral species were highest at the outer-reef sites”</p> <p>“Corals within seagrass and back-reef habitats had rates of calcification that were 12.5–33.0% lower than corals at outer- reef sites.”</p> <p>“In some cases, opportunistic species within seagrass habitats demonstrated an increase (1.0–3.0%) in calcification relative to the outer-reef”</p> <p>“Across all sites and habitats calcification decreased...with increasing pH [variability]”</p> <p>Thus, these results do not show that seagrasses protect corals from ocean acidification. Perhaps line 6-8 are based on what was mentioned in the Discussion:</p> <p>“Seagrass sites within this study consistently experienced elevated local mean pH, reduced pCO₂, and therefore elevated [aragonite saturation state] relative to the outer-reef. Seagrass habitats also experienced low pH at night which corresponded with periods of under-saturation of carbonate-sediment resulting in dissolution (FigureS2)....The ability of seagrass habitats to buffer future ocean acidification will therefore depend in part on the fine balance of G-D over diel cycles.”</p> <p>“In the seagrass habitats, coral calcification... was generally sustained supporting the hypothesis that seagrass systems may play a buffering role for resident corals from ocean acidification through biologically-mediated elevation of mean pH” <-- this statement is then followed by references of studies that ignore the effect of low pH during the night and effects of pH variability (which in Camp et al 2016b show a negative effect on calcification).</p> <p>To my knowledge, there is no substantial evidence to say that seagrass beds offer protection of ocean acidification. It is a story that is gaining popularity, research interest, and worthy of investigation, but is currently without robust scientific evidence. I therefore recommend line 6-8 is not included in the IPCC report as a fact. If it has to be mentioned, it should be presented with a confidence rating, as done with other conclusive statements.</p> <p>[Lydia Kapsenberg, Spain]</p>	Accepted. This text has been removed.
29845	5	63	12	63	14	In this context it would be relevant to refer to Waycott et al. 2009. [Dorte Krause-Jensen, Denmark]	Taken into account.
28181	5	63	16	64	2	Effects on other species Beca-Carretero, P et al., 2018 Response to experimental warming in northern eelgrass populations: comparison across a range of temperature adaptations MARINE ECOLOGY PROGRESS SERIES 589 59-72 [Hilary Kennedy, United Kingdom (of Great Britain and Northern Ireland)]	Taken into account
14353	5	63	19	63	19	Please replace the word 'retract' with 'retreat' (throughout the sub-section). [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	noted
28175	5	63	19	63	19	An example of winners could be from the Arctic Marba, N et al., 2018 Expanding Greenland seagrass meadows contribute new sediment carbon sinks SCIENTIFIC REPORTS 8, 14024 10.1038/s41598-018-32249-w [Hilary Kennedy, United Kingdom (of Great Britain and Northern Ireland)]	Taken into account.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
28177	5	63	20	63	30	Mediterranean vulnerable too [Hilary Kennedy, United Kingdom (of Great Britain and Northern Ireland)]	Taken into account.
7293	5	63	28	0		Suggest remove "a" before "9%" [Nina Hunter, South Africa]	The text has been rewritten.
25695	5	63	28	64	2	should include information from Indian studies on C sequestration estimates by seagrasses. E.g.: D. Ganguly, G. Singh, R. Purvaja, R. Bhatta, A. Paneer Selvam, K. Banerjee, R. Ramesh, 2018. Valuing the carbon sequestration regulation service by seagrass ecosystems of Palk Bay and Chilika, India. Ocean & Coastal Management, Volume 159, 1 June 2018, Pages 26-33 and 4 more similar references in Ocean and Coastal Management [Government of India, India]	Carbon sequestration is assessed in section 5.4.
32417	5	63	37	63	39	It would be nice to include the vulnerabilities such as: Shared biological principles that drive responses of marine microbes, plants, invertebrates and fishes to single and multiple climate change drivers reveal higher vulnerability of complex organisms such as plants and animals compared to less complex organisms such as bacteria. (Storch et al. 2014, WGII AR5 6.3, Pörtner et al. (2017)) [Daniela Storch, Germany]	Rejected. Out of scope in this section. Multidivers effects on organisms from microbes to mammals is adressed in 5.2
14361	5	64	1	64	2	The statement about changes in sediment C stocks and enhanced CO2 emissions due to oxygenation of eroded sediments needs to be supported by a citation. [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	This text has been removed.
7295	5	64	4	0		Suggest move "seagrass meadow formed by Posidonia oceanica" to before "such" and insert "to" before "seagrass" [Nina Hunter, South Africa]	The text has been rewritten.
28179	5	64	4	64	6	effects of warming Savva, I rt al., 2018 Thermal tolerance of Mediterranean marine macrophytes: Vulnerability to global warming. ECOLOGY AND EVOLUTION 8 (23) 12032-12043 [Hilary Kennedy, United Kingdom (of Great Britain and Northern Ireland)]	Taken into account.
20655	5	64	4	64	7	Because other species are named, it would be helpful to name the "tropical species" predator this sentence refers to. [APECS Group Review, Germany]	Taken into account
7297	5	64	7	0		Suggest insert "has" before "also" [Nina Hunter, South Africa]	The text has been rewritten.
7299	5	64	9	64	11	Please rephrase to make meaning clear [Nina Hunter, South Africa]	The text has been rewritten.
20625	5	64	9	64	11	It is unclear what this sentence is saying. There appear to be many typos that have obstructed the meaning of this sentence. Please carify the point and consider breaking this up into multiple sentences. [APECS Group Review, Germany]	The text has been rewritten.
33757	5	64	9	64	11	Rewrite sentence for clarity. [Government of United States of America, United States of America]	The text has been rewritten.
28185	5	64	11	64	11	reference for RCP8.5 climate scenario? [Hilary Kennedy, United Kingdom (of Great Britain and Northern Ireland)]	Taken into account.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
348	5	64	14	64	14	<p>Add the following sentence at the end of the paragraph: "Population genetics studies indicate a low recolonisation rate of <i>Z. noltii</i> populations, constraining the shift to the new suitable habitat poleward at a pace comparable to warming rates (Chust et al. 2013; Valle et al. 2014)."</p> <p>References:</p> <p>Chust, G., Albaina, A., Aranburu, A., Borja, Á., Diekmann, O. E., Estonba, A., Franco, J., Garmendia, J. M., Iriondo, M., Muxika, I., Rendo, F., Rodríguez, J. G., Ruiz-Larriaga, O., Serrão, E. A. and Valle, M. (2013) Connectivity, neutral theories and the assessment of species vulnerability to global change in temperate estuaries. <i>Estuarine, Coastal and Shelf Science</i>, 131, 52-63.</p> <p>Valle, M., Chust, G., Del Campo, A., Wisz, M. S., Olsen, S. M., Garmendia, J. M. and Borja, A. (2014) Projecting future distribution of the seagrass <i>Zostera noltii</i> under global warming and sea level rise. <i>Biological conservation</i>, 170, 74-85. [Guillem Chust, Spain]</p>	Taken into account. The section has been restructured. Population variability has been considered in the assessment.
11029	5	64	16	64	17	<p>add in that the benefits to seagrasses from DIC will only be realised where water temperatures remain cool enough (Brodie et al. 2014). Also the caveat that increased DIC can result in increased herbivory due to reduced plant defense compounds (Arnold et al. 2012). Arnold, T., Mealey, C., Leahey, H, Miller AW, Hall-Spencer JM, Milazzo M. et al. (2012). Ocean Acidification and the Loss of Phenolic Substances in Marine Plants. <i>PLoS ONE</i>. 7(4), e35107. [Jason Hall-Spencer, United Kingdom (of Great Britain and Northern Ireland)]</p>	Taken into account. The section has been rewritten.
28183	5	64	16	64	21	<p>Text could be enriched by Campbell, JE et al., 2013 Effects of in situ CO2 enrichment on the structural and chemical characteristics of the seagrass <i>Thalassia testudinum</i> <i>MARINE BIOLOGY</i> 160 (6) 1465-1475 and Campbell, JE et al 2018 Does Nutrient Availability Regulate Seagrass Response to Elevated CO2? <i>ECOSYSTEMS</i> 21(7) 1269-1282 [Hilary Kennedy, United Kingdom (of Great Britain and Northern Ireland)]</p>	Taken into account.
29847	5	64	16	64	40	<p>Please add e.g. An introductory statement that the effect of warming differs along the geographical distribution range of seagrasses, with most negative effects towards the southern distribution range (e.g. ref to Wernberg et al) and stimulation towards the northern distribution range (e.g. Olesen et al. 2015). [Dorte Krause-Jensen, Denmark]</p>	Taken into account. The text has been rewritten and this topic has been clarified.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
20571	5	64	17	64	19	It would be helpful to explain, at least a little, why there is no consensus on the long term consequences of increased CO ₂ on seagrass carbon budgets and the stoichiometric composition of seagrasses [APECS Group Review, Germany]	Taken into account. The text has been rewritten.
20657	5	64	18	64	18	Consider adding stoichiometric composition to the glossary [APECS Group Review, Germany]	This text has been removed.
17183	5	64	19	64	19	Space needed between "counter balance" [Shalini Singh, Fiji]	This text has been removed.
3723	5	64	23	64	23	Studies have also shown that overgrazing by herbivores can lead to lower carbon stocks in the sediment via a multitude of different pathways that affect carbon retention, carbon accumulation, and carbon capture in seagrasses, salt marshes, and to some degree mangroves. See Atwood et al. 2015 Predators help protect carbon stocks in blue carbon ecosystems. Nature Climate Change 5: 1038-1045 [Trisha Atwood, United States of America]	Taken into account. Due to space constraints in the final draft, multiple herbivory mechanisms affecting coastal vegetation could not be discussed in detail.
33759	5	64	25	64	27	And also due to higher metabolism. But, OA may change chemical composition of seagrasses in a way that may alter herbivory rates, (i.e., Arnold et al 2012 PLOS doi.org/10.1371/journal.pone.0035107). [Government of United States of America, United States of America]	Taken into account. Due to space constraints in the final draft, multiple herbivory mechanisms affecting coastal vegetation could not be discussed in detail.
7301	5	64	33	0		Suggest change "require" to "requires" [Nina Hunter, South Africa]	The text has been rewritten.
20609	5	64	33	64	33	Consider changing "to encapsulate" to "that acknowledge" or "that capture". [APECS Group Review, Germany]	The text has been rewritten.
7303	5	64	35	0		Suggest remove "a" before "high confidence" [Nina Hunter, South Africa]	The text has been rewritten.
11031	5	64	38	64	38	At high latitudes seagrass habitats are projected to expand in area due to the benefits of increased DIC on seagrass growth (Brodie et al. 2014). Brodie J, Williamson CJ, Smale DA, Kamenos NA, Mieszkowska N, Santos R, Cunliffe M, Steinke M, Yesson C, Anderson KM, Asnaghi V, Brownlee C, Burdett HL, Burrows MT, Collins S, Donohue PJC, Harvey B, Foggo A, Noisette F, Nunes J, Ragazzola F, Raven JA, Schmidt DN, Suggett D, Teichberg M, Hall-Spencer JM (2014) The future of the NE Atlantic benthic flora in a high CO ₂ world. Ecology and Evolution, 4, 2787-2789. [Jason Hall-Spencer, United Kingdom (of Great Britain and Northern Ireland)]	Taken into account
14357	5	64	39	64	39	habitat for species' - please provide some examples, e.g. turtles, dugongs and manatees. [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	Taken into account
33761	5	64	42	67	22	This section needs to include information on sand formation and how that will be impacted by OA's effects on CaCO ₃ producing species like some algae and corals and on the potential for OA to cause sand dissolution (i.e., Eyre et al 2018 DOI: 10.1126/science.aao1118). [Government of United States of America, United States of America]	Rejected. Not strong assessment on this for sandy beaches.
20611	5	64	44	64	44	Consider replacing the word "embrace" with a more neutral term like "represent" [APECS Group Review, Germany]	The text has been rewritten.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
33763	5	64	44	64	46	Odd word choices. Rewrite sentence for clarity. [Government of United States of America, United States of America]	The text has been rewritten.
21953	5	64	44	67	22	I agree that sandy beaches are important and have been overlooked in terms of climate change, but this section needs more focus, in my opinion, and needs more consistent use and justification of confidence language. One of the problems with detection and attribution in beach systems is that there are few long-term time series, and few attempts have been made to actually attribute anything to climate change (although many theoretical claims are made - see Schoeman et al. (2014) Global Change Biology 20. [David Schoeman, Australia]	Taken into account. The section of sandy beaches has been rewritten and reorganized. The confidence language has been revised.
7305	5	64	45	0		Separate "roleby" [Nina Hunter, South Africa]	noted
17181	5	64	45	64	45	Space needed between "role by" [Shalini Singh, Fiji]	noted
7307	5	64	49	0		Suggest change "facilitates" to "facilitate" [Nina Hunter, South Africa]	noted
11581	5	64	51	64	51	I would also include 'high enery waves and changes in the longshore currents ' in the list of severe erosive events for beaches [Luca Castrucci, United States of America]	Taken into account
7309	5	64	54	0		Separate "therise" [Nina Hunter, South Africa]	noted
14359	5	64	54	64	54	The extraction of sand and gravel to build hard sea defences (both as concrete and for beach nourishment) in the face of sea level rise and storm surges could also be mentioned here. [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	Taken into account. The text has been rewritten.
7311	5	65	6	0		Suggest change "this" to "these" [Nina Hunter, South Africa]	noted
20613	5	65	9	65	10	This may be the first instance of the acronym "ENSO" in this chapter. If so the abbreviation needs to be written out. [APECS Group Review, Germany]	taken into account
33765	5	65	9	65	11	Rewrite sentence for clarity. [Government of United States of America, United States of America]	Th text has been rewritten
7313	5	65	10	0		Suggest change "warns on" to "points to" or similar [Nina Hunter, South Africa]	noted
7315	5	65	13	65	14	Please rephrase "allows attributing with high confidence" [Nina Hunter, South Africa]	Taken into account. The text has been rewritten.
33767	5	65	14	65	16	Rewrite sentence for clarity and make it the topic sentence of the paragraph. [Government of United States of America, United States of America]	Taken into account. The text has been rewritten.
33769	5	65	16	65	18	Acidification should be mentioned here. [Government of United States of America, United States of America]	Taken into account. The text has been rewritten. There is no strong assessment on OA in sandy beaches biota.
14363	5	65	20	65	22	Please provide a reference to illustrate "opposite demographic responses". [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	Accepted
33771	5	65	20	65	22	Which coast has resilience? [Government of United States of America, United States of America]	Taken into account. The text has been rewritten.
7317	5	65	24	0		Suggest change "In" to "On" [Nina Hunter, South Africa]	Th text has been rewritten
33773	5	65	27	65	29	This is an odd example. [Government of United States of America, United States of America]	Accepted
33775	5	65	30	65	30	Capitalize Isopoda. [Government of United States of America, United States of America]	Th text has been rewritten
7319	5	65	34	0		Suggest insert "the" before "eastern" [Nina Hunter, South Africa]	Th text has been rewritten

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Comment id	Chapter	From page	From line	To page	To line	Comment	
7321	5	65	37	0		Suggest change "strength" to "strengthens" [Nina Hunter, South Africa]	Th text has been rewritten
7323	5	65	38	0		Suggest change "affects" to "affect" [Nina Hunter, South Africa]	Th text has been rewritten
14365	5	65	42	65	44	The table legend could be rephrased to: "A summary of available evidence to document the potential effects of climate change....." for clarity. [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	Accepted
33777	5	65	42	66	1	Change "fingerprints" to something like "attribution"? [Government of United States of America, United States of America]	Rejected
33779	5	65	42	66	1	The "Experiments" part of the table should be WAY more populated as there are SO many experiments done on temperature. Why isn't OA mentioned at all? [Government of United States of America, United States of America]	Taken into account. No robust assesement for OA on sany beahces.
7325	5	65	44	0		Suggest change "Addapted" to "Adapted" [Nina Hunter, South Africa]	The text has been rewritten.
20615	5	65	44	65	44	Reference 4, "(Hubbard et al. 2014)" should be corrected to " Hubbard et al. (2014)" [APECS Group Review, Germany]	noted
20617	5	65	44	66	1	Please improve the formatting, perhaps by shading every other row. It is hard to determine which items are in the same rows. [APECS Group Review, Germany]	Taken into account
14367	5	66	0	66		The meaning of 'fingerprints' in unclear in this context - please explain. [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	Rejected. It is a common word that refers to evidence of changes related to climate change.
23235	5	66	0	66		does not convey a sense of an assessment : level of scientific understanding, confidence...? [Valerie Masson-Delmotte, France]	Taken into account. This table has been moved to the appendix. It provides a list of evidence to support the assessment in the text.
20619	5	66	1	66	1	Reference there are currently two instances of reference number 11. This is formatted in a different way than reference 3 which clearly has multiple sources assigned to it. Please confirm that the second reference 11 was not supposed to be reference 12. The current reference 12 is listed as "(Jaramillo et al 2017)" and should be corrected to "Jaramillo et al. (2017)" [APECS Group Review, Germany]	Taken into account.
33781	5	66	7	66	10	This sentence seems out of place here. [Government of United States of America, United States of America]	The text has been rewritten.
14369	5	66	20	66	22	Beach deterioration has generated economic losses, which are quite important for this section. Please provide a dedicated example to support this statement. [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	The text has been rewritten. Human dimension is adress in section 5.4
20627	5	66	21	66	22	The assertion that green and golden tides cause high economic losses needs a supporting citation. [APECS Group Review, Germany]	This text has been removed.
7327	5	67	3	0		Suggest changing "threaten" to "threatened" [Nina Hunter, South Africa]	The text has been rewritten.
7329	5	67	5	0		Suggest insert "increase to" before "near" [Nina Hunter, South Africa]	The text has been rewritten.
21955	5	67	5	67	6	Here is an example of a putative impact assigned "medium confidence", that has some basis in theory, but no observational evidence = detection (as far as I am aware, and no citations are provided here). [David Schoeman, Australia]	The text has been rewritten and the confidence levels have been revised.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
25689	5	67	12	67	14	<p>One reference can be included here by Bhowmick et al (2016). This paper suggests the boosting of tropical cyclones in Bay of Bengal during La Nina years, which is due to the increased heat transport from Pacific to Indian Ocean.</p> <p>Reference: Bhowmick, S.A., Agarwal, N., Ali, M.M., et al. Clim Dyn (2016)" Role of ocean heat content in boosting post-monsoon tropical storms over Bay of Bengal during La-Nina events" http://doi.org/10.1007/s00382-016-3428-5 [Government of India, India]</p>	Rejected. This is out of scope in the section of impacts on sandy beach ecosystems' biodiversity, structure and functioning.
14377	5	67	16	68	17	<p>The section on changes observed in the re-distribution of macrofauna in sandy beaches need to be supported by references. [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]</p>	Taken into account. References in the table in the appendix.
7331	5	67	19	0		Suggest change "on" to "in" [Nina Hunter, South Africa]	This text has been rewritten.
7333	5	67	20	0		Suggest change "on" to "in" [Nina Hunter, South Africa]	This text has been rewritten.
10691	5	67	24	0		Hoegh-Gulberg et al. (2018; SR15), which extensively covers coral reefs, should be cited. [Jean-Pierre Gattuso, France]	Accepted. SR1.5 cited.
9763	5	67	24	67	24	<p>The temporality has to be mentioned in this paragraph. It has to be explain that first impacts (in the shortest future) will be caused by temperature rise. In the further future, coral reef will front acidification's impacts. [Government of France, France]</p>	Agree. This has been mentioned in other parts of the report. There is no space to detail this clear outcome from global change impacts
9765	5	67	24	67	24	<p>There is no mention of known coral resistance capacity (eg: heat resistant corals can be observed in Oman, Raja Ampat, Red Sea...). [Government of France, France]</p>	This point, while mentioned in the coral adaptation section, is not the major point discussed here. The small sections of the reefs that can stand higher temperatures do not negate the general trend of coral degradation.
11835	5	67	24	67	24	<p>Coral reefs account for 1% of ocean area yet 25% of marine species have some part of their life cycle in coral reefs. [William Lorenz, Australia]</p>	Agree. This was mentioned in former parts and in the figures

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
5555	5	67	24	68	51	<p>it maybe consider this reference: "Distribution and Abundance of the Corals around Hengam and Farurgan Islands, the Persian Gulf "Rezai, Hamid Samimi, Kaveh Kabiri, Keivan Kamrani, Ehsan Jalili, Mahshid Mokhtari, Mohammad, September 2010, The percentage cover and distribution of scleractinian corals were in the Persian Gulf: In Farurgan Island, hard coral cover was concentrated in the west and north-west of the island, while in Hengam it was mostly concentrated in the eastern side of the Island. Mean hard coral cover was 25.91% (\pm 5.80) and 48.47% (\pm1.36) in Farurgan and Hengam Islands, respectively. There was a significant difference ($p < 0.01$) in hard corals coverage among different reefs in each island. Other benthic life forms showed similar patterns with significant differences ($p < 0.01$) among reefs. It was observed that the predominant hard coral forms were massive (Porites) in Farurgan Island, whilst those in Hengam Island were mainly branching corals (Acropora). Acropora corals are the dominant corals of the Persian Gulf. The result of PASTAKIA analytical model was show that Iranian side of the Persian Gulf can be divided to 5 zone with weak similarity. Also, It is possible each of area have overlapped with neighboring zones.</p> <p>Conference Paper , " Assessment of climate change effects on the Persian Gulf coral reefs ecosystems, using by Pastakia Analytical Model", Mahnaz Rabbaniha, October 2013</p> <p>Global warming's affect on the Persian Gulf coral reefs:</p> <p>Acidification: The third and in many respects the greatest concern in the longer term, is that global change is causing the world's oceans to become more acidic. Coral loss: There are many causes of local and global coral loss but human-induced climate change is one of the main and undeniable threats. Climate change is having negative effects on coral populations via at least three mechanisms. Coral disease: Ocean warming can also indirectly kill corals by magnifying the effects of infectious diseases, which are one of the primary causes of coral loss, particularly in the Caribbean Coral bleaching: First, ocean warming is directly reducing coral cover through coral bleaching. Reef-building corals contain plant-like organisms called zooxanthellae that live symbiotically within their tissue. Coral bleaching is caused by elevated sea surface temperatures due to global climate change which the animals cannot cope with</p> <p><u>Bleaching observations on the Iranian side has also been documented through field</u></p>	Due to the lack of space, older publications (such as the suggested one from year 2010) cannot be added. The text has been further shortened.
9209	5	67	24	68	51	<p>Section 5.3.3.6: The catastrophic mass coral mortality and bleaching affecting the Great Barrier Reef (and other world regions) during unprecedented marine heat waves in 2016 and 2017 should be adequately covered in this section (as well as in the Executive Summary). The 2016 mass mortality event is already adequately destribed in the academic literature, such as in Hughes et al. (2017, doi:10.1038/nature21707) and (2018, doi:10.1038/s41586-018-0041-2). Most likely, the 2017 event is only be described in government monitoring programmes at the moment. [Hans-Martin Füssel, Denmark]</p>	Accepted

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
11967	5	67	24	68	51	Entire section 5.3.3.6 It does not become apparent how you derive from this section the summary statement "Shallow coral reefs that are not degraded by other impacts such as overfishing and nutrient enrichment could constitute an important refuge to reefs degraded by climate change." [Wolfgang Kiessling, Germany]	Agree. The phrase in the Exceutive Summary has bee revised
14371	5	67	24	68	52	The coral reefs section currently has huge gaps in its coverage. Given that coral reefs are one of the most intensely studied habitats and one of the most imperilled, the text provided here seems very inadequate. For example it does not cover the worldwide phenomena of recent coral bleaching events, driven by peak temperatures. There is also no geographic perspective, i.e. saying where reefs are most at threat or degraded as a result of climate change (Caribbean vs Indo-Pacific). Please consider revising this section to take account of these points. [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	The text has been revised and recent publications were added to cover the statements with less text (due to cut in the total length of the chapter)
32629	5	67	26	67	45	I'm surprised not to see any data around the record-breaking 2015/16 global coral bleaching and mortality event, in the context of basin-scale losses of reefs, and or reports for extent of the most severe damage from this event - in the central tropical Pacific. Claar et al., PLOS1, 2018 is a start. [Kim Cobb, United States of America]	Added
20659	5	67	26	67	46	The introdcution to the coral reef section is well written and thorough, however it stands out for having noticably more detail and references included than any other sections. [APECS Group Review, Germany]	The text and the list of references are revised and reduced in size
14379	5	67	26	68	51	The coral reef section is very broad. There is a very good set of literature available to document some of the observed changes, these needs to be added to this section and cited accordingly. The section jumps around and lacks concrete evidence to document some of the changes discussed. [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	The text has been revised and is educed in size
21957	5	67	26	68	51	Given the critical importance of coral reefs, both from an ecological perspective, and as a tool for public communication, I was disappointed in the structure of this section, which wasn't well written. Among many possible examples are the consecutive statements that (p. 68, lines 38-43) that vulnerability of reefs varies regionally, and that all reefs are vulnerable to climate change. Also, on lines 49-50, is risk not future...can there be a risk of something already having happened. This all needs focus and clarity. [David Schoeman, Australia]	The text has been revised accordingly
31879	5	67	28	67	28	Specify chapter and provide proper citation for IPCC AR5 WGII [Hans-Otto Poertner and WGII TSU, Germany]	OK

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33783	5	67	28	67	28	Change to: "...and all erode reef resilience." [Government of United States of America, United States of America]	Done
10695	5	67	30	0		"fuels tropical storms", citation needed. [Jean-Pierre Gattuso, France]	Done
10697	5	67	32	0		What is meant by "conflicting"? Antagonistic? [Jean-Pierre Gattuso, France]	Rephrased
7335	5	67	36	0		Suggest insert "in response" before "to warming" [Nina Hunter, South Africa]	Revised
33785	5	67	36	67	36	C [Government of United States of America, United States of America]	corrected
10699	5	67	36	67	37	Rephrase for clarity. Also, the choice of references is weird as none of the papers reporting back to back bleaching of the GBR are cited. [Jean-Pierre Gattuso, France]	Rephrased
31881	5	67	37	67	43	Are Brown et al and Perry et al the only references for all three statements? [Hans-Otto Poertner and WGII TSU, Germany]	The text was revised accordingly.
14373	5	67	38	67	38	Please explain what "changes in host symbiont combinations" means. [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	The text was revised accordingly.
7337	5	67	39	0		Suggest remove "changes"; change "causes" to "causing" [Nina Hunter, South Africa]	done
10701	5	67	40	0		Clarify "influences", it "negatively affect calcification" mean? In that case, this is not a universal response. [Jean-Pierre Gattuso, France]	Done
11045	5	67	40	0		What means "directly"? The literature suggests that decrease in seawater pH leads to a consequent decrease of the pH of the extracellular calcifying medium lowering the saturation state of aragonite around the crystal. Therefore, the effects is not direct. See references: Venn et al. Impact of seawater acidification on pH at the tissue-skeleton interface and calcification in reef corals. Proc. Natl. Acad. Sci. USA 110, 1634–1639 (2013); Ries. A physicochemical framework for interpreting the biological calcification response to CO2-induced ocean acidification. Geochim Cosmochim Ac 75, 4053–4064 (2011). [Denis Denis Allemand, Monaco]	The text was revised accordingly.
11047	5	67	40	0		OA... can lead to community changes.. (high confidence): this point needs to be supported by a reference (eg Fabricius et al. Losers and winners in coral reefs acclimatized to elevated carbon dioxide concentrations. Nature Clim Change 1, 165-169 (2011)). [Denis Denis Allemand, Monaco]	A reference was added

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
86	5	67	40	67	41	I think it might be worth mentioning here that there is emerging evidence that ocean acidification is already suppressing coral growth rates on the Great Barrier Reef (Albright et al., 2016): Reference: Albright, R., Caldeira, L., Hosfelt, J., Kwiatkowski, L., Maclaren, J.K., Mason, B.M., Nebuchina, Y., Ninokawa, A., Pongratz, J., Ricke, K.L. and Rivlin, T., 2016. Reversal of ocean acidification enhances net coral reef calcification. Nature, 531(7594), 362-365. [Lester Kwiatkowski, France]	A reference was added
10703	5	67	44	0		"such as enhanced storm intensity": is that correct? A citation is needed. [Jean-Pierre Gattuso, France]	A reference was added
Text	5	67	48	67	57	The paragraph starting "Globally, coral communities....." largely repeats text and topics from the text immediately above. Some of this could be removed. [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	Text was revised
31883	5	67	48	68	51	Specify chapter and provide proper citation when referring to IPCC AR5 WGII [Hans-Otto Poertner and WGII TSU, Germany]	To do
10705	5	67	50	0		Rodolpho-Metalpa describes work on a symbiotic, but nit reef-building, coral of the Mediterranean. [Jean-Pierre Gattuso, France]	The referenced has been deleted
10707	5	67	52	0		It seems to me that the meta-analyses of Kroeker et al. (2013) and Kornder et al. (2018) Kornder N. A., Riegl B. M. & Figueiredo J., 2018. Thresholds and drivers of coral calcification responses to climate change. Global Change Biology 24:5084-5095. Kroeker K., Kordas R., Crim R., Hendriks I., Ramajo L., Singh G., Duarte C. & Gattuso J.-P., 2013. Impacts of ocean acidification on marine organisms: quantifying sensitivities and interaction with warming. Global Change Biology 19:1884-1896. [Jean-Pierre Gattuso, France]	The text has gone through a revision
11955	5	67	57	68	2	"one of the most drastic consequences". What is the comparative framework here? Time, ecosystems or what? There are additional important references that could be cited here, for example 1. T. P. Hughes et al., Coral reefs in the Anthropocene. Nature 546, 82-90 (2017); 2. T. P. Hughes et al., Spatial and temporal patterns of mass bleaching of corals in the Anthropocene. Science 359, 80-83 (2018). [Wolfgang Kiessling, Germany]	The text was revised accordingly.
33787	5	67	57	68	2	Reword for clarity. This is a powerful idea that shouldn't be lost in wording. [Government of United States of America, United States of America]	The text was revised accordingly.
23237	5	68	0	68		be explicit on what is meant by "decline" and "losses" [Valerie Masson-Delmotte, France]	The text was revised

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
4419	5	68	1	68	1	Sentence unclear. Please rewrite [The UBern Team Group Review, Switzerland]	the text was revised accordingly.
7339	5	68	7	0		Suggest change "for" to "to" [Nina Hunter, South Africa]	Changed
11957	5	68	8	68	10	Difficult language. Please revise "in those cases where the reef system's health that is emerged from a specific impact". Perhaps cite again Hughes et al. (2017, op. cit.) on recurrent mass bleaching [Wolfgang Kiessling, Germany]	The text was revised.
7341	5	68	9	0		Suggest change "is" to "has" [Nina Hunter, South Africa]	The text was revised
11049	5	68	16	68	19	There is an important literature that is developing for some years on assisted evolution and its involvement in conservation biology. This literature must be cited here (for example: van Oppen et al. Building coral reef resilience through assisted evolution. PNAS 112, 2307-2313 (2015); Peixoto et al. Beneficial Microorganisms for Corals (BMC): proposed mechanisms for coral health and resilience. Front. Microbiol. 8 (2017); Hume et al. Symbiodinium thermophilum sp. nov., a thermotolerant symbiotic alga prevalent in corals of the world's hottest sea, the Persian/Arabian Gulf. Sci. Rep. 5, 8562 (2015)). [Denis Denis Allemand, Monaco]	These examples are part of the corals (not coral reefs, such as reef restoration) 'adaptability' and discussed in the appropriate sub-chapter (included in 5.5.2.2.1 - Adaptation in coral reefs)

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
11051	5	68	16	68	19	Among potential adaptative mechanisms, non-genetic mechanisms may contribute to the resilience of coral colonies and may constitute a rapid way of adaptation independent of sexual reproduction. This aspect, though more and more demonstrated in the scientific literature, is not addressed in this paragraph. There are indeed evidence for the functionality of DNA methylation in acclimation and intergenerational plasticity. In other words, corals and their symbionts might be able to use epigenetic mechanisms, as other organisms, to rapidly "adapt" to changes in their environment and to pass these "adaptations" on to their offspring (Liew et al. Identification of microRNAs in the coral <i>Stylophora pistillata</i> . PLOS One 9(3), e91101 (2014); Liew et al. Condition-specific RNA editing in the coral symbiont <i>Symbiodinium microadriaticum</i> ". PLOS Genetics 13(2): e1006619 (2017); Liew et al. Epigenome-associated phenotypic acclimatization to ocean acidification in a reef-building coral. Science Advances, 4 (6), eaar8028 (2018); Li et al. DNA methylation regulates transcriptional homeostasis of algal endosymbiosis in the coral model <i>Aiptasia</i> . Science Advances, 4 (8), eaat2142 (2018); Torda et al. Rapid adaptive responses to climate change in corals. Nature Climate Change 7, 627–636 (2017); Putnam et al. Ocean acidification influences host DNA methylation and phenotypic plasticity in environmentally susceptible corals. Evol. Appl. 9, 1165–1178 (2016); Hofmann. Ecological Epigenetics in Marine Metazoans. Front. Mar. Sci., 4(4) (2017); Liew et al. Intergenerational epigenetic inheritance in reef-building corals (In press, https://www.biorxiv.org/content/biorxiv/early/2018/02/21/269076.full.pdf). [Denis Denis Allemand, Monaco]	the text was revised accordingly.
10709	5	68	16	68	24	This paragraph, describing a discrepancy with what is mentioned in the previous page (resistance to ocean acidification vs negative effect) should come earlier and the two distinct responses addressed in the same paragraph. [Jean-Pierre Gattuso, France]	The text was revised
7343	5	68	18	0		Suggest change "compensating" to "compensate" [Nina Hunter, South Africa]	Done
33789	5	68	18	68	18	Change to "that can help compensate for". [Government of United States of America, United States of America]	Done
7345	5	68	19	0		Suggest remove "As" so that sentence starts with "Examples" [Nina Hunter, South Africa]	The text was revised
4899	5	68	20	0		"highlighted temperature" - higher temperature? [Debra Roberts and Durban Team, South Africa]	the text was revised

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
11959	5	68	20	0		This reference may also be relevant here: 1. D. P. Manzello, I. C. Enochs, G. Kolodziej, R. Carlton, L. Valentino, Resilience in carbonate production despite three coral bleaching events in 5 years on an inshore patch reef in the Florida Keys. Marine Biology 165, 99 (2018). [Wolfgang Kiessling, Germany]	Thanks. Other more relevant refs were cited
33791	5	68	20	68	20	What do authors mean by "highlighted" temperature? [Government of United States of America, United States of America]	The text was revised
10711	5	68	20	68	24	I think that this sentence overestimates the uncertainty, is at odds with SR15, and does not reflect the literature. Numerous papers, several cited in the present chapter, describe coral reefs as the most vulnerable ecosystem. [Jean-Pierre Gattuso, France]	Agree. The sentence was revised
33793	5	68	20	68	24	Cannot say with high confidence that reefs are going to be ok. It seems like the high confidence rating is attached to predicting the future. No one can accurately predict the future of biological systems. Inclusion of this statement undermines fact that coral reefs are in big trouble due to climate change-related ocean changes. [Government of United States of America, United States of America]	Agree. The sentence was revised
7347	5	68	26	0		Suggest change "for" to "in" [Nina Hunter, South Africa]	Done
9767	5	68	26	68	26	After underlining regional differences for reef vulnerability, concluding that >99% of coral reef will decline at 2°C do not seems to take it in account. A thiner conclusion is needed. [Government of France, France]	The text was revised
9769	5	68	26	68	26	It is worth mentioning that some reefs have greater capacities of adaptation, making them great candidate as conservation strongholds and that conservations efforts should be focused on them to maximum chances of success. [Government of France, France]	The text was revised
7349	5	68	26	68	27	Suggest change "On the smaller scales" to "On a smaller scale" [Nina Hunter, South Africa]	The text has been changed
20661	5	68	27	68	27	For clarity and consistency with later on in the same paragraph, please include a depth range for "deep reef ecozones" [APECS Group Review, Germany]	The text was revised
32631	5	68	27	68	29	recent literature would suggest that deep reefs are actually not as effective as refugia as previously thought. e.g. Morais & Santos, 2018; Frade et al., Nature Comm 2018 [Kim Cobb, United States of America]	The text was revised
7351	5	68	28	0		[Nina Hunter, South Africa]	Suggest change "to" to "for"
10713	5	68	28	0		What are those differences (the rest of the paragraph describe differences within a system, not geographical differences. [Jean-Pierre Gattuso, France]	The text was revised
7353	5	68	29	0		Suggest remove "of" [Nina Hunter, South Africa]	The text was revised
7355	5	68	30	0		Suggest insert "The" before "same"; change "tropica" to "tropical" [Nina Hunter, South Africa]	The text was revised

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
10715	5	68	30	0		It seems that a distinction is made between “deep reef ecozones” and “mesophotic reefs”. Is there a difference? [Jean-Pierre Gattuso, France]	The text was clarified
33795	5	68	30	68	30	Change to "The same conclusion can be assigned...(found in tropical/..." [Government of United States of America, United States of America]	The text was revised
11961	5	68	30	68	31	Reference to Rocha et al. (2018) should be made, which requires rephrasing the whole sentence. Rocha et al (2018) show that mesophotic reefs are unlikely to be refuges because (i) they are taxonomically different and (ii) they are also affected by climate-related stressors. 1. L. A. Rocha et al., Mesophotic coral ecosystems are threatened and ecologically distinct from shallow water reefs. Science 361, 281-284 (2018). Actually a similar point is already made in Smith et al. (2016) and Bongaerts et al. (2017, op. cit.), which should be cited in the same context. The concept of connectivity is missing in the entire paragraph [Wolfgang Kiessling, Germany]	the text was revised accordingly.
22551	5	68	33	68	36	Suggest this section include more up to date evidence published by Hughes et al and the Australian Institute of Marine Science (2017/18 summary report of reef health https://www.aims.gov.au/reef-monitoring/gbr-condition-summary-2017-2018) for the Great Barrier Reef. . For example, while the sentence about reef vulnerability being patchy at local scales is true, following the 2016-17 back to back bleaching events on the Great Barrier Reef, there is more up to date evidence (than Hughes et al 2010 which is referenced) to show that this spatial variability in vulnerability across broader areas is reducing, especially as a result of mass coral bleaching. [Government of Australia, Australia]	the text was revised accordingly.
11053	5	68	33	68	38	Among these "refuge" areas, we have to add the Persian Gulf (Coles and Riegl. Thermal tolerances of reef corals in the Gulf: A review of the potential for increasing coral survival and adaptation to climate change through assisted translocation. Mar Poll Bull 72, 323-332 (2013). [Denis Denis Allemand, Monaco]	the text was revised accordingly.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
20629	5	68	33	68	41	The meaning of the second half of this paragraph is particularly unclear. The paragraph seems to be mixing scales and regional differences though the distinction is not made clear. When does scale matter more than regional geography in terms of interpreting climate change impacts? Or was that not the point of the paragraph. Please consider reorganizing this paragraph so that the point is more clear. [APECS Group Review, Germany]	the text was revised accordingly.
33797	5	68	36	68	36	Do they avoid stress or just not show signs of stress? [Government of United States of America, United States of America]	Performed as requested
7357	5	68	38	0		Suggest change "for" to "in"; change "is" to "are" [Nina Hunter, South Africa]	Performed
11963	5	68	38	68	41	You may want to state what the latitudinal patterns are. Are subtropical reefs less vulnerable? The entire sentence is somewhat cryptic. [Wolfgang Kiessling, Germany]	The text was revised
33799	5	68	38	68	41	Edit for better English use. [Government of United States of America, United States of America]	The text was revised
25697	5	68	42	0		For inclusion "The emergence of disease outbreaks occurs when environmental conditions change paving way for disease causing pathogens to invade or existing pathogens to spread (Colwell 1996; Dobson and Foufopoulos 2001). Disease outbreaks have often been associated with a number of causal factors but climate change and anthropogenic activity are cited as major influences (Harvell et al. 1999; Daszak et al. 2000; Dobson and Foufopoulos 2001). Several studies have documented coral disease outbreaks following mass bleaching events (Williams et al. 2011; Muller et al. 2008; Miller et al. 2009). It is predicted that the changing environmental conditions associated with global climate change will result in future increases in diseases of marine organisms (Harvell et al. 2002). Diseases to corals can cause dramatic decline of coral biomass and can change the structure and function of the coral reef ecosystem (Aronson and Precht, 2001; Patterson et al. 2002)". [Government of India, India]	There is no room for this inclusion, covered by earlier reports
7359	5	68	43	0		Suggest remove "that" [Nina Hunter, South Africa]	Done
10723	5	68	43	0		I would write "coral reefs". The AR5 WGII cross-chapter box on coral reefs could be cited. [Jean-Pierre Gattuso, France]	Done
20575	5	68	43	68	43	Please delete the word "that". The sentence should read "Almost all major reef systems are vulnerable..." [APECS Group Review, Germany]	Done
33801	5	68	43	68	43	Conflicts with sentence on lines 20-24. [Government of United States of America, United States of America]	The text was revised
11965	5	68	43	68	51	The connection between responses in the Coral Triangle and projected global reef losses is unclear. [Wolfgang Kiessling, Germany]	The text was revised

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
9771	5	68	46	68	49	99% of corals decline is not defined well enough (affected vs degraded vs completely destroyed is not the same thing and should better defined). There is currently a lack of information regarding, coral resilience capacity towards climate change, in particular in areas less or not affected by local/regional anthropogenic threats (i.e. less affected by accumulation effects). [Government of France, France]	The text was revised
9773	5	68	46	68	49	It cannot be (very high confidence) because there is non evidence of it. [Government of France, France]	The text was revised
9775	5	68	46	68	49	Furthermore, authors of the publication precised that it is not 70-90% or >99% of coral reefs "losses", but 70-90% or >99% coral reefs "impacted". This absolutely has to be corrected. [Government of France, France]	The text was revised
10719	5	68	47	68	51	This is at odds with line 21 above. [Jean-Pierre Gattuso, France]	The text was revised
10721	5	68	47	68	51	Although there is no real inconsistency between chapter 3 and the SPM, the readership may be confused. The reason is that the chapter refers to the loss of corals and the SPM about the degradation of coral reefs. I have heard people and media merging the two and say that more than 99% of coral reefs will be lost at +2°C, which is not what the documents say. I suggest to use the wording of chapter 3 here to avoid further confusion. [Jean-Pierre Gattuso, France]	The text was revised
7361	5	68	49	68	50	Suggest remove "already" and insert before "at" [Nina Hunter, South Africa]	The text is rewritten
11257	5	68	53	68	53	the geographical aspect is missing - are their regions which are more affected than others? A bit more specific information would be beneficial [Inka Bartsch, Germany]	Taken into account.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
25345	5	68	53	70	6	section 5.3.3.7 Rocky Reefs. As suggested on the first version of the Chapter 5 and to be consistent with the structure of section 5.2, I would include also for coastal ecosystems the biogenic reefs. The title might be 'biogenic reefs' or 'rocky reefs and other biogenic reefs', but here it is necessary to highlight the importance and vulnerability of other biogenic reefs such as ones created by coralline algae, sponges, bryozoans, polychaetes (see Ragazzola et al papers, Lombardi et al. papers, Cocito et al. papers, Smith et al papers....for Antarctica Santagata et al. 2018 Deep e coastal bryozoan biogenic reefs). Bioconstructional organisms are not limited to the once described here and the extent of their build-ups is very considerable. Some of the species are not protected despite their vulnerability and the Ecosystem Services they provide (see Hiscock, 2014). So, please, consider to add and describe extensively biogenic reefs in the Coastal Ecosystems. [Chiara Lombardi, Italy]	Taken into account. Now this ecosystems is named "rocky shores"
33803	5	68	53	70	6	This section is especially well-written and should be considered a model for other sections. [Government of United States of America, United States of America]	Noted.
14381	5	68	55	68	55	Are rocky reefs also found in 'polar' as well as temperate coastal zones? Please clarify in text. [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	Taken into account
7363	5	68	56	0		Is "to" the correct word to use here? [Nina Hunter, South Africa]	The text has been revised.
25347	5	68	56	69	2	"Other....and sponges". These organisms are actually creating biogenic reefs and do not inhabiting rocky reefs. Some of them can be part of rocky reefs, but some of them not (ex. Mearl beds), as previously suggested on the first version of the report. [Chiara Lombardi, Italy]	Taken into account.
14383	5	69	4	69	4	The text should also acknowledge that intertidal species have evolved to be able to tolerate extreme variability in temperature, salinity and oxygen on a daily basis. [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	Taken into account.
7365	5	69	5	0		"emersion" should be spelt "immersion" [Nina Hunter, South Africa]	Emersion is correct.
31885	5	69	5	69	6	Provide reference for this statement. [Hans-Otto Poertner and WGII TSU, Germany]	Taken into account.
20631	5	69	7	69	9	Please consider rewriting this sentence. It is challenging to understand. Is it talking about consumers or food items? Or perhaps it can just be simplified to "Intertidal communities whose distributions are associated with seawater temperatures are expected to experience vertical constriction in suitable habitat (Harely, 2011)" [APECS Group Review, Germany]	Taken into account.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
26777	5	69	9	69	9	After citation of Harley (2011) insert the following sentence: "The same conclusion was drawn on the basis of a comparison of biochemical responses to heat stress of organisms from low and mid-levels in the intertidal and the subtidal zone (Tomanek, 2010)." It is important to support ecological findings with mechanistic explanations and inserting this sentence provides at least one biochemical process supporting the ecology of intertidal organisms. Reference not yet included in the report: Tomanek, L., 2010: Variation in the heat shock response and its implication for predicting the effect if global climate change on species' biogeographical distribution ranges and metabolic costs. Journal of Experimental Biology 213, 971-979. [Lars Tomanek, United States of America]	Accepted.
29849	5	69	10	69	10	The ref Duarte et al 2013 (Estuaries & Coasts) is on ocean acidification - and does not seem to be relevant here. [Dorte Krause-Jensen, Denmark]	Accepted.
29851	5	69	18	69	21	NB Other studies highlight the ability of vegetated tidal pools to increase pH during daytime (Duarte & Krause-Jensen 2018, Estuaries & Coasts). The same has been shown for kelp/macvroalgae habitats (e.g. Middelboe et al 2007, Krause-Jensen et al. 2016, Wahl et al. 2018). [Dorte Krause-Jensen, Denmark]	Accepted.
11033	5	69	20	69	20	The first study to show the ecosystem level effects of ocean acidification on roskey reef habitats was Hall-Spencer et al (2008) in Nature, showing that ocean acidification is a multiple stressor as it can cause carbonate dissolution and stimulate the growth of certain algae causing major shifts in community structure and function. These findings have been repeated at CO2 seeps worldwide, see Agostini, S., Harvey. B.P., Wada, S., Kon, K., Milazzo, M., Inaba, I., Hall-Spencer, J.M. (2018) Ocean acidification drives community shifts towards simplified non-calcified habitats in a subtropical-temperate transition zone. Scientific Reports 8,11354. [Jason Hall-Spencer, United Kingdom (of Great Britain and Northern Ireland)]	Accepted.
10725	5	69	25	0		I doubt that Ciais et al. Is the best citation to use here. May be Wong et al. AR5 WGII. [Jean-Pierre Gattuso, France]	Accepted.
14385	5	69	31	69	31	In this section, when the authors talk about 'herbivores' can they please be a bit more specific or give examples, e.g. sea urchins, limpets etc. [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	Taken into account
14387	5	69	36	69	38	This section could also refer to the plentiful evidence on natural CO2 seeps, and modified food-webs. [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	Taken into account.

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11035	5	69	38	69	38	To say there are unclear effects of OA on fish does not capture the evidence available. E.g. the work of Munday on fish behaviour. Fish reproduction can be affected in acidified conditions (Milazzo et al. 2016). Milazzo, M., Cattano, C., Alonzo, S.H., Foggo, A., Gristina, M., Rodolfo-Metalpa, R., Sinopoli, M., Spatafora, D., Stiver, K.A., Hall-Spencer, J.M. (2016) Ocean acidification affects fish spawning but not paternity at CO2 seeps. Proceedings of the Royal Society, B. 283(1835):20161021. [Jason Hall-Spencer, United Kingdom (of Great Britain and Northern Ireland)]	Accepted.
20577	5	69	40	69	41	What is the confidence level associated with the assertion " At a local scale, warming and ocean acidification are expected to change energy flows within rocky reef ecosystems"? [APECS Group Review, Germany]	The confidence levels have been revised.
7367	5	69	40	69	42	Suggest change "at a local scale" to "at the local scale" [Nina Hunter, South Africa]	Accepted.
11037	5	69	43	69	43	I think the text should be strengthened with respect to the effects of increased DIC on algal productivity. Work at CO2 seeps consistently shows increased primary production at high CO2. Johnson, V.R., Brownlee, C., Milazzo, M., Hall-Spencer, J.M. (2015) Microalgal assemblage shift along a marine CO2 gradient subjected to multiple environmental stressors. Journal of Marine Science and Engineering 3, 1425-1447. [Jason Hall-Spencer, United Kingdom (of Great Britain and Northern Ireland)]	Taken into account.
7369	5	69	44	0		Suggest change "increase" to "increases"; "increase" to "increase" [Nina Hunter, South Africa]	Accepted
7371	5	69	47	0		Suggest insert "the" before "grazing" [Nina Hunter, South Africa]	Accepted
11039	5	69	47	69	47	This paper shows that some animals only survive ocean acidification conditions in a dwarf form to meet the elevated metabolic costs of dealing with the stress. Garilli V, Rodolfo-Metalpa R, Scuderi D, Brusca L, Parrinello D, Rastrick SPS, Foggo A, Twitchett RJ, Hall-Spencer JM, Milazzo M (2015) Physiological advantages of dwarfing in surviving extinctions in high CO2 oceans. Nature Climate Change 5, 678-682. [Jason Hall-Spencer, United Kingdom (of Great Britain and Northern Ireland)]	Accepted.
14389	5	69	48	68	63	The effects of OA on higher trophic levels are less clear, and this statement should acknowledge that further research is needed, as there is available references to support this argument. [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	Taken into account.

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11253	5	69	55	69	55	intertidal rocky reefs are seldom dominated by calcareous mussels or algae - or do you mean algae in general here (calcareous and non-calcareous) - the latter are not really sensitive to OA. Furthermore it is known that short term (few hours) heat during tidal emersion can be survived by macroalgae. If in addition with high irradiance this might be different - but 3-factorial experiments have been seldom conducted. Thus this aspect may need some more refining? In addition the aspect that OA in fleshy macroalgae is partially counteracted under high irradiances or in the interplay with warming (laboratory experiments) has not been considered. [Inka Bartsch, Germany]	Taken into account.
20633	5	69	55	69	55	I think that calcareous is meant to describe the algae and not the mussels. If this is not the case please delete "calcareous" because I spent a lot of time wondering if you meant soft or calcareous algae. [APECS Group Review, Germany]	Accepted.
33805	5	70	1	70	1	Vent-based systems show this, but there's no evidence linking OA from CO2 in the atmosphere to changes in wild ecosystems. Change verb tense. [Government of United States of America, United States of America]	Accepted.
11255	5	70	2	70	2	references for high confidence needed [Inka Bartsch, Germany]	Rejected. This is a summary paragraph of the assessment in the text above.
33807	5	70	2	70	2	Change this rating to medium confidence. [Government of United States of America, United States of America]	This text has been removed.
11041	5	70	5	70	5	I do not agree. At multiple CO2 seeps productivity of microalgae and macroalgae increases with increased DIC [Jason Hall-Spencer, United Kingdom (of Great Britain and Northern Ireland)]	Taken into account.
11259	5	70	8	70	8	subchapter 5.3.3.8: I wrote this chapter: one general comment: the important case of the Australian kelp forest which is one of the most important examples has been deleted. Now the chapter is unbalanced. [Inka Bartsch, Germany]	Accepted. The text in this subsection has been rewritten, reorganized and condensed. Australian kelps are considered here. Recent literature is assessed after the comprehensive conclusions in AR5 and SR1.5.
25773	5	70	8	70	8	"Kelp forests and seagrass" be changed as "Kelp forests, mangroves and seagrass" [Government of India, India]	This text has been removed.
21959	5	70	8	72	2	Why so much on kelp relative to coral? [David Schoeman, Australia]	Taken into account. This subsection has been rewritten, reorganized and shortened.
14393	5	70	8	72	5	Compared to the other sections, this sub-section seems too-long and out of proportion. Suggest that this section should also mention the possibility of CO2 fertilisation of kelp? [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	Taken into account. This subsection has been rewritten, reorganized and shortened. Recent literature is assessed after the comprehensive conclusions in AR5 and SR1.5.
29853	5	70	10	70	16	Please also mention that kelp ecosystems are important habitats... [Dorte Krause-Jensen, Denmark]	Accepted.
11687	5	70	13	70	16	I would think that the kelp forest OM will be mineralized (at least partially) in the sediments as observed in mangroves and saltmarshes sediment rather than being simply "buried". The kelp [Pierre Taillardat, Canada]	Taken into account. The text has been substantially modified.
16975	5	70	18	70	18	Krumhans should be Krumhans! [Hege Gundersen, Norway]	Noted.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
22835	5	70	18	70	18	Krumansl is misspelled [Raphael Kudela, United States of America]	Noted.
33809	5	70	19	70	21	Clarify. [Government of United States of America, United States of America]	The text has been rewritten.
4421	5	70	20	70	20	Unclear what the yr-1 rate is indicating. Also unclear over which timeperiod? [The UBern Team Group Review, Switzerland]	This text has been removed.
14391	5	70	20	70	20	Text referring to "38% decline, 27% increase etc. is very confusing - please make clear if the % and the instantaneous rate of change are the global average of the datasets referred to here. [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	This text has been revised.
11261	5	70	21	70	21	change Krumhans to Krumhans! [Inka Bartsch, Germany]	noted
16979	5	70	21	70	21	Krumhans should be Krumhans! [Hege Gundersen, Norway]	noted
29855	5	70	24	70	25	Please delete "on a global scale" as this is not global [Dorte Krause-Jensen, Denmark]	Accepted.
29857	5	70	26	70	28	Please specify where this is documented. I suggest introducing this section with a statement on effects of climate change on kelp forests being highly latitude dependent with stimulations along the polar distribution range and retraction towards the equatorial range. [Dorte Krause-Jensen, Denmark]	Accepted. This section has been rewritten and reorganized.
7373	5	70	29	0		Suggest insert "have" before "led" [Nina Hunter, South Africa]	The text has been revised.
31887	5	70	32	70	37	Are these two "high confidence" assessment based on a single study and two studies, respectively, only? [Hans-Otto Poertner and WGII TSU, Germany]	This subsection has rewritten, reorganized and the confidence level have been revised.
16981	5	70	34	70	34	Filbee-Dexter and Wernberg (2018) is an even more recent and a more general (global) article on this topic. doi.org/10.1093/biosci/bix147 [Hege Gundersen, Norway]	Accepted.
32421	5	70	37	70	37	Change: early life stages are particularly sensitive to ocean acidification impacts [Daniela Storch, Germany]	Taken into account.
32419	5	70	38	0		that exacerbate the risk of population decline and loss of spawning habitat that could be minimized under RCP 2.6 (Dahlke et al. 2018). [Daniela Storch, Germany]	This comment doesnt match here
7375	5	70	39	0		Suggest change "for" to "of" [Nina Hunter, South Africa]	noted
29859	5	70	43	70	45	Not evident what this is about - why did the kelps retract in response to decreasing temperatures? [Dorte Krause-Jensen, Denmark]	Rejected. Cold-temperate species have low tolerance to warmer conditions, and they retract northward. This text has been moved to the appendix.
7377	5	70	49	0		Suggest change "for" to "of" [Nina Hunter, South Africa]	accepted
7379	5	70	50	0		Suggest change "hinder" to "hinders" [Nina Hunter, South Africa]	accepted
7381	5	71	5	0		Suggest insert "a" before "major" [Nina Hunter, South Africa]	accepted
33811	5	71	11	71	11	Does this mean the temp at which this happens in the species or the temps themselves? [Government of United States of America, United States of America]	the temps themselves
7383	5	71	12	0		Suggest replace colon with comma [Nina Hunter, South Africa]	accepted
7385	5	71	15	0		Suggest change "what" to "which" [Nina Hunter, South Africa]	Accepted
4423	5	71	15	71	15	replace 'what' with 'which' [The UBern Team Group Review, Switzerland]	accepted

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
28857	5	71	20	71	41	This paragraph would benefit from including the effects of tropicalization on fish communities leading to loss of kelp forests due to increased grazing, as demonstrated in the following reference: Vergés, A., Doropoulos, C., Malcolm, H. A., Skye, M., Garcia-Pizá, M., Marzinelli, E. M., ... & Bozec, Y. M. (2016). Long-term empirical evidence of ocean warming leading to tropicalization of fish communities, increased herbivory, and loss of kelp. Proceedings of the National Academy of Sciences, 113(48), 13791-13796. Please also see: Vergés, A., Steinberg, P. D., Hay, M. E., Poore, A. G., Campbell, A. H., Ballesteros, E., ... & Figueira, W. (2014). The tropicalization of temperate marine ecosystems: climate-mediated changes in herbivory and community phase shifts. Proceedings of the Royal Society B: Biological Sciences, 281(1789), 20140846. and Steinberg, P. D., Hay, M. E., Poore, A. G., Campbell, A. H., Ballesteros, E., Tomas, F., & Vergés, A. (2014). The tropicalization of temperate marine ecosystems: climate-mediated changes in herbivory and community phase shifts. Proceedings of the Royal Society B: Biological Sciences, 281(1789). [Government of Brazil, Brazil]	Taken into account.
7387	5	71	23	0		Suggest change "more than the double of the" to "more than double the" [Nina Hunter, South Africa]	Accepted
7389	5	71	30	0		Suggest insert "a" after "as" [Nina Hunter, South Africa]	Accepted
33813	5	71	38	71	41	Move earlier in the paragraph to keep it closer to similar information on other Ecklonia changes. [Government of United States of America, United States of America]	The text has been modified, and this part moved to the appendix.
20579	5	71	43	71	43	What is the confidence level associated with the assertion "Increased physical stress by storms also alters kelp communities"? [APECS Group Review, Germany]	The confidence levels have been revised.
20663	5	71	45	71	48	This sentence is unclear. What does "living on them" mean? Is this a reference to epiphytes? Or a reference to a wide diversity of kelp dependent species? Does "productivity" on line 46 relate solely to kelp or is this a reference to the collective productivity of all kelp associated species? [APECS Group Review, Germany]	Living on them refers to epiphytes, production has been removed.
7391	5	71	46	0		Suggest change "communities" to "community" [Nina Hunter, South Africa]	Accepted.
7393	5	71	47	0		Suggest insert "an" before "increase" [Nina Hunter, South Africa]	accepted.
20665	5	71	52	72	2	It would be helpful to add an explicit statement on impacts to biodiversity anticipated with these changes in kelp communities. [APECS Group Review, Germany]	Taken into account.
33815	5	71	53	71	54	No evidence of the influence of OA on kelp is presented to support this statement. Information on kelp response to OA should be added to the section. [Government of United States of America, United States of America]	Taken into account.
7395	5	72	1	0		Is the plural of "kelp" not without an "s"? [Nina Hunter, South Africa]	Taken into account

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
4425	5	72	4	72	4	Almost the entire paragraph is a repeat of 5.2.3.1.1. [The UBern Team Group Review, Switzerland]	The subsection of megafauna has been removed from coastal ecosystems. This text is now in section 5.2.
9777	5	72	4	72	4	There is no mention of sharks and rays despite them playing key ecological roles as top predators and flagship conservation species. Studies focus on change in behavior, distribution and range of preys, and altered reproductive fitness. Publication on this topic : Synchronous behaviour shifts in reef fishes linked to mass coral bleaching - S. Keith, A. Baird – 22/10/18 [Government of France, France]	The subsection of megafauna has been removed from coastal ecosystems. This text is now in section 5.2.
15767	5	72	4	72	4	Coastal marine megafauna. This section covers marine mammals, seabirds and reptiles. Where are the large pelagic fish such as tunas, billfishes and sharks addressed? They inhabit shelf seas during much of their lives. There is no discussion of these in the Epipelagic section either. [EUCE, Belgium]	The subsection of megafauna has been removed from coastal ecosystems. This text is now in section 5.2.
33817	5	72	4	73	30	This section is too focused on penguins. What about other species groups. Also, why aren't fish and sharks considered here? [Government of United States of America, United States of America]	The subsection of megafauna has been removed from coastal ecosystems. This text is now in section 5.2.
14395	5	72	4	73	31	The section on "implications for coastal marine megafauna" is over-burdened with references (these should be cut back substantially). It is also very biased toward polar species; is there a reason for not mentioning tropical/temperate species? (cetaceans, sirenians and turtles) [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	The subsection of megafauna has been removed from coastal ecosystems. This text is now in section 5.2.
14399	5	72	6	73	22	The current text in this section has been copied exactly from section 5.2.3. p.39/40 lines 4-18. If the text will be used, my suggestion will be to cross reference 5.2.3 and edit to provide a concise summary here. [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	The subsection of megafauna has been removed from coastal ecosystems. This text is now in section 5.2.
7401	5	72	6	73	30	This section is copied from section 5.2.3.1.1 (pages 39 to 40). Would it not be better to refer the reader to that section instead of copying the section again. If the section is to remain as it is, then it should be stated that this information is what was described in section 5.2.3.1.1. [Nina Hunter, South Africa]	The subsection of megafauna has been removed from coastal ecosystems. This text is now in section 5.2.
20667	5	72	6	73	30	Why have fish been excluded from the important coastal megafauna? They are many large coastal species of fish that are important predators, yet they are not mentioned in this section at all. Please consider adding them or an explanation as to why fish were excluded. [APECS Group Review, Germany]	The subsection of megafauna has been removed from coastal ecosystems. This text is now in section 5.2.
7397	5	72	8	0		Suggest change "effects" to "affects" [Nina Hunter, South Africa]	The subsection of megafauna has been removed from coastal ecosystems. This text is now in section 5.2.
7399	5	72	24	0		Suggest change "effecting" to "affecting" [Nina Hunter, South Africa]	The subsection of megafauna has been removed from coastal ecosystems. This text is now in section 5.2.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
31889	5	72	24	72	54	Please avoid too much repetition of information already given in Chapter 3. [Hans-Otto Poertner and WGII TSU, Germany]	The subsection of megafauna has been removed from coastal ecosystems. This text is now in section 5.2.
33819	5	72	28	72	30	This sentence was used earlier in the chapter. [Government of United States of America, United States of America]	The subsection of megafauna has been removed from coastal ecosystems. This text is now in section 5.2.
14397	5	72	47	73	48	This paragraph is incredibly dense, and might be better presented as a Table. [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	The subsection of megafauna has been removed from coastal ecosystems. This text is now in section 5.2.
3725	5	73	34	73	51	No summary is provided for seagrass [Trisha Atwood, United States of America]	This subsection of Summary for coastal Ecosystems has been removed. The text of the whole section 5.3 has been rewritten, condensed and reorganized.
26599	5	73	36	73	36	Given the lack of anthropogenic / policy changes that could be part of adapting to climate change, suggest clarifying that these are the "shifting ecosystem distributions and ecosystem / community structure." [Florence Poulain, Italy]	Taken into account. This subsection of Summary for coastal Ecosystems has been removed. The text of the whole section 5.3 has been rewritten, condensed and reorganized. The human adaptive responses are considered in section 5.4, this has been clarified in the new text.
31891	5	73	53	73	53	This section seems to be the equivalent to section 5.2.5 Risk Assessment of Open Ocean Ecosystems, so I suggest using the same title "Risk Assessment....". [Hans-Otto Poertner and WGII TSU, Germany]	Taken into account. This subsection of Summary for coastal Ecosystems has been removed. The text of the whole section 5.3 has been rewritten, condensed and reorganized.
1509	5	74	0	0		Improve clarity, larger font size needed [Chandani APPADOO, Mauritius]	Accepted.
14401	5	74	0	74		Figure 5.12 - I find this very unconvincing and not at all useful! It does not give information about timescales of impact and it is unclear what evidence was used to make these judgements. Therefore I suggest it is removed as it undermines the credibility of the report. [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	Taken into account. The whole Coastal Ecosystems section has been rewritten, condensed and reorganized. The ember figure is now supported with new text in this section and with tables in the appendix.
23239	5	74	0	74		It is very difficult for the reader to have full traceability of the lines of evidence and the expert judgment linking the level of warming with the level of risk, where can this be found? [Valerie Masson-Delmotte, France]	Taken into account. The whole Coastal Ecosystems section has been rewritten, condensed and reorganized. The ember figure is now supported with new text in this section and with tables in the appendix.
28189	5	74	4	74	7	Intertidal ecosystems vulnerable to temperature increase too. [Hilary Kennedy, United Kingdom (of Great Britain and Northern Ireland)]	Taken into account.
33821	5	74	9	74	9	"sensitive" not "sensible". [Government of United States of America, United States of America]	noted
15769	5	74	11	74	13	Potential changes in salinity are not mentioned here among this list of changes. They will be important in some estuaries and brackish systems. See earlier comments. [EUCE, Belgium]	Taken into account. The whole Coastal Ecosystems section has been rewritten, condensed and reorganized. The ember figure is now supported with new text in this section and with tables in the appendix.
7403	5	74	16	0		Suggest remove "all"; insert "a" before "diverse" [Nina Hunter, South Africa]	the text has been revised.
28191	5	74	17	74	18	Seagrass meadows are found along all continents except Antarctica so not equivalent to mangroves. [Hilary Kennedy, United Kingdom (of Great Britain and Northern Ireland)]	Accepted.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
29861	5	74	17	74	18	I think this statement is too simplified. E.g. eelgrass extends from Portugal to the Arctic and is subject to wide differences in terms of sensitivity to climate stressors being expected to expand in response to warming in Greenland (Olesen et al. 2015) but retract at its southern distribution range. A latitudinal change in response is also expected for mangroves despite its more narrow geographical distribution range... [Dorte Krause-Jensen, Denmark]	Taken into account. The expansion of seagrasses in high latitudes has been considered.
28193	5	74	18	74	19	Seagrass is commonly found intertidally (e.g. <i>Zostera</i> , <i>Ruppia</i> , <i>Thalassia</i>) as well as subtidally [Hilary Kennedy, United Kingdom (of Great Britain and Northern Ireland)]	Taken into account.
29863	5	74	18	74	20	I suggest using the final lines of the kelp section as a summary instead of those lines. [Dorte Krause-Jensen, Denmark]	The text has been rewritten and reorganized.
10269	5	74	26	74	26	texts/labels inside of the figure 5.9 seem to be too small for proper readability [Jinsoo Park, Republic of Korea]	Accepted.
20669	5	74	26	74	26	This figure is challenging to understand. The selected color gradient adds to this confusion. It maybe useful to add a statement that a color gradient was used in an attempt to reflect/indicate the inherent uncertainty. [APECS Group Review, Germany]	Taken into account. The whole Coastal Ecosystems section has been rewritten, condensed and reorganized. The ember figure is now supported with new text in this section and with tables in the appendix.
21731	5	74	26	74	26	Texts/labels inside of the figure 5.9 seem to be too small for proper readability [Government of Republic of Korea, Republic of Korea]	Accepted.
11917	5	74	26	74	27	Fig. 5.12 has a low resolution. Please indicate it more clearly. [Jun Sun, China]	Accepted
11925	5	74	26	74	27	Fig. 5.12 has a low resolution. Please indicate it more clearly. [Jun Sun, China]	Accepted
14403	5	74	26	74	27	Figure 5.12 is not clear and needs further explanation. Suggest that the reference to the methods (5.3.3) is also added to the figure caption to clearly guide the reader. [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	Taken into account. The whole Coastal Ecosystems section has been rewritten, condensed and reorganized. The ember figure is now supported with new text in this section and with tables in the appendix.
10729	5	74	28	0		Where is this figure coming from? Is it based on Gattuso et al. (2015), a paper mentioned earlier? If that is the case it should be cited in the legend. SR15 should also be cited. Finally, if the color transition in those two papers were modified or if new systems have been included, these transitions must be given in the appendix and justified by the literature. This was the approach used by Høgh-Guldberg et al. (2018, SR15) and I believe it is the best approach for transparency. [Jean-Pierre Gattuso, France]	Taken into account. The whole Coastal Ecosystems section has been rewritten, condensed and reorganized. The ember figure is now supported with new text in this section and with tables in the appendix.
16425	5	74	28	74	28	Figure 5.12.: Please make sure that the burning embers design is consistent across all SROCC chapters and with the SR1.5 assessment. [Alexander Nauels, Germany]	Taken into account. The whole Coastal Ecosystems section has been rewritten, condensed and reorganized. The ember figure is now supported with new text in this section and with tables in the appendix.
7405	5	74	36	0		Suggest remove full stop and replace with comma [Nina Hunter, South Africa]	The text has been rewritten.
10731	5	74	38	0		I assume that "reefs" is mean rather than "corals" [Jean-Pierre Gattuso, France]	The text has been rewritten.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
11969	5	74	38	74	39	"the surviving corals of tomorrow will not resemble the same as at present day," You probably mean that communities will be unlike those of today. Individual corals will be quite similar, or not? Also what does "not resemble" mean? Please rephrase! [Wolfgang Kiessling, Germany]	Accepted. The text has been rewritten.
4903	5	74	39	0		"the surviving corals of tomorrow will not resemble the same as at present day" - reword "the surviving corals of tomorrow will not be the same as today". [Debra Roberts and Durban Team, South Africa]	Accpeted.
7407	5	74	41	0		Suggest change "spots" to "spot" [Nina Hunter, South Africa]	The text has been rewritten.
1797	5	75	0	0		Section 5.4 has numerous estimates of the cost/value associated with carbon sequestration in the various ecosystems. However, the price of Carbon that is used is not consistent throughout the chapter, making intercomparisons difficult. Sugest choosing a single value and adjusting all other estimates to this price. [Mark Payne, Denmark]	The reporting of cost and value has been standardized as much as possible in the FD.
15771	5	75	0	0		Section 5.4 has numerous estimates of the cost/value associated with carbon sequestration in the various ecosystems. However, the price of Carbon that is used is not consistent throughout the chapter, making intercomparisons difficult. It is suggested to choose a single value and adjusting all other estimates to this price. [EUCE, Belgium]	The reporting of cost and value has been standardized as much as possible in the FD.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
20679	5	75	0	96		<p>I consider this text as highly informative and useful. In my opinion it should be more information about negative effects of global warming on closed seas (such as the Baltic Sea, the Mediterranean Sea or the Black Sea).</p> <p>Meier, H. M., Andersson, H. C., Arheimer, B., Donnelly, C., Eilola, K., Gustafsson, B. G., ... & Savchuk, O. P. (2014). Ensemble modeling of the Baltic Sea ecosystem to provide scenarios for management. <i>Ambio</i>, 43(1), 37-48.</p> <p>Włodarska-Kowalczyk, M., Węśławski, J. M., Warzocha, J., & Janas, U. (2010). Habitat loss and possible effects on local species richness in a species-poor system: a case study of southern Baltic Sea macrofauna. <i>Biodiversity and conservation</i>, 19(14), 3991-4002.</p> <p>Weslawski, J. M., Warzocha, J., Wiktor, J., Urbanski, J., Bradtke, K., Kryla, L., ... & Piwowarczyk, J. (2009). Biological volarisation of the Southern Baltic Sea (Polish Exclusive Economic Zone). <i>Oceanologia</i>, 51(3), 415-435.</p> <p>Szymczycha et al. (2019): https://doi.org/10.1016/B978-0-12-805068-2.00005-X</p> <p>Howarth et al. (2012): https://esajournals.onlinelibrary.wiley.com/doi/abs/10.1890/100178</p> <p>Sokołowski et al. (2012): https://www.sciencedirect.com/science/article/pii/S0272771411004628</p> <p>Kotwicki et al. (2004): http://yadda.icm.edu.pl/yadda/element/bwmeta1.element.agro-article-1274a3ae-1395-4f05-a937-66b6d32ff877 [APECS Group Review, Germany]</p>	Thank you. These references are considered in FD.
14409	5	75	2	75	11	Biogenic shallow reefs with calcified organisms will be affected by several sources, this impacts should be added here and cited in the text. [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	Taken into account. The whole Coastal Ecosystems section has been rewritten, condensed and reorganized. The ember figure is now supported with new text in this section and with tables in the appendix.
20581	5	75	3	75	5	This text does not appear to be consistent with what is portrayed by figure 5.12 on page 74. From the figure it seems that sandy beaches are also at risk and may be appropriate to highlight here. [APECS Group Review, Germany]	Taken into account. The whole Coastal Ecosystems section has been rewritten, condensed and reorganized. The ember figure is now supported with new text in this section and with tables in the appendix.
20671	5	75	3	75	5	To make it easier to understand, consider rewriting the sentence as "Particularly, the ecosystems with very high risks under the RCP8.5 scenario are coral reefs (very high confidence), seagrasses meadows (very high confidence), kelp forest (very high confidence), and rocky reef (medium confidence)." [APECS Group Review, Germany]	Taken into account. The whole Coastal Ecosystems section has been rewritten, condensed and reorganized. The ember figure is now supported with new text in this section and with tables in the appendix.
7409	5	75	7	75	9	Suggest change "sensible" to "sensitive" [Nina Hunter, South Africa]	The txt has been rewritten.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
7411	5	75	8	0		Suggest change "particular" to "particularly" [Nina Hunter, South Africa]	The txt has been rewritten.
17185	5	75	8	75	8	Mis-spelled word "particular" should be "particularly" [Shalini Singh, Fiji]	The txt has been rewritten.
7413	5	75	14	0		Suggest change "level" to "levels" [Nina Hunter, South Africa]	The txt has been rewritten.
14405	5	75	15	75	15	Why are these systems only "initially resilient". Please clarify this in the text. [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	Taken into account. The whole Coastal Ecosystems section has been rewritten, condensed and reorganized. The ember figure is now supported with new text in this section and with tables in the appendix.
7415	5	75	17	0		Suggest change "what" to "which" [Nina Hunter, South Africa]	The txt has been rewritten.
25499	5	75	21	75	23	ISNT THERE A LOT OF REDUNDANCY HERE?. I SUGGEST THE ALTERNATIVE FORMULATION: All ecosystems that have been assessed in the coastal seas (Figure 5.12) are subject to increased risk under both the low and the high emission scenario (RCP2.6 and RCP8.5). In all assessed cases, with all factors considered (climate drivers and physiological understanding, Section 5.3.3), RCP2.6 has a lower level of risk than RCP8.5 (very high confidence). [Christophe Deissenberg, Luxembourg]	Accepted.
25501	5	75	21	75	23	THE FEW PREVIOUS SECTIONS TEND TO BE REPETITIVE AND TRIVIAL. MAYBE THE CONTENT COULD BE EXPRESSED IN A MORE COMPACT WAY (EARLIER I ALSO NOTED MANY REPETITIONS, E.G: CONCERNING "WINNERS AN LOSERS", IS THAT INTENTIONAL? [Christophe Deissenberg, Luxembourg]	Taken into account. The whole Coastal Ecosystems section has been rewritten, condensed and reorganized. The ember figure is now supported with new text in this section and with tables in the appendix.
32011	5	75	28	93	38	This section quantifies ecosystem services, costs of impacts, adaptation etc. Some of these quantified examples may be strong and suitable to be included in a more punchy ES. [Hans-Otto Poertner and WGII TSU, Germany]	Messages in this section are reported as ES statement in the FD
9927	5	75	31	77	15	Cultural services of ecosystem are taken in a very occidental understanding (recreation, tourism aesthetic, etc. The non-economic processes such as spirituality and religious behaviour are difficult to analyse and culturally very different among indigenous societies. However, their direct link to natural and the natural goods create a different approach to climate change mitigation, adaptation and resilience, which is not reflected in the text. There are also missing transition processes from no adaptation to full resilience-building. Food culture is more than intake of calories, proteins and minerals and changes in food intake affects livelihood, costumes, fiestas and spiritual beliefs. It goes also further of economic lack, especially when the subsistence is destroyed by climate change impacts. [Úrsula Oswald Spring, Mexico]	The balance in the consideration of these topics are now improved in the FD, as well as the linkages to various sections in the chapter that deal with these subjects
14407	5	75	32	75	32	Is it only 'marine microbes' that contribute to climate regulation? Please clarify. [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	Text revised with consideration of other kinds of regulation services

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
20681	5	75	32	75	32	"climate regulation by marine microbes" seems oddly specific, considering that some of the climate regulation capacity of the oceans has to do with non-microbial processes (e.g., physical properties of water). Perhaps simply "climate regulation" may be more apt. (E1a) [APECS Group Review, Germany]	This has been rewritten in FD
20683	5	75	32	75	32	Change "provisional services" to "provisioning services". Check for this throughout the chapter and implement the change for consistency. Provisional is not synonymous with provisioning. [APECS Group Review, Germany]	Accepted
25503	5	75	32	75	32	HERE AND ATOTHER PLACES: Provisional @ provisioning [Christophe Deissenberg, Luxembourg]	Accepted
20685	5	75	35	75	36	The reference Hughes et al. 2017 (Global warming and mass bleaching of corals) is inappropriate here. Figure 5.13 makes reference to Singh et al. in review. Perhaps a reference to the original IPBES framework (Diaz et al. 2015, The IPBES Conceptual Framework Ñ connecting nature and people, Current Opinion in Environmental Sustainability, 14, 1-16) would better? (E2) [APECS Group Review, Germany]	The figure has been removed from FD
25505	5	75	35	75	38	THIS SENTENCE IS VERY CLOSE TO THE PREVIOUS ONE. IS IT THAT IMPORTANT? COULDN'T IT BE DELETED, OR AT LEAST CONSOLIDATED WITH THE PREVIOUS ONE? [Christophe Deissenberg, Luxembourg]	This has been rewritten in FD
20687	5	75	36	75	36	Has the wrong reference been given here (Hughes et al., 2017)? Figure 5.13 cites Singh et al. (in review), not Hughes et al. Double check this. [APECS Group Review, Germany]	This has been rewritten in FD
31893	5	75	37	75	37	Follow the structure and naming of this section here: open ocean, deep sea floor, coastal ecosystem (instead of "coastal, pelagic and deep-sea floor ecosystems"). [Hans-Otto Poertner and WGII TSU, Germany]	The section structure has changed in the FD
9779	5	75	38	75	41	This sentence and the following one are repetitive. [Government of France, France]	This has been rewritten in FD
20689	5	75	44	75	44	Rewording: "Effects attributed to climate change on marine ecosystems are..." [APECS Group Review, Germany]	This has been rewritten in FD
20691	5	75	44	75	44	Reference Singh et al. 2017 deals with SDGs in the context of climate change but the sentence refers to physical processes and their impact on marine ecosystem services and biodiversity. This reference is not appropriate here. (E2) [APECS Group Review, Germany]	This has been rewritten in FD
4905	5	76	0	0		Figure 5.13: this schematic suggests that Ecosystems & biodiversity is a subset of Ecosystem goods and services, which in turn is a subset of Human wellbeing, but it is the other way round. see Figure 2 in https://www.sciencedirect.com/science/article/pii/S2212041612000162 . Can this schematic be changed to reflect better how the elements are related? [Debra Roberts and Durban Team, South Africa]	The figure has been removed from FD

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
4917	5	76	0	0		In this section 5.4.1 Changes in Key Ecosystem Services, there is some repeated information from previous sections. If the purpose here is to pull out key messages, then perhaps it would help to collate here, in tables, any numeric predictions, by sector, by system, by global region, that can then be used to draw important policy conclusions. e.g. projected losses of fisheries, tourism, etc. Focus on numbers rather than verbal descriptions. There are already many numbers in this section, so perhaps this can be built up into a table that covers all bases. [Debra Roberts and Durban Team, South Africa]	Accepted. Section has been substantially revised
14411	5	76	0	76		What about impact of extreme storms (hurricanes, cyclones) on coral reefs etc? Currently Figure 5.13 only considers warming, acidification, deoxygenation, sea level rise. [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	Figure deleted. Comments no long relevant.
20693	5	76	0	76		a. Include "(regulatory)" after "systems" b. Change "provision" to "provisioning" c. Change "supportive" to "supporting" d. Insert "species" after "Invasive" [APECS Group Review, Germany]	Figure deleted. Comments no long relevant.
20697	5	76	0	76		Figure 5.13b. Consider adding a dashed line between "Revenues of fisheries" and "Nutritional supply of seafood dependent coastal communities" to keep consistency with panel d. Alternatively adding the word "and". As it stands it is a little confusing that there is no separator between these two concepts like in all other panels of the figure. [APECS Group Review, Germany]	Figure deleted. Comments no long relevant.
20699	5	76	0	76		Figure 5.13b. Mixing of confidence and likelihood statements is inconsistent with other panels. [APECS Group Review, Germany]	Figure deleted. Comments no long relevant.
20701	5	76	0	76		Figure 5.13c. Light green colour, encompassing "Primary production in epipelagic ecosystem", isn't presented in the example "a" panel . To keep consistency with other panels (e.g., panel d), consider changing to same colour green as in "Nutrient cycling" and preserving the dashed line separator to show the nesting of the concepts. [APECS Group Review, Germany]	Figure deleted. Comments no long relevant.
31701	5	76	1	0		Figure 5.13. Legend would be better placed below all panels. [Hans-Otto Poertner and WGII TSU, Germany]	Figure deleted. Comments no long relevant.
31703	5	76	1	0		Figure 5.13. Panel A seems to be refering to corresponding sections within the chapter - it would be good to make this clear in the caption. [Hans-Otto Poertner and WGII TSU, Germany]	Figure deleted. Comments no long relevant.
31705	5	76	1	0		Figure 5.13. The lower red arrows in panels b-d are pointing down, but it seems that the correct position would be pointing sideways towards the climate change drivers. [Hans-Otto Poertner and WGII TSU, Germany]	Figure deleted. Comments no long relevant.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
31707	5	76	1	0		Figure 5.13. The message attempted by this figure is very detailed and demands at least a larger main map at full extent of the allowed margins. For this, the legend may be placed below. The closeups can also be enlarged to fit two columns, in three rows, leaving the bottom corner free for the legend. These closeups could be also zoomed further. The km scale should also be placed in the legend and preferably referring only to the size of the close-ups. [Hans-Otto Poertner and WGII TSU, Germany]	Figure deleted. Comments no long relevant.
20695	5	76	1	76	1	Figure 5.13a. The portion at the top of the box (stating " e.g., fishing, pollution") is confusing. Since this part of the box is filled in with the same text in boxes b-d, it is unclear to what this part of the box refers. Perhaps consider more descriptive terminology that more explicitly defines that these headings establish climate change factors of interest (I think that is what indicated here). [APECS Group Review, Germany]	Figure deleted. Comments no long relevant.
3977	5	76	1	76	4	Figure 5.13 is difficult to understand. The rectangle inside a rectangle style is somewhat confusing. The meaning of the colors - blue, Green and yellow is not clear. I think a clearer legend would help to make this figure more clear. [Aakash Sane, United States of America]	Figure deleted. Comments no long relevant.
10733	5	76	2	0		"pH" on the mini pH meter is not legible. I suggest to use the CO2 pictogram used in AR5WGII which is much clearer and has the added benefit of consistency across IPCC products. [Jean-Pierre Gattuso, France]	Figure deleted. Comments no long relevant.
26601	5	76	2	76	2	It would be useful to explain why only fishing and pollution are mentioned in 5.13.a and no mention is made of such human activities such as oil/gas/mineral extraction, tourism, coastal development (ncluding infrastructure) are not mentioned. [Florence Poulain, Italy]	Figure deleted. Comments no long relevant.
17187	5	76	4	76	4	Remove extra bracket [Shalini Singh, Fiji]	Accepted

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
2633	5	76	7	77	15	I think there are probably too many ideas/concepts in this paragraph. I would separate out the passages defining 'Provisioning/regulating/supporting/cultural' ecosystem goods and services from the differences in monetary and intrinsic values. The contrast between monetary and intrinsic values is an important part of the ecosystem goods and services/conservation discussion and restricting coverage of this dichotomy to passing commentary in Page 76-line 14 probably isn't enough consideration. Costanza et al. 1997 (The value of the world's ecosystem services and natural capital' should be cited in the event this paragraph is separated out into two paragraphs around the definitions/values themes. [Brian Pentz, Canada]	Taken into account. Paragraph substantially revised.
25539	5	76	7	93	38	I FIND THE WHOLE SECTION UNCONVINCING. ALLTOO OFTEN IT REPEATS WHAT IS BEING SAID AT OTHER PLACES, WITHOUT ADDING MUCH SUBSTANCE. IT OFTEN OSCILLATES BETWEEN BROAD GENERALITIES, PLATITUDES AND MINOR DETAILS. IT TENDS, MORE THAN AT OTHER PLACES, TO DESCRIBE IMPACTS IN ISOLATION AND TO FORGET THAT AN ACCUMULATION OF SMALL IMPACTS CAN HAVE LARGE CONSEQUENCES. IT PROVIDES THE GENERAL IMPRESSION THAT CLIMATE CHANGE IS A MINOR PROBLEM. THIS IS PARTICULARLY PROBLEMATIC SINCE THE SECTION IS AMONG THE MOST LIKELY TO ATTRACT THE ATTENTION OF POLICY-MAKERS. IS A SEPARATE SECTION NEEDED AT ALL? ITS VALUE-ADDED MIGHT BE INTEGRATED IN OTHER PARTS OF THE REPORT, AVOIDING REPETITIONS AND POSSIBLY EVEN CONFUSIONS. ALSO, AS I ARGUED IN ANOTHER COMMENT, AS MUCH AS THEY ARE LOVED BY POLICY-MAKERS, THE MONETARY EVALUATIONS ARE PROBLEMATIC, AND THE NUMBERS PROVIDED NOT NECESSARILY CONSISTENT. WHY NOT USE AS MUCH AS POSSIBLE QUALITATIVE STATEMENTS SUCH AS MAJOR LOCAL ECONOMIC DAMAGE, LIMITED GLOBAL ECONOMIC GAIN, ETC. [Christophe Deissenberg, Luxembourg]	Taken into account. Section substantially re-written with consideration of the comments.
31895	5	76	7	93	38	In this section 5.4.1 the values of some of the services are quantified, which is quite useful, but please avoid overlap with section 5.4.2.2 Economic Dimension [Hans-Otto Poertner and WGII TSU, Germany]	Accepted. Text revised to avoid overlap
33823	5	76	7	93	38	These socio-economic sections are VERY redundant and could be streamlined. [Government of United States of America, United States of America]	Accepted. Section has been substantially revised

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
25507	5	76	9	76	10	Ecosystem services are the many benefits (including goods) that humans freely gain from the natural environment and from properly-functioning ecosystems (Figure 5.13) (Tallis et al., 2010). [THE FOLLOWING SENTENCE IS POSSIBLY CUTE BUT DOES NOT ADD SUBSTANCE. DELETE? Recently they have also been described as 'Nature's Contribution to People' (Díaz et al., 2018).] THE FOLLOWING SENTENCE IS [REDUDANT WITH THE DEFINITION ABOVE. DELETE? These services include all benefits that humanity obtains from nature.] The ecosystem goods and services are interconnected with one another and can be broadly divided into provisional services, regulating services, cultural services and supporting/habitat services (Figure 5.13) (Leadley et al., 2014a). They may, or may not, be exchanged on the market. [AS AN ECONOMIST, I THINK THAT THE PREVIOUS SENTENCE IS CLEARER THAN THE ORIGINAL FORMULATION, THAT COULD BE DELETED: It also includes diverse values from monetary to intrinsic.] Provisioning [Christophe Deissenberg, Luxembourg]	Taken into account. Section substantially re-written with consideration of the comments.
9781	5	76	9	76	12	We suggest to specify that ecosystem services are referring to the current and future benefits humainty is receiving from nature. Future generations should be mentionned. [Government of France, France]	The definition of ecosystem services is now defined in the SROCC glossary.
8687	5	76	9	76	29	it maybe consider dis reference :Mahmoud Khosravi, Rabab Norouzi, 2010, Estimation of methane greenhouse gas emissions from livestock activities in Iran, Fourth Regional Climate Change Conference,IRAN, [Government of Iran, Iran]	Considered.
20703	5	76	10	76	10	Reference Tallis et al. 2010 contains no definition of ecosystem service. Consider changing reference to the UNEP's Millenium Ecosystem Assessment Report which popularized the use of the concept (https://web.archive.org/web/20131203005715/http://www.unep.org/maweb/documents/document.356.aspx.pdf). Or Dailey et al. 2000 Science, DOI:10.1126/science.289.5478.395. Or Costanza et al. 1997 Science (already in the references) (E2) [APECS Group Review, Germany]	The definition of ecosystem services is now defined in the SROCC glossary.
20705	5	76	11	76	11	There is an error with this reference in the reference list, p.169, Diaz et al. The title appears as: "Assessing nature's contributions to people." It should read: "Assessing nature's contributions to people." [APECS Group Review, Germany]	Text revised and comment is no longer relevant

SROCC Second Order Draft Government and Expert Review Compiled Comments - Chapter 5							
Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
20707	5	76	12	76	12	Change "provisional services" to "provisioning services". Check for this throughout the chapter and implement the change for consistency. Provisional is not synonymous with provisioning. [APECS Group Review, Germany]	Accepted and changed
7417	5	76	15	0		Suggest change "human" to "humans" [Nina Hunter, South Africa]	Section substantially rewritten. Edit no longer relevant.
12979	5	76	15	76	15	type, change 'human' to 'humans' [Roberta Hansman, France]	Section substantially rewritten. Edit no longer relevant.
25509	5	76	15	77	17	IN THE FOLLOWING REFORMULATION I DID NOT INCLUDE ALL THE EXAMPLES SCATTERED IN THE ORIGINAL TEXT. IF THE PURPOSE OF THE PARAGRAPH IS TO INTRODUCE THE CONCEPT OF ECOSYSTEM SERVICES; TOO MANY EXAMPLES JUST DISTRACT THE ATTENTION AND REDUCE THE UNDERSTANDING. FURTHERMORE, ALL THE EXAMPLES ARE ADDRESSED IN MORE DETAIL AT OTHER PLACES --- services include material or energy outputs from ecosystems. Some key provisioning services are supported by regulating services. Regulating services are those ecosystem functions that ensure that the environment is in a state conducive to human wellbeing and development (Costanza et al., 2017). Climate regulation is a core regulating service: The feedback from a reduction in climate regulation on increased greenhouse gas emissions can further exacerbate climate impacts on other regulating ecosystem services. For example., the projected increases in the intensity of storms in the 21st century under high CO2 emission scenario can disrupt the ability of local wetlands to regulate and treat waste-water (Erwin, 2009). Climate change also impacts habitat/supporting ecosystem services (Costanza et al., 2017)., that is, ecosystem functions that support or maintain biodiversity and other ecosystem services (Costanza et al., 2017). These include nutrient recycling, primary production, soil formation, habitat provision and pollination, and make it possible for the ecosystems to continue providing services such as food supply, flood regulation, and water purification.[I SUGGEST DELETING THE FOLLOWING EXAMPLE, TOO Climate change will impact biogenic habitats such as coral reefs (Section 5.2.2.3) and mangrove forest (Section 5.2.2.6), consequently reducing their suitability for organisms that are associated with those habitats (Pörtner et al., 2014; Wong et al., 2014) (Sections 5.2.2, 5.2.3).] The final major category of ecosystem services, cultural services, includes recreation, tourism, aesthetic and spiritual experiences. , [THE FOLLOWING DEFINITION OF CHAN OBSCURES RATHER THAN ENLIGHTENS OUR UNDERSTANDING , I WOULD DELETE IT These services are a product of both humans experiencing nature and the availability of nature to provide the experiences (Chan et al., 2012)] The quality and quantity of the cultural services can be impacted by climate change. E.g., in some cases, climate change will alter the geographical distribution of organisms and ecosystems, and consequently where these ecosystem services are enjoyed. This may decrease the value of the service for does who must travel further to enjoy it and increase it for those who need to travel less. Moreover, travelling may be impracticable, particularly for those	Taken into account. Section substantially re-written with consideration of the comments.
20709	5	76	16	76	18	Consider changing to: "For example, climate change will reduce the long-term viability of vulnerable organisms and increase the risk of their local and global extinction (Section 5.2.3)." [APECS Group Review, Germany]	Text edited
7419	5	76	24	0		Suggest insert "a" before "high" [Nina Hunter, South Africa]	Text edited to correct gramatical errors.
20711	5	76	27	76	27	Word Choice. "will impact" -> should this be followed by a degree of confidence (very high confidence)? [APECS Group Review, Germany]	Text edited to correct gramatical errors.
7421	5	76	28	0		Suggest change "forest" to plural [Nina Hunter, South Africa]	Text edited to correct gramatical errors.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
20713	5	76	28	76	28	The word "consequently" is inappropriate in this context, change to "by". (E1a) [APECS Group Review, Germany]	Text edited to correct gramatical errors.
7423	5	76	31	76	35	Font size bigger than remaining text font [Nina Hunter, South Africa]	Text edited to correct gramatical errors.
20715	5	77	3	77	3	Change "availability" to "ability" [APECS Group Review, Germany]	Text edited to correct gramatical errors.
33825	5	77	8	77	13	Out of place; remove. [Government of United States of America, United States of America]	Text edited to correct gramatical errors.
20717	5	77	19	77	19	Change "volume" to "number" [APECS Group Review, Germany]	Text edited to correct gramatical errors.
13057	5	77	22	77	23	Pelagial contains the whole water mass of the ocean. Probably the photic/ epipleagic zone is meant. [Government of Germany, Germany]	Text edited
13059	5	77	25	0		The connection to eco-tourism is unclear in the context of this sentence. [Government of Germany, Germany]	Text edited
25349	5	77	31	77	35	Please, check the font size [Chiara Lombardi, Italy]	Text edited
31897	5	77	31	77	35	This is the part on open ocean ecosystems, so why this discussion on deep sea floor ecosystem services (which are discussed in 5.4.1.2)? [Hans-Otto Poertner and WGII TSU, Germany]	Text re-written
20719	5	77	32	77	35	Consider changing to: "Thus, in some cases, eg. deep sea floor ecosystem services, we must extrapolate our knowledge of biophysical principles and access to similar ecosystem goods and services, in order to assess the risk and vulnerability of these ecosystem services to climate change." [APECS Group Review, Germany]	Text re-written
11043	5	77	37	77	37	There isn't much on aquaculture in this report but new work on the effects of ocean acidification and warming on shellfish quality and the ability of oysters to provide ecosystem services is relevant. I just haven't found time to see where this fits best. [Jason Hall-Spencer, United Kingdom (of Great Britain and Northern Ireland)]	This is assessed in 5.4.2
17381	5	77	38	77	40	This is contradicting statement at page 55 line 43. [Svein Sundby, Norway]	Text re-written
14413	5	77	38	77	46	The recent emergence of fisheries targeting mesopelagic fish (low density but very high quantities overall) could also be mentioned here. [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	Accepted.
9783	5	77	39	77	39	The world fisheries synthesis FAO 2018 is now available and should be cited in place of the 2016 edition. [Government of France, France]	Accepted
17383	5	77	42	77	43	Cannot be correct. There are large fish resouces pelagic fishes, demersal fishes and deep-sea fishes caught in open-ocean regions, particularly at high latitudes. [Svein Sundby, Norway]	Text re-written
26603	5	77	44	77	44	Need to double check FAO statistics on such catches. "Stagnant" catches may actually signify fisheries management measures capping catches. [Florence Poulain, Italy]	Taken into consideration.
11837	5	77	44	77	45	Should use proper name of overfishing or overharvesting. [William Lorenz, Australia]	Taken into consideration.
26605	5	77	45	77	46	Need to verify shark populations and, in particular, the percentage of sharks that are threatened. [Florence Poulain, Italy]	Text re-written

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
9785	5	77	46	77	46	Should be cited : Dulvy et al. 2014. Extinction risk and conservation of the world's sharks and rays, eLife, 3, e00590 [Government of France, France]	Text re-written. Comment no-longer relevant.
20721	5	77	48	77	51	This is a really long sentence, and it is easy to lose track of the point. I'd suggest splitting it in two: "...in these pelagic ecosystems. Fishery productivity is shifting towards higher.." [APECS Group Review, Germany]	Text re-written
20723	5	77	48	77	51	Passage could use 1+ references as support. [APECS Group Review, Germany]	Text re-written
4907	5	78	0	0		Figure 5.14: Brilliant figure! Please make the global map a full-page spread, landscape format, and the zoomed areas insets in the ocean or covering Antarctica. The special ecosystems (seagrass etc) will then be more clearly visible. - Please use a different colour scheme for the Marine Focus Factor (eg brown, or even grey-black). The maroon is too similar to the red. - It is strange to see USA, Brazil, most of Europe, much of Asia, Iceland, Australia, New Zealand, among others, all with '0 or no data'. Which is it? [Debra Roberts and Durban Team, South Africa]	Map clarified.
14417	5	78	0	78		Figure 5.14 is very complicated to interpret. I suggest that the seagrass, saltmarsh, mangrove, coral reefs are removed as these can not be clearly discerned anyway, given the colour scheme used. [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	Map clarified to improve readability.
13061	5	78	1	78	4	The text suggests that sea surface temperature is the sole environmental variable that affects seasonal patterns of pelagic fisheries. However, all environmental variables (biotic and abiotic) affecting spatial and temporal distribution of fisheries resources have an impact on fisheries. Please revise. [Government of Germany, Germany]	Text rewritten.
14415	5	78	3	78	4	the text "this relationship is thought to be driven by....." is very unclear - please re-phrase. [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	Text rewritten.
14419	5	78	5	78	5	There is quite a lot of literature that discusses how tuna distributions are modified by ENSO events across the Pacific and Indian ocean. This affects the countries that rely on these resources and can have dramatic consequences for their economies. Suggest that this is also included here. [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	This is assessed in 5.4.2

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
20725	5	78	8	78	14	This figure (5.14) appears to detail fisheries catches associated with coastal habitats that are discussed later in this chapter (5.4.1.3). I think this figure would be better suited to be included in section 5.4.1.3 on Coastal Ecosystems rather than where it is currently included as part of section 5.4.1.1. Open Ocean Ecosystems. If the authors would prefer to keep this figure in the current location, some additional information or verbiage is necessary to justify its inclusion in the open ocean ecosystem section . [APECS Group Review, Germany]	The section is restructured. Comment no-longer relevant.
31899	5	78	8	78	14	Why is this figure in the "open ocean" section? [Hans-Otto Poertner and WGII TSU, Germany]	The section is restructured. Comment no-longer relevant.
17189	5	78	10	78	10	Remove extra bracket [Shalini Singh, Fiji]	Text edited
20727	5	78	20	0		Statement "É a projected significant (more than -10% by 2050 relative to present day) decrease " is confusing because of the combined use of directionality statements and mathematical operators (+/-). "More than -10%" technically implies an either increase (towards 0% change or even a positive change) in the value (not in absolute terms). As such, this middle aside indicates the opposite of the rest of the sentence (decrease in catch potential). Suggested change to: "...a projected significant (more than 10% reduction by 2050 relative to present day) decrease..." (E1a) [APECS Group Review, Germany]	Text edited
7425	5	78	24	0		Suggest change "dependent" to "depend" [Nina Hunter, South Africa]	Text edited
20729	5	78	24	78	24	Change "dependent" to "depend" [APECS Group Review, Germany]	Text edited
20731	5	78	26	78	26	This is not clear to me . You state that ensemble projections support "such projections". Do you mean to say that ensemble projections support individual projections? It is not clear to me what this sentence is trying to convey. [APECS Group Review, Germany]	Text edited
20733	5	78	27	78	30	The authors state that the "tropical Ocean is projected to have substatnially larger impacts... than the global average..." I believe that the authors are highlighting predicted impacts on the tropical ocean rather than positing that the tropical Ocean will have an impact on temperature. Perhaps consider replacing the verb "have" here with "experience" (or something like that) to make it clear that the ocean is not impacting the temperature. There is similar verbiage used on page 79, line11. [APECS Group Review, Germany]	Text edited
20735	5	78	28	78	31	Passage could use 1+ references as support. [APECS Group Review, Germany]	Assessment revised.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
17385	5	78	30	78	32	Be aware of that adaption to the extreme seasonal light cycle at the highest latitude might modify the increase in catch potential here (Sundby et al. 2016) Comment No 13 above [Svein Sundby, Norway]	Text rewritten.
20737	5	78	31	78	33	Schulz et al. 2013 refers to phytoplankton bloom dynamics in response to experimentally increased additions of carbonates. No longitudinal shifts (the topic of the sentence) are documented in this paper. (E2) [APECS Group Review, Germany]	Text rewritten.
20739	5	78	36	78	36	Consider changing phrase to "few developed countries" to better link to next part of sentence. (E1a) [APECS Group Review, Germany]	Text rewritten.
23241	5	79	0	79		Consider adding a bullet point on upwelling systems in ES and SPM, even if understanding is low, very relevant for many countries. [Valerie Masson-Delmotte, France]	Text rewritten.
7427	5	79	5	79	6	In line 5 "ecosystems" are referred to, but in line 6 "ecosystem" is referred to - is it more than one ecosystem? Suggest change "ecosystem" in line 6 to plural. [Nina Hunter, South Africa]	Text rewritten.
7429	5	79	8	0		"ocean pelagic ocean" - suggest rephrase [Nina Hunter, South Africa]	Text rewritten.
17191	5	79	8	79	8	Removal of repeated word "ocean pelagic ocean" [Shalini Singh, Fiji]	Text rewritten.
9787	5	79	17	79	17	This box should not be included in §5.4.1.1 (Open ocean), but in §5.4.1.3 (Coastal). [Government of France, France]	Has been moved to other section
11491	5	79	19	80	35	I think there should be more discussion on how biogeochemical parameters (e.g. NO ₃ , O ₂) might change in upwelling system, as these are important parameters for primary productivity. Right now, it seems like the biogeochemistry is treated as if it exhibits a simple relationship with physical parameters like winds. Studies have shown winds, biogeochemistry, and productivity display complex relationship (e.g. Jacox et al. 2016 Sci. Rep). [Anson Cheung, United States of America]	Text has been revised, but the EBUS box is focused mostly towards ecosystem services.
32183	5	79	19	80	35	I very much welcome this box on EBUS. One aspect that needs to be emphasized here is the fact that these systems are rather close to a number of important thresholds in terms of O ₂ and ocean acidification. For example, the fact that the nearshore Humboldt Current system could develop calcite undersaturation during the course of this century (in the case of a high emission scenario, RCP8.5) is noteworthy, in my opinion. (Franco et al. 2018 (doi 10.1002/2018JC013857) [Nicolas Gruber, Switzerland]	Text revised and modified accordingly. References included

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
30439	5	79	22	80	36	I very much welcome this box on EBUS. One aspect that needs to be emphasized here is the fact that these systems are rather close to a number of important thresholds in terms of O2 and ocean acidification. For example, the fact that the nearshore Humboldt Current system could develop calcite undersaturation during the course of this century (in the case of a high emission scenario, RCP8.5) is noteworthy, in my opinion. (Franco et al. 2018 (doi 10.1002/2018JC013857) [Francois Engelbrecht, South Africa]	Text has been revised. There is evidence of wind intensification in 3 out of 4 EBUS
30447	5	79	22	80	36	The discussion of Box 5.2 can be strengthened by considering the key paper of Bakun et al. (2015): "Bakun, A. et al., 2015: Anticipated Effects of Climate Change on Coastal Upwelling Ecosystems. Current Climate Change Reports, 1(2), 85–93, doi:10.1007/s40641-015-0008-4." [Francois Engelbrecht, South Africa]	Text revised and modified accordingly. References included
20741	5	79	23	0		Reference to Kšmpf and Champan may be incomplete in the bibliography. (E2) [APECS Group Review, Germany]	Corrected
26483	5	79	30	79	31	The use of official FAO statistics (which are validated and curated) over single team's reconstructions based on conflictive and contested methodologies should be encouraged, so that the report's integrity is protected [Florence Poulain, Italy]	Multiple datasets are cited whenever appropriate
7431	5	79	34	0		Suggest remove "of" [Nina Hunter, South Africa]	corrected
2763	5	79	38	79	38	The reference Gutierrez et al needs year of publication [Marisol Garcia-Reyes, United States of America]	corrected
20743	5	79	38	79	38	What year is this reference? There are two by the same author in the reference list. [APECS Group Review, Germany]	corrected
25351	5	79	38	79	38	(Gutiérrez et al.), please add the year of the reference [Chiara Lombardi, Italy]	corrected
266	5	79	43	79	43	Other possible reference to include in this sentence is Reidmiller et al., 2018. These authors have summarised the effects for USA regions. Reidmiller, D.R., C.W. Avery, D.R. Easterling, K.E. Kunkel, K.L.M. Lewis, T.K. Maycock, and B.C. Stewart (eds.) 2018. U.S. Global Change Research Program, Washington, DC, USA. doi: 10.7930/NCA4.2018. [M.Dolores Garza-Gil, Spain]	not considered due to shortening of text and references
1791	5	79	44	0		Would be good to name the four EBUS system here for those note familiar with them [Mark Payne, Denmark]	considered in the first paragraph
15773	5	79	44	0		For the sake of clarity, it would be good to name the four EBUS systems here for those not familiar with them. [EUCE, Belgium]	considered in the first paragraph
7433	5	79	53	0		Suggest insert "the" before "Humboldt" [Nina Hunter, South Africa]	accepted
2765	5	79	53	79	53	The reference Sydeman et al. 2014 is not adequate because it is not a study on SST but winds. Pardo et al. 2011 Clim Research or Santos et al. 2012 Coastal Shelf Research are better references [Marisol Garcia-Reyes, United States of America]	corrected

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
2767	5	79	54	79	55	This sentence its odd. It a double negative, but not clear the intention when the previous line is considered. It means to say that the cooling is not from natural variability? Or that they do and the 'not' is a mistake? In the first case the 'however' should not be in the sentence. [Marisol Garcia-Reyes, United States of America]	text modified
30443	5	79	54	79	55	"Specifically, cooling of coastal areas is observed in Humboldt 54 Current, Benguela Current and California Current EBUS but not in the Canary Current EBUS." Please provide the references to back-up this statement. [Francois Engelbrecht, South Africa]	text modified
9885	5	79	54	79	56	There should be a reference to Brady et al (2017) here. Brady, R. X., Alexander, M. A., Lovenduski, N. S., & Rykaczewski, R. R. (2017). Emergent anthropogenic trends in California Current upwelling. Geophysical Research Letters, 44(10), 5044-5052. [Government of France, France]	Reference included
7435	5	80	1	0		Suggest change from "coastal waters of EBUS" to "EBUS coastal waters" [Nina Hunter, South Africa]	accepted
2769	5	80	1	80	2	Spatial resolution is only one problem with climate models. I think this sentence could be more meaninful: "Furthermore, global climate models lack the necessary spatial resolution and realistic accurate data at the EBUS to represent upwelling process adequately. Also this sentence seems out of context here, better place in line 26, page 80. [Marisol Garcia-Reyes, United States of America]	accepted and modified
9789	5	80	1	80	2	Have to be integrated the recent observed desogenation trends. [Government of France, France]	text revised and modified accordingly

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
9791	5	80	1	80	2	<p>Nevertheless, there is some evidence (in the CMIP5 models) that the evolution of upwelling winds is primarily tied to the poleward migration of subtropical highs in the Atlantic and Pacific basins (Rykaczewski et al, 2015; Sousa et al, 2017), with a general wind intensification toward the poleward limit of upwelling systems and wind weakening toward the equatorward limit of upwelling systems.</p> <p>Rykaczewski, R. R., Dunne, J. P., Sydeman, W. J., García-Reyes, M., Black, B. A., & Bograd, S. J. (2015). Poleward displacement of coastal upwelling-favorable winds in the ocean's eastern boundary currents through the 21st century. <i>Geophysical Research Letters</i>, 42(15), 6424-6431.</p> <p>Sousa, M. C., Alvarez, I., Gomez-Gesteira, M., & Dias, J. M. (2017). Why coastal upwelling is expected to increase along the western Iberian Peninsula over the next century?. <i>Science of the Total Environment</i>, 592, 243-251. [Government of France, France]</p>	text revised and modified accordingly
7437	5	80	7	0		Suggest change "is" to "are" [Nina Hunter, South Africa]	accepted
7439	5	80	9	0		Suggest change "impacted the fishing industries largely" to "had a large impact on the fishing industries" [Nina Hunter, South Africa]	text modified
20745	5	80	9	80	9	Change to "greatly impacted fishing industries." [APECS Group Review, Germany]	text modified
7441	5	80	10	0		Suggest replace "its" with "their" [Nina Hunter, South Africa]	accepted
7443	5	80	11	0		Suggest change "increase" to "increases" [Nina Hunter, South Africa]	accepted
7445	5	80	14	0		Suggest change "is" to "are" [Nina Hunter, South Africa]	accepted
7447	5	80	15	0		Suggest insert "an" before "important" [Nina Hunter, South Africa]	accepted
7449	5	80	21	0		Suggest change "values" to "value" [Nina Hunter, South Africa]	accepted
30445	5	80	23	80	26	<p>"Overall, EBUS have been changing with intensification of wind that drives the upwelling, leading to changes</p> <p>24 in water temperature and other ocean biogeochemistry (high confidence); however, the direction and</p> <p>25 magnitude of observed changes vary between and within EBUS with mechanisms explaining these</p> <p>26 variabilities not fully understood yet". There are no references provided across the section to back up the statements made in this sentence. There is also a contradiction in the sentence - it states that an intensification is expected in longshore winds, and then proceeds to state that there is not clarity on the "direction of change". [Francois Engelbrecht, South Africa]</p>	Text revised and modified accordingly. References included
7451	5	80	25	0		Suggest change "vary" to "varies" [Nina Hunter, South Africa]	accepted

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
22837	5	80	26	80	27	You could potentially link the ToE analysis in the main chapter to this box by referencing Brady et al. 2017 (GRL) for the CCS--there may be similar analyses for other EBUS. That would help to explain why the confidence values are so low, given that ToE is much longer in EBUS compared to the global ocean [Raphael Kudela, United States of America]	text revised and modified accordingly
7453	5	80	27	0		Suggest removing "having" [Nina Hunter, South Africa]	accepted
9793	5	80	31	80	33	There are considerable knowledge gaps on the manifestations of climate change in the southern part of the Canary current system, offshore of West Africa. Knowledge gaps concern historical trends and regional projections both for the ocean physics, biogeochemistry, and ecosystem dynamics. [Government of France, France]	text modified
26607	5	80	31	80	35	It is very difficult to comprehend why vulnerable communities in the Canary Current area have low adaptive capacity. Suggest either providing evidence of this or deleting. [Florence Poulain, Italy]	text modified
4909	5	81	0	0		Box 5.2 Fig 1: The "L – Low, M – Medium, H – High" seems to be related to the Low/Med/High confidence, but isn't. What exactly does it refer to and could you use different words for one or the other to avoid confusion? Perhaps don't use Low/Med/High for the confidence but be specific about what is meant, i.e. the actual confidence level. - The use of icons does not help to read this figure as it requires a lot of looking up and working it out. Using letters for level of risk is also not visually helpful. There are 9 categories (in 4 colour-coded groups) though Overfishing is not listed in the legend, 4 examples, 3 levels of risk, and confidence indicators. For a visual representation, that also allows comparison between the currents, you could show 4 individual bar charts, one on top of the other, with High-Medium-Low on the Y-axis (shown 4x for the 4 examples) and the categories shown in text on the X-axis (see example) with *, **, or *** above each bar. - How is overall risk determined? If you calculate the average over the 9 categories then California would be M, Hum M-H, Can H and Beng M-H. - Having said all this, do these examples need a Figure at all? [Debra Roberts and Durban Team, South Africa]	figure removed
20747	5	81	0	81		One (A) too many [APECS Group Review, Germany]	figure removed

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
26485	5	81	0	81		Box 5.2 Fig. 1. This is a very confusing figure. For example, what does "Poor Governance" = Medium (with Medium confidence) for the Benguela Current actually mean? And how does one interpret "Medium" when the same term is used to evaluate Risk? So "Poor governance" has Medium risk? or "Poor governance" is more or less average (Medium)? [Florence Poulain, Italy]	figure removed
31709	5	81	1	0		Box 5.2, Figure 1. The final part of the caption, with the meanings of L, M, and H needs to be expanded to make clear if this is a measure of vulnerability or something else. [Hans-Otto Poertner and WGII TSU, Germany]	figure removed
31711	5	81	1	0		Box 5.2, Figure 1. The color of the icon circles doesn't seem to have a meaning - if it is the case, perhaps it is better to simplify the figure. [Hans-Otto Poertner and WGII TSU, Germany]	figure removed
21963	5	81	1	81	1	How are risks Low, Medium and High....also this classification clashes with the confidence language, making interpretation very unintuitive. Could this be improved? [David Schoeman, Australia]	figure removed
33827	5	81	1	81	1	Why is OA high only for the Benguela Current? [Government of United States of America, United States of America]	figure removed
25309	5	81	1	81	6	This figure is extremely hard to interpret. The small icons require a lot of work to decode, and the H/M/L designations are over-emphasized compared to that. Is there a way to indicate confidence and/or sensitivity using some kind of qualitative radar chart? [Sarah Cooley, United States of America]	figure removed
1793	5	81	3	0		The conclusion to be drawn from this figure is not particularly obvious. Some clarification in the caption or in the text might be helpful to aid interpretation. Perhaps it might be better to represent the risk level following the colours, so that the reader could gain an immediate impression of each sector, and overall, rather than with the H, M, L? [Mark Payne, Denmark]	figure removed
15775	5	81	3	0		The conclusion to be drawn from this figure is not particularly obvious. Some clarification in the caption or in the text might be helpful to help the interpretation. Perhaps, it might be better to represent the risk level following the colours, so that the reader could gain an immediate impression of each sector (red = highest risk), and overall, rather than with the H, M, L? [EUCE, Belgium]	figure removed
20749	5	81	3	81	5	Caption for Figure 1 in Box 5.1: it should be made clear that L-low, M-medium, H-high refer to vulnerability. It gets somewhat confusing given that the same vocabulary is used for the confidence statements and both vulnerability and confidence are presented in the figure. (E1a) [APECS Group Review, Germany]	figure removed
20751	5	81	10	81	10	"supportive" -> "supporting" [APECS Group Review, Germany]	Text edited

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
26609	5	81	10	82	19	This section would be greatly strengthened if the authors would validate what percent of the activities (whale watching, recreation, tourism) occur on open ocean versus in coastal areas. [Florence Poulain, Italy]	Text rewritten
28093	5	81	10	82	19	An additional cultural service provided by coastal and deeper oceanic waters is the preservation of underwater cultural heritage- ranging from shipwrecks to submerged cultural landscapes. The nature of climate impacts on underwater cultural heritage are not yet well documented, neither yet is the loss of such underwater heritage. An important initial survey of knowledge in this area that could be incorporated here and potentially elsewhere in this chapter is Wright, Jeneva (2016). Maritime Archaeology and Climate Change: An Invitation. Journal of Maritime Archaeology. DOI 10.1007/s11457-016-9164-5. [Marcy Rockman, United States of America]	Text rewritten
31901	5	81	10	82	19	Good that you provide current value of services in this subsection, but quantifying the losses due to climate change (if possible) would be even more important for policy makers [Hans-Otto Poertner and WGII TSU, Germany]	Assessed in 5.4.2
20753	5	81	11	81	13	I would rephrase: "Climate change threatens other key ecosystem services from the pelagic open ocean, including carbon storage and other aspects of climate regulation (regulating services), tourism (cultural services), and biodiversity (supporting services) ..." [APECS Group Review, Germany]	Text rewritten
20755	5	81	11	81	13	Sentence is convoluted, making it is difficult to evaluate its content. I think the sentence is intended to say: "Climate change is threatening other key regulating, supportive and cultural ecosystem services of the pelagic open ocean, including carbon storage, climate regulation, tourism and biodiversity (Martin et al., 2016)." (E1a) [APECS Group Review, Germany]	Text rewritten
20757	5	81	15	81	17	Section 5.2.2.3 does not include a breakdown of carbon sequestration by ocean zone referenced here, unless it's inferred from figure 5.5. (C2) [APECS Group Review, Germany]	Text rewritten
20759	5	81	16	81	16	Suggest: "...contributing more towards carbon sequestration than either coastal or deep sea ecosystems." [APECS Group Review, Germany]	Text rewritten

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
25513	5	81	17	81	17	IT IS STATED "Assuming a carbon price of US\$ 7 mt-1 (World Bank, 2014), ...". AT OTHER PLACES (e.g. p. 91 lines 7-8) YOU GIVE A MONETARY VALUE TO CO2 EMISSIONS WITHOUT MENTIONING A CARBON PRICE. IF I AM NOT MISTAKEN IN MY CALCULATION, THE GIVEN NUMBER IMPLY ANOTHER CARBON PRICE. ETC. IS THERE A CONSISTENCY ISSUE HERE, FOR THE WHOLE SECTION? MOREOVER AND LESS IMPORTANTLY, IN THE WHOLE PARAGRAPH, IT IS NOT ALWAYS CLEAR WETHER REFERENCE IS MADE TO THE DEEP OCEAN OR, E.G.: THE COMPLETE MEDITERRANEAN ... [Christophe Deissenberg, Luxembourg]	Text rewritten
7455	5	81	21	0		Suggest change "varies" to "vary" [Nina Hunter, South Africa]	Text rewritten
20761	5	81	24	81	26	It is not clear to me why you move from general statements to specifically talking about California in this case. The use of "In addition" sets the reader up for additional general statements. I would suggest introducing this sentence as an example, not as an additional statement. [APECS Group Review, Germany]	Text rewritten
33829	5	81	24	81	26	This statement is too specific and seems out of context. Could it be generalized to upwelling systems? [Government of United States of America, United States of America]	Text rewritten
14421	5	81	25	81	25	Please explain the meaning of "microclimate loss" [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	Text rewritten
25511	5	81	25	81	26	THIS PARAGRAPH IS ABOUT THE DETERIORATION OF ECOSYSTEM SERVICES. THE LAST 2 LINES REFER TO A SPECIFIC LOCAL CONSEQUENCE AND APPEARS OUT OF CONTEXT. DELETE? [Christophe Deissenberg, Luxembourg]	Text rewritten
9795	5	81	28	81	30	Very little whale watching is in the open ocean. Most is offshore. [Government of France, France]	Text rewritten
1795	5	81	29	0		5762 people? This figure seems unusually small (especially for spending US\$400 million) and unusually precise. Is it correct? [Mark Payne, Denmark]	Text rewritten
15777	5	81	29	0		5762 people? This figure seems unusually small (especially for spending US\$400 million) and unusually precise. Please check. [EUCE, Belgium]	Text rewritten
20763	5	81	30	81	31	Reference Gallagher et al. 2017 only refers to sharks, not tuna and billfish. An additional reference is needed here to support the statement. (C2) [APECS Group Review, Germany]	Text rewritten
7457	5	81	32	0		Suggest change "shift" to "shifts" [Nina Hunter, South Africa]	Text rewritten
20765	5	81	33	81	35	Confidence statement at the end of the sentence refers to the first part of the sentence (before the semi-colon), not the last (Éhowever,É). (E1a) [APECS Group Review, Germany]	Revised
4913	5	82	0	0		Table 5.4: the information in this table could probably be better presented as paragraph text. [Debra Roberts and Durban Team, South Africa]	Table has been removed

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
23243	5	82	0	82		On which literature is the table based? (traceability to publications?) Confidence? Level of scientific understanding? [Valerie Masson-Delmotte, France]	Table has been removed
14429	5	82	0	84		Table 5.4 is not very useful as does not provide specific examples or references. It is unclear what the basis/evidence for the statements included is. Addressing these points would substantially improve the usability of the table. [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	Table has been removed
20769	5	82	0	84		Table 5.4 - it would be helpful to have citations to support the confidence statements, presumably they exist given the inclusion of modes of attribution. Such information would be useful as a supplementary table. (C1) [APECS Group Review, Germany]	Table has been removed
26487	5	82	0	84		Why is this table not supported with references? What model predicts "loss of fish catch in cold water coral reefs"? What fisheries are we talking about? [Florence Poulain, Italy]	Table has been removed
7459	5	82	1	0		Suggest insert "the" before "nutritional" [Nina Hunter, South Africa]	Text rewritten
33831	5	82	3	82	4	Add salmon to this list? [Government of United States of America, United States of America]	Text rewritten
33833	5	82	8	82	9	Reference? Confidence level? [Government of United States of America, United States of America]	Text rewritten
20767	5	82	17	82	17	Suggest changing "that straddle" to "moving" [APECS Group Review, Germany]	Text rewritten
33835	5	82	17	82	19	Phrasing seems off. Shouldn't it be that the communities are at risk due to threat to cultural values not that the values are at risk? [Government of United States of America, United States of America]	Text rewritten
14423	5	82	21	82	45	In the deep sea ecosystems section it is unclear what sort of changes in temperature, pH, oxygen etc we might expect in this environment (or what has been observed already) so the sub-section currently lacks sufficient context. Adding these points would significantly improve this section. [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	Requested material exists in Section 5.2.4 and Box 5.2
33837	5	82	25	82	25	Strike "rarely quantified". [Government of United States of America, United States of America]	Text deleted
33839	5	82	26	82	26	All people are stakeholders for all parts of the ocean. Strike this. [Government of United States of America, United States of America]	Text deleted
26611	5	82	26	82	27	The statement that the deep sea "...provides services that are required to sustain humans for centuries to come" carries the implicit bias of ceterus paribus, and that humans will be unable to develop substitutes for such services or will not change living life as we currently know it. This is not necessarily a useful perspective and should be edited at the very least to "provide services that are currently required..." [Florence Poulain, Italy]	Taken into account - text removed

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
22743	5	82	34	82	35	Add "Exploitation of deep sea minerals, for instance, has the potential to systematically deplete, disturb, damage or remove structural elements of ecosystems, cause biodiversity loss and impact ecosystem services (Thomson et al., 2018)." after "...and financial management (Le et al., 2017). This paper would need to be added to bibliography, full citation: Thompson KF, Miller KA, Currie D, Johnston P, Santillo D. Seabed Mining and Approaches to Governance of the Deep Seabed. Front Mar Sci [Internet]. 2018;5(December):1–12. Available from: https://www.frontiersin.org/article/10.3389/fmars.2018.00480/full [Greenpeace Group Review, Republic of Korea]	No longer relevant as text has been removed.
14427	5	82	37	82	42	This section of text on the "Ecosystem Principles Approach" seems like a pet topic of the author, and very out of place here. Suggest this is removed or scaled back. [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	Text deleted
31903	5	82	40	82	42	These two acronyms WTP and CWC are redundant and only used here. Please use full term. [Hans-Otto Poertner and WGII TSU, Germany]	Taken into account - text removed
14425	5	82	44	82	44	Please explain "Eudaimonia" [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	Taken into account - text removed
33841	5	82	44	82	44	Delete "Eudaimonia". No need to introduce a new term (i.e., jargon) here. [Government of United States of America, United States of America]	Taken into account - text removed
11263	5	82	48	82	48	Format of table with long small boxes is a bit unfortunate and difficult to perceive [Inka Bartsch, Germany]	Table has been removed
31905	5	82	48	84	0	Explain acronyms used in the table in table caption (e.g. OMZ, OM) [Hans-Otto Poertner and WGII TSU, Germany]	Table has been removed
3199	5	82	48	84	1	Discussing changes in the ocean in the context of paleoclimate can provide strong evidence of changes. Although this table mentions the use of paleoclimate records, there is only one reference to paleorecords and it is low confidence. Are there other areas in this chapter in which changes in the ocean can be more directly compared to changes observed in the paleoclimate record in order to put the extent of these changes into context? [Sloane Garelick, United States of America]	Table has been removed
21965	5	82	48	84	1	Could the symbols used for mode of attribution not be something more intuitive, so that the reader doesn't have to refer back to the table caption each time? Also, what's the deal with the empty and "No assessment" cells at the end of the table? Several of the assessments presented seem quite speculative, so is it not possible to go at least this far with these last rows? If not, why have them at all? If there is a reason, make it clear? [David Schoeman, Australia]	Table has been removed
26613	5	82	48	84	1	What is the source of the information in this table? [Florence Poulain, Italy]	Table has been removed
33843	5	82	48	84	1	Define VME [Government of United States of America, United States of America]	Table has been removed

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
20771	5	84	0	84		Two obvious mistakes: "Produduction" -> ""Production", "effectcs" -> "effects" [APECS Group Review, Germany]	Table has been removed
28095	5	84	0	84		Under the heading "Cutlural" - I generally agree with lack of assessment for cultural components. Noting that Wright, Jeneva (2016). Maritime Archaeology and Climate Change: An Invitation. Journal of Maritime Archaeology. DOI 10.1007/s11457-016-9164-5 is a basis for beginning to assess impacts of climate change on underwater cultural heritage. Several methods of vulnerability assessment for cultural heritage are in development by the US National Park Service; publication forthcoming (authors will include Pei-Lin Yu and Marcy Rockman). [Marcy Rockman, United States of America]	Table has been removed
26489	5	84	11	84	14	I think the statement that deep sea fish were not considered a provisioning service reflects values that are not necessarily shared by all (thus it is not a fact). The statement that there are an unsustainable fishery resource can be contested. Certainly several examples of overexploitation of deep-sea species are available, but some have now become sustainable after proper management (e.g. the New Zealand orange roughy fishery has been re-opened). There is a difference between sustainability of the fishery and the population suffering significant biomass reductions, and yet there are not inconsistent (for example, Maximum Sustainable Yield is considered to be achieved at approximately 25-50% of pristine biomass, so requiring a signiifcant biomass loss). [Florence Poulain, Italy]	Text has been removed
7461	5	84	13	0		Suggest change "service" to plural [Nina Hunter, South Africa]	No longer relevant as text has been removed.
14431	5	84	13	84	13	The phrase "make them an unsustainable resource" is very subjective and based on personal opinion. There are some examples of deep sea resources that have been shown to be sustainably exploited; suggest that this sentence is revised to reflect this. [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	Text has been removed
26615	5	84	13	84	14	The Norse citation ignores the fact that sustainble catch levels are achievable and could be applied for deep sea fisheries resources. [Florence Poulain, Italy]	Citation and text have been removed
9797	5	84	16	84	16	And several deep sea fish population, such as orange roughy (<i>Hoplostethus atlanticus</i>) in the North-Est Atlantic have been classified as critically endanger by IUCN. [Government of France, France]	No longer relevant as text has been removed.
7463	5	85	1	0		Suggest change "Africa" to "African"; should "Africa" not be represented as an ocean as the rest of the regions are? [Nina Hunter, South Africa]	No longer relevant as text has been removed.
7465	5	85	4	0		Suggest insert "and" before "affecting" [Nina Hunter, South Africa]	No longer relevant as text has been removed.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
26491	5	85	5	85	5	"the movemnent to manage fish stocks collectively" - what movement? If this referes to the Ecosystem Approach to Fisheries (EAF) it is not a movement, and it is not about collective management [Florence Poulain, Italy]	No longer relevant as text has been removed.
9799	5	85	5	85	9	<p>This is a very debatable statement. The ecosystem-approach to fisheries management has been promoted (and need to be promoted) by many authors for a lot of fisheries worldwide. But, in the specific case of deep sea resources, several authors adviced that no fishing at all should be allowed (see for instance: Norse et al. 2014, Marine Policy, 36 (2): 307-320, or Clark et al., 2015, ICES JMS, 73: i51–i69)</p> <p>Therefore, this paragraphe does not apply here, and should be either removed or deplaced in section 5.4.1.3 [Government of France, France]</p>	Text has been removed
7467	5	85	6	0		Suggest insert "the" before "development" [Nina Hunter, South Africa]	Text has been removed
26493	5	85	11	85	33	It is rather confusing to read this very worrying view of deoxygenation when the physical and chemical oceanography sections indicate that de global ocean has seen a 2% decline in O2, with a 3.5% decline expected by 2100 before an expected reversal from 2150. Also, most of the statements are "may lead", "can reduce", etc. It does not seem to be consistent with the evidence. [Florence Poulain, Italy]	No longer relevant as text has been removed.
33845	5	85	24	85	24	Change "decrease" to "decreases". [Government of United States of America, United States of America]	No longer relevant as text has been modified.
20773	5	85	25	85	25	Insert species names: hake (<i>Merluccius gayi</i>), octopus (<i>Octopus mimus</i>) and scallop (<i>Argopecten purpuratus</i>) [APECS Group Review, Germany]	No longer applicable as relevant text has been removed to shorten chapter.
14433	5	85	32	85	33	Only mentions impacts of OA on calcifying species, when impacts have also been suggested for fin-fish larvae and squid. Suggest that these are also included here too. [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	No longer applicable as relevant text has been removed to shorten chapter.
33847	5	85	41	85	42	Carbon value earlier in chapter was stated as \$7/ton. This needs to be consistent in the document. [Government of United States of America, United States of America]	Carbon value no longer assigned in text, only amounts of carbon are discussed
33849	5	85	44	85	44	Is this the \$19USD, \$7 USD, or something else? Give value. [Government of United States of America, United States of America]	Carbon value no longer assigned in text, only amounts of carbon are discussed
14435	5	85	47	85	47	Which RCP scenario are these changes projected under? Please clarify. [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	Text revised
33851	5	85	48	85	51	At what Carbon value? [Government of United States of America, United States of America]	Carbon value no longer assigned in text, only amounts of carbon are discussed
7469	5	85	54	0		Suggest remove "the" before "beneath" [Nina Hunter, South Africa]	No longer relevant as text has been removed.
17193	5	85	54	85	54	Removal of extra word "the" from the sentense "from the beneath the seabed" [Shalini Singh, Fiji]	No longer relevant as text has been removed.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
31907	5	86	4	86	18	Ensure traceability of assessments back to the literature [Hans-Otto Poertner and WGII TSU, Germany]	No longer relevant as text has been removed.
20775	5	86	4	86	8	Nitrogen, silica, phosphorus, hydrogen and sulfur cycles are listed in the first part of sentence #1 of the paragraph, but only nitrogen processes are listed thereafter - thus coming across as an apples-to-oranges comparison. The suggested edit would involve either a) focusing the paragraph on just the nitrogen cycle - for example, change the first sentence to: "Cycling of limiting nutrient nitrogen also occurs in the deep sea, mediated by nitrogen fixation, denitrification, anaerobic ammonium oxidation..." (no other changes needed), or b) elaborating upon the other listed cycles. E.g. for phosphorus: Van Cappellen and Ingall 1994, Benthic phosphorus regeneration, net primary production, and ocean anoxia: A model of the coupled marine biogeochemical cycles of carbon and phosphorus, Paleooceanography and Paleoclimatology, 9, 677-691, https://doi.org/10.1029/94PA01455 ; Föllmi, 1995, 160 m.y. record of marine sedimentary phosphorus burial: Coupling of climate and continental weathering under greenhouse and icehouse conditions, Geology, 23, 503-506, <a href="https://doi.org/10.1130/0091-7613(1995)023<0503:MYROMS>2.3.CO;2">https://doi.org/10.1130/0091-7613(1995)023<0503:MYROMS>2.3.CO;2 . (E1b) [APECS Group Review, Germany]	No longer relevant as text has been removed.
20777	5	86	4	86	8	It's important to note in this paragraph that these cycles are usually closely coupled to the carbon cycle, such that feedbacks play a critical role in determining these cycles. (C2) [APECS Group Review, Germany]	No longer relevant as text has been removed.
20779	5	86	6	86	6	The Marlow et al. 2014 paper in Nature Communications deals with sulphur-coupled methane oxidation and therefore does not reflect the content of the sentence. As such, the confidence statement (high confidence) attributed to this sentence lacks considerable support from the literature. E.g. of marine nitrogen cycle references: Gruber 2004, The Dynamics of the Marine Nitrogen Cycle and its Influence on Atmospheric CO2 Variations, The Ocean Carbon Cycle and Climate, 97-148. (E2) [APECS Group Review, Germany]	text omitted. Now Marlow et al. 2014 in reference to carbon sequestration within carbonate
20781	5	86	10	86	12	It might be helpful to add the terms option value and bequest value to the glossary in Annex I. [APECS Group Review, Germany]	No longer relevant as text has been removed.
25515	5	86	10	86	18	POSSIBLY THE WHOLE PARAGRAPH COULD BE DELETED. THE VERY CURSORY MENTION TO OPTION AND BEQUEST VALUES IN A NARROW SPECIFIC CONTEXT IS ARGUABLY MORE CONFUSING THAN ENLIGHTENING [Christophe Deissenberg, Luxembourg]	Taken into account - text removed

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
14437	5	86	23	86	23	It is not only fish that migrate vertically but also zooplankton; suggest this is added for completeness. [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	Text rewritten
28195	5	86	23	86	24	suggest relevant to include zooplankton here. [Hilary Kennedy, United Kingdom (of Great Britain and Northern Ireland)]	Text rewritten
33853	5	86	39	86	39	Missing comma after "pharmaceuticals"? [Government of United States of America, United States of America]	Text rewritten
7471	5	86	47	0		Suggest remove parentheses around "Section 5.2.4" [Nina Hunter, South Africa]	Text rewritten
26617	5	86	50	87	35	This subsection would benefit enormously by distinguishing between some of the early (2006ish) studies and subsequent studies which are more balanced. [Florence Poulain, Italy]	Text rewritten
25353	5	86	50	93	38	Section 5.4.1.3 Coastal Ecosystem. As previously reported, there is no mention about other Biogenic Reef (e.g. mussel and oyster, algae, sponges, bryozoan, polychaetes) from coastal environment.s They should be added in the description beacuse their economic value in the acquiculture, the role as biodiversity promoters, etc....according to all the other description on coral reefs and other coastal ecosystems. These reefs are consistenly lacking from the document and they should be added beacuse the importance they have, the studies which have been published and for providing the state of art of these vulnerable ecosystems. [Chiara Lombardi, Italy]	Text rewritten
11265	5	86	52	86	52	include kelp forests here as well [Inka Bartsch, Germany]	Text rewritten
29865	5	86	52	86	54	Macroalgal beds/kelp forests should also be included in this group of valuable ecosystems: [Dorte Krause-Jensen, Denmark]	Text rewritten
33855	5	86	56	86	56	A reference is needed here. [Government of United States of America, United States of America]	Text rewritten
1799	5	87	1	0		If the value estimations per hectare are so uncertain, then the high degree of signfiicant figures here is probably not justified. [Mark Payne, Denmark]	Text rewritten
15779	5	87	1	0		If the value estimations per hectare are so uncertain, then the high degree of significant figures here is probably not justified. [EUCE, Belgium]	Text rewritten
22839	5	87	1	87	1	I would suggest given the fiscal year for those dollar values--IPCC reports are cited for many years and the dollar values are quickly dated, so it is helpful to provide some guidance on what year they are scaled to [Raphael Kudela, United States of America]	Text rewritten
7473	5	87	3	0		Suggest change "reef" to "reefs"; remove "of" [Nina Hunter, South Africa]	Text rewritten

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
3729	5	87	7	87	10	Although there is little discussion about tidal flats in this report, it may be pertinent to mention that a new study has estimated that there has been a global loss of 16% of tidal flat in the last 32 years (0.55% per yr). Murray et al. 2019. Nature https://doi.org/10.1038/s41586-018-0805-8 [Trisha Atwood, United States of America]	Text rewritten
11689	5	87	7	87	10	See "Hamilton SE, Casey D. Creation of a high spatio-temporal resolution global database of continuous mangrove forest cover for the 21st century (CGMFC-21). Global Ecology and Biogeography 2016; 25: 729-738." for a more up to date estimate of mangrove deforestation [Pierre Taillardat, Canada]	Text rewritten
11269	5	87	7	87	7	There is a small instantaneous rate of change of -0.018 yr ⁻¹ with declines in 38% of the ecoregions with kelps present, 27% increases and 35% of no change related to a multitude of drivers (Krumhansl et al. 2016). [Inka Bartsch, Germany]	Text rewritten
29867	5	87	10	87	10	Please add Waycott et al 2009 as seagrass reference to this (check that percentages are correct) [Dorte Krause-Jensen, Denmark]	Text rewritten
3727	5	87	15	87	15	Duke et al. 2007 estimates of mangrove deforestation (0.99% per yr) were based on rates from the 1980's and 1990's. However, estimates of mangrove deforestation from data collected post 2000 show a reduced rate of deforestation (0.16-39%; Hamilton and Casey 2016). Thus, recent rates of deforestation do not support the idea that mangroves would be extinct in the next 100 years. Hamilton and Casey 2016. Global Ecology and Biogeography https://doi.org/10.1111/geb.12449 [Trisha Atwood, United States of America]	Text rewritten
33857	5	87	15	87	17	Reference? [Government of United States of America, United States of America]	Text rewritten
14439	5	87	21	87	21	Which "three critical ecosystem services"? It would be easier for the reader to spell these out initially. [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	Text rewritten
29869	5	87	21	87	21	Please mention those vcritical ecosystem services [Dorte Krause-Jensen, Denmark]	Text rewritten
33859	5	87	21	87	22	List three services here. [Government of United States of America, United States of America]	Text rewritten
33861	5	87	22	87	24	Strike sentence. Not relevant. [Government of United States of America, United States of America]	Text rewritten
7475	5	87	30	0		Suggest change "to" to "of" [Nina Hunter, South Africa]	Text rewritten
33863	5	87	30	87	31	Give details here. [Government of United States of America, United States of America]	Text rewritten
33865	5	87	33	87	34	Is this consistent with monetary values given earlier in the chapter? Document needs consistency in how \$ values are reported. Need to give year and type of currency. [Government of United States of America, United States of America]	Text rewritten

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
7477	5	87	34	0		Cost to whom? Suggest provide more detail here for clarity. [Nina Hunter, South Africa]	Text rewritten
29871	5	87	37	87	37	I this section I suggest adding the importance of seaweed aquaculture [Dorte Krause-Jensen, Denmark]	Text rewritten
7479	5	87	38	0		Suggest change "shelf seas" to "shelf sea" (in line with usage on following page) [Nina Hunter, South Africa]	Text rewritten
26495	5	87	39	0		FAO 2016 refers to the SOFIA Report which is produced every two years by FAO. As the 2018 was published in July 2018 it is worth updating the chapter's references. There is more than one citation of this nature [Florence Poulain, Italy]	Text rewritten
7481	5	87	40	0		Suggest delete "through" as it does not seem to fit in here? [Nina Hunter, South Africa]	Text rewritten
10271	5	87	42	87	42	"67 - 74 million" : the en dash is to be used here instead of hyphen, without spaces on either side (67–74) [Jinsoo Park, Republic of Korea]	Text rewritten
21733	5	87	42	87	42	"67 - 74 million" : the en dash is to be used here instead of hyphen, without spaces on either side (67–74) [Government of Republic of Korea, Republic of Korea]	Text rewritten
26497	5	87	43	87	45	The swap between capture fisheries and aquaculture makes these 3 lines confusing. ("aquaculture catches"?). Also mangroves, seagrasses and coral reefs do not support the majority of fish catches as the sentence suggests. [Florence Poulain, Italy]	Text rewritten
9801	5	87	44	87	46	No. It is untrue to write the "most". It could be "A major part" or "An important part", (but not the majority of catch is supported by Coral reefs + seagrass bed + mangroves). [Government of France, France]	Text rewritten
5053	5	87	54	87	56	Consider quantifying the population. [Debra Roberts and Durban Team, South Africa]	Text rewritten
4915	5	88	0	0		Figure: What are the units in (b) and (d)? - Is no change projected in the uncoded coastlines? - In (a) and (c) the categories are strange. Suggest re-classifying, e.g. in steps of 20, starting at <-70. The light beige colours are too close to discriminate on the map. Keep it simple, and ensure the extreme values are easy to see. It would make sense to use a two-colour scheme as in other figures in the chapter (eg maroon - pale yellow - green) where pale-yellow is used for the near-zero change category (eg -10 to 10). - What are the blue and red lines in (e) and (f)? - How do the projections up to 2018 compare with observations? [Debra Roberts and Durban Team, South Africa]	Figure revised.
16585	5	88	0	88		The title of the scale of figure 5.15 is cut [Jens Rassmann, Belgium]	Figure revised.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
20783	5	88	0	88		The four top figures are too small to be of any use. The colors also blend too easily in with one another. It is impossible to read the legend to the right of each of these figures, even when enlarging, as the text is too blurred to read. Therefore, it is difficult to get an accurate idea of what the figures are supposed to show. I would suggest splitting this information out from figure 5.15 [APECS Group Review, Germany]	Figure revised.
23245	5	88	0	88		check coherency with SR15 for fisheries productivity as a function of each 0,5°C of warming. [Valerie Masson-Delmotte, France]	Checked
1801	5	88	1	0		This figure is based on a single catch potential projection model. However, a better figure would be based on the outputs of the FISH-MIP project, which uses multiple projection systems to encapsulate the model uncertainty associated with these projects. Heike Lotze (Contributing Author to this chapter) is closely involved with this and could contribute an appropriate figure. [Mark Payne, Denmark]	Figure revised.
15781	5	88	1	0		This figure is based on a single catch potential projection model. However, a better figure would be based on the outputs of the FISH-MIP project, which uses multiple projection systems to encapsulate the model uncertainty associated with these projects. Heike Lotze (Contributing Author to this chapter) is closely involved with this and could contribute an appropriate figure. [EUCE, Belgium]	Figure revised.
31713	5	88	1	0		Figure 5.15. The legends are way too small. You could make a single layer for the panels at the left and another for the panels at the right, and place them below in an horizontal way. [Hans-Otto Poertner and WGII TSU, Germany]	Figure revised.
31715	5	88	1	0		Figure 5.15. It seems that panels E and F would also need a legend to know which are these three models. [Hans-Otto Poertner and WGII TSU, Germany]	Figure revised.
11267	5	88	1	88	1	please consider Economic value reference for kelp forests: Bennett et al. 2016: Marine and Freshwater Research, 2016, 67, 47–56 http://dx.doi.org/10.1071/MF15232 [Inka Bartsch, Germany]	Text rewritten
10273	5	88	2	88	2	(average between 2041 – 2060) relative to 2000 (1991 – 2010) --> (average between 2041–2060) relative to 2000 (1991–2010) [Jinsoon Park, Republic of Korea]	Text rewritten
21735	5	88	2	88	2	(average between 2041 – 2060) relative to 2000 (1991 – 2010) --> (average between 2041–2060) relative to 2000 (1991–2010) [Government of Republic of Korea, Republic of Korea]	Text rewritten
7483	5	88	5	0		Suggest change colon to comma [Nina Hunter, South Africa]	Text rewritten
10275	5	88	6	88	6	relative to 1950-1961 --> relative to 1950–1961 [Jinsoon Park, Republic of Korea]	Text rewritten
21737	5	88	6	88	6	relative to 1950-1961 --> relative to 1950–1961 [Government of Republic of Korea, Republic of Korea]	Text rewritten
8679	5	88	11	88	22	it maybe consider this reference : [Government of Iran, Iran]	Text rewritten

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
8681	5	88	11	88	22	it maybe consider dis reference :Ehsan Khorsandi, Ahmad Moghaddam,2010,Investigation of the Pattern of Chlorophyll Changes in the Persian Gulf for a 12 -year Period Using Satellite Data and Investigating the Impact of Climate Change on it, Fourth Regional Climate Change Conference,IRAN, [Government of Iran, Iran]	Text rewritten
33867	5	88	15	88	18	Reference? [Government of United States of America, United States of America]	Text rewritten
26623	5	88	15	88	19	This paragraph doesn't make sense and mixes model results with actual realities -- of improved governance/management which results in reduced fishing effort. [Florence Poulain, Italy]	Text rewritten
7485	5	88	16	0		Suggest insert "the" before "majority" [Nina Hunter, South Africa]	Text rewritten
33869	5	88	18	88	19	Reference? Connect this sentence to the ones prior as it refutes their general claims. [Government of United States of America, United States of America]	Text rewritten
7487	5	88	21	0		Suggest change "seas" to "sea" [Nina Hunter, South Africa]	Text rewritten
26619	5	89	1	89	1	Loss of coastal fisheries productivity has many major drivers: overfishing caused by poor governance, policies favoring of monocropping of single species such as seaweed or shrimp)-- of which critical coastal habitat is a by-product. [Florence Poulain, Italy]	Text rewritten
7489	5	89	4	0		Suggest insert apostrophe after "fisheries" [Nina Hunter, South Africa]	Text rewritten
20785	5	89	5	89	7	It is not clear to me why the comparison is being made to the Atlantic eastern Pacific, as no further information is given about it (no real reason for the context). The sentence could read: "For mangrove forests, spatial analysis of the Indo-West Pacific suggests that higher floral and faunal diversity is correlated with a greater range of species exploited for fuel, timber and crustaceans (Huxham et al., 2017)." [APECS Group Review, Germany]	Text rewritten
33871	5	89	5	89	7	Strike. Not relevant. [Government of United States of America, United States of America]	Text rewritten
20787	5	89	14	89	17	This is a very long sentence, and the main point is buried at the end (models predict a decrease). I would suggest rewording for clarification: "An ensemble of simulations from multiple CMIP5 Earth System Models projects a decrease in maximum catch potential relative to 2000 of 2.8–8.7% by 2050 and 2.8–9.1% by 2095, under RCP2.6 (FAO, 2018). These models reflect projected changes in temperature, net primary production (and in some cases oxygen, salinity and sea ice extent)." [APECS Group Review, Germany]	Text rewritten
20789	5	89	17	89	18	I would suggest rewording for clarity: "Under RCP8.5, the projected decrease in maximum catch potential relative to 2000 is larger: 7.0–11.8% by 2050 and 16.2–25.5% by 2095 respectively." [APECS Group Review, Germany]	Text rewritten

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Comment id	Chapter	From page	From line	To page	To line	Comment	
20791	5	89	18	89	20	The meaning is not clear in this sentence. To say "will" is not correct - it indicates that this change is definite when instead we are looking at a projection. I would suggest "Cumulatively, these projections suggest a loss of up to 3.4 million tonnes in potential catches...". For the second part of the sentence, what is meant by "changes of 6.4% of the exploited species per degree Celsius"? The word "changes" is imprecise. I have looked at the reference in question, which mentions species turnover. However, I can't find 6.4% mentioned anywhere in the article. I therefore can't suggest an alternative - this will need to be reworded to reflect the reference better, or dropped. [APECS Group Review, Germany]	Text rewritten
7491	5	89	23	0		Suggest remove "a" [Nina Hunter, South Africa]	Text rewritten
26499	5	89	24	89	26	This section is good, but unnecessarily simplistic. The FAO report on the impacts of climate change on fisheries explores the difference between realised catch and potential catch, and highlights the importance of management decisions to avoiding global declines in catch and to promote adaptation options to benefit from the impacts of climate change (when applicable. e.g. migrations are from a place TO a place, bringing positives and well as negatives). I am surprised the authors have disregarded this crucial piece of evidence as this report is meant to assist policy makers. It would have brought the complexity of management into life in the context of climate change. It is not too late [Florence Poulain, Italy]	Text rewritten
7493	5	89	25	0		"in decline in a decline" - suggest replacing with "in a decline in"; insert apostrophe after "fisheries" [Nina Hunter, South Africa]	Text rewritten
17195	5	89	25	89	25	Removal of repeated word " in decline in a decline fish stocks" [Shalini Singh, Fiji]	Text rewritten
20793	5	89	25	89	25	"in decline in a decline fish" -> "in a decline in fish" [APECS Group Review, Germany]	Text rewritten
14441	5	89	28	89	30	There is no real mention of OA impacts on shellfish species in aquaculture - suggest this is included here too. [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	Text rewritten

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
20795	5	89	32	89	37	The meaning is not clear, as this sentence is too long. The main point should come across first. "in many regions" is redundant as you already state "around the Pacific islands". Suggest: "For example, around the Pacific Islands, more than 50% of exploited fishes and invertebrates are projected to become locally extinct under RCP8.5, following projected changes in SST, decreases in surface dissolved oxygen and NPP (by $\geq 3^{\circ}\text{C}$, $\geq 0.01\text{ ml L}^{-1}$, and $0.5\text{ g m}^{-2}\text{ d}^{-1}$ respectively by 2100). Under this scenario, 74% of the area is projected to experience a loss in catch potential of more than 50%." [APECS Group Review, Germany]	Text rewritten
7495	5	89	35	89	36	Suggest change "these factors...than 50%" to "74% of the area is projected to experience a loss in catch potential of more than 50% as a result of these factors" [Nina Hunter, South Africa]	Text rewritten
7497	5	89	40	0		Suggest change "reef" to "reefs" [Nina Hunter, South Africa]	Text rewritten
33873	5	89	41	89	41	Is this MSY per year? [Government of United States of America, United States of America]	Text rewritten
33875	5	89	42	89	43	Effect on what? Fisheries revenue/catch? [Government of United States of America, United States of America]	Text rewritten
7499	5	89	43	0		Suggest change "costs" to "cost"; estimated to cost whom \$105 billion? Is it possible to clarify this? [Nina Hunter, South Africa]	Text rewritten
33877	5	89	45	90	5	Why no discussion of shellfish and OA here? This is a major oversight. [Government of United States of America, United States of America]	Text rewritten
26501	5	89	47	89	48	The sustainability of aquaculture production will be impacted by CC, but as we are talking of over 600 species it is an extremely simplistic statement [Florence Poulain, Italy]	Text rewritten
28197	5	89	48	89	50	Very high losses of mangroves are attributed to conversion to aquaculture such as shrimp ponds. [Hilary Kennedy, United Kingdom (of Great Britain and Northern Ireland)]	Text rewritten
7501	5	89	49	0		Suggest change "includes" to "include" [Nina Hunter, South Africa]	Text rewritten
20797	5	89	51	89	51	Insert species names and correct the common names as well: Atlantic salmon (<i>Salmo salar</i>), gilthead seabream (<i>Sparus aurata</i>) and cobia (<i>Rachycentron canadum</i>) [APECS Group Review, Germany]	Text rewritten
26621	5	89	52	89	52	Did the studies actually consider shifts in the location of this marine aquaculture -- or only that it would not be able to remain as productive in areas where it currently occurs? There is a significant difference in outcome in terms of food security and nutrition. [Florence Poulain, Italy]	Text rewritten
7503	5	89	53	0		Suggest change "level that is" to "levels that are" [Nina Hunter, South Africa]	Text rewritten
20799	5	89	54	89	54	"growth" -> "growth potential" [APECS Group Review, Germany]	Text rewritten
20801	5	89	54	89	55	Would it be possible to attribute a confidence statement to this sentence? It seems like there should be sufficient literature to do so. (C1) [APECS Group Review, Germany]	Text rewritten
20803	5	90	1	90	1	"salmon" -> "Atlantic salmon (<i>Salmo salar</i>)" [APECS Group Review, Germany]	Text rewritten

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
26503	5	90	3	90	4	Fishmeal production has been in decline in the last decade despite carnivorous aquaculture continuing to grow at record levels. This is because technological advances are reducing the percentage of fishmeal in the diet of salmon. The paragraph must acknowledge the advances of the industry in weaning their dependency on wild fish catch. [Florence Poulain, Italy]	Text rewritten
7505	5	90	8	0		Suggest change "contributed by" to "as a result of" [Nina Hunter, South Africa]	Text rewritten
33879	5	90	8	90	10	Give reference and confidence statement. [Government of United States of America, United States of America]	Text rewritten
268	5	90	8	90	8	Again other possible reference to include in this sentence is Reidmiller et al., 2018. These authors have summarised the services provided by coastal ecosystems. Reidmiller, D.R., C.W. Avery, D.R. Easterling, K.E. Kunkel, K.L.M. Lewis, T.K. Maycock, and B.C. Stewart (eds.) 2018. U.S. Global Change Research Program, Washington, DC, USA. doi: 10.7930/NCA4.2018. [M.Dolores Garza-Gil, Spain]	Text rewritten
7507	5	90	9	0		Suggest insert "a" before "reduction" [Nina Hunter, South Africa]	Text rewritten
20805	5	90	10	90	13	"provisional" -> "provisioning". Change sentence to read: "Substantial impacts on non-fisheries' provisioning services are expected under 'business-as-usual' climate change in the 21st century (high confidence), even though the quantitative attribution and projection of such losses is limited (low confidence)." [APECS Group Review, Germany]	Text rewritten
28199	5	90	15	90	23	Coastal ecosystems esp seagrass meadows are valued most highly for their nutrient removal, regulating services. [Hilary Kennedy, United Kingdom (of Great Britain and Northern Ireland)]	Text rewritten
7509	5	90	20	0		Suggest change "sink of carbon" to "carbon sink" [Nina Hunter, South Africa]	Text rewritten
7511	5	90	22	0		Suggest change "witin" to "within"; replace "supporting" with "support a" [Nina Hunter, South Africa]	Text rewritten
17197	5	90	22	90	22	Mis-spelled word "witin" should be "within" [Shalini Singh, Fiji]	Text rewritten
20807	5	90	22	90	22	"provisional" -> "provisioning" [APECS Group Review, Germany]	Text rewritten
7513	5	90	25	0		Suggest change "storm" to "storms"; change "coastline" to "coastlines" [Nina Hunter, South Africa]	Text rewritten
20809	5	90	25	90	25	"Their losses" -> "loss of habitat" [APECS Group Review, Germany]	Text rewritten
29879	5	90	25	90	39	In this section I would also add the role of marine vegetated ecosystems in climate change adaptation against ocean acidification through the increase of pH in productive periods - e.g. Middelboe et al 2007, Hendriks et al 2014, Krause-Jensen et al 2016, Wahl et al 2018 [Dorte Krause-Jensen, Denmark]	Text rewritten
7515	5	90	28	0		Suggest change "reef" to "reefs" [Nina Hunter, South Africa]	Text rewritten
20811	5	90	33	90	33	By value do you mean "economic impact"? Please clarify. [APECS Group Review, Germany]	Text rewritten
7517	5	90	34	0		Suggest change "impacts" to "impact" [Nina Hunter, South Africa]	Text rewritten

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Comment id	Chapter	From page	From line	To page	To line	Comment	
7519	5	90	35	0		Suggest insert "a" before "reduction" [Nina Hunter, South Africa]	Text rewritten
20813	5	90	37	90	39	The Duarte et al. 2013 reference (Duarte, C. M. et al., 2013: Is Ocean Acidification an Open-Ocean Syndrome? Understanding Anthropogenic Impacts on Seawater pH. Estuaries and Coasts, 36 (2), 221-236, doi:10.1007/s12237-013-9594-3.) contained within the bibliography isn't the right reference here. It discusses coastal dynamics in relation to ocean acidification, not coastal vegetation buffering against storms and coastal erosion. The correct reference is to Duarte et al. 2013, The role of coastal plant communities for climate change mitigation and adaptation, Nature Climate Change, 3, 961D968. (E2) [APECS Group Review, Germany]	Text rewritten
29873	5	90	39	90	39	NB: For the reference list. Please be aware that there are two Duarte et al 2013 and references and add a,b to distinguish between them in the text. In this case the reference should be to Duarte et al 2013 (Nature Climate Chagne) which is nt currently in the reference list. [Dorte Krause-Jensen, Denmark]	Text rewritten
29875	5	90	40	90	53	I suggest mentioning Blue Carbon just briefly with a reference to section 5.5.1.1.2. where it is discussed in detail. And please mention that macroalgae/seaweeds are also blue carbon habitats (Krause-Jensen & Duarte 2016, Krause-Jensen et al. 2018). [Dorte Krause-Jensen, Denmark]	Text rewritten
20815	5	90	41	90	41	"regulatory" -> "regulating" [APECS Group Review, Germany]	Accepted
20817	5	90	41	90	53	This is a general comment on this paragraph. The topic sentence (first sentence) indicates that the papragraph will discuss the vulnerability of carbon sequestration to climate change. In reality, you do this in the next paragraph on page 91. Rephrase the sentence to indicate that the topic of this paragraph is the important role various ecosystems play in carbon sequestration. [APECS Group Review, Germany]	Text rewritten
11271	5	90	44	90	44	Please also consider recent estimation of Krause-Jensen and Duarte 2016. Nature Geoscience: DOI: 10.1038/NGEO2790 for contribution of macrophytes including macroalgae for carbon sequestration; mighth also go into Table 5.5 [Inka Bartsch, Germany]	Text rewritten
14443	5	90	45	90	48	This figure is not really described or utilised in the text. Suggest this is removed. [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	Text rewritten
10277	5	90	46	90	46	MgCO2eg --> MgCO2-eq [Jinsoon Park, Republic of Korea]	Text rewritten
21739	5	90	46	90	46	MgCO2eg --> MgCO2-eq [Government of Republic of Korea, Republic of Korea]	Text rewritten
7521	5	90	47	0		Suggest change "bed" to "beds" [Nina Hunter, South Africa]	Text rewritten

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
3731	5	90	47	90	49	It is not clear how the mean carbon storage in Mg CO ₂ ha ⁻¹ are being calculated and how (and why) they differ from the mean CO ₂ eq. calculated in lines 46-48 [Trisha Atwood, United States of America]	Text rewritten
7523	5	90	48	0		There are only two figures but there are mangroves, salt marshes and seagrass beds - three: is there a missing figure? [Nina Hunter, South Africa]	Text rewritten
3733	5	90	53	90	53	McLeod's estimates of carbon sequestration by blue carbon ecosystems is at the high end of estimates, and there is a fair bit of uncertainty around these. It may be more appropriate to show the range of estimates for carbon sequestration which are 0.08-0.22 Gt C yr ⁻¹ , according to Duarte et al. 2013 Duarte et al. 2013. Nature Climate Change 3: 961-968 https://doi.org/10.1038/nclimate1970 [Trisha Atwood, United States of America]	Text rewritten
10279	5	90	56	91	1	table 5.5. please make sure that en dash rather than hyphen has been used (seems that hyphens were used here) [Jinsoo Park, Republic of Korea]	Table deleted
21741	5	90	56	91	1	Table 5.5. please make sure that en dash rather than hyphen has been used (seems that hyphens were used here) [Government of Republic of Korea, Republic of Korea]	Table deleted
7525	5	90	57	0		Suggest change "multiple" to "multiply" [Nina Hunter, South Africa]	Text rewritten
3735	5	91	0	91		Table 5.5. It is not clear why the authors have chosen to use Pendleton et al. 2012's figure for these calculations. In many cases Pendleton's estimates do not reflect recent studies or the information provided in the text of this report. For example, this report provides an average value of soil carbon stocks for mangroves of 280 Mg ha ⁻¹ , this should equate to ~1028 Mg CO ₂ . However, the average near surface susceptible C in the table is 933 Mg CO ₂ (and that is suppose to include biomass). Another example is that the estimate for mangrove conversion is 4-19 times higher than those recently reported by Hamilton and Casey 2016 for deforestation rates between 2000-2012. Hamilton and Casey estimate a loss rate between 0.16 and 0.39% per year. The use of these lower, more recent rates, would significantly reduce the carbon lost and CO ₂ emissions in the following columns. Hamilton and Casey 2016. Global Ecology and Biogeography https://doi.org/10.1111/geb.12449 [Trisha Atwood, United States of America]	Table deleted
7527	5	91	3	0		Suggest insert "the" before "carbon budget" [Nina Hunter, South Africa]	Text rewritten
29877	5	91	4	91	4	I would delete "because of climate change", since any losses of these ecosystems would impact blue carbon stocks [Dorte Krause-Jensen, Denmark]	Text rewritten

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
11691	5	91	8	91	10	Hamilton and Friess (2018) estimated the CO2 emissions from mangrove conversion between 0.02 to 0.09 GtC y-1. Hamilton SE, Friess DA. Global carbon stocks and potential emissions due to mangrove deforestation from 2000 to 2012. Nature Climate Change 2018: 1. [Pierre Taillardat, Canada]	Text rewritten
28201	5	91	12	91	13	This is true for mangrove and seagrass as well as salt marsh. [Hilary Kennedy, United Kingdom (of Great Britain and Northern Ireland)]	Text rewritten
20819	5	91	13	91	15	Abella Perez et al. 2016 reference is not about methane emissions, but sea turtle conservation. Please remove. (E2) [APECS Group Review, Germany]	Text rewritten
28203	5	91	13	91	15	This is more true for mangrove and seagrass as they are more common in saline environments. [Hilary Kennedy, United Kingdom (of Great Britain and Northern Ireland)]	Text rewritten
11695	5	91	15	91	18	You can also refer to Taillardat P, Friess DA, Lupascu M. Mangrove blue carbon strategies for climate change mitigation are most effective at the national scale. Biology Letters 2018; 14.for a more recent and up to date estimate of carbon burial in blue carbon ecosystems. [Pierre Taillardat, Canada]	Text rewritten
1803	5	91	18	0		550ha of salt marshes globally? That's a moderately size farm.... There's probably a few digits missing here. [Mark Payne, Denmark]	Text rewritten
15783	5	91	18	0		550ha of salt marshes globally? That's a moderately size farm.... There's probably a few digits missing here. Please check and revise appropriately if needed. [EUCE, Belgium]	Text rewritten
33881	5	91	18	91	20	This should be in Section 5.3. [Government of United States of America, United States of America]	Text rewritten
7529	5	91	22	0		Suggest change "are" to "is" [Nina Hunter, South Africa]	Text rewritten
20821	5	91	22	91	28	Kelleway references throughout paragraph should be to Kelleway et al. 2017a. (E2) [APECS Group Review, Germany]	Text rewritten
20823	5	91	27	91	27	"provisional" -> "provisioning". [APECS Group Review, Germany]	Text rewritten
14445	5	92	0	92		This whole paragraph seems to repeat text from above and could be deleted. [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	Text rewritten
20825	5	92	0	92		Where does this figure come from? No reference is given. [APECS Group Review, Germany]	Text rewritten
31717	5	92	1	0		Figure 5.16. The figures uses boxes and lines of different styles giving the impression that these differences convey meaning, but these are missing in the caption or as a legend. [Hans-Otto Poertner and WGII TSU, Germany]	Text rewritten
25355	5	92	1	92	8	Figure 5.16. I would specify positive and negative feedbacks towards what. Negative feedbacks drawing show a positive situation for plants, which are able to cope with high rate of soil formation. Negative and positive feedbacks should be specified even in the tables of figure A and B. [Chiara Lombardi, Italy]	Text rewritten

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
16593	5	92	4	92	7	Figure 5.15 includes below two Time 2 sub-figures illustrating the response of vegetated coastal ecosystems to rising sea level under different rates of soil formation. Case A is called "negative feedback" and Case B is "positive feedback". I believe this terminology is confusing and, in terms of climate change, case A situation should be considered as a positive feedback because increases the uptake of atmospheric CO ₂ , whereas case B should be a negative feedback because generates net CO ₂ outgassing. Consequently, I suggest to modify also figure captions as follows: "Biogeomorphic feedbacks involving plant biomass, sediment accretion and inundation that control the response of vegetated coastal ecosystems to rising sea levels. (A) Under high rate of soil formation, plants are able to offset sea level rise and may produce a positive feedback by increasing the uptake of atmospheric CO ₂ . In addition, belowground root production contributes to the formation of new soils and consolidates the floor line. (B) Under low rate of soil formation, and when sea level rise exceeds critical thresholds, plants become severely stressed by inundation leading to less organic accretion, belowground subsidence and decay, and a negative feedback of sea level rise by the net CO ₂ outgassing. This figure does not consider landward movements, controlled by topography and human land-use." [Alejandro Cearreta, Spain]	Text rewritten
7531	5	92	11	0		Suggest change "ecosystems" to "ecosystem" [Nina Hunter, South Africa]	Text rewritten
33883	5	92	11	92	27	Reduce redundant text in this paragraph. [Government of United States of America, United States of America]	Text rewritten
7533	5	92	15	0		Suggest insert "a" before "decrease" [Nina Hunter, South Africa]	Text rewritten
11971	5	92	15	0		"The loss of live coral results" --> "The loss of live coral cover results" [Wolfgang Kiessling, Germany]	Text rewritten
7535	5	92	24	0		Suggest change "reefs" to "reef" [Nina Hunter, South Africa]	Text rewritten
7537	5	92	31	0		Suggest insert "a" before "23%" [Nina Hunter, South Africa]	Text rewritten
23247	5	93	0	93		Some aspects of economic losses should be provided in ES and SPM. [Valerie Masson-Delmotte, France]	OK
10735	5	93	1	0		Delete "by Deloitte Access Economics" [Jean-Pierre Gattuso, France]	Text rewritten
33885	5	93	1	93	1	Strike "Deloitte Access Economics". This is clear from the reference. [Government of United States of America, United States of America]	Text rewritten
20827	5	93	1	93	2	Please specify currency. USD? [APECS Group Review, Germany]	Text rewritten
26625	5	93	1	93	3	What is the value of the fisheries production? [Florence Poulain, Italy]	Text rewritten
10737	5	93	3	0		It is O'Mahony rather than O'Mahoney [Jean-Pierre Gattuso, France]	Text rewritten

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
25517	5	93	7	93	12	THIS IS A GENERAL AND MOST IMPORTANT COMMENT THAT APPLIES TO THE VALUATION OF ANY ECOSYSTEM SERVICE. I SUGGEST PLACING IT AT THE BEGINNING OF THE SECTION OR EARLIER AND EXPANDING IT. IT MIGHT BE WORTH MENTIONNING THAT THE EVALUATION IS USUALLY VERY LOCAL AND LINEAR (WITHIN A PARTIAL EQUILIBRIUM FRAMEWORK OR A GROSSLY OVERSIMPLIFIED GENERAL EQUILIBRIUM FRAMEWORK). IMPACTS ARE EVALUATED LARGELY IN ISOLATION – FEEDBACKS WITHIN THE ECONOMIC AND THE NATURAL SYSTEMS ARE IGNORED ... IN OTHER WORDS, ALTHOUGH SOME OF MY COLLEAGUES ECONOMIST WILL DISAGREE, EVALUATION IS MADE ASSUMING IMPLICITELY BUSINESS AS USUAL AND RELATIVELY SMALL PERTUBATIONS. [Christophe Deissenberg, Luxembourg]	Text rewritten
20829	5	93	7	93	7	Currency? USD? [APECS Group Review, Germany]	Text rewritten
10739	5	93	14	0		The par starts with “Another class of servces” but tourism was alreary discussed in the preceding paragraph. Merge. [Jean-Pierre Gattuso, France]	Text rewritten
10741	5	93	14	0		The “global value of US\$ 36 billion per year” seems inconsistent with the range given in the previous page. [Jean-Pierre Gattuso, France]	Text rewritten
20831	5	93	14	93	15	Topic sentence is a repetition of the statistic on line 4 of the same page. Consider removing and beginning the paragraph with the following sentence, modified to: "Coral reef tourism is a reef service highly impacted by global changes (high confidence)." (E1a) [APECS Group Review, Germany]	Text rewritten
33887	5	93	14	93	18	Integrate into prior paragraph. [Government of United States of America, United States of America]	Text rewritten
14447	5	93	14	93	21	This text seems to repeat sections that have already been included previously - suggest this is deleted. [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	Text rewritten
10743	5	93	20	93	21	Please clarify what is meant here. [Jean-Pierre Gattuso, France]	Text rewritten
20833	5	93	23	93	24	Suggest rewording for clarity: "Overall, climate change impacts all ecosystem services (high confidence)." [APECS Group Review, Germany]	Text rewritten
10745	5	93	23	93	38	Where is this assessment of ecosystem services coming from? As mentioned above for ecosystem risks, the source should be mentioned and the transitions explained if those from gattuso et al. Have been revised. Also, why not add a burning ember figure? It could be another panel of the burning embers figure showing ecosystem risks. [Jean-Pierre Gattuso, France]	Text rewritten

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
20835	5	93	23	93	38	This is a general comment for the whole paragraph. Please cite your references, as none are provided. [APECS Group Review, Germany]	Text rewritten
33889	5	93	24	93	25	Why doesn't this apply to algae and seagrasses too? [Government of United States of America, United States of America]	Text rewritten
7539	5	93	25	0		Suggest change "invertebrates" to "invertebrate" [Nina Hunter, South Africa]	Text rewritten
7541	5	93	26	0		Suggest insert apostrophe after "fisheries" [Nina Hunter, South Africa]	Text rewritten
7543	5	93	27	0		Suggest change "impacts" to "impact" [Nina Hunter, South Africa]	Text rewritten
7545	5	93	29	0		Suggest insert "of" before "coastal"; change "reef" to "reefs" [Nina Hunter, South Africa]	Text rewritten
33891	5	93	29	93	30	Loss is due to gradual temp change, not just events. [Government of United States of America, United States of America]	Text rewritten
20837	5	93	29	93	32	Suggest rewording for clarity (sentence is too long): "Loss of coastal ecosystems due to sea level rises and an increase in extreme events will increase coastal communities' exposure to storms, erosion and saltwater intrusion via the loss of their coastal protection services (high confidence) and contribute to the loss of carbon sink capacity (medium confidence). Coral reefs, mangroves and saltmarshes are particularly vulnerable to these risks." [APECS Group Review, Germany]	Text rewritten
7547	5	93	34	0		Suggest change "represent" to plural [Nina Hunter, South Africa]	Text rewritten
20839	5	93	35	93	38	Suggest rewording for clarity: "Coastal ecosystems risk climate change impacts on their regulating and supportive services, intrinsic values, and cultural services (such as indigenous culture, recreational fishing and tourism), via the biodiversity and ecosystem functions they depend on (high confidence)." [APECS Group Review, Germany]	Text rewritten
25519	5	93	35	93	38	IT IS SOMEWHAT UNUSUAL AND PRESUMABLY INAPPROPRIATE TO SPEAK OF THE INTRINSIC VALUE OF TOURISM AND RECREATIONAL FISHERY. (INTRINSIC VALUE IS A PHILOSOPHICAL CONCEPT. ALTHOUGH IT HAS BEEN APPROPRIATED BY ENVIRONMENTAL ECONOMISTS, IT SHOULD BE USED WITH CARE ...) THUS MY SUGGESTION FOR A REFORMULATION: confidence). Climate change also puts at risk the intrinsic value and cultural importance of coastal ecosystems when dependent on their biodiversity and ecosystem functions or on the regulating and supportive services they provide (high confidence). [Christophe Deissenberg, Luxembourg]	Text rewritten
31909	5	93	40	114	28	There is a lot of overlap and repetition among subsections in this section 5.4.2. [Hans-Otto Poertner and WGII TSU, Germany]	Text rewritten

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
25359	5	93	40	115	1	5.4.2 Climate Risk, vulnerability....Section. As suggestes above, I would include a dedicated box to non-idigenous species. Their intorduction is related to climate change and other anthropogenic impacts, facilitated by different vectors (e.g. maritime trasport), and impacting human wellbeings (see papers of Azzuro, Occhipinti, Marchini, Galil....). [Chiara Lombardi, Italy]	Text rewritten
14449	5	93	42	93	45	The correct name is Vibrio cholerae [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	Text rewritten
2635	5	93	43	93	45	A recent report estimated that the total asset from these ocean-based economic sectors is at least US\$24 trillion, generating hundreds of millions of jobs (WWF 2015).' I think Teh et al 2013 would make a better reference than WWF 2015. Teh, L. C., & Sumaila, U. R. (2013). Contribution of marine fisheries to worldwide employment. Fish and Fisheries, 14(1), 77-88. [Brian Pentz, Canada]	Text rewritten
7549	5	93	51	0		Suggest change "assessment" to plural [Nina Hunter, South Africa]	Text rewritten
33893	5	93	51	93	51	Change are to is [Government of United States of America, United States of America]	Text rewritten
7551	5	93	55	0		Suggest replace "are based on assessments on" with "is based on assessments of" [Nina Hunter, South Africa]	Text rewritten
33895	5	93	55	93	55	Change is to are [Government of United States of America, United States of America]	Thanks. Done
33897	5	93	56	93	56	Change "of these" to "on these". Change is to are. [Government of United States of America, United States of America]	Thanks. Done
7553	5	94	0	0		In first column, change "Environments" to singular [Nina Hunter, South Africa]	Thanks. Done
26627	5	94	12	94	14	Noting the request to avoid editorial comments, the text in this table requires significant editing to clarify the contents /meaning. [Florence Poulain, Italy]	The text is now proof-read to avoid editorial errors.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
2637	5	94	16	104	19	<p>This section reviews the cultural and social impacts of climate change on communities. I think it would be good to include a discussion of the cultural identity of fishing communities and how it stands to be impacted by climate change. There are thousands of fishing communities around the world whose history, identity, and culture are deeply intertwined with the fishing industry. The loss of fishing activity because of climate change (either by species relocation or species/ecosystem collapse) carries important implications for the identity and culture of such towns.</p> <p>Lobster fishing towns in New England are an example of this point. Climate change is driving lobster populations north, towards Canada and away from American towns whose history, culture, and identity are defined through their relationship with the lobster fishery. [Brian Pentz, Canada]</p>	We attempted to assess this now, although the extent of the assessment is constrained by limited evidence.
9929	5	94	18	94	22	<p>Health security is not only linked to toxic marine intake, but disasters have also created water-borne illnesses and vector, especially in the tropics. But the increase of temperature and water after an extreme event has widened the geographical range of vector illnesses. [Úrsula Oswald Spring, Mexico]</p>	These topics are addressed in other sub-sections of this chapter.
33899	5	94	24	94	25	<p>Why aren't non-indigenous cultures considered? Many are strongly dependent on marine systems for their identity and persistence. [Government of United States of America, United States of America]</p>	Yes, non-indigenous added
33901	5	94	24	94	25	<p>What is the difference between cultural aspects and cultural dimensions? [Government of United States of America, United States of America]</p>	No difference
13063	5	94	27	97	44	<p>Discussion on climate change impacts on marine health is mostly limited to food safety and human diseases, but what about aquatic animals? The only hint that they may be affected is given on page 5-109, lines 51-53. Please consider to expand that discussion. [Government of Germany, Germany]</p>	This section is about the human dimension and the impact on human health. The impacts on the species are in section 5.3.
7555	5	95	1	0		<p>Suggest replace "are considered as" to "is considered a" [Nina Hunter, South Africa]</p>	OK, approve suggested change
33903	5	95	1	95	2	<p>Singular and plural verb use is confusing here. [Government of United States of America, United States of America]</p>	OK, approve suggested change
7557	5	95	2	0		<p>Suggest change "concerns" to singular [Nina Hunter, South Africa]</p>	OK, approve suggested change
20841	5	95	4	95	5	<p>More recent research suggests that 10 species of Vibrio have been isolated in humans: Morris et al. 2018. Minor Vibrio and Vibrio-like species associated with human disease. Link here: https://www.uptodate.com/contents/minor-vibrio-and-vibrio-like-species-associated-with-human-disease [APECS Group Review, Germany]</p>	Suggest to update the statement of 12 to 10 (due to the taxonomy change)

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Comment id	Chapter	From page	From line	To page	To line	Comment	
7559	5	95	7	0		Suggest change "system" to plural [Nina Hunter, South Africa]	OK, approve suggested change
14451	5	95	9	95	9	Suggested addition - "Vibrio bacteria, particularly V. parahaemolyticus and V. vulnificus." [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	Rejected, the evidence specifically pointed to Vibrio cholera
7561	5	95	10	0		Please insert "respectively" after "death" [Nina Hunter, South Africa]	Ok, respectively is missing. Approve suggested change
14453	5	95	16	95	16	Suggested addition - Vibrios are already the most expensive marine pathogens in the US (see Ralson et al. 2011; J Water Health. 2011 Dec; 9(4): 680–694.) [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	The relevant text has been deleted in the final draft.
7563	5	95	20	0		Suggest insert "A" before "recent" [Nina Hunter, South Africa]	The chapter has been edited to avoid grammatical errors.
7565	5	95	24	0		Suggest change "diseases" to singular [Nina Hunter, South Africa]	The chapter has been edited to avoid grammatical errors.
7567	5	95	26	0		Suggest change "intrusion" to plural [Nina Hunter, South Africa]	The chapter has been edited to avoid grammatical errors.
33905	5	95	29	95	32	Repetitive with sentences earlier in paragraph. [Government of United States of America, United States of America]	The chapter has been edited to avoid grammatical errors.
7569	5	95	30	0		Suggest change "increase" to "increased" [Nina Hunter, South Africa]	The chapter has been edited to avoid grammatical errors.
7571	5	95	33	0		Suggest change "population" to plural [Nina Hunter, South Africa]	The chapter has been edited to avoid grammatical errors.
33907	5	95	37	95	47	Redundant with prior paragraph. Combine the two and remove redundant statements. [Government of United States of America, United States of America]	Text edited
20843	5	95	40	95	40	Word Choice. What is meant by "grow faster"? Do you mean "spread more rapidly"? Please be more concrete. [APECS Group Review, Germany]	Text edited
7573	5	95	41	0		Suggest insert "with an" before "increase"; remove "higher" [Nina Hunter, South Africa]	The chapter has been edited to avoid grammatical errors.
22841	5	95	49	95	49	This may be outside the scope of Chapter 5, but the increased prevalence of coastal flooding is also linked to more pathogenic bacteria exposure in human populations. For example: https://link.springer.com/chapter/10.1007/978-3-319-75453-6_10 [Raphael Kudela, United States of America]	Taken into account.
33909	5	95	50	95	50	Use HAB. Acronym was already defined above. [Government of United States of America, United States of America]	Text edited
33911	5	95	53	95	53	Delete "that" [Government of United States of America, United States of America]	The chapter has been edited to avoid grammatical errors.
7575	5	95	54	0		Suggest remove "also" before "affected" [Nina Hunter, South Africa]	The chapter has been edited to avoid grammatical errors.
17199	5	95	54	95	54	Removal of repeated word "also have also" [Shalini Singh, Fiji]	The chapter has been edited to avoid grammatical errors.
7577	5	96	9	0		Suggest replace "for" with "of" [Nina Hunter, South Africa]	The chapter has been edited to avoid grammatical errors.
15899	5	96	17	96	20	HABs are not restricted to microalgae. In the Pacific Islands and the Caribbean / Southeastern USA, macroalgal species such as Sargassum and Gracilaria are becoming very common causing algal blooms (NYeurt and Iese, 2014). The cause of these algal blooms has been linked to increase in coastal nutrients from land runoffs, increasing human population, overfishing of herbivorous fishes, and increase in seawater temperature. [Antoine De Ramon NYeurt, Fiji]	Taken into account.
7579	5	96	20	0		Suggest change "affect" to "affected" [Nina Hunter, South Africa]	This text has been removed.
17201	5	96	20	96	20	Grammar correction to add "ed" at the end of "affect" [Shalini Singh, Fiji]	This text has been removed.
21047	5	96	20	96	20	"have increasingly affected" [APECS Group Review, Germany]	This text has been removed.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
21039	5	96	20	96	21	I don't think that HABs affect 'human society'. Probaby 'blue economy is a right word. [APECS Group Review, Germany]	Rejected, HABs affect humansociety by affecting health, economy, tourisms.
4919	5	96	21	0		There seems to be a disproportionate number of examples from the USA. This is an economic impact example which is hugely relevant. Is that because most studies are done in the USA and there are few other examples? It would give the report a more balanced feel if it aimed to give examples from different regions whenever possible, so that in total there was a balance of evidence from across the world. [Debra Roberts and Durban Team, South Africa]	Accepted. More evidence from other regions have been added.
22845	5	96	22	96	22	We attempted to update this globally in Bernard et al., 2014, Developing global capabilities for the observation and prediction of harmful algal blooms. Oceans and Society: Blue Planet. Cambridge Scholars Publishing, and in R.M. Kudela et al. 2015. Harmful Algal Blooms. A Scientific Summary for Policy Makers, IOC/UNESCO, Paris (IOC/INF-1320.), if you want to include a value that is more than just the US. [Raphael Kudela, United States of America]	Taken into account. More recent evidence has been cited from other regions.
20973	5	96	23	96	26	the sentence is difficult to read/discern meaning: are 'harmful algal outbreaks increasing in their frequency and intensity because of warming, and nutrient fluctuations? If so, why such low confidence in how global CC affects HABs? Consider clarifying/simplifying sentence [APECS Group Review, Germany]	This text has been modified for clarification.
20849	5	96	28	96	29	The way it's worded, it sounds like a foregone conclusion that HABs were driven by climate change. I suggest rewording to say something like 'Since AR5, ... showed HABs can be attributed to climate change.' [APECS Group Review, Germany]	Accepted, the text has been modified.
20851	5	96	29	96	31	Is it increase in HAB-related impacts, or an increase in the frequency/severity of HABs? These are nto necessarily the same thing [APECS Group Review, Germany]	Taken into account. The text has been rewritten for clarification.
7581	5	96	33	0		Was "Data" not intended instead of "Date"? [Nina Hunter, South Africa]	This text has been removed.
20923	5	96	33	96	33	remove "and" hosted. Correct sentence - "hosted within the International Oceanographic Date Exchange" [APECS Group Review, Germany]	This text has been removed.
20855	5	96	38	96	39	What does 'rise in bloom window' refer to? A longer bloom period? [APECS Group Review, Germany]	This text has been modified.
7583	5	96	40	0		Suggest remove semi colon after "acidification" and insert bracket before "low" [Nina Hunter, South Africa]	Accepted.
20975	5	96	40	96	41	is there also a link to deoxygenation and HABs, not just warming and acidification. It would be nice to see something about the relationship with deoxygenation and HABs here as well [APECS Group Review, Germany]	Taken into account. There is not strong assessment on this. Enhanced stratification in shallow, eutrophic estuaries induces deoxygenation and may trigger HABs. This is mentioned in section 5.3.1 Estuaries.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
20853	5	96	41	96	45	Note that this is CO2 related acidification, or at least that an increase in CO2 would lead to enhanced acidification [APECS Group Review, Germany]	Accepted. The text has been modified.
21049	5	96	43	96	43	Vicicitus globosus should be italicized [APECS Group Review, Germany]	Accepted.
33913	5	96	43	96	43	Italicize Vicicitus globosus [Government of United States of America, United States of America]	Accepted.
20977	5	96	44	96	44	writing: "and in general over the whole planktonic food web' seems quite broad, and there isn't a lot of room to support or explain this. I'd suggest to somehow elaborate on this phrase or delete it. The rest of the sentence stands alone nicely. [APECS Group Review, Germany]	The text has been modified.
14455	5	96	45	96	45	Suggest also referencing Townhill et al. (2018) [ICES Journal of Marine Science (2018), doi:10.1093/icesjms/fsy113] [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	Accepted..
22847	5	96	49	96	49	There are many, many papers discussing nutrients and toxicity. It seems odd to choose those two papers which focus on very specific organisms. I would at least include some of the reviews, such as https://link.springer.com/chapter/10.1007%2F978-3-319-70069-4_12 , https://www.sciencedirect.com/science/article/pii/S0079661110000194 , https://www.sciencedirect.com/science/article/pii/S1568988316300142 [Raphael Kudela, United States of America]	Taken into account.
21041	5	96	49	96	50	Not enough evidence of the role of climate in HABs [APECS Group Review, Germany]	The text has been modified for clarification.
22849	5	96	50	96	50	See also https://www.sciencedirect.com/science/article/pii/S1568988317301191 [Raphael Kudela, United States of America]	Taken into account
33915	5	96	52	96	56	Take out "therefore" as it makes process of inference challenging. [Government of United States of America, United States of America]	The text has been modified.
7585	5	96	55	0		Suggest change "are" to "is" [Nina Hunter, South Africa]	The text has been modified.
20925	5	97	2	97	2	The sentence is restructured here "Finally, in the coastline of the Canary Islands, a modelled distribution of harmful benthic [APECS Group Review, Germany]	This text has been removed
33917	5	97	2	97	2	Add reference to: Ritzman, J., A. Brodbeck, S. Brostrom, S. McGrew, S. Dreyer, T. Klinger, and S. K. Moore. 2018. Economic and sociocultural impacts of fisheries closures in two fishing-dependent communities following the massive 2015 U.S. West Coast harmful algal bloom. Harmful Algae 80:35-45. [Government of United States of America, United States of America]	Accepted
20927	5	97	3	97	4	cyanobacteria lyngbia majuscular predicts an expansion in their population linked to changes in topography and wave exposure" [APECS Group Review, Germany]	This text has been removed
20857	5	97	6	97	10	Phenolgy is not mentioned in the above paragraph, with the exception of one ambiguous comment about the bloom window. Please be more specific regarding the effect on bloom phenology or remove statement. [APECS Group Review, Germany]	This text has been removed.

SROCC Second Order Draft Government and Expert Review Compiled Comments - Chapter 5							Chapter Team Response
Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
21043	5	97	9	97	10	The entire section 'Box 5.3: Harmful Algal Blooms and Climate Change' mixes up between global warming and atmospheric CO2/ocean acidification. While both are connected but it is not justified to extend the connection between ocean acidification and HABs to global climate change/warming and HABs. [APECS Group Review, Germany]	Accepted. The text has been modified.
20979	5	97	12	97	17	Consider consolidating and merging this paragraph with the next paragraph [APECS Group Review, Germany]	The text has been modified.
20859	5	97	14	97	16	I don't understand this sentence, starting with 'where the exposure of organisms...'. I think the intended message was 'HABs are common in coastal areas, where they experience the interactive effects of climate change and other human-induced environmental changes' [APECS Group Review, Germany]	This text has been removed.
22851	5	97	16	97	16	See https://pubs.acs.org/doi/abs/10.1021/acs.est.7b05950 [Raphael Kudela, United States of America]	Accepted
27271	5	97	19	97	30	Suggestion- Include some data/information on blooms occurrence in South Atlantic Coastal Areas- e.g. Castro et al. 2016- OCEAN & COASTAL MANAGEMENT, v. 128, p. 40-51, 2016 [Gleyci Moser, Brazil]	Accepted
7587	5	97	21	97	23	Unitalicize references [Nina Hunter, South Africa]	Accepted
14457	5	97	21	97	23	What about other potential 'threats' such as proliferation of jellyfish - and impacts on people directly (stings), aquaculture and industry (power station intakes etc.)? [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	Out of scope in this HABs box.
25357	5	97	21	97	23	(Gilbert et al....Riebesell in press), please remove the italic [Chiara Lombardi, Italy]	Accepted
7589	5	97	25	0		Suggest change "ecosystems" to "ecosystem" [Nina Hunter, South Africa]	Accepted
20929	5	97	32	97	33	The sentence should be restructured to have valid meaning [APECS Group Review, Germany]	Accepted
26629	5	97	36	97	36	Ironically, the statement in Box 5.3 that "The greatest problems for human society will be caused by being unprepared..." applies to the entire text. [Florence Poulain, Italy]	Accepted
7591	5	97	38	0		Suggest remove "at a local scale" and insert "local scale" before "sustained" [Nina Hunter, South Africa]	Accepted
22843	5	97	39	97	44	Suggest citing Wells et al. (https://www.sciencedirect.com/science/article/pii/S1568988315300615) and Heisler et al. (https://www.sciencedirect.com/science/article/pii/S1568988308001066) as general reviews of monitoring and eutrophication in this section [Raphael Kudela, United States of America]	Taken into account.
14459	5	97	48	97	48	Suggested additional reference - Link et al (2011) "Guidelines for incorporating fish distribution shifts into a fisheries management context" F I S H and F I S H E R I E S , 2011, 12, 461–469 [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	Taken into account.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
13065	5	97	48	98	1	The alteration of POP (e.g. PCB) accumulation by organism due to climate change is unclear. Of cause climate change will alter the whole ecosystem inducing lots of indirect effects at the same time. But we cannot yet predict if the accumulation will increase or decrease because we cannot predict alterations in species composition or nutrition. Therefore it is quite unsure if this will lead to a new problem. [Government of Germany, Germany]	Taken into account.
13067	5	97	48	99	15	The term "contaminant" is more suitable compared to the used term "pollutant". Furthermore, not only POPs and MeHg are relevant (see e. g. Boxall et al. 2009: Impacts of Climate Change on Indirect Human Exposure to Pathogens and Chemicals from Agriculture). From Hg in the water phase, 90% is already present in the methylated form. The release of chemicals sorbed to sediments by invasive species is not addressed at all. Therefore, the subsection should be extended and give a comprehensive overview or omitted. [Government of Germany, Germany]	Taken into account. Text is edited to highlight the use of PoPs and MeHg as examples of possible pathways of interactions between contaminants and climate change in the ocean.
16611	5	97	49	99	15	I think something could be included in this section regarding high-latitude ice melt opening up areas to resource extraction (e.g. oil in the Arctic, mineral resources in Greenland such as Uranium and precious metals). Perhaps this is a bit speculative as there may not be much data on changes to date, but there may be appropriate literature available to make a more concrete point regarding this. At least something could be included to say that the increased access to resources due to ice melt introduces international and national regulatory/policy challenges. This latter point may make this comment fit better into the next section (5.4.2.1.3), and this may also result in changes in areas primarily inhabited by indigenous communities (section 5.4.2.1.4). [David Janssen, Switzerland]	Out of scope: This is discussed in chapter 3
16613	5	97	49	99	15	A recent modeling study (Desforbes et al 2018, doi: 10.1126/science.aat1953) tied orca whale population collapse to POPs. This could be relevant here. [David Janssen, Switzerland]	Reference added
16615	5	97	49	99	15	Desforbes et al. 2017 (doi:10.1021/acs.est.7b03532) investigated toxicity from mixtures of contaminants found in marine mammals rather than individual contaminants. This study showed that mixtures found in marine mammals had lower thresholds for adverse effects than previously suggested by individual compound studies. [David Janssen, Switzerland]	Taken into account

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
30149	5	97	50	97	50	Please, insert the words 'amplify the' between and & biomagnification so to read as:and amplify the biomagnification... [Juan Jose Alava, Canada]	Accepted
30151	5	97	50	97	50	In addition to Alava et al., 2017; please, also include the following citation for the newest publication on this topic to further support this statement (e.g., amplification of food web bioaccumulation under climate change): (Alava et al., 2018) Reference: Alava, J.J., Cisneros-Montemayor, A.M., Sumaila, R., Cheung, W.W.L. 2018. Projected amplification of food web bioaccumulation of MeHg and PCBs under climate change in the Northeastern Pacific. Scientific Reports 8:13460 DOI:10.1038/s41598-018-31824-5 [Juan Jose Alava, Canada]	Accepted
30153	5	97	50	97	50	In addition to Desforbes et al. 2016, please add the following citation: Desforbes et al., 2018) [Juan Jose Alava, Canada]	Accepted
20861	5	97	55	98	1	Is this statement referring to humans? [APECS Group Review, Germany]	Taken into account
30155	5	98	2	98	3	In addition to Fort et al., 2015, please, include the following citations here: (Scheuhammer et al., 2015; Wiener et al., 2007) References: Scheuhammer, A., Braune, B., Chan, H. M., et al. (2015). Recent progress on our understanding of the biological effects of mercury in fish and wildlife in the Canadian Arctic. Science of the Total Environment, 509– CRC Press Boca Raton. Wiener, J., Bodaly, R., Brown, S., et al. (2007). Monitoring and evaluating trends in methylmercury accumulation in aquatic biota. In R. Harris, D. P. Krabbemhoft, R. Mason, M. W. Murray, R. Reash & T. Saltman (Eds.), Ecosystem responses to mercury contamination (pp. 87–122). FL: CRC Press Boca Raton. [Juan Jose Alava, Canada]	Accepted
21051	5	98	3	98	3	delete "the" in "including the neurological" [APECS Group Review, Germany]	Accepted
20981	5	98	4	98	8	Consider moving this sentence to the end of the following paragraph which explains why/how this is the case (line29, p98) [APECS Group Review, Germany]	Taken into account
7593	5	98	5	0		Suggest change "is" to "are" [Nina Hunter, South Africa]	The chapter has been edited to avoid gramatical errors.
20867	5	98	10	98	44	Transitions between talking about humans to talking about other elemnts of the food web is somewhat awkward. At times, I wasn't sure if the text was referring to humans or (non-human) apex predators [APECS Group Review, Germany]	Taken into account
7595	5	98	11	0		Suggest change "pollutants" to "pollutant" [Nina Hunter, South Africa]	Text is edited - no longer relevant.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
21053	5	98	11	98	11	climate-change pollutant interactions [APECS Group Review, Germany]	The chapter has been edited to avoid gramatical errors.
7597	5	98	12	0		Sugget change "evidences" to "evidence" [Nina Hunter, South Africa]	The chapter has been edited to avoid gramatical errors.
21055	5	98	12	98	12	Scientific evidence [APECS Group Review, Germany]	The chapter has been edited to avoid gramatical errors.
30157	5	98	12	98	12	In addition to these citations and to further support this statement; please, also include Alava et al., 2018 (as aforementioned in for page 97, Line 50). [Juan Jose Alava, Canada]	Accepted
20931	5	98	13	98	13	highlighted that [APECS Group Review, Germany]	The chapter has been edited to avoid gramatical errors.
7599	5	98	16	0		Suggest change "is" to "are" [Nina Hunter, South Africa]	The chapter has been edited to avoid gramatical errors.
13069	5	98	16	98	29	It is not clear whether a significant increase of enhance methylation of mercury is to be expected after increased temperature induced by climate change. Please include a discussion of the role of already high methylation rate of mercury around 80-90 % e.g. in fish muscle. Houserova P. et al. 2007, Total mercury and mercury species in birds and fish in aquatic ecosystem in the Czech Republic. Environ Poll 145:185-194. [Government of Germany, Germany]	Agree with comment, but space constrains do not allow further development of this and as is the statement does not say that the change has to be significant
20983	5	98	17	98	19	Can details explaining why and how these metals are more bioavailable in acidified habitats be added to the end of this sentence? There is an explanation on line 24-27 but it may be more impactful if this was moved up in the text [APECS Group Review, Germany]	Taken into account.
33919	5	98	24	98	26	Is this true over the range of pH change expected with OA? [Government of United States of America, United States of America]	Taken into account. The text now acknowledges limited evidence on this.
7601	5	98	25	0		Suggest insert "the" before "enhancement" [Nina Hunter, South Africa]	The chapter has been edited to avoid gramatical errors.
7603	5	98	27	0		Suggest change "projection" to "projections" [Nina Hunter, South Africa]	The chapter has been edited to avoid gramatical errors.
21057	5	98	27	98	27	Modelling projections [APECS Group Review, Germany]	The chapter has been edited to avoid gramatical errors.
20985	5	98	27	98	29	Clarify what is happening: Are the whales around the Faroe Islands injesting more mercury, thus causing human exposure change? Are the whales only living around these islands? [APECS Group Review, Germany]	Taken into account. Due to limited space, the assessments refer the details to the cited references.
30159	5	98	29	98	30	Please, add the following new text/information from a very recent published paper in 2018 (Alava et al., 20128 as aforementioned in for page 97, Line 50): Moreover, a recent trophic-dynamic ecosystem and food web bioaccumulation modeling work projected the amplification of food web bioaccumulation of PCBs and MeHg in a marine food web of killer whales from the Northeastern Pacific (Alava et al. 2018). [Juan Jose Alava, Canada]	Accepted
20863	5	98	31	98	32	This sentence is confusing. Climate change alters the response of humans to human exposure to pollutants? [APECS Group Review, Germany]	The chapter has been edited to avoid gramatical errors.
7605	5	98	37	0		Suggest change "for" to "of"; remove "and" [Nina Hunter, South Africa]	The chapter has been edited to avoid gramatical errors.
20865	5	98	37	98	37	vulnerability' is vague here [APECS Group Review, Germany]	The chapter has been edited to avoid gramatical errors.
21059	5	98	37	98	37	remove and from "and the vulnerability" [APECS Group Review, Germany]	The chapter has been edited to avoid gramatical errors.
30161	5	98	37	98	37	Please, delete " and" to give sense to the sentence. [Juan Jose Alava, Canada]	The chapter has been edited to avoid gramatical errors.
33921	5	98	37	98	37	Strike "and" [Government of United States of America, United States of America]	The chapter has been edited to avoid gramatical errors.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
30163	5	98	38	98	38	Please, change to 'this' instead of latter to give sense to the sentence so to read as: ...suggests that the this region may be.... [Juan Jose Alava, Canada]	The chapter has been edited to avoid gramatical errors.
30165	5	98	41	98	41	Please, add after 'POPs', add the following text:and mercury ; so to read as: The impact of POPs and mercury on top predators... [Juan Jose Alava, Canada]	The chapter has been edited to avoid gramatical errors.
30167	5	98	42	98	42	Please, add the following citation (McKinney et al. 2005) after the word density ; so to read as:in their population density (McKinney et al. 2005) [Juan Jose Alava, Canada]	Text is edited - no longer relevant.
20869	5	99	1	99	1	Directions of arrows difficult to see on Fig 5.17 [APECS Group Review, Germany]	Figure quality improved.
20933	5	99	1	99	1	Please include a semi-colon(;), Anthropogenic Climate Change and Pollution: [APECS Group Review, Germany]	The chapter has been edited to avoid gramatical errors.
3979	5	99	1	99	5	I think it won't be a problem if this figure is removed. It is too confusing to understand and is extremely dense. Instead, this figure can be removed and only referenced to Booth and Zeller (2005) and it might have the same effect than including it in the chapter. [Aakash Sane, United States of America]	Figure quality improved.
10747	5	99	2	0		You may want to consider fig. 1 in Lloyd S. Peck, Organisms and responses to environmental change, Marine Genomics, Volume 4, Issue 4, 2011, Pages 237-243, [Jean-Pierre Gattuso, France]	Taken into account
30169	5	99	6	99	6	Please, delete Booth and Zeller (2005) and instead use Alava et al. (2017) as the correct in text- citation here (this figure is adapted from the original Figure 1 published in Alava et al., 2017). Booth and Zeller (2005) is not the publication that contributed with the conceptual scheme showed in Figure 5.17. [Juan Jose Alava, Canada]	Accepted
26631	5	99	11	97	13	Need to verify this figure using FAO statistics. [Florence Poulain, Italy]	Taken into account
13071	5	99	14	99	15	To predict a higher pollution risk for humans due to fish consumption after climate change is highly speculative. At the moment we cannot predict if pollution in e.g. fish increases or decreases with climate change. What we can predict is that something might change. Please provide more evidence and specify spatial relationships or revise the statement to reflect uncertainty. [Government of Germany, Germany]	Taken into account. The statement is revised.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
9931	5	99	17	101	2	Human security is understood in AR5 as freedom from fear (conflicts, which are analysed); freedom from want, where the socioeconomic factors are crucial to overcome extreme poverty and where especially the subsistence fishers in coastal areas are highly exposed to lose their livelihood and survival; freedom from extreme events, including early warning, disaster evacuation, etc. and freedom to live in dignity within a state of law. This last theme is completely absent and in most developing, but also developed countries corruption, bribing from mulinational enterprises (MNS), lack of legal application of environmental laws, etc. avoid efficient adaptation, mitigation and resilience-building (read also Brauch et al. 2009 and 2011) about human security. [Úrsula Oswald Spring, Mexico]	Text is edited - no longer relevant.
28875	5	99	17	101	2	The approach taken in subsection 5.4.2.1.3 makes a series of political assessments deriving from some scientific findings. It further goes beyond the main heading of this section "Social and cultural dimensions" (5.4.2.1), based on some approaches to international security and risk management that are of a political, not scientific, basis. This whole subsection is problematic and should be reviewed to represent climate change as a potential risk multiplier of disputes in specific political, socio, economic or environmental situations - not as the root cause of conflict. Focus should be on distributional disputes. [Government of Brazil, Brazil]	Text is edited to focus on potential conflicts from changing resources under climate change.
33923	5	99	17	101	2	Well-written section and a model for the rest of the chapter. [Government of United States of America, United States of America]	Thank you.
20987	5	99	17	101	3	This section is on human security and conflict is missing text explaining food security crisis. There is a section further on explaining food security issues but it seems like it also warrents a statement in this section as well, perhaps in the summary paragraph (p 100 line 57) [APECS Group Review, Germany]	Text is edited to focus on potential conflicts from changing resources under climate change. Food security is assessed in other sub-section.
28877	5	99	18	99	22	Replace current text with: "Adverse impacts of climate change may represent an additional factor in managing risk arising from distributional disputes over ocean resources. This assessment identified risks to human communities and their wellbeing that may emerge from climate change effects on the ocean through disputes." [Government of Brazil, Brazil]	Text edited.
7607	5	99	21	0		Suggest insert "in which" before "social" [Nina Hunter, South Africa]	The chapter has been edited to avoid gramatical errors.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
7609	5	99	21	0		Which assessment is being referred to? If referring to this chapter then rather state "In this chapter risks to human communities and their wellbeing that emerge from climate change effects on the ocean through conflicts is assessed" [Nina Hunter, South Africa]	Clarified
28879	5	99	24	99	24	Replace current text with: "Climate change effects on ocean conditions (Section 5.2.2) can contribute to disputes over fisheries..." [Government of Brazil, Brazil]	The text has been changed. Thanks
20935	5	100	2	100	2	remove the word "before" at the end of this sentence [APECS Group Review, Germany]	Agree. Thanks
20937	5	100	2	100	3	remove "occurred before and" [APECS Group Review, Germany]	Agree. Thanks
7611	5	100	4	0		Suggest change "salmons" to "salmon" [Nina Hunter, South Africa]	Done. Thanks
20989	5	100	4	100	7	Great example here, but point could be strengthened with another example of international conflict due to shifting stocks [APECS Group Review, Germany]	Taken into consideration
7613	5	100	8	0		Suggest change "framework does" to "frameworks do" [Nina Hunter, South Africa]	Thanks, done
7615	5	100	8	0		Sentence difficult to understand - if most of the legal frameworks do not have explicit provisions then there are some that do? Please clarify meaning. [Nina Hunter, South Africa]	Sentence removed
26633	5	100	8	100	10	This sentence is incorrect or, at best, extremely subjective. Most existing international fisheries governance legal frameworks DO have the means for accommodating stock shifts. That the management is not yet there is a separate and distinct issue and, in fact, does not need to be explicitly "climate-considered". [Florence Poulain, Italy]	Sentence removed
28881	5	100	8	100	13	Delete: "However, most existing international fisheries governance legal framework does not have explicit provisions to directly account for these shifting fish distributions and abundance. Without a climate-considered governance framework, chances for disputes in the sharing and exploitation of these fisheries resources are higher (high confidence), consequently increasing the risk of overfishing (high confidence) and fractured international relationships, and political conflicts that could spill over into other, non-fishery areas of international politics (low confidence)." This "finding" is a political assessment of the current fisheries regimes and presents a set of value judgments that are not rooted in empirical evidence, for instance, does not consider the role of implementation gaps of the current legal regime for oceans and fisheries. This is further politically sensitive since it assumes that the provisions of UNCLOS, the UNFSA and RFMOs would need to be reviewed. [Government of Brazil, Brazil]	Sentence removed

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Comment id	Chapter	From page	From line	To page	To line	Comment	
7129	5	100	9	100	12	I disagree that there is high confidence that the risk of overfishing will increase due to shifting the distribution of some stocks because there is not enough evidence to sustain that. I rather say low confidence or medium confidence at the most. [Luis Eduardo Calderon-Aguilera, Mexico]	Yes agree and sentence removed
7617	5	100	20	0		Suggest remove "the"; change "capacity" to "capacities" [Nina Hunter, South Africa]	Thanks, done
7619	5	100	21	0		Suggest change "the society" to "a society" [Nina Hunter, South Africa]	Done. Thanks
20991	5	100	22	100	26	I'm having a hard time understanding how these sentences are related to extreme events. Can these two sentences be reworded to explain why marine resources would be exploited with regard to extreme events, and how they offer a coping mechanisms (referring to short term income?) [APECS Group Review, Germany]	Agree. Those sentences has been displaced to the previous paragraph about fisheries.
20871	5	100	22	100	29	This seems to be mostly about fisheries and may be more appropriate in the previous paragraph. [APECS Group Review, Germany]	Yes, done. Thanks
5055	5	100	28	100	28	Could this also be between two different communities within the same country thus creating conditions for intrastate conflict among local communities? [Debra Roberts and Durban Team, South Africa]	Added: "or between two different communities within the same country thus creating conditions for intrastate conflict among local communities"
20873	5	100	31	100	42	Statements in this paragraph seem to contradict each other somewhat. While I have no doubt these are the findings of these studies, wording should be restructued to convey a clear message [APECS Group Review, Germany]	Text re-written
14461	5	100	37	100	39	Please define indigenous communities [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	See glossary please
7621	5	100	39	0		Suggest change "from" to "by" [Nina Hunter, South Africa]	Thanks, done.
7623	5	100	41	0		Suggest change "harms" to "harm" [Nina Hunter, South Africa]	Thanks, done
20993	5	100	48	100	51	this seems counter-intuitive, and not well linked to the previous sentence. Are you saying that marine conservation is bad ('induces social disruptions'); if so this needs additional explanation explaining specifically how climate protection, adaptation, and conservation are a bad thing. as it reads now it sounds like these things cause conflict. [APECS Group Review, Germany]	Text re-written
23387	5	100	53	100	53	Very generic statement about conflict with high confidence contradicting outcomes of AR5 and SR15. Please check very very carefully, and assess confidence for various levels of warming and specific aspects. Check amount of evidence carefully. [Valerie Masson-Delmotte, France]	Sentence changed to lower confidence level.
28883	5	100	53	100	53	Replace current text with: "In summary, climate change may represent a potential risk multiplier in specific political, social, economic and environmental contexts, and in the absence of adequate risk management measures." [Government of Brazil, Brazil]	Thanks, changed
7625	5	100	54	0		Suggest change "resources" to "resource" [Nina Hunter, South Africa]	Done. thanks
7627	5	100	55	0		Suggest change "dispute" to "disputes"; insert "a" before "lack" [Nina Hunter, South Africa]	Sentence changed

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
26635	5	100	57	100	57	Why is increased inequality and social unrest labelled as "low confidence"? This is an emerging area of work and concern. [Florence Poulain, Italy]	Because it is still emerging, not enough evidence yet.
7629	5	101	1	0		Suggest change "resources" to "resource" [Nina Hunter, South Africa]	Done. Thanks
4921	5	101	4	0		Is there information somewhere in the report on adaptation strategies used by indigenous peoples or efforts to collect knowledge about this? Eg conferences or literature on indigenous knowledge on adaptation - actual details as opposed to just mentioning it? [Debra Roberts and Durban Team, South Africa]	We have a section 5,5,2,4,5 on the role of education and local knowledge in adapting to climate change.
21003	5	101	4	102	39	Overall in this section, the explanation of how cultural beliefs are/would be affected by climate change was poorly addressed and difficult to find [APECS Group Review, Germany]	Section has been restructured
9933	5	101	4	104	19	Do not limit indigenous culture to French Polynesia. There are multiple other regional coastal areas more important, where indigenous have started to deal with mitigation and adaptation. OIT 169 is also protecting indigenous communities from governmental of MNE development processes, which would destroy their own livelihood, but also ecosystem protections. See especially tourism in the tropic and mining. This part is too Eurocentric. Indigenous have dealt thousands of years with climate change adaptation, which is not reflected in this part. [Úrsula Oswald Spring, Mexico]	We have explained at the beginning that we are taking one example and we agree that there are many others.
20995	5	101	5	101	23	Consider shortening this paragraph and simplifying the text. [APECS Group Review, Germany]	Yes, thanks
7631	5	101	6	0		Suggest change "the coast" to "coastlines" [Nina Hunter, South Africa]	Done. Thanks
7633	5	101	19	0		Suggest change "for" to "of" [Nina Hunter, South Africa]	Done. thanks
21061	5	101	21	101	23	Sentence doesn't make sense [APECS Group Review, Germany]	Sentence rewritten
26637	5	101	21	101	23	Whilst the experience of Indigenous culture from a Pacific perspective is very valid, how and why was this chosen for this chapter and not elsewhere (and vice versa with respect to other Indigenous perspectives, especially if particular and different? [Florence Poulain, Italy]	We needed an explicit example
7635	5	101	22	0		Suggest delete "therefore"; insert "from" before "experience" and "the" before "Indigenous" [Nina Hunter, South Africa]	Thanks
33925	5	101	22	101	23	Edit for clarity. [Government of United States of America, United States of America]	Done
14463	5	101	25	101	44	Please add a reference for this statement. [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	Reference added

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
25527	5	101	25	102	20	THIS LINES COULD BENEFIT FROM A MAJOR REWRITING TRYING TO PRESENT WHAT IS HAPPENING IN A STRAIGHTFORWARD, SIMPLE MANNER. THIS DOING, THE "PARADOX" MENTIONNED ON LINE 7 p. 102 IS LIKELY TO DISAPPEAR. IN ANY EVENT, ITS HARD FOR ME TO UNDERSTAND HOW THIS PARADOX MAY HAVE ENCOURAGED PACIFIC PEOPLE TO ENVISAGE CLIMATE CHANGE IN TERM OF THEIR BELIEFS. RATHER, ACTING ACCORDING TO THEIR TRADITIONS LEADS TO BEHAVIORS THAT MAY APPEAR "PARADOXICAL" FROM A WESTERN PERSPECTIVE. [Christophe Deissenberg, Luxembourg]	Taken into consideration
25521	5	101	26	101	26	the transmission thereof, and ocean education. THIS IS VERY OBSCURE [Christophe Deissenberg, Luxembourg]	Changed: The transmission of ocean education
25523	5	101	26	101	34	THESE LINES ARE PURE GIBBERISH. HERE WHAT I TOOK OUT OF THEM: Geological and climatic history refers to time intervals of thousands or even millions of years. Traditional knowledge, on the other hand, relates to shorter periods ranging from several generations to a few centuries. ALL THE REST SHOULD BE REFORMULATED, AND IF POSSIBLE MUCH SIMPLIFIED [Christophe Deissenberg, Luxembourg]	Thanks for nice comment; Sentenses have been removed.
20875	5	101	27	101	27	Different than what? Confusing [APECS Group Review, Germany]	Changed: In the Pacific, the perception of climate change refers to different time frames
7637	5	101	28	0		Suggest change "refers" to "refer" [Nina Hunter, South Africa]	sentence modified
16595	5	101	28	101	29	When talking about the effects of climate change on Indigenous knowledge, the paragraph says that "Geological and climatic history refers to time intervals of thousands or even millions of years. Traditional knowledge, on the other hand, relates to shorter periods ranging from several generations to a few centuries." I believe this is not correct. The Anthropocene epoch concept (putative beginning around 1950s) clearly illustrates the idea that geology can deal with time intervals of single years and decades (and not only of thousands or even millions of years). In the same way, this special report demonstrates that climate change can be considered at intervals of decades and centuries (and not only of thousands or even millions of years). Consequently, geological and climatic history can refer to time intervals similar to traditional knowledge. I suggest to eliminate these two lines/ideas. [Alejandro Cearreta, Spain]	We agree. Thanks
20877	5	101	28	101	31	Distinction between traditional knowledge and Indigenous knowledge not clear here. [APECS Group Review, Germany]	See cross-chapter box on ILK

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
20879	5	101	37	101	37	What is meant by 'outside discourse'? They do not believe the climate is changing? [APECS Group Review, Germany]	Yes
7639	5	101	39	0		Suggest change "sandbank" to plural [Nina Hunter, South Africa]	Done, thanks
33927	5	101	39	101	39	Change to "sandbanks". [Government of United States of America, United States of America]	Done, thanks
25525	5	101	43	101	43	THIS I CANNOT UNDESTAND EITHER: in the sense that more mythological syncretism may be produced by the concentration of people in the safest places. [Christophe Deissenberg, Luxembourg]	Text re-written
7641	5	101	46	0		What is 'foundation'? The foundation of the earth? Please state in more detail so that this is clear. [Nina Hunter, South Africa]	The foundation of the earth
7643	5	101	47	0		Suggest remove "the" before "knowledge" [Nina Hunter, South Africa]	Done, thanks
20881	5	101	47	101	49	Changes do not come about because of prophesying in any sense though. This is unclear. [APECS Group Review, Germany]	Text re-written
20883	5	101	47	101	49	What changes? Changes in the knowledge and practices? [APECS Group Review, Germany]	Yes, Changes in the knowledge and practices
20885	5	101	54	101	55	Is this shift really due to climate change? [APECS Group Review, Germany]	Not really
7645	5	101	56	0		Suggest change "to" to "in" [Nina Hunter, South Africa]	Done. Thanks
7647	5	101	57	0		Suggest remove "such" [Nina Hunter, South Africa]	Done. Thanks
20997	5	102	1	102	2	Explain how. As it, it sounds like schools are not beneficial or useful. [APECS Group Review, Germany]	They participate in the erosion of local knowledge
7649	5	102	2	0		Suggest replace "rise" with "elevation"? [Nina Hunter, South Africa]	Agreed
7651	5	102	3	0		Suggest change "guide" to "guides" [Nina Hunter, South Africa]	Removed
7653	5	102	4	0		What techniques are being referred to here? Please clarify. [Nina Hunter, South Africa]	Removed
7655	5	102	7	0		Suggest remove "the" [Nina Hunter, South Africa]	Done, thanks
20999	5	102	8	102	10	How does the building of double canoes relate to the cultural embrace of climate change? Are these boats being constructed for future storms/conditions? [APECS Group Review, Germany]	This example has been removed
7657	5	102	10	0		Suggest insert "the" before "re-enactment" [Nina Hunter, South Africa]	This sentence has been removed
7659	5	102	14	0		Please clarify "now extended to previously unknown scales" - meaning not clear [Nina Hunter, South Africa]	Removed
21001	5	102	15	102	15	Is the rahui a monument? Or something like an MPA? [APECS Group Review, Germany]	No
7661	5	102	18	0		Suggest remove "they" and insert "the indigenous people" [Nina Hunter, South Africa]	Changed. Thanks
25529	5	102	33	103	34	A MORE PROVOCATIVE SUGGESTION: where losses associated with culture are less tangible than those associated with economic losses ==> because they do not directly impact market incomes. [Christophe Deissenberg, Luxembourg]	Rejected. Not supported by literature assessed.
7663	5	102	37	0		Suggest remove "the" [Nina Hunter, South Africa]	Done, thanks
26639	5	102	37	102	39	What is the basis for these confidence levels? They seem low. [Florence Poulain, Italy]	Text re-written. No longer applicable.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
2639	5	102	41	104	19	<p>Section 5.4.2.1.4 does well to cover and discuss the importance of fisheries to indigenous cultures. But I think its geographic scope is a bit too narrow. Impacts of climate change on fisheries will be felt by Indigenous cultures all around the world; this section focuses on Indigenous groups in the Pacific. The example is then (too) briefly extrapolated to other Indigenous cultures. The section notes that a discussion of the impacts of climate change on Arctic Indigenous people is presented in Chapter 3 of the SROCC.</p> <p>I think it might be more effective to bring all of the discussion of the impacts of climate change on Indigenous groups from the entire SROCC into one section of Chapter 5. This would provide a clear, focused, comprehensive overview of the experienced and expected impacts that Indigenous peoples, groups, and cultures will face because of climate change. Dividing this discussion across different chapters/sections of the SROCC undercuts the effectiveness and clarity of the SROCC's coverage of climate change impacts on Indigenous people.</p> <p>It seems to me that this discussion would fit much more neatly into Chapter 5 than Chapter 3. [Brian Pentz, Canada]</p>	This section is based on one xample to show the importance of the ocean for indigenous communities and how climate change can threaten their culture.
21009	5	102	41	104	19	<p>Section may be reduced in length by cutting some of the generalities out, particularly those described previously, as there seems to be some repetition. [APECS Group Review, Germany]</p>	This section has been shortened
28097	5	102	42	102	44	<p>Following on from the section above about Indigenous communities, oceans include cultural heritage that is relevant to non-Indigenous communities and histories, such as the growth and expansion of colonialism, capitalism, and the modern world as seen in shipwrecks and related tangible coastal and near-coastal heritage. A relevant summary of impacts on underwater cultural heritage is Wright, Jeneva (2016). Maritime Archaeology and Climate Change: An Invitation. Journal of Maritime Archaeology. DOI 10.1007/s11457-016-9164-5. A key overview of the importance of the history of the modern world and capitalism (although this is not directly coastal in focus) is Wurst, L. & Mrozowski S.A. (2016). Capitalism in Motion. Hist Arch 50: 81. https://doi.org/10.1007/BF03377335. [Marcy Rockman, United States of America]</p>	Thanks for the suggestion and references.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
7665	5	102	43	0		Suggest remove "the"; change "discover" to "discovery" [Nina Hunter, South Africa]	Agreed and changed
5059	5	102	43	102	43	Do you mean "discovery"? [Debra Roberts and Durban Team, South Africa]	Yes. As above. Discover should be discovery
33929	5	102	43	102	43	Change to "discovery". [Government of United States of America, United States of America]	As above. Agreed.
7667	5	102	45	0		Change "psycological" to "psychological" [Nina Hunter, South Africa]	Agreed and changed.
21063	5	102	45	102	45	spelling mistake, psychological [APECS Group Review, Germany]	As above. Agreed and changed.
7669	5	102	48	101	49	"are other cultural dimensions becoming more widely acknowledged as key cultural dimensions potentially disturbed by climate change" - sentence very long and difficult to understand with repetition of terms - please rephrase for clarity [Nina Hunter, South Africa]	Please replace the whole sentence with: Other cultural dimensions that are becoming more widely acknowledged as potentially disturbed by climate change include the appreciation of scientific, artistic, spiritual, and health opportunities, as well as appreciation of biodiversity, lifestyle and aesthetics.
7671	5	102	50	0		"their support to human well-being through the cultural dimensions" - suggest rephrase to "the way in which these marine ecosystems support human well-being through cultural dimensions" [Nina Hunter, South Africa]	Agreed and changed
13151	5	102	53	103	7	Again, a very welcome paragraph, but much too short. I suggest strongly that (as above), you need a whole section on CC Ed. What I said above can easily be adapted, mutatis mutandis, to oceans. You state "Critical element to reducing vulnerability to climate change is to educate people that they are core to the Earth system and have a huge influence on the balance of the system." [David Crookall, France]	Apologies, the space is limited and we cannot extend the paragraph. Sorry
13157	5	102	53	103	7	First, pls fix the grammar. [David Crookall, France]	The word "their" on line 53 has been removed.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
13159	5	102	53	103	9	<p>Second, your statement is powerful, but so little in the paragrah to back it up, and to show which pathways to follow for CC ed. If education is critical to helping people realize that they are "core to the Earth system", and to giving them tools to influence that system in positive ways, then why, why oh why, has have you given so little space and emphasis in the report?</p> <p>Please see my comments under Chapter 1: Framing and Context of the Report, above.</p> <p>If doctors paid as little attention to patients as you have to CC ed, there would either be major outcries about the health system, or there would be major court cases againts this dereliction of basic duty. I alm sorry, but I do have to say that it boggles the mind to see how short shrift you are giving to education, probably the biggest single long-term measure that can be taken to combat CC. It is as if you are concerned with the doctor's instrumentrs, wihtout concern for the patients on which they will be used. Patient safety and respect for the patient are just as important for treatement as the instruments!</p> <p>There is little hope that the IPCC reports will gain widespread acceptance by, and even traction with, ordinary people if they are not given full opportunity to learn the skills, knowledge, habits, attitudes, behaviours, etc regarding the issues and actions. Such neglect of CC edu is to invite deniers to up the ante in their attempts to control CC knowledge and action. [David Crookall, France]</p>	Apologies, no space to extend those points. We will insist on this section (high agreement).
7673	5	102	57	0		Suggest insert full stop before "Research" [Nina Hunter, South Africa]	Agreed and changed
7675	5	103	2	0		Suggest change "Critical element to" to "A critical element in" [Nina Hunter, South Africa]	Agreed and changed
7677	5	103	7	0		Suggest change "support" to "supporting" [Nina Hunter, South Africa]	Agreed and changed
21065	5	103	7	103	7	"can affect the role of the ocean to support such public education" [APECS Group Review, Germany]	Please remove the words: can affect the role of the ocean.
21005	5	103	9	103	11	perception' is discussed in the first sentence, but not well linked to the rest of the paragraph. What is meant by 'deep osean'? [APECS Group Review, Germany]	We removed this paragraph
20887	5	103	11	103	17	This should possibly be merged with p.102 lines 7-20 [APECS Group Review, Germany]	This paragraph has been removed
7679	5	103	12	0		Suggest replace "reaction" with "response"; change "islands" to "island" [Nina Hunter, South Africa]	This paragraph has been removed
14465	5	103	16	103	17	This whole section of text (ending with Helm et al. 2018) is very waffly, suggest this could be deleted. [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	This paragraph has been removed

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
21007	5	103	16	103	17	add a citation for this statement [APECS Group Review, Germany]	Suggest: Fidelman, P., L. S. Evans, S. Foale, C. Weible, F. von Heland, and D. Elgin. 2014. Coalition cohesion for regional marine governance: A stakeholder analysis of the Coral Triangle Initiative. Ocean & Coastal Management 95:117-128.
33931	5	103	19	103	20	How were ratings derived? [Government of United States of America, United States of America]	ratings removed.Thanks
14467	5	103	19	103	31	This whole section of text (ending with Turner et al. 2008) is very waffly and could be deleted. [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	Done
25531	5	103	24	103	40	I DIDN'T CHECK BUT YOU MIGHT HAVE A NUMERICAL CONSISTANCY PROBLEM WITH EARLIER SECTIONS – SEE MY PREVIOUS REMARKS [Christophe Deissenberg, Luxembourg]	Solved.
21067	5	103	28	103	29	Not a very meaningful sentence, does not add value to the chapter [APECS Group Review, Germany]	Text removed.
7681	5	103	29	103	30	Suggest move "associated with climate change" to after "wellbeing" for clarity [Nina Hunter, South Africa]	Text removed.
7683	5	103	31	0		Suggest insert "A" before "recent" [Nina Hunter, South Africa]	Text removed.
33933	5	103	34	103	38	This sentence is difficult to read and should be rewritten for clarity. [Government of United States of America, United States of America]	Suggest replacing sentence with: Given the observed impacts and high risks of impacts from climate change on most coastal ecosystems where people are living, any impacts on marine ecosystems are likely elevate the risk of impacts on mental and psychological aspects of human well-being (loew agreement, low evidence).
7685	5	103	35	103	36	"interacting closely with" - word(s) missing after "with", please insert [Nina Hunter, South Africa]	Sentence now improved
33935	5	103	40	103	41	Provide explanation for rating. [Government of United States of America, United States of America]	low evidence because it "could be postulated" with few papers on this topic.
14469	5	103	40	103	48	This whole section of text (ending with Oyinola et al. 2018) is repetitive and could be deleted. [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	Not sure if there is a mix up? Cant find Oyinola?
7687	5	104	10	0		Suggest rephrase "affects differently the human cultures and well-being" to "affects human cultures and well-being differently" [Nina Hunter, South Africa]	Agreed and changed.
7689	5	104	11	0		Suggest replace "their life" with "people's lives" [Nina Hunter, South Africa]	Agreed and changed.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
4923	5	104	21	0		Economics is hugely important for policy makers. This section would benefit from a detailed table (and figure possibly) that summarises the most important cost implications (losses and adaptation costs) eg fisheries, tourism, livelihoods, for different regions, something that policy makers from different regions and sectors can use to extract useful information and that will point to sources with more detailed information. If you consider for instance that "ecosystem services define up to 90% of poor rural communities' incomes, worldwide" (106-4) and that "in developing countries .. tourism is the main source of entry of foreign currencies" (110-6) it becomes clear why this section is so very important. [Debra Roberts and Durban Team, South Africa]	I am not sure that we still have time or space to insert this kind of table, but I recognize that it would have been very useful.
26641	5	104	21	110	7	It is unclear as to why the economic dimension section includes food security and nutrition and is more focussed on financial rather than economic dimensions. [Florence Poulain, Italy]	Economic dimension include financial aspects. Food security and nutrition are also economic aspects.
33937	5	104	29	104	29	Food should be part of this list, too, given how shellfish aquaculture works. [Government of United States of America, United States of America]	OK, added ".....farmed animals, provisioning service (shellfish feed on plankton in the water) and regulatory....." on P104 line 28
33939	5	104	33	104	35	This is incorrect and should be highly edited. The oyster industry in the Pacific NW of the US had trouble with production in oyster hatcheries in 2005-10ish, but those hatchery problems related to OA have been solved and production is no longer impaired by OA. The 3200 jobs number is not what was lost by the industry due to OA, but the number employed by shellfish aquaculture writ large in Washington State (Washington Shellfish Initiative white paper, December 2011, shellfish_white_paper_20111209.pdf). This statement was likely taken and modified from this press release: https://today.oregonstate.edu/archives/2015/feb/study-outlines-threat-ocean-acidification-coastal-communities-us http://www.governor.wa.gov/news/ Regardless, a data-rich statement like this needs a reference. [Government of United States of America, United States of America]	Ok, we changed the sentence (p104 line35) to ".The oyster industry in the Pacific Northwest of the United States providing over 3,200 jobs in Washington State (Washington Shellfish Initiative, 2011) has already lost nearly US\$110 million in annual revenue due to ocean acidification." Reference: Washington Shellfish Initiative, 2011. https://pcsga.org/wprs/wp-content/uploads/2013/04/Washington-Shellfish-Initiative.pdf
7691	5	104	38	0		Perhaps replace "assessment" with "section" so that it is clear what is being referred to [Nina Hunter, South Africa]	Agreed. P104 line 38, we replaced "assessment" with "section"
7693	5	104	39	0		Replace "of" with "on" as in following sentence [Nina Hunter, South Africa]	Thanks, done. replace "of" with "on" ---became "climate change impacts on marine fisheries"
20939	5	104	42	104	48	Restructured: Since AR5, global projections on the economics of climate change impacts on marine fisheries have [APECS Group Review, Germany]	We restructured this sentence: "Global projections on the economics of climate change impacts on marine fisheries have.....social-economic factors since IPCC AR5."
20941	5	104	43	104	43	incorporated a broad range of social-economic factors that are driven by shifts in species [APECS Group Review, Germany]	Change to "incorporated a broad range of social-economic factors that are driven by shifts in species"

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
20943	5	104	44	104	44	distributions and maximum catch potential of fish stocks (Section 5.4.1) as well as projected changes in the [APECS Group Review, Germany]	The suggestion is the same as the sentence in the report. No action is needed.
20945	5	104	45	104	45	prices of fisheries landings and marine fisheries revenues. [APECS Group Review, Germany]	If change from "," to " and", the sentence meaning will be different. So, no need to change.
26505	5	104	45	104	49	this is rather confusing. 90% of countries will see a decrease in fisheries revenues but global decreases under RCP2.6 are only 7%. So only 10% are winners? this seems to contradict the winners and losers language used in other parts of the chapter. Also does not seem to match trends in catch potential projections which see significant increases in high latitudes and decreases in low latitudes. In fact the text says that revenues do not necessarily match catch potential in EEZs, but i find puzzling that the overall global figures seem quite consistent for both revenues and catch potential [Florence Poulain, Italy]	The reviewer may have misunderstood the meaning in these sentences. In the report, we indicate that 89% of countries are projected to have a negative fisheries revenues under RCP 8.5 scenario in the 2050s relative to the global status (NOT RCP 2.6 scenario). And the global average fisheries revenues are projected to decrease by 10% and 7% in the 2050s from the current status under RCP 8.5 and RCP 2.6 scenarios, respectively. I cannot see there is any contradiction between these two statements and it does not contradict with the winner and loser language used in other parts of this chapter. These sentences also match with the trends in catch potential projections that showed in this report because the 10% of countries with fisheries revenues increase (under RCP 8.5 scenario) are mainly in the high latitudinal regions including Norway, Iceland, Finland, etc. So, it's consistent with the trends of change in MCP in EEZs and trends showed in other parts of the report (i.e., increase in MCP in high latitudes and decrease in MCP in low latitudes).
20947	5	104	46	104	46	These will negatively impact in 89% of the [APECS Group Review, Germany]	No need to change.
20949	5	104	47	104	47	world of fishing countries under the RCP8.5 scenario by 2050s relative to the current status, with an estimated [APECS Group Review, Germany]	Change "in the 2050s" to "by the 2050s"
20951	5	104	48	104	48	global decreases of 10.4% \pm 4.2% and 7.1% \pm 3.5% under RCP8.5 and RCP2.6, respectively (Lam et al., [APECS Group Review, Germany]	The suggestion is the same as the sentence in the report. No action is needed.
20953	5	104	49	104	49	48 2016). [APECS Group Review, Germany]	No need to change.
20955	5	104	54	104	55	Restructured: Hence affecting the dependent communities with a subsequent decrease in sea food workers' [APECS Group Review, Germany]	Restructure the sentence to "Hence, the subsequent impacts on the dependent communities leads to a projected decrease in seafood workers'...."
33941	5	104	57	104	57	Put this in terms of RCP scenarios, as that is what is used in the rest of the document. [Government of United States of America, United States of America]	The results presented here are not the same as RCP 8.5 and 2.6 scenarios. It refers to the change in household seafood expenditures under the warming scenario to either 3.5 deg or 1.5 deg regardless of the year for reaching these targeted temperature. Please refer to the methodology part in Sumaila et al. 2019. So, it's not too accurate to rephrase the words in this sentence to RCP scenarios. Reference: SUMAILA, U. R., TAI, T. C., LAM, V. W. Y., CHEUNG, W. W. L., BAILEY, M., CISNEROS-MONTEMAYOR, A. M., CHEN, O. L. & GULATI, S. S. 2019. Benefits of the Paris Agreement to ocean life, economies, and people. Science Advances, 5, eaau3855.
7695	5	105	1	0		Sentence difficult to understand - perhaps a word other than "to" would help clarify the meaning? [Nina Hunter, South Africa]	Done: changed "to" to "for dealing with".

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
26507	5	105	1	105	8	This section underplays Gaines et al 2018 which reads "reforming fisheries in ways that jointly fix current inefficiencies, adapt to fisheries productivity changes, and proactively create effective transboundary institutions could lead to a future with higher profits and yields compared to what is produced today". It also shows positive outcomes for biomass, harvests and profits for RCP2.6, 4.5 and 6.0 if adaptation takes place, and even positive outcomes for fish biomass under RCP8.5 under full adaptation. Underplaying Gaines follows a pattern in the chapter where the role of management is underplayed as having little impact compared to the impacts of climate change. Indeed, for fisheries at least the impacts of management are far greater than the impacts of climate change alone, something that has been reflected in existing literature (e.g. Barange et al. 2014 NCC) [Florence Poulain, Italy]	We have focused on the added risks of climate change on fisheries, and the large effects of changing fishing patterns or fisheries management have now been stated explicitly.
7697	5	105	4	105	5	What does "even with full adaptation scenario" mean? [Nina Hunter, South Africa]	The full adaptation scenario assumes that management addresses both productivity and range shift challenges. The text has been modified.
21551	5	105	17	105	20	The selective use of one particular index (Human Development Index) is irrelevant and sweeping in this context. It is not possible that one particular index is able to capture the complex relationship between development levels and particular industries (in this case fisheries). Suggest the following formulation to emphasise the vulnerability of LDCs, while also maintaining consistency in the use of terms across the chapter: Therefore, negative impacts on the catch and total fisheries revenues obtained by these countries may have greater implications for jobs, economies, food and nutritional security. [Government of Singapore, Singapore]	The sentence changed to "Therefore, negative impacts on the catch and total fisheries revenues obtained by these countries may have greater implications for jobs, economies, food and nutritional security."
7699	5	105	21	0		Suggest insert "a" before "relatively" [Nina Hunter, South Africa]	insert "a" before "relatively"
7701	5	105	22	0		Suggest remove "the" [Nina Hunter, South Africa]	Remove "the" --".....also worsen non-climate related socio-economic....."
7703	5	105	23	0		"hence" is used twice in the same row - consider changing one "hence" with "therefore" so that it reads better? [Nina Hunter, South Africa]	Change the 2nd "Hence" to "Therefore"
7705	5	105	26	0		Remove semi colon and move full stop to after "2017)" [Nina Hunter, South Africa]	Remove semi colon and move full stop to after "2017)"
21069	5	105	26	105	26	Dasgupta citing should come before period. Remove ; [APECS Group Review, Germany]	Remove semi colon and move full stop to after "2017)"
7707	5	105	28	0		Suggest replace "they" with "these communities" for clarity of meaning [Nina Hunter, South Africa]	Line 28: replace "they" with "these communities"

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
7709	5	105	29	0		Suggest replace "gaining species" with "that will gain species" [Nina Hunter, South Africa]	replace "gaining species" with "that will gain species"
7711	5	105	31	0		Suggest remove "some" [Nina Hunter, South Africa]	remove "some"
23249	5	105	31	105	33	Example of trend in vulnerability to be reported in SPM, relevant for risk assessment on top of exposure and hazard. [Valerie Masson-Delmotte, France]	SPM
21011	5	105	39	105	39	Write out the FSM name [APECS Group Review, Germany]	Add "Federated State of Micronesia (FSM)"
33943	5	105	39	105	39	What is FSM? Federated State of Micronesia? [Government of United States of America, United States of America]	Add "Federated State of Micronesia (FSM)"
33945	5	105	44	105	44	Define GDP on first use. [Government of United States of America, United States of America]	Add "Gross Domestic Product (GDP)"
10281	5	105	44	105	45	the em dash may be used here instead of en dash, without spaces on either side [Jinsoo Park, Republic of Korea]	Agreed. the em dash may be used here instead of en dash, without spaces on either side
21743	5	105	44	105	45	The em dash may be used here instead of en dash, without spaces on either side [Government of Republic of Korea, Republic of Korea]	Agreed. the em dash may be used here instead of en dash, without spaces on either side
26643	5	105	44	105	47	This statement is essential for the report and all the more so given it is an SDG. Suggest reorienting the entire section on Economic Dimension around this. [Florence Poulain, Italy]	We put it in key messages. Thanks
7713	5	105	47	0		Line 47 ends by saying that the heavy reliance on fisheries makes these island communities very sensitive to the effects of climate change, but instead of then saying what the effects are (drawing a direct link) the next paragraph begins with reference to coral reefs. This link needs to be made clear initially - a logical next step. [Nina Hunter, South Africa]	Added "Marine ecosystems along most of the coastal communities, particularly those in the tropics, are highly exposed to climate change. " The 1st sentence on line 49 moved to line 52 (i.e., after....(Bell et al. 2018))"
20957	5	105	49	105	49	Among different ecosystems, [APECS Group Review, Germany]	Changed to "Among different ecosystems"
33947	5	105	53	105	54	This statement seems too broad. [Government of United States of America, United States of America]	Line 53 and 54, we inserted ",national governments of most of the countries with coral reef habitats "
7715	5	105	56	0		Suggest change "of" to "from" [Nina Hunter, South Africa]	Done: changed "of" to "from"
30279	5	106	0	106		the economic impact on women involved in fisheries (post-harvest practices) is well highlighted, but additional emphasis could be placed on their involvement in post-harvest practices, where added value generated is the highest, and on the fact that their contribution is not captured or measured in monetary terms. in addition, they may be further vulnerable because of their lack of access to alternative revenue-generating activities. [Charlotte de Fontaubert, United States of America]	This section has been removed
26649	5	106	4	110	7	Why is this section here and, particularly, after the food security and nutrition section? [Florence Poulain, Italy]	This section has been removed
9935	5	106	6	106	16	Gender is not women, see comments above. Only a transversal approach with a gender perspective will allow to understand the socio-cultural processes and especially the educational part and food culture. Both are very gender related. [Úrsula Oswald Spring, Mexico]	This section has been removed

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
25699	5	106	6	106	16	The gender issue under the discussion of vulnerability and resilience with references to pertinent literature may also be included. [Government of India, India]	This section has been removed
33949	5	106	6	106	16	What about the gender breakdown of those doing the harvest? Is it mostly men? If this section is to be retained, there should be similar treatment of the people doing the harvesting and the risks to them from climate change, which are also large. [Government of United States of America, United States of America]	This section has been removed
20959	5	106	8	106	8	Restructured: that involves selling and processing of fish in the landing sites and local markets. [APECS Group Review, Germany]	This section has been removed
20961	5	106	8	106	9	Restructured: Often it is mostly women that are working in canning, processing and other ancillary economic activities related to marine resources. [APECS Group Review, Germany]	This section has been removed
15831	5	106	11	106	14	Thus, women may be disproportionately affected relative to men when climate change impacts fisheries. No evidence is presented for this and it does not follow from the rest of the paragraph, [EUCE, Belgium]	This section has been removed
7717	5	106	12	0		Suggest change "credits" to "credit" [Nina Hunter, South Africa]	This section has been removed
7719	5	106	13	0		After reading that "women may be disproportionately affected relative to men" I was left wondering about how men will be affected - all that is said is that men are off fishing, but to my mind men will also be seriously affected if they are no longer able to fish because of a decline in fish catches. Please state something about how men will be impacted on by climate change. [Nina Hunter, South Africa]	This section has been removed
20963	5	106	13	106	14	Restructured: Thus, women may be disproportionately affected relative to men when comparing gender differences in climate change impacts on fisheries. [APECS Group Review, Germany]	This section has been removed
25701	5	106	13	106	14	"Climate change impacts on coastal tourism and corresponding decline in tourism revenue's impact on economies is shown as medium confidence. Is this medium or higher confidence?" [Government of India, India]	This section has been removed
7721	5	106	21	0		Suggest change "livelihood" to "livelihoods"; change "on" to "in" [Nina Hunter, South Africa]	We changed "livelihood" to "livelihoods"; We changed "on" to "in"
33951	5	106	23	106	25	A reference is needed to support this statement. [Government of United States of America, United States of America]	The sentence changed.
26645	5	106	24	106	25	This is a strange comment: Prices and costs will influence the responses of fishers, however, the responses will be dependent on the type of management of the fishery more than climate change. [Florence Poulain, Italy]	The sentence changed.
7723	5	106	27	0		Suggest remove "the" before "management" [Nina Hunter, South Africa]	Thanks, done

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
29881	5	106	30	106	30	In this section, consider also mentioning the potential for seaweed aquaculture. [Dorte Krause-Jensen, Denmark]	One sentence added in the text "Short-term climate change impacts on aquaculture can include losses of production and infrastructure arising from extreme events such as floods, increased risks of diseases, parasites and harmful algal blooms (FAO, 2018)"
26647	5	106	30	108	2	Why is this section part of the conomic dimension? This is the social dimension of fisheries. [Florence Poulain, Italy]	One sentence introduced to explain the economic dimension.
31911	5	106	30	108	2	Why is this part on food security and nutritional health in the section "economic dimension"? If you want to keep it here, then at least make a link to economy. [Hans-Otto Poertner and WGII TSU, Germany]	We added one sentence to explain the economic aspect:"It is an economic issue as capture and aquaculture contribute to the GDP directly or as imported and exported goods. "
20889	5	106	31	106	32	Citation for healthy diet statement [APECS Group Review, Germany]	Added: FAO. 2018. The State of World Fisheries and Aquaculture 2018 - Meeting the sustainable development goals. Rome. Licence: CC BY-NC-SA 3.0 IGO
33953	5	106	31	106	33	Add references and discussion to explain why agreement in the literature isn't strong. [Government of United States of America, United States of America]	Replaced by" low evidence"
14471	5	106	31	106	43	Text from Hilmi et al. (2017) onward (to Bell et al. 2018a) is oddly specific and feels very out of place, suggest this paragraph is deleted. [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	This has been modified
7725	5	106	32	0		Suggest change "proteins" to "protein" [Nina Hunter, South Africa]	Thanks, done
7727	5	106	34	106	35	Where are the references to support the claim of "new literature"? Or will this be pointed to in the paragraphs that follow? If so please state this. [Nina Hunter, South Africa]	Yes, they are below
22745	5	106	55	106	55	Add. "Short-term climate change impacts on aquaculture can include losses of production and infrastructure arising from extreme events such as floods, increased risks of diseases, parasites and harmful algal blooms (FAO, 2018)." Add source to bibliography: Barange, M., Bahri, T., Beveridge, M.C.M., Cochrane, K.L., Funge-Smith, S. & Poulain, F., eds. 2018. Impacts of climate change on fisheries and aquaculture: synthesis of current knowledge, adaptation and mitigation options. FAO Fisheries and Aquaculture Technical Paper No. 627. Rome, FAO. 628 pp. [Greenpeace Group Review, Republic of Korea]	Added, thanks
23251	5	107	0	107		What about changes in diets in rich countries to reduce global demand and alleviate risks of food insecurity for regions where marine anima proteins are key for nutrition? [Valerie Masson-Delmotte, France]	Yes, we mentionned it in the text.
7729	5	107	3	0		Suggest insert "the" before "nutritional" [Nina Hunter, South Africa]	Thanks, done
14473	5	107	4	107	17	What are 'PICTs'? Please explain. [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	Done: Pacific Island Countries and Territories
21013	5	107	6	107	6	Sentence needs to be clearer: "Under climate change the distribution of tuna in the tropical Pacific Ocean will shift, resulting in declining abundance"? [APECS Group Review, Germany]	Removed

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
7731	5	107	11	0		What is meant by "countries in the west"? Which countries are these? [Nina Hunter, South Africa]	Removed
26509	5	107	12	107	14	This goes back to comments above on Box 5.1 Fig. 2a. Skipjack future changes in revenue will cause -2% to +2% in PICT's GDP by 2100. But if habitat is almost completely lost (as reflected in Box 5.1) then where does the revenue come from? This paragraph (l. 6-17) further validates earlier criticisms of Box 5.1 [Florence Poulain, Italy]	Removed
5061	5	107	12	107	17	Did this take into account emission scenarios? What will be difference for low and high emissions scenarios? [Debra Roberts and Durban Team, South Africa]	Removed
7733	5	107	15	0		"to vary up to between" - suggest remove "up to" for clarity [Nina Hunter, South Africa]	Removed
20965	5	107	15	107	15	revenue to be around -0.3% and +21% [APECS Group Review, Germany]	Removed
31719	5	107	19	0		Figure 5.18. As it is, it seems that there is too much color... perhaps the figure could be a bit easier to navigate if you use for the first color gradient (change in max catch) a single color blue gradient, similar to the single color red gradient below. This two will be then easy to separate visually. [Hans-Otto Poertner and WGII TSU, Germany]	Taken into consideration
21015	5	107	21	107	21	figure is fuzzy, it is also difficult to make out colors are on land or sea with all the overlap in the islands (i.e. SE Asia and the Pacific) [APECS Group Review, Germany]	This is probably because the file has low resolution. High resolution file is now provided.
21017	5	107	21	107	21	Curious why 2050 projections weren't used? The strength of the more near-future projections might be more impactful? [APECS Group Review, Germany]	The spatial pattern of impacts are similar for the end of century projection and the mid century projection, and the end of century projection is presented and assessed in the ecosystem services sub-section. So, we keep the end of century projection to ensure traceability and linkages between the two subsections.
26651	5	107	27	107	28	As with the statement on page 97, line 37, this is one of the key messages of the chapter. [Florence Poulain, Italy]	Thank you.
7735	5	107	28	0		Suggest move "for vulnerable coastal communities" to after "food security" for clarity [Nina Hunter, South Africa]	Thanks, done
21019	5	107	32	107	32	What is meant by "exposure" in this sentence? Vulnerability? It may be less awkward to say 'may reduce communities reliance on seafood-based diets, and thus less affected by climate-driven stock changes' [APECS Group Review, Germany]	Thanks, done
5063	5	107	34	108	2	What is the magnitude of the increase/decrease? [Debra Roberts and Durban Team, South Africa]	Sorry, impossible to say. We just tried to have transition to next section below.
20893	5	108	5	108	6	Is there a citation for this? [APECS Group Review, Germany]	Yes, https://ec.europa.eu/maritimeaffairs/sites/maritimeaffairs/files/docs/body/study-maritime-and-coastal-tourism_en.pdf As well as references here in: https://www.omicsonline.org/open-access/coastal-tourism-importance-and-beach-users-preferences-the-bigfives-criteria-and-related-management-aspects-2167-0269-1000347.pdf

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
20891	5	108	9	108	9	important biodiversity' is vague [APECS Group Review, Germany]	<p>We included in parentheses (hosting approximately 17,000 species, 20-30% of which are considered endemic).</p> <p>Bianchi CN, Morri C. Marine biodiversity of the Mediterranean Sea: Situation, problems and prospects for future research. Marine Pollution Bulletin. 2000;40:367-376</p> <p>Boudouresque CF. Marine biodiversity in the Mediterranean: Status of species, populations and communities. Scientific Reports of Port-Cros National Park. 2004;20:97-146</p>
20895	5	108	21	108	23	Is there a citation for this? [APECS Group Review, Germany]	<p>Thanks, we added this reference for the first part of the sentence: Spalding, M., Burke, L., Wood, S. A., Ashpole, J., Hutchison, J., & zu Ermgassen, P. (2017). Mapping the global value and distribution of coral reef tourism. Marine Policy, 82, 104-113.</p> <p>and this one for the second part: Wongthong, P., & Harvey, N. (2014). Integrated coastal management and sustainable tourism: A case study of the reef-based SCUBA dive industry from Thailand. Ocean & coastal management, 95, 138-146.</p>
7737	5	108	22	0		Suggest change "visitor" to plural [Nina Hunter, South Africa]	OK, thanks
5065	5	108	25	108	26	Is there a global estimate for this? That is likely to be more useful than this single case estimate. It will also be useful to provide the estimated loss under low and high emission scenarios [Debra Roberts and Durban Team, South Africa]	<p>There is currently no global economic estimate available, with only a handful of studies providing such estimates for diverse localities. A quantitative estimate at the global level of the impact of the erosion of sandy beaches due to sea-level rise on the other hand does exist - Hinkel et al (2013).</p> <p>Hinkel, J., Nicholls, R. J., Tol, R. S., Wang, Z. B., Hamilton, J. M., Boot, G., ... & Klein, R. J. (2013). A global analysis of erosion of sandy beaches and sea-level rise: An application of DIVA. Global and Planetary change, 111, 150-158.</p> <p>The point re: range provision is well taken. Additional useful references include: Pendleton, L., Mohn, C., Vaughn, R. K., King, P., & Zoulas, J. G. (2012). Size matters: The economic value of beach erosion and nourishment in Southern California. Contemporary Economic Policy, 30(2), 223-237. Scott, D., Simpson, M. C., & Sim, R. (2012). The vulnerability of Caribbean coastal tourism to scenarios of climate change related sea level rise. Journal of Sustainable Tourism, 20(6), 883-898.</p>
7739	5	108	26	0		Suggest insert "the" before "principal" [Nina Hunter, South Africa]	OK - text now modified accordingly
33955	5	108	29	108	29	Define SIDS on first use. [Government of United States of America, United States of America]	OK - text modified to include Small Island Developing States here

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
20897	5	108	29	108	30	SIDS not defined - while likely mentioned early in the report, it ay be more helpful to have it written out fully - many will likely only read sections of the report in a sitting [APECS Group Review, Germany]	OK - see previous comment
21967	5	108	30	108	32	Is there a confidence assessment for this statement? It's a big call to make with only an "Information Bulletin" as a citation? [David Schoeman, Australia]	See also: Friedlander, A. M., Shackeroff, J. M., & Kittinger, J. N. (2013). Customary marine resource knowledge and use in contemporary Hawai 'i 1. Pacific Science, 67(3), 441-461. Cullen, L. C., Pretty, J., Smith, D., & Pilgrim, S. E. (2007). Links between local ecological knowledge and wealth in indigenous communities of Indonesia: Implications for conservation of marine resources. The International Journal of Interdisciplinary Social Sciences, 2(1), 289-299. Berkes, F., Colding, J., & Folke, C. (2000). Rediscovery of traditional ecological knowledge as adaptive management. Ecological applications, 10(5), 1251-1262. Jupiter, S. D., Cohen, P. J., Weeks, R., Tawake, A., & Govan, H. (2014). Locally-managed marine areas: multiple objectives and diverse strategies. Pacific Conservation Biology, 20(2), 165-179.
26653	5	108	30	108	32	This is only true if the newer management measures fail to recognize and internalize traditional management. [Florence Poulain, Italy]	Absolutely - see references above as well - text to be modified accordingly. Changed to: This trend is exacerbated in locations where traditional effective means of management have been eroded (such as taboos and religious beliefs among others) or where new forms of management fail to incorporate traditional management practices.
20899	5	108	32	108	32	Effective in what way? [APECS Group Review, Germany]	Yes, it is: effective in sustainably managing marine resources. Sentence reworded
7741	5	108	34	0		Suggest insert "the" before "tourism" [Nina Hunter, South Africa]	OK - text now modified accordingly
33957	5	108	34	109	27	The tourism sector is very carbon intensive (plane flights, etc). Provide discussion of the reduction in emission of CO2 caused by the reduction in the intensity of this sector, which is culturally valuable but not essential for life for those who go on trips. [Government of United States of America, United States of America]	This is an iportant point - We added Lenzen et al. (2019) for relevant highlights and literature. Lenzen, M., Sun, Y. Y., Faturay, F., Ting, Y. P., Geschke, A., & Malik, A. (2018). The carbon footprint of global tourism. Nature Climate Change, 8(6), 522.
25533	5	108	40	108	40	such as tourists' preferences è such as tourist's choices (PREFERENCES IS A TECHNICAL TERM IN ECONOMICS AND WOULD BE MISUSED HERE ...) [Christophe Deissenberg, Luxembourg]	OK - Done
33959	5	108	40	108	41	Page 89, line 43 says that the cost of bleaching is \$105M! [Government of United States of America, United States of America]	This is not removed.
20901	5	108	40	108	43	This is unclear - moderate bleaching what number is USD 20 billion? Total costs? Be specific [APECS Group Review, Germany]	total cost over a 50-year time frame with a 3% discount rate
22553	5	108	45	108	47	Suggest reviewing the amount 'around \$1.7 million per year' - this should be 'around \$1.09 mllion per year'. [Government of Australia, Australia]	This is not a monetary amount but the number of tourists.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
7743	5	108	46	0		Suggest move "visitors" from after "2.8 million" to "1.7 million" [Nina Hunter, South Africa]	OK - text now modified accordingly
20903	5	108	46	108	47	Maybe better to put percent decline [APECS Group Review, Germany]	while percentage is informative, total number here also serves the purpose of highlighting the popularity of the GBR
7745	5	108	47	0		Suggest change "This" to "Thus"; change "expenditures" to "expenditure" [Nina Hunter, South Africa]	The sentence as currently phrased is indeed not adequate. We have changed the sentence start to respond to this concern. Changed to : this is the equivalent of ... Expenditure has been changed as suggested
23253	5	108	50	107		It is not allowed to cite a web site. [Valerie Masson-Delmotte, France]	Point well taken - citation has been replaced with the following reference: Everett et al. (2018) Tourism as a driver of growth in the Pacific. A pathway to growth and prosperity for Pacific Island countries https://www.adb.org/sites/default/files/publication/430171/tourism-growth-pacific.pdf
33961	5	108	50	108	50	Remove web link. [Government of United States of America, United States of America]	See response above
20909	5	108	50	109	27	These two paragraphs could likely be merged - best to arrange topically rather than regionally [APECS Group Review, Germany]	We merged the two paragraphs following the modified sentence: For many SIDS, including Pacific Island Countries and Territories, tourism is one of the main industries that provides Include the following references at the end - i.e., Jiang and DeLacy, 2014 Everett et al. (2018) above and UNWTO (2014) Tourism in Small Island Developing States - http://cf.cdn.unwto.org/sites/all/files/docpdf/tourisminsids.pdf
11577	5	108	57	108	57	I would also include 'ocean waves', which following a change in coastal enviroment can effetc beaches and critical [Luca Castrucci, United States of America]	Ocean waves are encompassed in cyclones and storm surges - otherwise if ocean waves in an of themselves are to be considered a threat we would need a citable reference to be able to include this here
20907	5	109	6	109	6	Is there a citation for this? [APECS Group Review, Germany]	Added: Cannonier, C., & Burke, M. G. (2019). The economic growth impact of tourism in Small Island Developing States—evidence from the Caribbean. Tourism Economics, 25(1), 85-108. And: Dehoorne, O., Murat, C., & Petit-Charles, N. (2011). International tourism in the Caribbean area: current status and future prospects. Études caribéennes, (16).
20905	5	109	6	109	8	I believe this sentence may be more appropraite in the previous section about fisheries [APECS Group Review, Germany]	Agreed - this sentence has now been shortened and merged with the previous sentence to read as follows: While fisheries provide important livelihood opportunities and food security opportunities for local communities, tourism is the main driver of economic growth and is a key source of government revenue for SIDS throughout the Caribbean region.
7747	5	109	10	0		Please insert a reference for the USAID assessment [Nina Hunter, South Africa]	USAID (2013) Rapid climate change vulnerability assessment. The Eastern and Southern Caribbean regional report. 181p
5067	5	109	10	109	10	What year was the report published? [Debra Roberts and Durban Team, South Africa]	2013 - see previous comment for full reference
5069	5	109	11	109	11	Perhaps specify these countries? [Debra Roberts and Durban Team, South Africa]	We could list these as a footnote - Antigua and Barbuda, Barbados, Dominica, Grenada, Guyana, St Kitts and Nevis, St Lucia, St Vincent and the Grenadines, Suriname and Trinidad and Tobago.
7749	5	109	16	0		Which part of the AR5 report is being referred to? [Nina Hunter, South Africa]	Text edited.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
33963	5	109	17	109	27	Too detailed compared to the rest of the report. Summarize information instead. [Government of United States of America, United States of America]	Based on the comment the sentences have now been summarised as follows: The long-term projected rise in sea levels of between 0.5 and 1m, is likely to severely impact important tourism infrastructure throughout the region (Simpson 2010) and result in reductions of around US\$100 million in hotel revenue, or about 3 percent of GDP, over the long run (Cashman et al. 2012)
14475	5	109	21	109	27	The section describing numbers of hotel rooms seems far too parochial and specifice - suggest this is removed. [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	See comment above
14477	5	109	29	109	43	Do these economic estimates primarily relate to Hurricane Irma? Please be specific about which events these impacts correspond to. [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	Losses are attributed to specific storms in the text - e.g., line 34: In 2015, tropical storm Erika devastated Dominica causing US\$483 million in total damages and losses
20911	5	109	29	109	43	Is information available about these phenomena from other areas? [APECS Group Review, Germany]	Similar information is available for a number of cyclones in the Pacific region in section 5,4,2,3,1: we brought these two sections together
20967	5	109	30	109	30	projections indicating a continous increasing trend in hurricane intensity [APECS Group Review, Germany]	OK - text now modified accordingly
7751	5	109	36	0		Suggest remove "damages" [Nina Hunter, South Africa]	OK - text now modified accordingly

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
14479	5	109	41	109	43	There is no mention of the possibility that diseases or pests might vacate an area as a result of climate change. The chapter only discusses 'threats and losses' and makes no references to opportunities and potential winners. For example, certain HAB and disease species are characteristic of colder waters, and become less common in Europe (a benefit for humans). Suggest that these points are included in the text. [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	<p>The comment is interesting and well taken - however as certain diseases and pests vacate areas, others more common of tropical countries move in - e.g., dengue or malaria, potentially creating bigger health threats.</p> <p>Moreover, a number of references indicate that by and large HABs and other pathogenic agents are likely to increase in frequency and severity (e.g., Moore et al. 2008, Baker-Austin et al. 2013, Portier et al. 2013), although source organisms may shift (i.e., dinoflagellates vs diatoms in the case of HABs Hinder et al. 2012) and with several studies acknowledging that the link between climate change, HABs and other diseases is often speculative and complex, requiring more targeted research (Dale et al. 2006, Wells et al. 2016, Baker-Austin et al. 2013).</p> <p>Therefore, while this is considered to be an interesting topic, given the overarching remit of this chapter, the authors think that a detailed discussion around this issues falls outside of the purview of this section.</p> <p>Baker-Austin, C., Campos, C. J., Turner, A., Higman, W., & Lees, D. (2013). Impacts of climate change on human health. MCCIP Sci. Rev, 2013, 257-262.</p> <p>Dale, B., Edwards, M., & Reid, P. C. (2006). Climate change and harmful algal blooms. In Ecology of harmful algae (pp. 367-378). Springer, Berlin, Heidelberg.</p> <p>Hinder, S. L., Hays, G. C., Edwards, M., Roberts, E. C., Walne, A. W., & Gravenor, M. B. (2012). Changes in marine dinoflagellate and diatom abundance under climate change. Nature Climate Change, 2(4), 271.</p>
5071	5	109	42	109	42	Indicate what NOAA stands for. [Debra Roberts and Durban Team, South Africa]	OK - text now modified to include US National Oceanic and Atmospheric Administration when NOAA first mentioned
33965	5	109	42	109	42	Define NOAA on first use. [Government of United States of America, United States of America]	See response above

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
14481	5	109	45	110	2	This is a very biased assessment that only talks about threats and losses. There are locations around the world where conditions will become more attractive for tourism. There has been quite a lot of modelling on this topic, built around the "Tourist comfort index" [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	<p>p108 line 52 highlights the continued and growing importance of tourism to SIDS in the Pacific - and the same is true globally (WTT0 2018) as well as for other regions (e.g., Caribbean WTT0 2018).</p> <p>This is before considering how tourism numbers may increase at a specific individual country level. Moreover, it is likely that a number of parameters besides 'thermal preferences' will influence future visitor numbers and/or that such indices may be particularly relevant for temperate, generally developed countries (see Dubois et al. 2016 for discussion around care needed around index utilisation and Scott et al. 2016). Many developing countries would fall outside of this window but provide other appealing features.</p> <p>Dubois, G., Ceron, J. P., Gössling, S., & Hall, C. M. (2016). Weather preferences of French tourists: lessons for climate change impact assessment. <i>Climatic change</i>, 136(2), 339-351.</p> <p>Scott, D., Rutt, M., Amelung, B., & Tang, M. (2016). An inter-comparison of the holiday climate index (HCI) and the tourism climate index (TCI) in Europe. <i>Atmosphere</i>, 7(6), 80.</p> <p>https://www.e-unwto.org/doi/pdf/10.18111/9789284419876</p> <p>https://www.wttc.org/-/media/files/reports/economic-impact-research/regions-2018/caribbean2018.pdf</p>
26655	5	109	46	109	47	Whilst the study was on the recreational sector, there is no reason for this to not extend to the commercial sector as changing cost structures would also alter the provision of fish to the touristic sector. [Florence Poulain, Italy]	<p>Range shifts definitely extend to the commercial sector - and in fact most work undertaken to date around this issue has been undertaken for commercial species (e.g., Cheung et al. 2010, 2013).</p> <p>Cheung, W. W., Watson, R., & Pauly, D. (2013). Signature of ocean warming in global fisheries catch. <i>Nature</i>, 497(7449), 365.</p> <p>Cheung, W. W., Lam, V. W., Sarmiento, J. L., Kearney, K., Watson, R. E. G., Zeller, D., & Pauly, D. (2010). Large-scale redistribution of maximum fisheries catch potential in the global ocean under climate change. <i>Global Change Biology</i>, 16(1), 24-35.</p>
20913	5	109	51	109	51	Disease transmission among humans? Please be specific [APECS Group Review, Germany]	Thanks, specified
21021	5	109	53	109	53	Additionally, the publicity of 'dead zones' will negatively impact tourism (i.e. Rabotyagov et al: Review of Environmental Economics and Policy, volume 8, issue 1, 2014, pp. 58–79 doi:10.1093/reep/ret024 [APECS Group Review, Germany]	Consideration and reference will be added

SROCC Second Order Draft Government and Expert Review Compiled Comments - Chapter 5							
Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
7753	5	109	54	110	4	The word "deleterious" is used three times in this section; please consider using it only once and replacing the others [Nina Hunter, South Africa]	Well spotted. Consider rephrasing p110 line 1 to: This is likely to have more profound impacts on SIDS... and Overall, climate change will have substantial negative impacts on...
23255	5	110	0	111		It seems that there is overlap with chapter 4. Is real estate aspect linked to ocean or sea level rise? Then maybe more adequate in 5. Some of these points need to be visible in ES/SPM (stranded assets / real estate)? [Valerie Masson-Delmotte, France]	The focus in our chapter is on overall risk to assess and property values related to climate change impacts in the ocean.
5073	5	110	2	110	2	Why not on imported goods as a whole? [Debra Roberts and Durban Team, South Africa]	It is indeed on imported goods as a whole - with tourism actually driving an important component of imports into SIDS. Text modified accordingly
22161	5	110	4	110	5	"Climate change impacts on coastal tourism and corresponding decline in tourism revenue's impact on economies is shown as medium confidence. However, the analysis in the section above clearly shows that this high confidence." [NAYANIK SINGH, India]	I would keep "medium confidence"
14483	5	110	4	110	7	This "environmental dimension" section is repetitive and needs restructuring. It is very biased and one-sided, with little acknowledgement that there may be benefits/opportunities from climate change at certain localities (even if the overall picture is bleak). [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	The text will be modified to acknowledge that despite projections indicating that many countries will suffer from climate change impacts in the future, tourism on the whole is expected to increase substantially, particularly for a number of low to middle income countries. Such an outlook indicates that the sector is likely to provide substantial economic and development opportunities in the future, but that to be sustainable over the long term activities will need to take climate change into consideration. See UNWTO (2018) reference included above.
4911	5	110	6	0		"developing countries where tourism is the main source of entry of foreign currencies." To support this statement, please add data and examples from Africa. [Debra Roberts and Durban Team, South Africa]	Tourism is an important contributor to gross domestic product and employment in many African countries. Between 1995 and 2014, international tourist arrivals to Africa grew by an annual average of 6%, and tourism exports by 9%. Between 1995-1998 and 2011-2014, the average total contribution of tourism to GDP increased from \$69 billion (6.8%) to \$166 billion (8.5%) respectively. The sector also contributed to generating more than 21 million jobs on average between 2011-2014. UNCTAD (2017) Economic development in Africa: Tourism for transformative and inclusive growth. Trade and Development Board, 64th session, Geneva, Switzerland. 6p
20969	5	110	6	110	6	tourism is the main source of foreign revenue [APECS Group Review, Germany]	OK - text now modified accordingly
26657	5	110	11	111	47	This section is largely about economic impacts of CC, not the environmental dimension of sustainable development. [Florence Poulain, Italy]	This section is about monetary and economic values related to environment. It is about human-wellbeing related to environmental dimension.
33967	5	110	11	111	49	This section needs work to synthesize information instead of listing details from various studies. [Government of United States of America, United States of America]	Thanks, this section has been modified.

SROCC Second Order Draft Government and Expert Review Compiled Comments - Chapter 5							
Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
7755	5	110	14	0		Suggest change "resource" to "resources" [Nina Hunter, South Africa]	OK - text now modified accordingly
7757	5	110	24	0		Suggest change "possible creating" to "possibly create" [Nina Hunter, South Africa]	OK - text now modified accordingly
33969	5	110	29	110	36	Repetitive. Summarize findings together. [Government of United States of America, United States of America]	Modified, thanks
7759	5	110	34	0		Suggest insert "the" before "US" [Nina Hunter, South Africa]	Text has been modified
33971	5	110	41	110	43	This is hard to understand. Explain finding in simpler terms. [Government of United States of America, United States of America]	Modified
7761	5	110	55	0		Suggest change "crisis" to "crises" [Nina Hunter, South Africa]	Section deleted
5075	5	110	55	111	2	Is the projection based on current or different emission scenario? [Debra Roberts and Durban Team, South Africa]	whole section removed
33973	5	111	4	111	4	Repetitive. [Government of United States of America, United States of America]	Thanks, modified
33975	5	111	6	111	25	This would have more impact if it were summarized instead of just listing specific numbers. The main point is not the details, but the cumulative understanding; that is what the authors should focus on. [Government of United States of America, United States of America]	Text modified
5077	5	111	9	111	11	If possible, specify the emission scenario for this projection [Debra Roberts and Durban Team, South Africa]	IPCC A1B scenario as of the late twenty-first century
7763	5	111	21	0		Suggest change "fishery" to "fisheries" as used in previous sections [Nina Hunter, South Africa]	OK - text now modified accordingly
7765	5	111	29	0		Suggest change "developed countries" to "the developed country" [Nina Hunter, South Africa]	Changed to : "In a developed country context,
33977	5	111	33	111	35	Explain what this means in the context of this report to generalize the understanding. [Government of United States of America, United States of America]	This section has been re-written now.
21023	5	111	34	111	34	Clarify what is meant by 'negative news' - it is a bit too vague [APECS Group Review, Germany]	Suggest modifying text to: information about negative impacts to assets from climate change are communicated
33979	5	111	37	111	41	Summarize instead of quoting. [Government of United States of America, United States of America]	See suggestions in PDF file
20915	5	111	44	111	44	This may or may not be the most appropriate place to mention it, but I think the point should be made somewhere that defensive structures are only effective to a point, after which they may be useless (something like a seawall) [APECS Group Review, Germany]	This is assessed in Section 5.5
7767	5	111	45	0		"holders and cities" suggest change to "holders' and cities'" [Nina Hunter, South Africa]	OK - text now modified accordingly
13073	5	111	49	113	28	This subsection seems to be misplaced in the section „environmental dimension“ and should be shifted to section 5.5 [Government of Germany, Germany]	Marine renewable energy could sit in 5.4 as a part of ocean economics
14485	5	111	49	113	28	Offshore wind turbines are a much more "advanced technology" in terms of installed capacity, in comparison with other marine renewable sectors. [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	Thanks, this is now discussed
26659	5	111	49	113	28	This section is more about monetary impacts (a previous section) with additional text more relevant to the next section 5.4.2.4. -- but not for this section. [Florence Poulain, Italy]	Taken into account.

SROCC Second Order Draft Government and Expert Review Compiled Comments - Chapter 5							Chapter Team Response
Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
7769	5	111	50	0		Suggest insert "the" before "ocean" [Nina Hunter, South Africa]	this change is made
12977	5	111	50	111	50	insert 'The' at beginning of sentence ('The ocean...') [Roberta Hansman, France]	this change is made
21025	5	111	50	111	52	The opening sentences of this section are redundant and can be deleted. [APECS Group Review, Germany]	This has been changed
7771	5	111	51	111	52	Please clarify - "can be positive effects" needs clarity [Nina Hunter, South Africa]	Deleted
10749	5	111	54	0		You could mention (1) that ORE was found to be an ocean solution of choice, highly effective with few disbenefits (Gattuso et al. 2018) and (2) that it potential is gigantic (Possner et al., 2017) Gattuso J.-P., Magnan A. K., Bopp L., Cheung W. W. L., Duarte C. M., Hinkel J., Mcleod E., Micheli F., Oschlies A., Williamson P., Billé R., Chalastani V. I., Gates R. D., Irissou J.-O., Middelburg J. J., Pörtner H.-O. & Rau G. H., 2018. Ocean solutions to address climate change and its effects on marine ecosystems. <i>Frontiers in Marine Science</i> 5:337. Possner A. & Caldeira K., 2017. Geophysical potential for wind energy over the open oceans. <i>Proceedings of the National Academy of Science U.S.A.</i> 114:11338-11343. [Jean-Pierre Gattuso, France]	Have incorporated this reference
21969	5	111	54	111	57	ORC or OCE? [David Schoeman, Australia]	should be ORE, changed OCE to ORE
10751	5	111	57	0		I assume that ORE is meant. [Jean-Pierre Gattuso, France]	Yes this is corrected.
20917	5	111	57	111	57	OCE or ORE? [APECS Group Review, Germany]	should be ORE, change OCE to ORE
23257	5	112	0	113		Several paragraphs are relevant for WGIII but not this report, please check and remove (mitigation of shipping etc) [Valerie Masson-Delmotte, France]	Ok, removed.
14487	5	112	2	112	3	The text does not cover topics such as how climate change might impact access to offshore structures. For example whether changes in storminess might impact the ability to install and maintain offshore renewable energy infrastructure. Suggest this is included here. [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	Have included a brief mention of this
4927	5	112	3	0		Is there information that suggests "tidal barrage technology" while producing energy can also reduce the destructive power of greater wave height and power due to sea level rise and increased wind? The co-benefits? [Debra Roberts and Durban Team, South Africa]	A reference has been included for both tidal barrage and also wave energy
10259	5	112	5	112	5	The overall features of Sihwa Lake tidal power plant has been previous published by Korean engineers/scientists who have actually participated in the very project. Please cite the following reference. "Bae Y. H., Kim, K. O., Cho, B. H., 2010. Lake Sihwa tidal power plant project. <i>Ocean Engineering</i> , 37 (5-6), 454-463." [Jinsoo Park, Republic of Korea]	This reference has been added

SROCC Second Order Draft Government and Expert Review Compiled Comments - Chapter 5							
Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
21745	5	112	5	112	5	The overall features of Sihwa Lake tidal power plant has been previous published by Korean engineers/scientists who have actually participated in the very project. Please cite the following reference. "Bae Y. H., Kim, K. O., Cho, B. H., 2010. Lake Sihwa tidal power plant project. Ocean Engineering, 37 (5-6), 454-463." [Government of Republic of Korea, Republic of Korea]	This reference has been added
21027	5	112	13	112	15	The transition between the above opportunities (general) and how climate change is affecting transport need smoothing. [APECS Group Review, Germany]	yes, this has been modified.
17547	5	112	25	112	36	Shipping routes through the Arctic risk additional pollution, especially of short-lived climate forcers that can amplify warming in the region and accelerate localized warming. Stephenson S. R., et al. (2018) Climatic responses to future trans-Arctic shipping, GEOPHYSICAL RESEARCH LETTERS 45:9898–9908; Arctic Monitoring and Assessment Programme (AMAP) (2017) ADAPTATION ACTIONS FOR A CHANGING ARCTIC: PERSPECTIVES FROM THE BARENTS AREA; Arctic Council Secretariat (2017) EXPERT GROUP ON BLACK CARBON AND METHANE: SUMMARY OF PROGRESS AND RECOMMENDATIONS 2017; Sand M., et al. (2013) Arctic surface temperature change to emissions of black carbon within Arctic or midlatitudes, J. GEOPHYSICAL RESEARCH 118(14):7788–7798; see also Stohl A., et al. (2013) Black carbon in the Arctic: the underestimated role of gas flaring and residential combustion emissions, ATMOS. CHEM. PHYS. 13:8833–8855. [Kristin Campbell, United States of America]	thank you for your comment, we will include this sentence into the text.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
17659	5	112	25	112	36	Must emphasize that the risks and additional climate impacts far outweigh the benefits that may be gained from shipping, tourism, or other transit through the Arctic. Shipping routes through the Arctic risk additional pollution, especially of short-lived climate forcers that can amplify warming in the region and accelerate localized warming. Stephenson S. R., et al. (2018) Climatic responses to future trans-Arctic shipping, GEOPHYSICAL RESEARCH LETTERS 45:9898–9908, 9898 ("Because warming favors increased shipping traffic, previous studies have focused on the potential for ship emissions of black carbon (BC) and other particulates to enhance warming by lowering the otherwise high albedo of ice and snow (Browse et al., 2013; Corbett et al., 2010; Ødemark et al., 2012; Sand et al., 2016). The source of emissions is an important factor in determining the magnitude of this feedback and their ultimate climatic impact. Unlike BC transported to the Arctic from these midlatitude sources in Russia and Asia (Winiger et al., 2017; Wobus et al., 2016), strong surface inversions in the Arctic boundary layer make it more likely that BC emitted in the Arctic will be deposited on ice and snow, thereby maximizing its impact on surface temperature."); Arctic Monitoring and Assessment Programme (AMAP) (2017) ADAPTATION ACTIONS FOR A CHANGING ARCTIC: PERSPECTIVES FROM THE BARENTS AREA, 1 ("Changes in climate will have direct impacts on snow and ice, as well as on terrestrial, freshwater and marine ecosystems. In addition to climate change, the region's ecosystems are also influenced by several other impacts of human activities, such as chemical pollution, invasive species, and increased shipping and industrial developments. The end result is cumulative and cascading impacts on ecosystems and societies in the area."); Arctic Council Secretariat (2017) EXPERT GROUP ON BLACK CARBON AND METHANE: SUMMARY OF PROGRESS AND RECOMMENDATIONS 2017, 17 ("Arctic shipping currently accounts for about 5 percent of black carbon emissions within the Arctic; absent emission controls, shipping emissions within the Arctic could double by 2030 under some projections of Arctic vessel traffic."); Sand M., et al. (2013) Arctic surface temperature change to emissions of black carbon within Arctic or midlatitudes, J. GEOPHYSICAL RESEARCH 118(14):7788–7798, 7788 ("The climate model includes a snow model to simulate the climate effect of BC deposited on snow. We find that BC emitted within the Arctic has an almost five times larger Arctic surface temperature response (per unit of emitted mass) compared to emissions at midlatitudes. Especially during winter, BC emitted in North-Eurasia is transported into the high Arctic at low altitudes. A large fraction of the surface	see comment 17547 - we will include tis aspect briefly into the text
20919	5	112	25	112	36	While the discussion of shipping is valuable, I think it needs to be put into the context of blue economy, as that is the section title and the way in which the section opens [APECS Group Review, Germany]	the definition of "blue economy" varies among organizations. European Commission defines it as "All economic activities related to oceans, seas and coasts." Therefore we think that we are within the focus of the section title.
8683	5	112	38	112	57	it maybe consider dis reference : Parisa Sadat e Ashofte, 2010, The Effect of Climate Change on Runoff Using HadCM3 Model and Under Greenhouse Gas Emission Scenarios, Case Study of Corner Basin , Fourth Regional Climate Change Conference,IRAN, [Government of Iran, Iran]	This section has been removed
8691	5	112	38	112	57	it maybe consider dis reference : Mehri Hashemi Dovin, Ali Akbar Sabzi Parvar,2010, The consequences of the aviation industry in changing the global climate,Fourth Regional Climate Change Conference,IRAN, [Government of Iran, Iran]	This section has been removed

SROCC Second Order Draft Government and Expert Review Compiled Comments - Chapter 5							
Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
5057	5	112	41	112	41	"PAH" not needed as it is not used anywhere else in the chapter [Debra Roberts and Durban Team, South Africa]	This section has been removed
33981	5	112	44	112	54	Define IMO and MARPOL on first use. [Government of United States of America, United States of America]	This section has been removed
32471	5	112	48	0		the end of the phrase is not pertinent : "and recycle ships in an environmentally sound way" is not the case, there is a specific convention (Hong Kong convention) for that but just a few states signed it (2 european states in 2017!). Most ships are dismantled on asian beaches, without regard for minimum safety and environmental standards [Jacques Beall, France]	This section has been removed
32473	5	112	49	0		Phrase not correct "Recently implemented .. Fuel combustion" : since a few years there were some caps on sulfur emissions as well as Nitrogen emissions set up by IMO. In 2020 all ships should use fuel with less than 0,50 sulfur in it, that's the Global sulfur cap; there is some specific zones with more strict caps, those zones are called Emission Control Areas (ECA), there one in US and Canada EEZ, and one in North and Baltic Seas + Manche channel. [Jacques Beall, France]	This section has been removed
5079	5	112	49	112	50	By what magnitude? [Debra Roberts and Durban Team, South Africa]	This section has been removed
17203	5	112	50	112	50	Subscripting 2 in CO2 [Shalini Singh, Fiji]	This section has been removed
33983	5	112	50	113	3	The 2 in CO2 needs to be a subscript. [Government of United States of America, United States of America]	This section has been removed
17205	5	112	55	112	55	Subscripting 2 in CO2 [Shalini Singh, Fiji]	This section has been removed
7773	5	112	56	0		Suggest change "reducing" to "reduce" [Nina Hunter, South Africa]	This section has been removed
33985	5	112	56	112	56	Change "reducing" to "reduce". [Government of United States of America, United States of America]	This section has been removed
32475	5	112	57	0		After "...year 2018." you could add a phrase saying the European commission has already implemented a system to monitor, report and verify (MRV) emissions from all ships over 5,000 gross tonnage calling at EU ports. After a few years, there will be discussions between The European Council and the Parliament whether to align or not on the IMO system [Jacques Beall, France]	This section has been removed
7775	5	113	1	0		Suggest change "economical" to "economic" [Nina Hunter, South Africa]	This section has been removed
17207	5	113	3	113	3	Subscripting 2 in CO2 [Shalini Singh, Fiji]	This section has been removed
32477	5	113	5	0		LNG is considered as a transition solution, because it could be a brake on mid term scenarios to reach 2050 emissions targets (IMO Report 2013) [Jacques Beall, France]	This section has been removed
5081	5	113	11	113	11	Drop "HFO" as acronym is not used anywhere else in the chapter [Debra Roberts and Durban Team, South Africa]	This section has been removed
17209	5	113	14	113	14	Subscripting 2 in CO2 [Shalini Singh, Fiji]	will be done

SROCC Second Order Draft Government and Expert Review Compiled Comments - Chapter 5							Chapter Team Response
Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
17549	5	113	14	113	28	Reductions of emissions should extend across the sector and cover multiple climate forcers, targeting the short-lived forcers to reduce warming in the near-term, which is crucial for avoiding setting off feedbacks and breaching tipping points. [Kristin Campbell, United States of America]	We agree, however so far there are no relevant regulations for shipping addressing short-lived forcers. Therefore we decided not to include this.
17661	5	113	14	113	28	Reductions of emissions should extend across the sector and cover multiple climate forcers, targeting the short-lived forcers to reduce warming in the near-term, which is crucial for avoiding setting off feedbacks and breaching tipping points. Must also emphasize that the risks and additional climate impacts far outweigh the benefits that may be gained from shipping, tourism, or other transit through the Arctic. [Durwood Zaelke, United States of America]	We agree, however so far there are no relevant regulations for shipping addressing short-lived forcers. Therefore we decided not to include this.
20921	5	113	18	113	19	Human mortality? [APECS Group Review, Germany]	Yes
21029	5	113	19	113	19	Is this referring to human mortality? If so, specific details as to how would be interesting. [APECS Group Review, Germany]	yes, we refer to human mortality as discussed in the referenced publications. We will include one sentence here to explain more in detail.
5083	5	113	19	144	20	Are these the same for all emission scenarios? [Debra Roberts and Durban Team, South Africa]	We refer to Chapter 3 for their assessment here now.
7777	5	113	25	0		Suggest insert "the" before "establishment" [Nina Hunter, South Africa]	Yes, done. Thanks
9937	5	113	25	113	36	Mention the Artic Council, which includes mores countries than the enumerated [Úrsula Oswald Spring, Mexico]	This is covered by Chapter 3
21031	5	113	26	113	28	Alone, this sentence does not work well as a concluding statement for the section. Consider adding something like the following: "...accumulation of pollutants in the marine environment from the shipping industry." [APECS Group Review, Germany]	Thank you, we will include this into the sentence.
2641	5	113	30	114	28	I don't think I understand why '5.4.2.4 Impacts of Changing Ocean on Sustainable Development Goals' is covered briefly and in this part of the report. Arguably, sustainability and sustainable development in the context of climate change could be the type of framing that should characterize the entire SROCC. Restricting this coverage of climate change and the SDGs to two pages in the middle of Chapter 5 seems to downplay its importance and the centrality of these themes to the overall report. I suggest removing 5.4.2.4 and making a longer version of this argument in the introduction of the SROCC. [Brian Pentz, Canada]	We agree with the reviewer that sustainable development and the SDGs are broader and can frame the issue. However, this section specifically covers climate change effects on achieving the SDGs. There is not much literature on this point specifically but it is an important point so we have given a specific section to it.
7779	5	113	37	0		"specifically" spelt incorrectly [Nina Hunter, South Africa]	We have corrected the spelling here
17211	5	113	37	113	37	Mis-spelled word "Goas" should be "Goals" [Shalini Singh, Fiji]	We have corrected the spelling here
7781	5	113	41	0		Suggest change "highlights" to "highlight" [Nina Hunter, South Africa]	We agree with this suggestion. We have made this change.
7783	5	113	42	0		Suggest change "affects its" to "affect their" [Nina Hunter, South Africa]	We agree with this suggestion. We have made this change to "affect their ability to"
33987	5	113	42	113	42	Should be "affect their ability to". [Government of United States of America, United States of America]	We agree with this suggestion. We have made this change to "affect their ability to"

SROCC Second Order Draft Government and Expert Review Compiled Comments - Chapter 5							Chapter Team Response
Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
21033	5	113	44	113	44	As someone unfamiliar to the SDGs, the brief description for SDG14: 'life under water' is difficult to understand. Is there some other way to describe the meaning of SDG14, both here and for the following text? (i.e. p114, line 14) [APECS Group Review, Germany]	We have added the following after "Life after Water": "including indicators for marine pollution, habitat restoration and protected areas, ocean adification, fisheries, and coastal development"
14489	5	113	47	114	23	These last two paragraphs are very unwieldy to read and would be better as a table. [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	While the paragraphs document sequential consequences of climate change to SDG targets and goals, which can be highly detailed, we disagree that this information can be easily placed in a table. We have retained the paragraphs going forward.
7785	5	113	48	0		Suggest remove "an" [Nina Hunter, South Africa]	We agree with this suggestion. We have made this change.
12971	5	113	48	113	48	typo, either remove 'an' or change 'targets' to 'target' (i.e., '...before affecting an SDG target') [Roberta Hansman, France]	We agree with this suggestion. We have removed "an".
15691	5	113	52	113	52	"SDG 12" has to be added after "responsible consumption and production" [EUCE, Belgium]	We agree. We have added in this text
1511	5	114	0	0		Improve clarity, larger font size needed [Chandani APPADOO, Mauritius]	We have updated the figure for legibility
26511	5	114	0	114		I do not understand this figure - check any cell in the context of its axes and you'll see what I mean. Either it needs additional language or should be removed. [Florence Poulain, Italy]	We actually do not understand the comment here. However, we have updated the figure caption to read: "Summary of the kinds of relationships (below) from climate-impacted marine ecosystem services (rows) and the Sustainable Development Goals (columns). Pie charts represent the proportion of targets within each SDG that face particular relationships from climate-impacted marine ecosystem services."
7787	5	114	1	0		Suggest change "vector" to "vectors" [Nina Hunter, South Africa]	We agree. We have made this change.
12973	5	114	6	114	6	typo, change 'effected' to 'affected' [Roberta Hansman, France]	We agree. We have made this change.
7789	5	114	9	0		Suggest change "to" before "living" to "on" [Nina Hunter, South Africa]	We agree. We have made this change.
7791	5	114	10	0		Suggest change "affects" to "affect" [Nina Hunter, South Africa]	We agree. We have made this change.
7793	5	114	16	0		Suggest change "benefits" to "benefit" [Nina Hunter, South Africa]	Yes, thanks
12975	5	114	16	114	16	typo, change 'benefits' to 'benefit' [Roberta Hansman, France]	Yes thanks
7795	5	114	16	114	17	Suggest change "is sometimes necessary to achieve other SDGs" to "is necessary to achieving other SDGs" [Nina Hunter, South Africa]	We agree. We have made this change.
20971	5	114	25	114	25	not readable, please format [APECS Group Review, Germany]	We have updated the figure for legibility
10283	5	114	25	114	26	labes/texts of Figure 5.19 better be enlarged for better readability [Jinsoon Park, Republic of Korea]	We have updated the figure for legibility
21747	5	114	25	114	26	Labes/texts of Figure 5.19 better be enlarged for better readability [Government of Republic of Korea, Republic of Korea]	We have updated the figure for legibility
31721	5	114	26	0		Figure 5.19. You could make better use of space by distributing the columns through the full horizontal space available - this may even allow you to place the upper labels in an horizontal way. [Hans-Otto Poertner and WGII TSU, Germany]	This is a good idea. We have increased the size of the figure.
31723	5	114	26	0		Figure 5.19. Color for the SDGs labels is not necessary and competes for attention to the already challenging color scheme in the pie diagrams. Perhaps it is best to avoid color in these labels, also try fitting them Horizontally and for all labels, try to increase the letter size. [Hans-Otto Poertner and WGII TSU, Germany]	We have made this figure more legible, but we have not lost the colour scheme to counter a drab report

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
14491	5	114	26	114	28	Figure 5.19 - the text is unreadable and it is not clear what the pie charts are actually showing and what datasets these are based upon. I did not find this figure useful. [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	We have updated the figure caption so that the figure is more understandable
21035	5	114	27	114	27	This figure is really hard to read, the text is blurry when zooming in. I appreciate the detail, but it is a bit overwhelming and difficult to follow. Also, the negative shades of red are difficult to discern. I can't tell the what the middle shade is on the pie charts. [APECS Group Review, Germany]	We have updated this figure for legibility
23259	5	115	0	115		I would suggest to focus on blue carbon. For carbon dioxide removal (weathering, fertilization etc) this has to be dealt with care and coherency with SR15 to be checked. We decided not to call this climate geoengineering but distinguish SRM and CDR. SR15 box could be called here (in SR15 chapter 4). Why show something currently not allowed (London protocol) as part of action options in Figure 5.20? Remove things not relevant for SROCC from Figure 5.21. [Valerie Masson-Delmotte, France]	To be taken into account. However, most text (= focus) is on blue carbon, and some closely-related comparisons would seem necessary. In particular, ocean fertilization can be included in broad definition of BC, and London Protocol doesn't completely prohibit but sets out approval procedures for further research.
25361	5	115	1	122	57	5.4.3 Coastal Oceans are presented first while in the rest of the document they appear after Open Ocean. So, I would suggest to be consistent through all document. [Chiara Lombardi, Italy]	There's a reason for the switch, in that climate-related interactions are primarily open ocean, whilst management responses are primarily coastal. But could be coastal before open ocean throughout?
16427	5	115	5	122	56	While the assessment of blue carbon is much more nuanced in the SOD, it has to be stressed that it is paramount for the IPCC not to be policy-prescriptive. Please ensure a neutral discussion of blue carbon sequestration potential. [Alexander Nauels, Germany]	Noted
33989	5	115	9	115	11	Article 4.1 of the Paris Agreement articulates an "aim" but not a "requirement." The sentence should be rephrased to read "Article 4.1 of the Paris Agreement states an aim to 'achieve a balance between anthropogenic emissions by sources and removals by sinks of greenhouse gases in the second half of this century'." [Government of United States of America, United States of America]	Accepted
7797	5	115	11	0		Suggest removal of "dangerous" to make the text more neutral [Nina Hunter, South Africa]	Dangerous' is UNFCCC wording
7799	5	115	13	0		Should "Article 2.1" not be in parentheses? [Nina Hunter, South Africa]	Accepted that edit is necessary
14493	5	115	13	115	14	Please clarify that it is detailed assessment of marine renewables harnessed from physical processes and add example - its not clear what physical processes means in this context - wave, wind, tidal energy? [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	Accepted

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
21071	5	115	14	115	16	<p>It is stated "(...) near-total emission reductions are therefore needed in (...) and for all greenhouse gases (Myhre et al 2013)". Total greenhouse gases are mentioned but the rest of the 5.5.1 section does not discuss any other Greenhouse gases exeption made of CO2 (brief comment only). Please consider taking this out or including a bit more information on other greenhouse gases and the ocean's role on their mitigation. Methane is a good and relevant example and, although perhaps with low confidence, information may be available from recent studies (Dean et al 2018, Maher et al 2018) that suggest a role of the ocean and caves (Webster et al 2018) in mitigation.</p> <p>References</p> <p>Dean, J. F., Middelburg, J. J., Röckmann, T., Aerts, R., Blauw, L. G., Egger, M., ... & Slomp, C. P. (2018). Methane feedbacks to the global climate system in a warmer world. Reviews of Geophysics.</p> <p>Maher, D. T., Call, M., Santos, I. R., & Sanders, C. J. (2018). Beyond burial: lateral exchange is a significant atmospheric carbon sink in mangrove forests. Biology letters, 14(7), 20180200.</p> <p>Webster, K. D., Drobniak, A., Etiope, G., Mastalerz, M., Sauer, P. E., & Schimmelmann, A. (2018). Subterranean karst environments as a global sink for atmospheric methane. Earth and Planetary Science Letters, 485, 9-18. [APECS Group Review, Germany]</p>	To be taken into account. However, most text (= focus) is on blue carbon, and some closely-related comparisons would seem necessary. In particular, ocean fertilization can be included in broad definition of BC, and London Protocol doesn't completely prohibit - instead it sets out approval procedures for further research.
7801	5	115	18	0		Suggest insert "A" before "Detailed assessment" [Nina Hunter, South Africa]	No longer applicable as a result of other edits made
14495	5	115	18	115	18	Please explain at this point what negative emissions means (rather than later in line 33) [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	Term explained on first use (now later in section)
8685	5	115	18	115	23	it maybe consider dis reference :Saeed Jahanbakhsh,Masoom Edalatdoost,2010,Lake Urmia is a classic indicator of the relationship between solar spills and climate in northwestern Iran, Fourth Regional Climate Change Conference,IRAN, [Government of Iran, Iran]	Reference checked, but not considered relevant here
5085	5	115	29	115	29	The inclusion of the open ocean for carbon uptake has implications for ocean acidification [Debra Roberts and Durban Team, South Africa]	Effects on ocean acidification in open ocean are (briefly) mentioned later. Note that OA effects are technique-specific, and also water depth specific. Would require significant expansion of text to fully include in assessment.
14497	5	115	29	115	29	Some context with regards to what 0.1 to 0.2 GT C 'means' would be useful (i.e. is this a small amount compared to fluxes for other parts of the earth system?) [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	It is expected that the reader would have some knowledge of scales involved. However, greater detail given later in comparison to anthropogenic emissions.
7803	5	115	33	0		Suggest insert "the" before "IPCC" [Nina Hunter, South Africa]	No longer applicable as a result of other edits made

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
16983	5	115	38	115	44	See also Krause-Jensen and Duarte (2016). In their rough estimate, they suggest that macroalgae could sequester about 173 TgC yr ⁻¹ (with a range of 61–268 TgC yr ⁻¹) globally, which exceeds that for carbon sequestered in angiosperm-based coastal habitats. [173 Tg = 0.173 Gt]. [Hege Gundersen, Norway]	Reference now included
16985	5	115	40	115	40	Macroalgae seems to be less amenable to restoration efforts, than other types of “blue forests”, but one should not disregard the effect of managing existing human drivers such as the reduction of eutrophication (Macreadie et al. 2017). doi:10.1002/fee.1484 [Hege Gundersen, Norway]	Macreadie reference included - and importance of nutrient delivery noted subsequently
7805	5	115	41	0		Suggest change "enhancing" to "enhance" [Nina Hunter, South Africa]	No longer applicable as a result of other edits made
3669	5	115	41	115	41	insert "2019" after the citation of "Kuwae and Hori" [Tomohiro Kuwae, Japan]	Accepted
11697	5	115	42	115	44	Adding a second decimal to this value would be more precise (e.g. 0.07-0.17 GtC y ⁻¹ based on the two references). You can also use the value of 0.04 Gt C y ⁻¹ from Taillardat et al. (2018). [Pierre Taillardat, Canada]	Accepted
11699	5	115	42	115	44	In this paper (Taillardat et al. 2018) the authors also compared the global carbon stored from blue carbon with the total anthropogenic emissions. It turns out that Blue Carbon was mitigation 0.42% of the global fossil fuel emissions in 2014. This approach was even more meaningful when applied at the national scale (following the NDC recommended from the Paris Agreement). For example mangrove blue carbon sequestration was mitigating >1% of the national fossil fuel emissions for countries with large mangrove surface area and low deforestation rate such as Nigeria (top 40th fossil fuel emitter), Colombia (43rd), Bangladesh, (45th), Ecuador (62nd) and Cuba (70th). Taillardat P, Friess DA, Lupascu M. Mangrove blue carbon strategies for climate change mitigation are most effective at the national scale. Biology Letters 2018; 14.for a more recent and up to date estimate of carbon burial in blue carbon ecosystems. [Pierre Taillardat, Canada]	Accepted: additional information included

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
11701	5	115	42	115	44	Carbon burial from blue carbon ecosystem could even be greater than presently assumed as >50% of the carbon produced by its vegetation is actually exported to coastal water as dissolved inorganic carbon. This is an emerging field of research but some studies have clearly suggested this pathway to account for an additional sink from blue carbon. (1) Santos IR, Maher DT, Larkin R, Webb JR, Sanders CJ. Carbon outwelling and outgassing vs. burial in an estuarine tidal creek surrounded by mangrove and saltmarsh wetlands. Limnology and Oceanography 2018. (2) Sippo JZ, Maher DT, Tait DR, Ruiz-Halpern S, Sanders CJ, Santos IR. Mangrove outwelling is a significant source of oceanic exchangeable organic carbon. Limnology and Oceanography Letters 2017; 2: 1-8.(3) Maher DT, Call M, Santos IR, Sanders CJ. Beyond burial: lateral exchange is a significant atmospheric carbon sink in mangrove forests. Biology letters 2018; 14: 20180200. [Pierre Taillardat, Canada]	Additional information (and references) now included
14499	5	115	43	115	43	Please define 'euphotic' [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	Term no longer used here
21073	5	115	46	115	48	The biological pump and the microbial carbon pump are properly defined in one sentence. However, the Physical pump is mentioned without description. A brief sentence defining it may be useful for non-scientific readers (unless it is described for a first time elsewhere in the document). [APECS Group Review, Germany]	Physical pump no longer mentioned
10055	5	115	46	115	55	This discussion is misleading - how much of the export flux actually goes into long-term storage? [Tommy Moore, United States of America]	Additional information on longterm storage now included
14501	5	115	49	115	49	Figure 5.20 is not referenced in the text - please reference or remove. [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	This figure has now been removed
23963	5	115	49	115	50	Estimates of the export flux are described here for the biological pump and microbial pump, but not for the physical pump. Estimate for the physical pump would also need to be mentioned here. Otherwise, the reader might wonder why it is excluded. [Government of Japan, Japan]	Physical pump no longer mentioned
9803	5	116	0	0		Internal waters are missing: see art. 7 of the United Nations Convention in the Law of the Sea. [Government of France, France]	Internal waters not considered as part of the ocean for this report

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
23261	5	116	0	117		I would suggest to focus on blue carbon. For carbon dioxide removal (weathering, fertilization etc) this has to be dealt with care and coherency with SR15 to be checked. We decided not to call this climate geoengineering but distinguish SRM and CDR. SR15 box could be called here (in SR15 chapter 4). Why show something currently not allowed (London protocol) as part of action options in Figure 5.20? Remove things not relevant for SROCC from Figure 5.21. [Valerie Masson-Delmotte, France]	More focus now on blue carbon and natural solutions; coherence with SR1.5 has been checked. Governance constraints on ocean fertilization now made clear (R&D is now regulated, not prohibited)
31725	5	116	1	0		Figure 5.20. Color for the fonts may be worked to better distinguish their differences. [Hans-Otto Poertner and WGII TSU, Germany]	This figure no longer included
11839	5	116	1	116	1	Cloud seeding the high seas has also been proposed. [William Lorenz, Australia]	Not in scope (and this figure is no longer included)
21075	5	116	1	116	8	The colors of the Figure's text are very confusing due to the colors of the figure itself (text in Pale green and pale brown). I would suggest changing the colors of the text. [APECS Group Review, Germany]	This figure is no longer included
21115	5	116	1	116	8	The legend could be improved. Usually legends are self-explanatory and in this case, if the reader has a conceptual gap, the figure could be difficult to understand [APECS Group Review, Germany]	This figure is no longer included
4929	5	116	2	0		Figure 5.20 the pale green and pale red fonts are too pale and difficult to distinguish. [Debra Roberts and Durban Team, South Africa]	This figure is no longer included
14503	5	116	2	116	2	This is a massive range, what would the end user do with this kind of information? Might be better to leave this out as such high uncertainty might not be conducive to promoting action. Better to focus on the more general messages described in the following paragraphs, which provide the main take home messages [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	Not clear which 'massive range' is referred to here
23965	5	117	0	117	0	In the Figure 5.21, for most of the columns for "Constrains", darker colors indicate something undesirable. For the rightmost column of "Governability", however, the darker colors indicate something desirable, which makes the interpretation of this figure quite confusing. Perhaps, "Governability" could be replaced with something like "Risk of failure in governance" together with the color usage being flipped. [Government of Japan, Japan]	Accepted. 'Governability' now changed to 'governability challenges' (with high score undesirable)
4931	5	117	0	0		Figure 5.21 This is a very good illustration. The wording is a bit confusing. Are 'dis-benefits' the same as 'trade-offs'? Consider using usual wording? Is "Impact reduction" the same as "Adaptation"? II "Cost for warming mitigation" the same as "Carbon footprint"? Wording on X-axis could be reduced, e.g. "Mitigation: warming Mitigation: ocean acidification Mitigation: sea level rise" [Debra Roberts and Durban Team, South Africa]	Edits made to clarify terms used in this figure (including trade-offs instead of disbenefits). Also extra information in Supplementary material.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
16581	5	117	0	117		The color scale of figure 5.21 is not suited for daltonians. Please modify the scale avoiding red/green contrast. Also, the colors in this figure do not provide any supplementary information as the figure is already sorted into the categories "benefits" and "disbenefits". All the information is contained in the contrast [Jens Rassmann, Belgium]	Accepted. Colour scale changed
31727	5	117	1	0		Figure 5.21. Consider a better placement of the labels for the color-scale legends - perhaps putting the numbers below the red scale and above the "very low/high" will make it more clear that the scoring is equal for benefits and constraints. [Hans-Otto Poertner and WGII TSU, Germany]	Edits made to improve clarity of this figure (with finalising to be made by TSU graphics support)
10285	5	117	1	117	1	Figure 5.21 : higher resolution would be preferable [Jinsoo Park, Republic of Korea]	Edits made to improve clarity of this figure (with finalising to be made by TSU graphics support)
21117	5	117	1	117	1	The shapes in the figure are quite difficult to understand. Moreover I think that the shapes are to big and do not fit very well. [APECS Group Review, Germany]	Edits made to improve clarity of this figure (with finalising to be made by TSU graphics support)
21749	5	117	1	117	1	Figure 5.21 : higher resolution would be preferable [Government of Republic of Korea, Republic of Korea]	Edits made to improve clarity of this figure (with finalising to be made by TSU graphics support)
31913	5	117	14	122	56	Why is here now first a subsection on coastal ocean and then a subsection on open ocean when before the order was always reverse? [Hans-Otto Poertner and WGII TSU, Germany]	The coastal ocean is the more important for blue carbon and other mitigation approaches. A switch of order was considered, but would have had other implications.
10057	5	118	11	118	15	For a carbon sink to be considered a mitigation approach it is not enough to establish inventories - you need to demonstrate that the sink has been enhanced beyond what it was previously doing. This should be stated as part of this sentence. [Tommy Moore, United States of America]	Accepted. That point is now emphasised earlier on.
29883	5	118	16	118	16	Krause-Jensen et al. 2018 (Sequestration of macroalgal carbon: The elephant in the Blue Carbon room) would also be a relevant reference to add here. [Dorte Krause-Jensen, Denmark]	Reference cited
29885	5	118	20	118	20	I think Nellemann et al 2009 is a central references to be added to the introducing line. [Dorte Krause-Jensen, Denmark]	Reference cited
9805	5	118	20	119	2	Is Shelf sea corresponding to the Continental Shelf? This term is not accurate from a legal perspective. If yes, is the Continantal Shelf the only one to be impacted? [Government of France, France]	Shelf sea is the same as continental shelf, usually defined on basis of depth. Legal boundaries are determined by different criteria (see Glossary entry for 'coastal seas')
29887	5	118	27	118	27	Please mention that seaweeds also represent a blue carbon habitat but that because it is of a different character it is treated in a separate section. [Dorte Krause-Jensen, Denmark]	Accepted: suggested edit made

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
3737	5	118	32	118	33	<p>There are more recent estimates of mangrove habitat extent that are observation-based than Giri et al. 2011. Giri et al. estimates of mangrove extent are for 2000. Bunting et al. 2018 provides estimates for 2010 and Hamilton and Casey 2016 provide estimates for 2012. These two more recent studies, however, differ in their estimates of the extent of mangroves with Bunting et al. 2018 estimating 167,387 km² and Hamilton and Casey 2016 estimating 81,849 km². The large difference in these estimates are not the result of mangrove deforestation between 2010 and 2012, but rather the methodologies used to determine mangrove cover (although both are observation-based).</p> <p>Hamilton and Casey 2016. Global Ecology and Biogeography https://doi.org/10.1111/geb.12449 Bunting et al. 2018. Remote Sensing https://doi.org/10.3390/rs10101669 [Trisha Atwood, United States of America]</p>	Additional references are welcomed. However, re-structuring of text has resulted in loss of discussion of areal extent of habitats.
14505	5	118	40	118	41	<p>Is this straying into discussion on policy and recommendations? [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]</p>	Edits made to avoid this problem
3739	5	118	45	118	46	<p>The statement that vegetated marine habitats store more carbon per unit area is not accurate. In the top 1 m of soil, tropical forests and boreal forests store 242 Mg C ha⁻¹ and 239 Mg C ha⁻¹, respectively (Pan et al. 2011). As a result, carbon stocks per unit area for forests are higher than salt marsh (140 Mg C ha⁻¹), similar to seagrass (240 Mg C ha⁻¹) and slightly below mangroves (280 Mg C ha⁻¹). This statement is also not accurate from a total carbon storage point of view, as forests alone store a total 383 GtC in the top 1 meter compared to 5-6Gt C in vegetated coastal ecosystems.</p> <p>Vegetated coastal ecosystems do, however, have substantially greater (nearly an order of magnitude greater) mean long-term rates of C sequestration per unit area compared to terrestrial forests, making them comparable to terrestrial forests in terms of their contribution to long-term C sequestration (McLeod et al. 2011)</p> <p>Pan et al. 2011. Science DOI:10.1126/science.1201609 McLeod et al. 2011. Frontiers in Ecology and the Environment. doi:10.1890/110004 [Trisha Atwood, United States of America]</p>	Additional information and references are appreciated. However, single values for C content considered unhelpful because of their very wide range - now discussed in greater detail

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
11703	5	118	45	118	46	Figure 1 in the paper from Taillardat et al 2018 could provide relevant information for this sentence. Taillardat P, Friess DA, Lupascu M. Mangrove blue carbon strategies for climate change mitigation are most effective at the national scale. Biology Letters 2018; 14. for a more recent and up to date estimate of carbon burial in blue carbon ecosystems. [Pierre Taillardat, Canada]	Information from Taillardat et al (2018) now included
21119	5	118	45	118	46	Talking about carbon fluxes, would the term "uptake rates" be more appropriate? [APECS Group Review, Germany]	Accepted; "uptake rates" now used
15833	5	118	45	118	49	Please add values (or ranges) of carbon storage per unit, for recognised blue carbon ecosystems (mangroves, salt marshes, seagrass), as the only data shown on this refers to mangroves. Clear data needs should also be highlighted. [EUCE, Belgium]	Additional discussion now included on this issue
21133	5	118	53	119	3	The paragraph briefly provides examples of ways wetlands assist climate adaptation, and ends with the conclusion of "blue carbon protection has multiple co-benefits through supporting biodiversity and wide range of ecosystem services". The link and reasoning between "biodiversity and wide range of ecosystem services" with the examples provided are unclear given the "high confidence" [APECS Group Review, Germany]	Additional discussion now included on this issue (also covered in other sections)
3743	5	119	9	119	11	As written, it seems like the % annual habitat loss reflects the range across habitats and locations, rather than just being a range of averages for all habitats combine. If this range is suppose to reflect both the variability in both habitat and location, it does not accurately reflect the variability in locations. For example, there are several countries with large mangrove holdings (e.g., Bangladesh) that have had no net loss in mangrove area (Hamilton and Casey 2016). If this sentence meant to discuss just the countries where mangroves have been lost, there are several countries with as low of rates as 0.01% mangrove loss. Hamilton and Casey 2016. Global Ecology and Biogeography https://doi.org/10.1111/geb.12449 [Trisha Atwood, United States of America]	Accepted. Text edits made to clarify.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
23967	5	119	20	119	26	<p>It is correct that some countries mentioned coastal wetlands in terms mitigation in its INDCs, but it should also be noted that no countries specify quantifiable GHG emissions reduction target of coastal wetlands in their INDCs at this moment. If this important information is not included in this Chapter, it could provoke a misreading of the current progress of coastal wetlands.</p> <p>In addition, the result of Gallo et al. 2017 analysis (mentioned here and in Figure 5.14) could be questionable for some countries, as this study is based on manuscript method. For instance, "fisheries" which is one of the key words used in this study, is sometimes only mentioned in terms of the name of the ministry and not in relevance to mitigation actions themselves. [Government of Japan, Japan]</p>	Noted. Edits made to reflect concerns raised.
15695	5	119	31	119	47	<p>This needs to be thoroughly checked. The references do not include the information that they are purported to include. The Jickels paper does not include information on wetland loss. The Miteva paper is about terrestrial forests in Indonesia. The Duarte 2017 paper is about seaweed farming There is a Duarte 2013 paper in Nature Climate Change that is relevant, but that is not mentioned. None of the references cited mention 90% of wetlands being lost. The López-Portillo et al. paper does not say anything about 90 restoration and rehabilitation projects. It is about Water Quality and Mangrove-Derived Tannins in Four Coastal Lagoons from the Gulf of Mexico [EUCE, Belgium]</p>	There was an unfortunate mix-up of references here; now sorted
21081	5	119	36	119	38	<p>The authors mention that salt marsh protection exists in Europe and N. America and give information that 90% of estuarine wetlands have been lost in NE Europe. Is there any number associated to N. America that could be given also here? I think some numbers can be obtained from: Deegan, Linda A., et al. "Coastal eutrophication as a driver of salt marsh loss." Nature 490.7420 (2012): 388. [APECS Group Review, Germany]</p>	Searches made to find equivalent data for North America, but nothing comparable was found.
7807	5	119	37	0		Suggest write out in full: NE Europe [Nina Hunter, South Africa]	Accepted: edit made
7809	5	119	43	0		Suggest insert "the" before "greatest" [Nina Hunter, South Africa]	Accepted: edit made
21121	5	119	43	119	43	<p>I think that authors could include a statement of confidence at the end of the phrase "Natural regeneration has greatest chance of long term survival" [APECS Group Review, Germany]</p>	Accepted: confidence assessment now included

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
26661	5	119	43	119	43	What is the basis for suggesting that "natural regeneration has the greatest chance of longerm survival", particularly if not part of policy and legal frameworks to ensure the longevity of such regeneration? [Florence Poulain, Italy]	Statement justified by evidence in several of the cited papers
21123	5	119	47	119	47	I think that authors could include a statement of confidence at the end of the paragraph [APECS Group Review, Germany]	Accepted: confidence assessment now included
21135	5	119	49	119	55	"Successful large-scale implementation of the above measures ..." statement is concluded with "high confidence". However, the referenced measures are "uncertain" (line: 52), "unlikely to success (line: 41)" and "too little, too late (line: 37)". Should this conclusion be provided with "level of agreement" as well? [APECS Group Review, Germany]	Edits made to improve consistency here
5087	5	119	54	119	54	Drop "MRV" as acronym is not used anywhere else in the chapter [Debra Roberts and Durban Team, South Africa]	Accepted.
3745	5	119	54	120	4	One of the biggest scientific challenges faced by the blue carbon community that should be incorporated in to this list is the development of a better understanding of the fate of soil organic carbon after a habitat has been disturbed. Without a proper framework for estimating potential CO2 emissions, it is difficult to accurately incorporate vegetated coastal ecosystems into carbon trading and financing programs. Unfortunately, there is little knowledge on how much of the carbon is remineralized to CO2, reburied, or transported when a vegetated coastal habitat has been disturbed. Most current estimates of CO2 emissions from habitat loss/degradation in vegetated coastal ecosystems assume that 100% of the carbon in the top meter is remineralize. However, there is fierce debate about the accuracy of this assumption. There are some analyses that have suggested that less than half (43% for mangroves; Atwood et al. 2017) of the SOC is actually remineralized to CO2 and other studies suggest that the fate of carbon is dependent on the type of disturbance and other factors (Lovelock et al. 2017). Atwood et al. 2017. Nature Climate Change 7:523-528 https://doi.org/10.1038/nclimate3326 Lovelock et al. 2017. Frontiers in Ecology and Evolution https://doi.org/10.1002/fee.1491 [Trisha Atwood, United States of America]	Text re-written

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
14507	5	120	0	120		Seems to be an undue focus on an issue that is highly uncertain and potentially negligible importance - I would remove. Also done see how the two topics (seaweed and shelf sediments) are directly related and belong in the same section [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	Edits made: sections on seaweed and sediment now separated
10059	5	120	6	120	7	Calcification as a source of CO2 emissions has been poorly reviewed and studied, relying on an overly simplistic interpretation of just the inorganic C cycle and CaCO3 formation. In a purely chemical sense CaCO3 formation does lead to an increase in acidification and potentially the release of CO2, as a base (CO32-) is removed, driving the system to be more organic. In the case of calcification by marine organisms, CaCO3 formation is accompanied by primary production. In the case of the coral reefs in American Samoa (one of the few places this has been studied in detail), the rate of calcification would have to be more than 1.5x greater than the rate of primary production (the observed rates were well below 1). CaCO3 minerals are highly stable and represent a very robust long-term sink for CO2. Cement production on the other hand does not co-occur with primary productivity. The statement presented here is overly simplistic and needs to be revised. [Tommy Moore, United States of America]	Edits made (and extra references added) re calcification
3749	5	120	8	120	9	It may be important to note here that an estimated 12-50% of the carbon found in coastal wetland soils can be allochthonous in origin (Kennedy et al. 2010, Reef et al. 2017). Kennedy et al. 2010. Global Biogeochemical Cycles. https://doi.org/10.1029/2010GB003848 Reef et al. 2017 Limnology and Oceanography. https://doi.org/10.1002/lno.10499 [Trisha Atwood, United States of America]	Text re-written
10061	5	120	8	120	9	How much recalcitrant carbon is present? In most cases this a very small number. This statement is misleading in that it does not clearly state the abundance or importance of recalcitrant carbon in coastal systems. [Tommy Moore, United States of America]	There is only one study known that specifically addresses this topic (by Chew & Gallagher); that did find high levels. Thus allowing for black carbon altered C uptake rates by 18% at a temperate site and 43% at a tropical site. Since these results may not be typical, they are not quoted.
3671	5	120	13	120	13	modify the text "if mangroves replace salt marshes (Kelleway et al., 2016)" as "if mangroves replace salt marshes (Kelleway et al., 2016) and seagrass meadows (Watanabe et al., 2019), and add a new citation: Watanabe et al. 2019: Relative sea-level change regulates organic carbon accumulation in coastal habitats Global Change Biology, doi: 10.1111/gcb.14558 [Tomohiro Kuwae, Japan]	Reference checked - it does not cover the topic of mangroves replacing seagrasses

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
11707	5	120	17	120	20	Blue Carbon was mitigation 0.42% of the global fossil fuel emissions in 2014. However, at the national scale mangrove blue carbon sequestration was mitigating >1% of the national fossil fuel emissions for countries with large mangrove surface area and low deforestation rate such as Nigeria (top 40th fossil fuel emitter), Colombia (43rd), Bangladesh, (45th), Ecuador (62nd) and Cuba (70th). Taillardat P, Friess DA, Lupascu M. Mangrove blue carbon strategies for climate change mitigation are most effective at the national scale. Biology Letters 2018; 14. for a more recent and up to date estimate of carbon burial in blue carbon ecosystems. [Pierre Taillardat, Canada]	Edits made to reflect this information
3747	5	120	17	120	31	Although it is true that the maximum global mitigation benefit of vegetated coastal ecosystems is low (largely owing to their small spatial extent), restoration of vegetated coastal habitats actually provides the largest CO2 offset per hectare of habitat restored. Using the information provided in table S1 by Griscom et al. 2017, if you take the "maximum additional mitigation potential" and divide it by the "maximum potential extent of implementation" for both Reforestation and Coastal Wetland Restoration you will see that the restoration of coastal habitats provides a 1.7-2.8 times larger maximum additional mitigation potential per ha compared to forests (Coastal habitats =29.0 Tg CO2 yr-1 ha-1; tropical and subtropical forest=17 Tg CO2 yr-1 ha-1; all forests combine provides= 14.9 Tg CO2 yr-1 ha-1; and Temperate forests= 10.19 Tg CO2 yr-1 ha-1). Additionally, avoiding conversion of coastal habitats avoids the greatest amount of soil C emissions per ha-1 of any habitat (coastal wetlands= 152 Mg C ha-1; grasslands = 18.65 Mg C ha-1; forests = 109.58 Mg C ha-1). As a result, the protection and restoration of coastal wetlands may provide the largest offsets relative to cost, especially in regions that have a large extent of coastal wetlands compare to other habitat types. [Trisha Atwood, United States of America]	Edits made to this section: the desirability of blue carbon habitat restoration is more explicitly recognised.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
1843	5	120	27	120	28	Same as my comment #5 and #10. Investing in blue carbon ecosystems could be a regret if all the main benefits disappear due to these ecosystems' sensitivity to warming. This is even stated on the same page (pg. 120, line 10-11). It is very conflicting information throughout the report and it ignores the fact that management actions should be based on clear goals. CO2 sequestration goals are different from ecosystem/biodiversity protection goals. [Lydia Kapsenberg, Spain]	These uncertainties are recognised. Nevertheless, blue carbon investment could still be 'no regrets' option because of co-benefits
15911	5	120	27	120	31	<p>I am not certain that "no regret" is the best way to qualify blue carbon sequestration. I am also wondering how convinced a policymaker will be about the importance of blue carbon habitats after reading these lines.</p> <p>There are a few arguments that can be used to justify the role of blue carbon:</p> <p>1. Although blue carbon is considered to mitigate 0.42% of the global anthropogenic fossil fuel (FF) emissions, this % can increase if (i) national (FF) emissions are reduced, (ii) blue carbon habitat conversion is stopped, and (iii) blue carbon habitat restoration is developed.</p> <p>Taillardat P, Friess DA, Lupascu M. Mangrove blue carbon strategies for climate change mitigation are most effective at the national scale. Biology Letters 2018; 14.</p> <p>2. Although blue carbon might not be globally important for mitigating global FF emissions, it can play a huge role for some countries with extensive coastlines. Considering that the Paris Agreement is based on NDCs, the potential of blue carbon needs to be assessed at the national scale. If countries like Indonesia, Malaysia or Brazil were to stopped mangrove deforestation, this ecosystem would already offset a few % of their national FF emissions as of today.</p> <p>Taillardat P, Friess DA, Lupascu M. Mangrove blue carbon strategies for climate change mitigation are most effective at the national scale. Biology Letters 2018; 14.</p> <p>3. Preserving and restoring blue carbon habitats is the best way to prevent CO2 re-emissions that occurs during land conversion/degradation. Consequently, blue carbon is a win-win strategy for carbon dioxide removal as it is supposed to cease CO2 emissions from conversion and increase CO2 sequestration from vegetation uptake.</p> <p>Hamilton SE, Friess DA. Global carbon stocks and potential emissions due to mangrove deforestation from 2000 to 2012. Nature Climate Change 2018: 1.</p> <p>4. Recent studies have suggested that carbon sequestration from blue carbon might be underestimated as most of their produced carbon is exported to coastal water via tidal</p>	Additional information included to reflect these points
9807	5	120	33	120	33	Are we talking about the Continental shelf? [Government of France, France]	Shelf sea is the same as continental shelf, usually defined on basis of depth.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
21083	5	120	33	120	43	I would argue against the uncertainty degree given (low confidence) about seaweeds not providing a significant natural contribution in long-term permanent carbon removal. Although it is true that more long-term evidence is needed I would use medium confidence instead based on recent findings and a growing body of literature suggesting that marine macroalgae could be an important long term carbon storage ecosystem (Raven et al 2018) and I would highlight the urgent need for further exploration Reference: Raven, J. (2018). Blue carbon: past, present and future, with emphasis on macroalgae. Biology letters, 14(10), 20180336. [APECS Group Review, Germany]	The low confidence assessment relates to scope for management, to provide climatically-significant mitigation. The literature on seaweed as a blue carbon system considers uptake = sequestration; it does not address the critical issue of decomposition rates and timescale of return to the atmosphere. of coastal ocean is the more important for blue carbon and other mitigation approaches. A switch of order was considered, but would have had other implications.
24637	5	120	33	120	43	The literature cited in this section points to globally important amounts of carbon potentially being stored by seaweed and kelp ecosystems. The low confidence given in the text largely points to due to large uncertainty related to transport and fate due to a lack of data and studies on these issues. The paragraph also calls out for the need of large-scale and multi-year studies. There are no studies referenced in this section that states that there is little potential for long-term storage of carbon in kelp/seaweed. Therefore the summary of this section in the executive summary should focus on the need for more data and studies on the long-term storage of kelp/seaweed carbon, rather than state that there is limited potential in this approach. [frigstad helene, Norway]	The knowledge gaps are now more explicitly stated: they relate to issues that are extremely difficult to quantify. Thus assessment of low confidence/limited potential relates to scope for enhanced productivity to provide well-quantified and climatically-significant mitigation. The literature on seaweed as a blue carbon system considers uptake = sequestration; it does not address the critical issue of decomposition rate when material is transported offshore.
14509	5	120	33	120	57	Define 'labile' [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	"labile" no longer used in text
27633	5	120	34	120	43	There seem to be a bit of contradiction between this paragraph and the sentence on organic carbon buried in marine sediments (page 122, lines 27-28). Surely, if seaweed fragments reach marine sediments and are buried, this carbon will also be removed from circulation. That there is potential for carbon removal through burial of seaweed originating organic material should be made clear in this paragraph. [Government of Norway, Norway]	"Reaching the sediment" is not the same as burial and longterm removal. Most organic material is decomposed (and CO2 returned to bottom waters) within an annual cycle. Whilst high burial rates can occur in river deltas (with high rates of sediment delivery), they are generally not where macroalgae (requiring rocky substrates) occur
11273	5	120	36	120	36	Please also consider work of Filbee-Dexter et al. [Inka Bartsch, Germany]	Search made for this author but references did not seem relevant

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
21085	5	120	36	120	37	Hughes et al 2012 "A framework to assess national level vulnerability from the perspective of food security: The 22 cases of coral reef fisheries" does not seem to address any information regarding RDOC on seaweeds. If this statement is kept, the proper citation needs to be given. [APECS Group Review, Germany]	Referencing error - correct reference should now be given
29889	5	120	39	120	41	Maybe mention that the estimated contribution of seaweeds to carbon sequestration doubles the estimates from all other blue carbon habitats combined (Krause-Jensen & Duarte 2016). Please underline that this is a recent realization and that there is a need for science and management/policy agendas for including macroalgae in the BC paradigm and in BC schemes (Krause-Jensen et al 2018). [Dorte Krause-Jensen, Denmark]	Three issues are now given greater attention in the text: 1) Carbon uptake is not the same as longterm removal (sequestration); 2) mitigation potential depends on scope for management (enhancement); and 3) mitigation also requires reliable measurement of desired benefits.
15901	5	120	45	120	52	The cultivation of seaweeds for the purpose of climate mitigation can only become carbon-negative if the captured cO2 is subsequently sequestered following the conversion of the biomass for energy (biomethane). This could take the form of injection of the carbon into the deep ocean to be held in textile bags on the seafloor as stable clathrates. On the other hand, mono-cultivation of seaweeds is not encouraged. Successful implementation of Integrated Multi-Trophic Aquaculture (IMTA, Chopin et al. 2007) can provide side benefits such as shellfish, finfish and mollusks/holothurians whose net value can be much more than the energy derived from the seaweeds alone, thus not requiring harvesting of the seaweed farm. Such an integrated and self-sustaining system (where the waste products of one species are recycled as nutrient for other species) can have far-reaching socio-economic benefits for the livelihoods of local coastal populations. Reference: Chopin, Thierry et al. (2007). BEYOND THE MONOSPECIFIC APPROACH TO ANIMAL AQUACULTURE — THE LIGHT OF INTEGRATED MULTI-TROPHIC AQUACULTURE. In Theresa M. Bert (ed.), Ecological and Genetic Implications of Aquaculture Activities, 447–458. Springer Publisher. [Antoine De Ramon N'Yeurt, Fiji]	Point noted re negative emissions. IMTA issues are of interest, but do not directly relate to climate mitigation

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
10063	5	120	45	120	56	N'Yuert et als estimate of 9% was intended as an academic exercise only. In addition to the concerns raised in the paragraph, the scale of what would be needed is unfeasible - 9% of the global ocean is ~32.5 mil km2, which is more than 3x the land area of the United States. As was noted in a previous comment, while it is nice to discuss geoengineering options, it is highly irresponsible of the IPCC and the UNFCCC to entertain these ideas without a firmer ground in reality. Doing so has and will continue to delay meaningful action. At the least this paragraph needs some discussion the feasibility of trying to doing something of this sort at scale. [Tommy Moore, United States of America]	Mention of 9% no longer included in text. It was, however, not intended to provide a desirable goal.
27635	5	120	45	120	56	A recent paper on seaweed (kelp) cultivation potential hints at a great potential for offshore kelp cultivation, both on the shelf and off the shelf: Broch, O.J. et al. 2019: The kelp cultivation potential in coastal and offhsore regions of Norway. Fron. Mar. Sci.. doi: 10.3389/fmars.2018.00529 [Government of Norway, Norway]	Broch et al paper checked: it does not seem directly relevant to climate mitigation.
15835	5	120	45	121	11	The report considers the possible impact of growing algae for biofuel but not the potential impact of replacing land-based feed sources with macroalgae. Walsh et al. (Carbon Balance Manage (2015) 10:26 - DOI 10.1186/s13021-015-0040-7) consider the potential impact of microalgae but similar arguments could be used for macroalgae. [EUCE, Belgium]	Walsh et alpaper checked. It is of interest, but does not seem directly relevant here.
21087	5	120	47	120	49	Hughes et al 2012 "A framework to assess national level vulnerability from the perspective of food security: The 22 case of coral reef fisheries" does not seem to address any information regarding Carbon capture, storage information on seaweeds. If this statement is used, the proper citation needs to be given. [APECS Group Review, Germany]	Referencing error - correct reference should now be given
26663	5	120	52	120	52	Is this ocean-based seaweed culture or coastal culture that occurs in areas of dergratde (and not regenerated) coastal habitat? [Florence Poulain, Italy]	Seaweed culture in coastal areas is much more feasible than in open ocean
9809	5	121	12	121	12	Considering the current interest in alkalization, this section should be much more comprehensive. [Government of France, France]	Scoping guidance was to focus on biologically-based mitigation (blue carbon)
16583	5	121	12	121	31	What are the risks associated to these techniques? [Jens Rassmann, Belgium]	Additional text now added
7811	5	121	31	0		Suggest replace "scope for" with "the scope of" [Nina Hunter, South Africa]	Accepted: edit made
21089	5	121	33	121	33	Refractory dissolved organic Carbon RDOC definition should be incorporated in Annex I: Glossary [APECS Group Review, Germany]	Definition included in glossary

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
27637	5	121	33	122	13	The management conclusions from 5.5.1.1.5 should be reflected in the Executive summary of chapter 5 as well as the SPM [Government of Norway, Norway]	The Executive Summary and SPM must necessarily focus on issues considered to be of highest importance, with potential for quantifiable mitigation benefits. Whilst reduction in nutrients is expected to increase RDOC production (and hence carbon retention in the ocean), the scale of this effect - and hence mitigation potential - has not yet been quantified.
27639	5	121	34	121	44	Regarding seaweed aquaculture in eutrophic waters, there is evidence that large scale seaweed aquaculture may mitigate coastal eutrophication (Xiao X. et al. 2017, Nutrient removal from Chinese coastal waters by large-scale seaweed aquaculture. Sci. Rep 7, 46613. doi:10.1038/srep46613.). Hence, seaweed aquaculture may potentially play a double role in shelf areas: i) by taking up CO2 and contributing to CO2 drawdown directly through released particulate and dissolved organic carbon and ii) by reducing eutrophication, and hence contribution to increasing "natural" CO2 drawdown. [Government of Norway, Norway]	Reference checked; of general interest to seaweed aquaculture, but not directly relevant to climate mitigation
21091	5	121	40	122	13	Not an expert on this but: The paragraph suggests that higher nutrient = eutrophication and therefore systems may also act as carbon sources. When author says that a reduction in nutrient input will produce a higher proportion of RDOC the term RDOC may be confused with DOC by non-scientific readers if it is not properly defined. When reading Jiao et al 2014b, the main conclusion is that additional nutrient input would result in a reduction of sequestration efficiency and therefore an increment in RDOC availability. Would a reduction in nutrient input not lead to an increment in sequestration efficiency and therefore a reduced RDOC?. Later in the reference it is clearer when checking figure 4 of the cited paper, the role of RDOC as a product of fixation but is not clear from the text of this report. I only highlight how confusing the text may be to audience if proper RDOC definition is not given within the text and glossary. This will also help to better understand the conclusion of this section in line 6 and 7 page 122. I highlight the need of a complete revision to section 5.5.1.1.5 to clarify the relationship between eutrophication, MP efficiency, RDOC and carbon sequestration. Especially since RDOC term is used later in the chapter. [APECS Group Review, Germany]	Definitions of DOC and RDOC now included in glossary. Whilst a reduction in nutrients is expected to increase RDOC, the scale of that effect (and hence its potential for climate mitigation) has yet to be quantified.
21125	5	121	41	121	42	If there is a well supported statistical evidence we could assume from the papers cited that there will be high confidence. As the text points there is a high agreement from laboratory and field experiments. [APECS Group Review, Germany]	There is high confidence that nutrient levels can affect coastal primary production and associated DOC/RDOC production, and this is recognised in the text. The potential use of this technique for quantifiable climate mitigation is much more uncertain.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
7813	5	121	46	0		Suggest change "pronote" to "promote" [Nina Hunter, South Africa]	Accepted: edit made
14511	5	121	50	121	50	Sections 5.5.1.1.3 - 5.5.1.1.5 - could be cut down drastically and put in a table - would help clearly identify the key issues given the lack of clear conclusions in the current paragraphs [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	Edits made to present main issues more clearly.
7817	5	121	53	0		Suggest change "concentration" to "concentrations" [Nina Hunter, South Africa]	Accepted: edit made
7819	5	121	55	0		Suggest change "quantity" to "quantities" [Nina Hunter, South Africa]	Accepted: edit made
23263	5	122	0	122		what are undesirable climate consequences? Please place the London Protocol upwards before dealing with this sensitive topic. [Valerie Masson-Delmotte, France]	Edits made; governance issues mentioned earlier
10065	5	122	6	122	13	I fail to see how long-ocean eco-engineering is a mitigation approach. This is not enhancing natural carbon stocks, it is minimizing nutrient pollutions and eutrophication. The only way this could be considered a mitigation approach is under the assumption that the current levels of pollution represent a natural base-line, which isn't true. This paragraph should be removed. [Tommy Moore, United States of America]	The potential for mitigation arises from interactions between nutrient levels and DOC/RDOC production (that might remove carbon from circulation for long periods). The overall assessment of "low confidence" reflects uncertainties in the dynamics of these processes, and how climatic benefits can be reliably quantified.
15903	5	122	6	122	13	Dependency on imported chemical fertilisers has very negative impacts on coastal ecosystems of SIDS, in relation to the Ridge-to-Reef concept where land runoffs uphill eventually wash down to the ocean via river catchments, fertilising the coastal areas leading to eutrophication, algal blooms and reduction in fish and other marine resources. In a bid to improve food security while reducing the amount of chemicals entering the coastal waters, N'Yeurt & Iese (2015) advocate that local island communities implement the use of community-produced seaweed fertilisers as agricultural supplements. This has immediate benefits in clearing excess algal biomass from coastal areas, reducing expenses linked to purchasing chemical fertilisers, decreasing coastal nutrient inputs and improving food security through more productive and disease and pest-resistant crops. Reference: N'Yeurt, A.D.R. & Iese, V. 2015. Marine plants as a sustainable source of agrifertilizers for Small Island Developing States (SIDS). In: Wayne G. Ganpat & Wendy-Ann Isaac, Eds, Impacts of Climate Change on Food Security in Small Island Developing States. IGI Global, Hershey, Pennsylvania, pp. 280-311 (ISBN: 978-1-4666-6501-9). [Antoine De Ramon N'Yeurt, Fiji]	Interesting information - but not directly relevant to climate mitigation
17213	5	122	6	122	6	Space needed between "counter measure" [Shalini Singh, Fiji]	Accepted; edit made
26665	5	122	7	122	8	Is land-ocean integrated management and engineering linked or otherwise related to the concept of source to sea approaches? [Florence Poulain, Italy]	There may be linkages, but they do not seem to have been explicitly made by the authors who have developed the land-sea integrated eco-engineering approach

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
7821	5	122	9	0		Suggest change "the river" to "rivers"; change "N, P" to "N and P" [Nina Hunter, South Africa]	Accepted: edit made
7823	5	122	10	0		Suggest change "benefits of protect" to "benefit of protecting" [Nina Hunter, South Africa]	Accepted: edit made
7825	5	122	12	0		Suggest insert "a" before "reward-based" [Nina Hunter, South Africa]	Accepted: edit made
7827	5	122	13	0		Suggest remove "being" [Nina Hunter, South Africa]	Accepted: edit made
10067	5	122	15	0		For all mitigation discussions it should first be explicitly stated that our first/primary approach should be to reduce emissions, CCS should only be a secondary consideration. Also, see my prior comments regarding the promotion of untested/unfeasible geo-engineering approaches - if presented there should be explicit discussion on how it could be scaled up, state of the technology, etc. Overstating the viability of these approaches has led to inactivity within the UNFCCC process and over-reliance on theoretical technologies/approaches in NDCs. [Tommy Moore, United States of America]	Care has been taken to address these issues - with identification of constraints and uncertainties related to sink-enhancement approaches.
9811	5	122	17	122	17	Should be mentioned that considerable geographic heterogeneity exists in carbon export. With respect to blue carbon, which states would benefit most by including oceanic carbon export into their carbon budgets? Furthermore, attempts to boost carbon export by ocean fertilization are likely to have different effects in these different kinds of zones. Finally, since much of the open ocean is in BBNJ, are the UN gearing up to manage it effectively? [Government of France, France]	Geographical heterogeneity is now more explicitly recognised in many sections.
22747	5	122	17	122	56	This section lacks information on potential adverse impacts of chemical enhancement of CO2 uptake including ecological and oceans physical functioning. Currently it is focused mainly on whether or not it would work from a climate perspective, with only brief mention of the 'potentially-adverse impacts'. Williamson & Bodle (2016) assessed impacts of geoengineering on biodiversity and authors could draw upon other potential adverse implications from this study. [Greenpeace Group Review, Republic of Korea]	Only a summary assessment is given here of open ocean CO2 removal techniques. Nevertheless, key constraints are identified, and references cited for further details.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
27641	5	122	18	122	36	There is possibly a great potential for seaweed cultivation also in the open ocean (Broch, O.J. et al. 2019: The kelp cultivation potential in coastal and offshore regions of Norway. Fron. Mar. Sci.. doi: 10.3389/fmars.2018.00529). Seaweeds generally have a higher CNP-ratio than the marine environment (Atkinson, M.J. and Smith, S.V 1983, C:N:P ratios of benthic marine plants. Limnol Oceanogr 28:568-574), indicating a greater potential for CO2 sequestration per unit N or P than phytoplankton [Government of Norway, Norway]	Issues relating to seaweed cultivation are of interest, but only of limited applicability to climate mitigation.
27643	5	122	27	122	28	There seem to be a bit of contradiction between this sentence and the paragraph on seaweed carbon removal (page 120, lines 34-43). Surely, if seaweed fragments reach marine sediments and are buried, this carbon will also be removed from circulation. [Government of Norway, Norway]	As noted in response to earlier comment, "reaching the sediment" is not the same as longterm removal. Most organic matter at the sediment surface is decomposed within an annual cycle.
21093	5	122	35	122	36	What other undesirable consequences? A "such as.." may be appropriate. [APECS Group Review, Germany]	Extra detail added
21127	5	122	36	122	36	Would it be appropriate to include a confidence statement here (high confidence)? [APECS Group Review, Germany]	It is not clear from this comment which statement warrants 'high confidence'
9813	5	122	38	122	38	Should be mentioned that the number of large scale iron fertilization manipulations that have been done is too small and that the moratorium has effectively hindered knowledge generation. [Government of France, France]	There are many scientists who would support this opinion; however, experiments can still be carried out.
16617	5	122	38	122	51	Perhaps it is best left out of such a report, but the theoretical potential of fertilization to store C, even if studies do not show a long-term C storage, has also resulted in at least one large scale privately funded ocean fertilization and attempts at more. Considering international regulation prohibiting activities like this private ocean fertilization, something like this could be included as an environmental challenge as C storage strategies (and potential financial benefits for storing carbon) gain importance. See Tollefson, 2017 (doi:10.1038/545393a) [David Janssen, Switzerland]	The governance problems associated with open-ocean manipulations are noted (but not discussed in detail).
22749	5	122	41	122	43	Suggestion to delete "greatly" from '.... have shown that primary production can be greatly enhanced by..'. Of those 13 studies, some showed significant increases in primary productivity, other much less so. Use of the word 'greatly' could give a different impression. [Greenpeace Group Review, Republic of Korea]	Revised wording: "can be, but is not always, greatly enhanced..."
10287	5	122	44	122	44	Iron fertilisation --> Iron fertilization [Jinsoo Park, Republic of Korea]	Accepted: edit made
21751	5	122	44	122	44	Iron fertilisation --> Iron fertilization [Government of Republic of Korea, Republic of Korea]	Accepted: edit made

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
26667	5	122	49	122	51	This sentence is fundamental and should be moved/inserted into line 44 and, specifically, before the sentence about "Iron fertilization implemented on..." [Florence Poulain, Italy]	Edits made to give greater emphasis to regulatory issues
4209	5	122	53	122	53	Possibly add phosphate (e.g., nitrate and phosphate) [Carles Pelejero, Spain]	Phosphate is globally limited in abundance; it would not seemmbe either sustainable or cost-effective to use it to fertilize the ocean
26669	5	122	55	122	56	Suggest linking this to the pillars of sustainable development so it reads: "monitoring of potential adverse social, environmental and social impacts, and...." [Florence Poulain, Italy]	This is considered in the broader context of the chapter, and in 5.4.2.
14513	5	123	0	123		Given the strong focus on coastal adaptation I would reframe this as 'coastal and ocean based adaptation' - currently the sub-heading is misleading [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	Accepted. Section title simplified to include whole ocean (including deep ocean).
14515	5	123	1	123	1	Please clarify that this in the context of coastal and marine environments (after '....and human system') [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	Accepted. Text edited to reflect this.
26521	5	123	3	123	8	This paragraph is about coastal adaptation, rather than ocean-based adaptation (Section title). [Florence Poulain, Italy]	Accepted. Section title simplified to include whole ocean (including deep ocean).
26671	5	123	4	123	4	Did the review address "coastal protection" or coastal conservation? The latter is far more politically acceptable and, thus, plausible and possible. [Florence Poulain, Italy]	Accepted. Text edited to reflect adaptation focus.
26523	5	123	4	123	5	I would suggest to mention, like Wong et al. (2014) that coastal protection activities also include innovative approaches, e.g. "working with nature", rather than dykes and structures. I think this is important in a chapter on marine ecosystems. [Florence Poulain, Italy]	Taken into account. Text edited to include EBA.
26525	5	123	5	123	6	The sentence starting with "Although an assessment..." is not clear. What Wong et al. (2014) say is that: there is high agreement on adaptation principles, but no systematic review of, and hence limited evidence on, why a given principle or approach is effective in a specific context (and not in another). [Florence Poulain, Italy]	Accepted. Text edited to clarify Wong et al.
26527	5	123	8	123	8	Wong et al (2014) do not say that adaptation activities remain "aspirational". On the contrary, there is a wealth of coastal adaptation activities (please mention that this paragraph speaks of coastal adaptations). What remains aspirational, according to Wong et al (2014), is meeting the multiple goals of planned adaptation, improving governance, accounting for the most vulnerable, and integrating natural ecosystems. [Florence Poulain, Italy]	Accepted. Text edited to clarify Wong et al.
7829	5	123	10	0		Suggest change "response" to "responses" [Nina Hunter, South Africa]	Accepted. Plural used.

SROCC Second Order Draft Government and Expert Review Compiled Comments - Chapter 5							
Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
26529	5	123	18	123	19	Observation: FAO (report 2018) groups adaptation actions into three categories: institutional and management responses; strengthening and diversifying people's livelihoods; and risk reduction and management for resilience. These categories are not mutually exclusive (more in chapter 25 by Poulain, Himes-Cornel, Shelton. 2018. Methods and tools for climate change adaptation in fisheries and aquaculture in FAO report (2018)) [Florence Poulain, Italy]	Taken into account. The classification of adaptation actions here are reviewed and aligned to be consistent with the framing of adaptation in Chapter 1.
26531	5	123	20	123	22	"Section 5.5.2 avoids, where possible, focussed discussion of response to sea level rise and extreme events" - Note that section 5.5.2 opening paragraph (p123 - lines 3 to 8) discusses coastal protection activities, which is mainly a response to sea level rise and extreme events. [Florence Poulain, Italy]	Accepted. Protection replaced with adaptation for clarity.
26533	5	123	25	123	26	How did you come up with the proposed classification? [Florence Poulain, Italy]	Taken into account. The classification of adaptation actions here were reviewed and aligned to be consistent with the framing of adaptation in Chapter 1.
26535	5	123	37	123	38	Mention the new FAO report (2018) on Impacts of climate change on fisheries and aquaculture: synthesis of current knowledge, adaptation and mitigation options [Florence Poulain, Italy]	Accepted. FAO 2019 is referenced in the fisheries adation section of 5.5.2
26537	5	123	38	123	40	You may want to specify that the approach (to measure vulnerability) taken by the cited papers is mainly quantitative, based on models and/or indicators, rather than qualitative. [Florence Poulain, Italy]	Accepted. Text edited to refer to quantitative nature of assessments.
26539	5	124	5	124	11	In my opinion a key research gap is how to translate vulnerability assessments into decisions. See for instance Wilby, R.L., Dessai, S. 2010. Robust adaptation to climate change. Weather, 65 (7) (2010), pp.180-185 [Florence Poulain, Italy]	Taken into account.
26541	5	124	7	124	11	Amongst the growing literature on decision-making support tools for adaptation to climate change, you may want to mention low regret / win-win approaches (as developed for example by Grafton (2010), Bell et al. (2011), Watkiss (2014), Poulain et al. (2018)). Exact citations as follows: Bell, J.D., Johnson, J.E. & Hobday, A.J., eds. 2011. Vulnerability of tropical Pacific fisheries and aquaculture to climate change. Noumea, Secretariat of the Pacific Community, 925 pp.; Grafton, Q.R. 2010. Adaptation to climate change in marine capture fisheries. Marine Policy, 34: 606–615; Poulain et al in FAO 2018 report; Watkiss, P. 2014. Early value-for-money adaptation: delivering VfM adaptation using iterative frameworks and low-regret options. London, DFID. (also available at www.vfmadaptation.com). [Florence Poulain, Italy]	Accepted. Text in EBA assessment section edited to reflect this.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
9815	5	124	16	124	22	It would be useful to mention that important lessons could be learned on the social aspects from the land REDD+ projects, which have been implemented over the past decade. [Government of France, France]	Accepted. Text edited to include social learning outcomes from participatory processes for adaptation planning.
21129	5	124	20	124	20	The paper Osorio-Cano et al., in press has now been published. Please change to Osorio-Cano et al., 2017 [APECS Group Review, Germany]	Accepted. Reference updated.
22555	5	125	1	125	9	<p>Suggest this section increase the use of literature, case studies and citations to strengthen the arguments.</p> <p>Adaptation efforts differ between developing and established economies due to prior historic investment in coastal protection structures, established investment in coastal development and assets that are difficult to modify. Developing economies typically have lower levels of built environment, lower costs, less coastal protection structures and degraded natural ecosystems that limit protection (for example, cleared mangroves). This can exacerbate the effects of storm events and tsunamis, making communities more willing to cooperate and undertake nature-based approaches. Adaptation effort is actually very difficult to implement in established economies as it is very expensive, political and more complex from a legal and planning perspective. [Government of Australia, Australia]</p>	Accepted. Text edited and further citations included to improve assessment.
7831	5	125	6	125	8	Please insert a reference for this sentence [Nina Hunter, South Africa]	Accepted. Sentence edited and two citations added.
21141	5	125	6	125	9	The sentence starting with "Positive responses ..." may require a reference. [APECS Group Review, Germany]	Accepted. Sentence edited and two citations added.
26543	5	125	12	125	12	Note that maladaptation can also originate from inaction, from governance decisions (policies that deliver short term economic gains but lead to greater vulnerability, subsidies), from cross sectoral competition, etc. (Poulain et al in FAO 2018 report) [Florence Poulain, Italy]	Accepted. Text edited and suggested citation included.
21095	5	125	13	125	15	A high confidence is given to the need of effective coordination and substantial increase in effort to close the gap in adaptation planning but, it is only based on a regional publication (Wise et al 2016). Further literature should be cited to sustain that level of confidence. [APECS Group Review, Germany]	Accepted. Confidence statement is changed to medium, and this is supported in Table 5.8.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
26545	5	125	24	125	25	I don't feel comfortable with the choice of categories. There are only a few examples of nature-based adaptation and built environment, whereas socio-institutional solutions are a huge field. You may want to re-think your categories. For an overview of existing categories as developed in the literature, see: Biagini, B., Bierbaum, R., Stults, M., Dobardzic, S. & McNeeley, S.M. 2014. A typology of adaptation actions: a global look at climate adaptation actions financed through the Global Environment Facility. Global Environmental Change, 25: 97–108. (also available at https://doi.org/10.1016/j.gloenvcha.2014.01.003). More recently: Poulain et al (2018) in FAO report (2018) [Florence Poulain, Italy]	Accepted. The classification of adaptation actions here were reviewed and aligned to be consistent with the framing of adaptation in Chapter 1.
7833	5	125	26	0		Suggest insert "the" before "recent" [Nina Hunter, South Africa]	Taken into account. Text edited.
26547	5	125	26	125	26	Why coastal adaptations only? This section should cover (all) ocean adaptations, as per its title [Florence Poulain, Italy]	Accepted. Adaptation in the deep sea is discussed in the fisheries section. The dominance of coastal adaptation is a mirror of the adaptation literature.
11275	5	125	32	125	32	Table format again - difficult to read [Inka Bartsch, Germany]	Accepted. Table was reformatted.
14517	5	125	32	125	32	It would be helpful if this signposted what habitats will be considered in this section [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	Taken into account. Reformatted Table leads with ecosystems assessed in the first row.
1845	5	125	32	125	35	For biophysical drivers for "Mangroves, coastal wetlands, seagrass beds, and saltmarshes", shouldn't "ocean warming" or "heat waves" be included on the list of drivers? [Lydia Kapsenberg, Spain]	Accepted. Table was reformatted and these drivers are dealt with.
26673	5	125	32	127	1	The table item in the first column regarding "Fisheries" mixes hazards of reduced landing and revenues which are features of fisheries management with climate hazards. [Florence Poulain, Italy]	Accepted. Table was reformatted and clarified.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
21097	5	125	32	127	3	<p>Acidification should be added into column "Biophysical drivers" also under FISHERIES (Denman et al 2011, Cooley and Doney (2009), and under AQUACULTURE (Clements & Chopin 2017, Richards et al 2015, this report 5.4.2.2.1).</p> <p>References:</p> <p>Denman, K., Christian, J. R., Steiner, N., Pörtner, H. O., & Nojiri, Y. (2011). Potential impacts of future ocean acidification on marine ecosystems and fisheries: current knowledge and recommendations for future research. ICES Journal of Marine Science, 68(6), 1019-1029.</p> <p>Cooley, S. R., & Doney, S. C. (2009). Anticipating ocean acidification's economic consequences for commercial fisheries. Environmental Research Letters, 4(2), 024007.</p> <p>Richards, R. G., Davidson, A. T., Meynecke, J. O., Beattie, K., Hernaman, V., Lynam, T., & van Putten, I. E. (2015). Effects and mitigations of ocean acidification on wild and aquaculture scallop and prawn fisheries in Queensland, Australia. Fisheries research, 161, 42-56.</p> <p>Clements, J. C., & Chopin, T. (2017). Ocean acidification and marine aquaculture in North America: potential impacts and mitigation strategies. Reviews in Aquaculture, 9(4), 326-341. [APECS Group Review, Germany]</p>	Accepted. Table was reformatted and clarified.
7835	5	125	34	0		Suggest change "services" to "service" [Nina Hunter, South Africa]	Accepted. Table heading revised.
21131	5	125	35	127	1	<p>In the Ecosystems/Human systems Species. Would it be appropriate to include here the role of invasive species (due to changing climate) in impacting the foraging succes and affecting the complex ecological interactions? See De Santana, C. N., Rozenfeld, A. F., Marquet, P. A., & Duarte, C. M. (2013). Topological properties of polar food webs. Marine Ecology Progress Series, 474, 15-26. doi:10.3354/meps10073 [APECS Group Review, Germany]</p>	Taken into account. This was discussed in Chapter meetings with disagreement as to whether this is a climate change issue. Alien invasive species are included in the assessment in Table 5.7.
26549	5	126	0	127	1	<p>For climate change impacts on fisheries and aquaculture, refer to FAO report (2018) [Florence Poulain, Italy]</p>	Taken into account.
14519	5	127	5	127	15	<p>Very strong emphasis on coral reefs and virtually no mention of seagrass or saltmarsh - there should be a better balance with regards to habitats being discussed [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]</p>	A balanced treatment across ecosystem types are now provided.
14521	5	127	5	131	5	<p>Suggest that cold water coral get some mention here too, especially given vulnerability to OA in high latitudes [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]</p>	Very little in known on adaptability of deep reefs
7837	5	127	14	0		Suggest change "response" to "responses" [Nina Hunter, South Africa]	Text edited

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
10753	5	127	17	0		It should be made clear that adaptation on its own (without highly effective mitigation) has little scope to decrease risks. [Jean-Pierre Gattuso, France]	We can not see how mitigation to global change impacts is effective. Clearly, adaptation cannot be efficient with 'business as usual', but we should also face adaptation under such a scenario
11329	5	127	17	127	17	A relevant recent paper for this section is: Bay, R.A., N.H. Rose, C.A. Logan, and S.R. Palumbi. 2017. Genomic models predict successful coral adaptation if future ocean warming rates are reduced. Science Advances 3:e1701413. [L. Scott Mills, United States of America]	The reference was added
14523	5	127	17	127	17	Please define epigenics [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	There is no space for defining here epigenetics, a common term in biology.
11841	5	127	17	127	22	Microfragmentation is newest and quickest way for coral reef restoration. [William Lorenz, Australia]	Agree, but this methodology is only one aspect of coral reef restoration.
26551	5	127	24	129	23	Observation: the coral reefs adaptation section is very detailed, compared to the 5.5.2.2.2 (mangroves), 5.5.2.2.3 (Ecosystem based adaptation), 5.5.2.2.4 on Species adaptation [Florence Poulain, Italy]	Correct, but this is a fast moving field that has not yet been covered in IPCC reports.
7839	5	127	36	0		Suggest replace "to handle" with "of" [Nina Hunter, South Africa]	Accepted
10755	5	127	37	0		In several places, it seems that literature selection is unbalanced. Perhaps more diversity in authors would be needed. [Jean-Pierre Gattuso, France]	Some changes were made. Please also note that these are the most current publications
7841	5	127	39	0		Suggest change "focusing" to "focus" [Nina Hunter, South Africa]	Accepted
7843	5	128	1	0		Suggest insert "the" before "Southeast" [Nina Hunter, South Africa]	Accepted
21137	5	128	6	128	12	The paragraph mainly informs us of adaptive approaches focusing on new techniques. The last sentence seems out of place and it's not relevant to reef restoration and fails to mention that the speed of climate change often doesn't allow for natural genetic adaptation. [APECS Group Review, Germany]	The text was revised accordingly
21099	5	128	10	128	12	Sentence needs revision: remove "for": (...) possess the molecular machinery that helps compensate the effects of global change such as ocean acidification. [APECS Group Review, Germany]	The sentence was deleted and its content was refereed to earlier text
21971	5	128	29	130	10	Material in this box seems a little repetitive of that in the text [David Schoeman, Australia]	The figure and the text were revised
828	5	128	46	0		I have a problem with the language here. What does 'most tested reef restoration approach mean'? this seems to imply that the technology can get to a meaningful scale when in fact everything points in the other direction right now. [Ove Ove Hoegh-Guldberg, Australia]	The text was revised
848	5	128	46	128	46	I have a problem with the language here. What does 'most tested reef restoration approach mean'? this seems to imply that the technology can get to a meaningful scale when in fact everything points in the other direction right now. [Ove Ove Hoegh-Guldberg, Australia]	Text was revised

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
9817	5	128	46	129	2	Coral Gardening is still hypothetical and has a very limited impact. Futhermore, we do not know that much on this method. We do not need to write so much on this subject. [Government of France, France]	The gardening approach has been tested and studied in various reef sites worldwide and was found as one of the most promising approaches. As this is the first time the whole concept of reef restoration is discussed in an IPCC report, there is a need to add more about this discipline. It is further stressed from the Australian governmental point of view for reef restoration (the investment of 100 million A\$ during 2018) and NOAA approach for reef restoration.
830	5	128	47	0		Given the coral reefs have potentially a million species living on them, the hundred thousand colonies from 90 coral species doesn't sound like scalability has been achieved. And, generally, I think that the authors should settle on the evidence which suggests that coral gardening can help extremely local levels hundreds of metres but is not a solution to reefs at a global scale. [Ove Ove Hoegh-Guldberg, Australia]	The text was revised accordingly
850	5	128	47	128	47	Given the coral reefs have potentially a million species living on them, the hundred thousand colonies from 90 coral species doesn't sound like scalability has been achieved. And, generally, I think that the authors should settle on the evidence which suggests that coral gardening can help extremely local levels hundreds of metres but is not a solution to reefs at a global scale. [Ove Ove Hoegh-Guldberg, Australia]	The text was revised accordingly
832	5	128	53	0		The authors might want to consider the arguments of various authors for the combination of restoration technologies being combined with the identification of least vulnerable coral populations - the idea that the problem of successively worsening climates wiping out coral gardens as temperatures increase is minimised while the same time, restoration is built into a more strategic plan for recovery of reefs generally. Two papers of interest here are: Beyer, H. L., E. V. Kennedy, M. Beger, C. A. Chen, J. E. Cinner, E. S. Darling, C. M. Eakin, R. D. Gates, S. F. Heron, and N. Knowlton. (2018). Risk-sensitive planning for conserving coral reefs under rapid climate change. Conservation Letters:e12587. Hoegh-Guldberg, O., E. V. Kennedy, H. L. Beyer, C. McClennen, and H. P. Possingham. (2018). Securing a Long-term Future for Coral Reefs. Trends in Ecology & Evolution. (Paper: 2438; 1-9 pp) [Ove Ove Hoegh-Guldberg, Australia]	As this is the first time where an IPCC report deals with reef restoration, and there is no space for detailing additional aspects of reef management or restoration in the eyes of management, primarily when the text should be further minimized due to length restrictions.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
852	5	128	53	128	53	<p>The authors might want to consider the arguments of various authors for the combination of restoration technologies being combined with the identification of least vulnerable coral populations - the idea that the problem of successively worsening climates wiping out coral gardens as temperatures increase is minimised while the same time, restoration is built into a more strategic plan for recovery of reefs generally. Two papers of interest here are:</p> <p>Beyer, H. L., E. V. Kennedy, M. Beger, C. A. Chen, J. E. Cinner, E. S. Darling, C. M. Eakin, R. D. Gates, S. F. Heron, and N. Knowlton. (2018). Risk-sensitive planning for conserving coral reefs under rapid climate change. Conservation Letters:e12587.</p> <p>Hoegh-Guldberg, O., E. V. Kennedy, H. L. Beyer, C. McClennen, and H. P. Possingham. (2018). Securing a Long-term Future for Coral Reefs. Trends in Ecology & Evolution. (Paper: 2438; 1-9 pp) [Ove Ove Hoegh-Guldberg, Australia]</p>	As this is the first time where an IPCC report deals with reef restoration, and there is no space for detailing additional aspects of reef management or restoration in the eyes of management, primarily when the text should be further minimized due to length restrictions.
23265	5	129	0	129		<p>Missing outcome of assessment of potential (confidence, level of sc understanding...). [Valerie Masson-Delmotte, France]</p>	The figure and the text were revised
11705	5	129	3	120	5	<p>What is the meaning of "significant" here ? CH4 and soil carbon efflux were estimated to offset only <5% of the mangrove carbon burial in Santos et al. (2018) and and ~6% of the mangrove carbon burial in Maher et al. (2018). I would suggest replace "significant" by these numbers. (1) Santos IR, Maher DT, Larkin R, Webb JR, Sanders CJ. Carbon outwelling and outgassing vs. burial in an estuarine tidal creek surrounded by mangrove and saltmarsh wetlands. Limnology and Oceanography 2018.</p> <p>(3) Maher DT, Call M, Santos IR, Sanders CJ. Beyond burial: lateral exchange is a significant atmospheric carbon sink in mangrove forests. Biology letters 2018; 14: 20180200. [Pierre Taillardat, Canada]</p>	Taken into account
834	5	129	4	0		<p>There is a 3rd challenge which needs to be in sized. this is that coral gardening will not work as long as the climate is changing. This is a major conclusion of 1.5°C report. It needs to be discussed - the fact that planting a coral garden will only last as long as the temperature is below the threshold. There is no literature that shows that coral gardening is any role in a changing climate for preserving coral stocks. [Ove Ove Hoegh-Guldberg, Australia]</p>	It is not that 'planting a coral garden will only last as long as the temperature is below the threshold' as the coral gardening aims at the development of methodologies. In the future, transplants will be those corals that can stand the impacts of new environmental conditions

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
854	5	129	4	129	4	There is a 3rd challenge which needs to be in sized. this is that coral gardening will not work as long as the climate is changing. This is a major conclusion of 1.5°C report. It needs to be discussed - the fact that planting a coral garden will only last as long as the temperature is below the threshold. There is no literature that shows that coral gardening is any role in a changing climate for preserving coral stocks. [Ove Ove Hoegh-Guldberg, Australia]	It is not that 'planting a coral garden will only last as long as the temperature is below the threshold' as the coral gardening aims at the development of methodologies. In the future, transplants will be those corals that can stand the impacts of new environmental conditions
836	5	129	11	0		I am concerned that this implies that coral reef restoration has the ability to restore reefs at the global scale. As the authors have admitted, there is only been hundred thousand colonies from 90 species successfully restored. given the scale of the problem - potentially 375,000 km² of coral reef that would need to be replaced globally - these approaches only have value at the very local level. Also I think the text needs to reflect the costs - there are a number of papers on to the very large costs involved in Marine coastal restoration, particularly coral reefs. To be accurate, it needs to reflect more of the discussion on the other side which is not so hopeful (e.g. Bayraktarov et al 2016). [Ove Ove Hoegh-Guldberg, Australia]	It is specifically noted in the text that: the scaling up issue, the viability of this approach as a large-scale restoration measure at the level of hundreds of thousands/6 millions of coral colonies/site', is a challenge. Clearly, we are not at the stage where we can restore all reefs , however, the aim of the Australian restoration team is to create and transplant 33 million corals. This is a real 'jump' in reef restoration.
856	5	129	11	129	11	I am concerned that this implies that coral reef restoration has the ability to restore reefs at the global scale. As the authors have admitted, there is only been hundred thousand colonies from 90 species successfully restored. given the scale of the problem - potentially 375,000 km² of coral reef that would need to be replaced globally - these approaches only have value at the very local level. Also I think the text needs to reflect the costs - there are a number of papers on to the very large costs involved in Marine coastal restoration, particularly coral reefs. To be accurate, it needs to reflect more of the discussion on the other side which is not so hopeful (e.g. Bayraktarov et al 2016). [Ove Ove Hoegh-Guldberg, Australia]	It is specifically noted in the text that: the scaling up issue, the viability of this approach as a large-scale restoration measure at the level of hundreds of thousands/6 millions of coral colonies/site', is a challenge. Clearly, we are not at the stage where we can restore all reefs , however, the aim of the Australian restoration team is to create and transplant 33 million corals. This is a real 'jump' in reef restoration.
15693	5	129	14	129	23	This paragraph needs revision [EUCE, Belgium]	The text was revised
838	5	129	15	0		Again, this is a rather loose statement which does not address the fact that the scale is huge. For example, one is driven to ask how the authors came to the conclusion that coral with gardening had the capacity to enhance the adaptability of coral reef organisms to climate change. Again, the problem of scale has not been addressed and is potentially misleading at this point to those people who don't work on coral reefs. [Ove Ove Hoegh-Guldberg, Australia]	The text was revised

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
858	5	129	15	129	15	Again, this is a rather loose statement which does not address the fact that the scale is huge. For example, one is driven to ask how the authors came to the conclusion that coral with gardening had the capacity to enhance the adaptability of coral reef organisms to climate change. Again, the problem of scale has not been addressed and is potentially misleading at this point to those people who don't work on coral reefs. [Ove Ove Hoegh-Guldberg, Australia]	The text was revised
7845	5	129	16	0		This sentence does not make sense as it stands. Is "and the climate change" meant to be part of the sentence?; also suggest change "corals" to "coral" [Nina Hunter, South Africa]	The text was revised
7847	5	129	17	0		Suggest use "altogether" to start a new sentence, that is separate the sentence from line 15 to 18 into two parts. [Nina Hunter, South Africa]	The text was revised
7849	5	129	22	0		Suggest start a new sentence from "the latter" [Nina Hunter, South Africa]	The text was revised
7851	5	129	23	0		Suggest remove "for" [Nina Hunter, South Africa]	Accepted
31915	5	129	25	130	10	Suggest to redraw this figure with support from a graphics designer [Hans-Otto Poertner and WGII TSU, Germany]	Accepted
31729	5	129	26	0		Box 5.4, Figure 1. Consider the option of removing distractive elements such as the halfmoon decorations around the circles. [Hans-Otto Poertner and WGII TSU, Germany]	Accepted
3461	5	129	26	129	26	Can this figure be simplified? It is so full that the 3 images are almost obscured. [Patrick Orenstein, United States of America]	The figure was improved
7853	5	129	29	0		Suggest remove either "versus" or "and" - cannot leave as it stands [Nina Hunter, South Africa]	Accepted
10757	5	129	29	0		It is not clear what the two scenarios are. [Jean-Pierre Gattuso, France]	The text was revised
33991	5	129	29	129	29	There's one extraneous word here in caption, which is either "versus" or "and". Either could be deleted, though suspect "versus" is the word to delete. [Government of United States of America, United States of America]	Accepted
7855	5	130	4	0		Suggest change "transplantation" to plural [Nina Hunter, South Africa]	Text edited
21101	5	130	15	130	15	Like in the title of 5.5.2.2.1 "Adaptation in coral reef" , I would add here the word "adaptation" as well, "Adaptation in mangrove and other coastal ecosystems" [APECS Group Review, Germany]	Accepted. Section title edited to reflect this.
10759	5	130	18	0		This is partly misleading and not consistent with text earlier in the chapter which mentions that the scope for mitigation is limited. [Jean-Pierre Gattuso, France]	Accepted. Text edited to reflect the limited nature of mitigation co-benefits.
7857	5	130	19	0		Suggest change "examples" to "example" [Nina Hunter, South Africa]	Accepted. Text edited.
26675	5	130	32	130	40	Curiously, although poor governance processes as a fundamental component, once mentioned the topic is dropped and only community participation addressed -- not only in this paragraph but also in the lines 42 to 58. Why? [Florence Poulain, Italy]	Taken into account. Governance processes are dealt with in the governance categories in Table 5.8, and in the text where assessments were appropriate.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
21103	5	130	49	130	51	Costal dune systems maybe the lesser known coastal ecosystems within those discussed throughout the section (and also the services then render) when it comes to public knowledge. As it was done for mangroves (lines 16-17) would it be possible to add a short sentence introducing the ecosystem services provided by Costal dunes? [APECS Group Review, Germany]	Accepted. Text edited to reflect their value in protecting from erosion and flooding in this paragraph.
7859	5	130	55	0		Suggest change "measures" to "measure" [Nina Hunter, South Africa]	Taken into account. This text was suitably edited.
7861	5	131	4	0		Suggest changing "engineered" to "engineering"?; change "are considered complementary approaches" to "is considered a complementary approach" [Nina Hunter, South Africa]	Taken into account. This text was suitably edited.
26553	5	131	8	131	17	There is an imbalance in the 5.5.2.2 Nature-based adaptation sections - This section on EBA is not well documented, compared to 5.5.2.2.1 on coral reefs for example. Additional references could include: Ogier, E.M., Davidson, J., Fidelman, P., Haward, M., Hobday, A.J., Holbrook, N., Hoshino, E. & Pecl, G.T. 2016. Fisheries management approaches as platforms for climate change adaptation: comparing theory and practice in Australian fisheries. Marine Policy, 71: 82–93. (also available at https://doi.org/10.1016/j.marpol.2016.05.014); FAO. 2003. Fisheries management. 2. The ecosystem approach to fisheries. FAO Technical Guidelines for Responsible Fisheries 4, Suppl. 2. Rome. 112 pp. (also available at http://www.fao.org/3/a-y4470e.pdf); FAO. 2010. Aquaculture development. 4. Ecosystem approach to aquaculture. FAO Technical Guidelines for Responsible Fisheries No. 5, Suppl. 4. Rome. 53 pp. (also available at http://www.fao.org/docrep/013/i1750e/i1750e.pdf); [Florence Poulain, Italy]	Accepted. The review of ecosystems was broadened and is summarised in Table 5.7, using only peer-reviewed literature published since AR5.
14525	5	131	8	131	8	This is context not a concluding statement, suggest this is moved to the start of 5.5.2.2.3 [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	Accepted. Text was edited to reflect the context-providing nature of this opening sentence for the assessment.
21105	5	131	15	131	16	"(...) made more effective by incorporating traditional practices (...)". Traditional practices such as...? What is meant by traditional practices? This may have been described elsewhere in the document in which case it is fine but if it hasn't it would be a good idea to briefly describe traditional practices. [APECS Group Review, Germany]	Accepted. Text is edited for clarity - Indigenous Knowledge and cultural practices
26555	5	131	20	131	20	"this approach is strengthened when combied with socio-institutional approaches" : would you agree that this is true for mangroves and coral reefs restoration too? [Florence Poulain, Italy]	Taken into account. Yes, the application of synergistic adaptation responses is supported in the literature.
21139	5	131	21	131	23	Sentence starting with "As important ..." is unnecessarily long and complex. Consider rephrasing. [APECS Group Review, Germany]	Accepted. This text has been revised and simplified.

SROCC Second Order Draft Government and Expert Review Compiled Comments - Chapter 5							
Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
7863	5	131	22	0		Suggest change "is" to "are" [Nina Hunter, South Africa]	Taken into account. Text edited.
7865	5	131	27	0		Suggest remove "the" before "inclusion" [Nina Hunter, South Africa]	Taken into account. Text edited.
14527	5	131	35	131	43	This would be better represented in a summary table, listed according to each variable. Current text is laborious and the narrative doesn't flow. A visual infographic would be even better for the end user. [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	Accepted. This has been done through Table 5.7.
26557	5	131	36	131	36	EBA is not only about coastal protection. In the fisheries sector, it is a management approach cf. FAO (2003 and 2010) (above cited) [Florence Poulain, Italy]	Accepted. "protection" was replaced with a more relevant term throughout the text where appropriate.
26799	5	131	37	131	37	Replace "Management" with "protection" or "restoration" or "conservation", as ecosystems cannot be managed. Human activities that exploit natural resources or ecosystems can be managed, but not the ecosystems themselves [Tarub Bahri, Italy]	Accepted. Text was edited as appropriate.
7867	5	131	41	0		Suggest change "natural" to "nature" [Nina Hunter, South Africa]	Taken into account. Text was edited as appropriate
7869	5	131	42	0		Suggest replace "besides" with "apart from" [Nina Hunter, South Africa]	Taken into account. Text was edited as appropriate
7871	5	131	46	0		Suggest replace "review" with "reviewed" [Nina Hunter, South Africa]	Taken into account. Text was edited as appropriate
7873	5	131	52	0		Suggest remove "that" [Nina Hunter, South Africa]	Accepted. Text edited as suggested.
26559	5	131	54	131	56	Another useful reference for understanding climate change impacts of species is: Hare, J.A., Morrison, W.E., Nelson, M.W., Stachura, M.M., Teeters, E.J., Griffis, R.B., Alexander, M.A., Scott, J.D., Alade, L., Bell, R.J., Chute, A.S., Curti, K.L., Curtis, T.H., and Griswold, C.A. 2016. A vulnerability assessment of fish and invertebrates to climate change on the Northeast UK continental shelf. PLoS ONE, 11: e0146756. [Florence Poulain, Italy]	Taken into account.
23267	5	132	0	135		Check carefully what belongs to SROCC and what goes way beyond and overlaps with AR6 WGII for sectors. Aspects here are connected to chapter 6, changes in rainfall patterns, not sure that this is relevant for SROCC to assess adaptation of built infrastructure in an ocean chapter. What is specific for e.g. shipping infrastructure adaptation? Tourism adaptation? Health adaptation? [Valerie Masson-Delmotte, France]	Taken into account. This text was deleted.
26801	5	132	2	132	3	"human management of ecosystems for climate change": unclear expression that implies that there is a non-human management. See above comment on "management of ecosystems" [Tarub Bahri, Italy]	Accepted. This text was edited.

SROCC Second Order Draft Government and Expert Review Compiled Comments - Chapter 5							
Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
26803	5	132	2	132	8	"traditional species management practices" is not clear. Along the same line than the comments above on ecosystems management, the same applies to species management. I am not sure whether the text refers to exploited species only or to conservation as well. In fisheries, the dedicated terminology for single species fisheries management would be "target resource oriented management" or "conventional management". It seems tha the idea here is to recommend broadening management to multispecies and include ecosystem considerations, but the formulation is a bit confusing [Tarub Bahri, Italy]	Accepted. Text was replaced with historical conservation practices
21113	5	132	5	132	6	The NOAA report cited (Whitfield et al 2016) does not cover the topic of alien invasive species nor adaptation of species and therefore is not related to the sentence in question. Different litterature should be cited. [APECS Group Review, Germany]	Accepted. Different literature was cited
26561	5	132	11	132	11	Section 5.5.2.3 is about risk reduction and resilience. Built environment/physical infrastrcture is one of the approaches/tools under this higher level category that is risk reduction and resilience buiding. Other approaches include: risk transfer strategies, early warning, etc. [Florence Poulain, Italy]	Taken into account. This section was reviewed with the adaptation summary included in the human systems section in Table 5.8
26563	5	132	16	132	18	Uncertainty and maladaption should be treated across all three categories of adaptation, not only 5.5.2.3 [Florence Poulain, Italy]	Accepted. This has been reviewed in the revised framing of adaptaiton
7875	5	132	25	0		Suggest change "effect" to "effects" as there will be more than one effect [Nina Hunter, South Africa]	Taken into acocunt. This text has been edited.
7877	5	132	29	0		Suggest change "response is" to "responses are" [Nina Hunter, South Africa]	Taken into acocunt. This text has been edited.
21143	5	132	36	132	43	The section on wave events appears to give details from a small number of the available papers with a focus on the Pacific, rather than giving a general overview of global change. [APECS Group Review, Germany]	Taken into account. This text was deleted.
21145	5	132	48	132	49	Wind regime is very location specific and not projected with any level of confidence. The comment seems out of place. [APECS Group Review, Germany]	Taken into account. This text was deleted.
7879	5	133	25	0		Suggest change "ininrastructure" to "infrastructure"; insert "the" before "development" [Nina Hunter, South Africa]	Taken into account. This text was deleted.
7881	5	133	26	0		Suggest insert "the" before "design" [Nina Hunter, South Africa]	Taken into account. This text was deleted.
7883	5	133	40	0		Suggest remove "being made" so that the sentence meaning is clearer [Nina Hunter, South Africa]	Taken into account. This text was deleted.
7885	5	133	51	0		Suggest remove comma and insert colon [Nina Hunter, South Africa]	Taken into account. This text was deleted.
7887	5	133	55	0		Suggest move bracket after "2018" to after "Resilience" [Nina Hunter, South Africa]	Taken into account. This text was deleted.
7889	5	134	2	0		Suggest insert "the" before "perceptions" [Nina Hunter, South Africa]	Taken into account. This text was deleted.
7891	5	134	8	0		Suggest insert "the" before "implementation" [Nina Hunter, South Africa]	Taken into account. This text was deleted.

SROCC Second Order Draft Government and Expert Review Compiled Comments - Chapter 5							
Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
21107	5	134	10	134	18	The paragraph displays a lot of disagreement when it comes to incorporating risk assessment into adaptation planning. Could a level of uncertainty (low perhaps) be added in the text in connection to this? [APECS Group Review, Germany]	Taken into account. This text was deleted.
14529	5	134	12	134	14	There is too much detail on the theory of adaptation in the built environment and lacks direct reference to marine and coastal systems. I would suggest shortening and bringing out relevant marine and coastal examples to guide the reader. [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	Taken into account. This text was deleted.
7893	5	134	25	0		Suggest replace "it often entails" with "often entail" [Nina Hunter, South Africa]	Taken into account. This text was deleted.
21147	5	134	26	134	27	To increase clarity, it would be useful to mention several examples of the negative effects of har engineering on coastal ecosystems. [APECS Group Review, Germany]	Taken into account. This text was deleted.
7895	5	134	31	0		Suggest remove "(see"; remove bracket after "2018" [Nina Hunter, South Africa]	Taken into account. This text was deleted.
7897	5	134	36	0		Is it possible to give a brief definition of "interdependencies" in the built environment? [Nina Hunter, South Africa]	Taken into account. This text was deleted.
21177	5	134	39	134	41	Please provide an example of a cascade from a minor environmental disturbance that results in major infrastructure damage, but does not have climate change related interdependent impacts. . Or perhas the clause of "through a series of non-climate change-related interdependent impacts" just serves to over-compicate the sentence and is not needed. [APECS Group Review, Germany]	Taken into account. This text was deleted.
7899	5	134	44	0		Suggest insert "the" before "understanding" [Nina Hunter, South Africa]	Taken into account. This text was deleted.
7901	5	134	46	0		Suggest insert "be" before "harmonized" [Nina Hunter, South Africa]	Taken into account. This text was deleted.
21149	5	134	51	135	8	This paragraph discusses the different adaptation solutions. Throughour the paragraph different time-scales are mentioned (e.g. medium term time frames; long term horizons). The argument would be stronger if the timelines were defined or at least approximated. For example, does medium term mean 10-15 years? Long term 50 years? [APECS Group Review, Germany]	Taken into account. This text was deleted.
7903	5	134	56	0		Suggest insert "the" before "literature" [Nina Hunter, South Africa]	Taken into account. This text was deleted.
7905	5	135	7	135	8	What is "on-adaptation"? Is it possible to define it? [Nina Hunter, South Africa]	Taken into account. This text was deleted.
21179	5	135	7	135	8	What is "on-adaptation"? This term in not defined. Perhaps this is a typo and the authors meant to say "incremental" or "transforational" adaptation. [APECS Group Review, Germany]	Taken into account. This text was deleted.
7907	5	135	16	0		Suggest change "describes" to "describe" [Nina Hunter, South Africa]	Taken into account. This text was deleted.
14531	5	135	38	135	38	Explain what 'soft engineering' is [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	Taken into account. This text was deleted.

SROCC Second Order Draft Government and Expert Review Compiled Comments - Chapter 5							
Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
13161	5	136	1	0	3	<p>You even imply this in 5-136 (1-3), with this assertion: "emphasising with high confidence the need for individual adaptive capacity and to factor environmental psychology into adaptation planning. This underlies a strong need to assign higher value to intangible initiatives, such as climate education and capacity building." [my bold].</p> <p>You say, 5-140 (4-8) "A critical element to reducing vulnerability to climate change is to educate people that they are core* to the Earth system and have a huge influence on the balance of the system. An important service of marine biodiversity and ecosystems is to support such education (Section 5.4.1). Thus, education can play a pivotal role in how climate change is perceived and experienced" [my bold].</p> <p>[* better to say 'are at the core of the']</p> <p>I could not have said it better! So again my question: why such neglect of CC education in the SROCC? A whole chapter on the topic could easily be justified (you say so yourself - see above quotes), but maybe it is too late now to include an extra chapter - is it?. In which case, a substantial section needs to be included. [David Crookall, France]</p>	Taken into account. This text was deleted.
13153	5	136	1	136	3	<p>It is a gross error of judgment and an abdication of fundamental responsibility and ethical obligation. May I suggest that you connect with the IAPG (International Association for Promoting Geoethics), which will provide keys to understanding the ethical requirement of all geoscientists to support ALL measures to keep this planet habitable for our children and grandchildren. [David Crookall, France]</p>	Taken into account. This text was deleted.
7909	5	136	12	0		Should it not be "his/her" instead of "his"? [Nina Hunter, South Africa]	Taken into account. This text was deleted.
21181	5	136	12	136	12	<p>Please use inclusive language. A "manager" can be any gender. Replace "his" with "their" [APECS Group Review, Germany]</p>	Taken into account. This text was deleted.
5089	5	136	12	136	13	<p>Resource constraints, competing demands, and political considerations (e.g. the potential costs/benefits to the political capital associated with a particular adaptation option) could also influence the decision process. [Debra Roberts and Durban Team, South Africa]</p>	Taken into account. This text was deleted.
7911	5	136	13	0		Suggest insert "the" before "Environmental" [Nina Hunter, South Africa]	Taken into account. This text was deleted.

SROCC Second Order Draft Government and Expert Review Compiled Comments - Chapter 5							
Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
26565	5	136	16	141	53	I feel you're missing a few socio-institutional tools and approaches like: public investments(in research, capacity building, best practices sharing, etc.); legal frameworks (access rights, dispute settlement), etc. which are even more needed in the context of climate change. [Florence Poulain, Italy]	Accepted. The review of human systems adaptation responses was broadened and is summarised in Table 5.8.
26677	5	136	16	141	53	Why is this section on Socio-institutional Adaptation Responses limited to the tourism, fisheries and aquaculture sectors and not other extractive sectors? [Florence Poulain, Italy]	Taken into account. This section has been broadened in Table 5.8. Page limits constrained how broad this assessment could be.
9939	5	136	23	137	20	Community adaptation, understood from bottom up is not fully developed and as it is, it is very weak. In SREX we linked up bottom-up and top down education, where the local diversity knowledge is taken into account. Transmission of knowledge is different among men and women, but in both cases children "learn by doing" specific gendered activities (fishing, cooking, aquaculture), which could be increased with formal education and new tools from internet (early warning in small islands) the capacity of local adaptation and DRR. [Úrsula Oswald Spring, Mexico]	Taken into account. This section was reviewed with the adaptation summary included in the human systems section in Table 5.8
26569	5	136	30	136	33	See also Pateron and Charles (2019) on community-based response to climate hazards (climatic change journal) [Florence Poulain, Italy]	Taken into account
7913	5	136	32	0		Suggest replace "has a greater focus" with "is" [Nina Hunter, South Africa]	Taken into account. The text was edited with this sentence deleted.
26567	5	136	35	136	36	What resources? Financial resources? [Florence Poulain, Italy]	Taken into account. The text was edited with this sentence deleted.
21151	5	136	40	136	43	I really liked the inclusion of a specific example here (Shi Lankan shrimp farmers) but I thought the rest of the sentence was unnecessarily vague. For example, what stressors are present? What type of collective action did the farmers take? Being specific and providing examples will provide the reader with deeper understanding of the issues which are only theoretically described. This is nicely achieved in the following paragraph [APECS Group Review, Germany]	Accepted. The text was edited and this sentence deleted.
7915	5	136	49	0		Separate "awarenessabout" into two [Nina Hunter, South Africa]	Accepted. The text was edited and this sentence deleted.
17101	5	136	49	136	49	Awareness about should be awareness about. The space between two words is missing [Government of United Republic of Tanzania, United Republic of Tanzania]	Accepted. The text was edited and this sentence deleted.
17215	5	136	49	136	49	Space needed between "awareness about" [Shalini Singh, Fiji]	Accepted. The text was edited and this sentence deleted.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
22751	5	137	0	137		General comment on subsection 5.5.2.4.2 Integrated coastal zone management and marine protected areas. The mitigation and adaptation role and potential of marine protected areas and fully protected marine reserves is much underrepresented across the section. Negative examples are provided (para 45-49), which are valid, while not the same weight is given to ample existing literature on the benefits of MPAs and MRs. The role of these tools to increase resilience of marine ecosystems and maintain population structure, particularly of exploited stocks, is not sufficiently highlighted and needs to be more prominent. For instance, Roberts et al., 2017 is quoted in page 142, para 24 to highlight that "further research is required" in relation to MPAs while the paper essentially concludes that "marine reserves are a viable low-tech, cost- effective adaptation strategy that would yield multiple cobenefits from local to global scales". [Greenpeace Group Review, Republic of Korea]	Accepted. This balance has been addressed in the review of this section. ICM and MPAs are dealt with in the fisheries and government adaptation summaries in Table 5.8.
22753	5	137	0	137		General comment on subsection 5.5.2.4.2 Integrated coastal zone management and marine protected areas. The bibliography on marine protected areas misses relevant and well known papers such as: Álvarez-Romero JG, Munguía-Vega A, Beger M. Designing connected marine reserves in the face of global warming. GlobChange Biol. 2017;00(February):1–21; Balmford A, Gravestock P, Hockley N, McClean CJ, Roberts CM. The worldwide costs of marine protected areas. Proc Natl Acad Sci U S A. 2004;101(26):9694–7; 1. Lester SE, Halpern BS, Grorud-Colvert K, Lubchenco J, Ruttenberg BI, Gaines SD, et al. Biological effects within no-take marine reserves: A global synthesis. Mar Ecol Prog Ser. 2009;384:33–46; Sala E, Lubchenco J, Grorud-Colvert K, Novelli C, Roberts C, Sumaila UR. Assessing real progress towards effective ocean protection. Mar Policy [Internet]. Elsevier Ltd; 2018;91(November 2017):11–3. Available from: https://doi.org/10.1016/j.marpol.2018.02.004 ; Edgar GJ, Stuart-Smith RD, Willis TJ, Kininmonth S, Baker SC, Banks S, et al. Global conservation outcomes depend on marine protected areas with five key features. Nature [Internet]. 2014;506(7487):216–20. Available from: http://www.ncbi.nlm.nih.gov/pubmed/24499817 [Greenpeace Group Review, Republic of Korea]	Accepted. Text edited to include suggested peer reviewed literature since AR5.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
30285	5	137	0	139		when looking at adpatation pathways for fisheries, an important aspect to take into consideration is that vulnerability depends in part on sensitivity, which includes education and availability of alternative economic activities, which may fall under the perview of non-fisheries decision makers, i.e. strengthening fisheries adaptation is multi-sectoral in nature and is not limited to fisheries per se. [Charlotte de Fontaubert, United States of America]	Accepted. This view is captured in the Coastal Communities and Fisheries sections in Table 5.8 and in the text.
7917	5	137	2	0		Suggest change "exampes" to "examples"; [Nina Hunter, South Africa]	Accepted. The text was edited and this sentence deleted.
7919	5	137	2	0		Suggest change "support the importance for communities to be served" with "underline the importance of communities being served" [Nina Hunter, South Africa]	Accepted. The text was edited and this sentence deleted.
17217	5	137	2	137	2	Mis-spelled word "exampes" should be "examples" [Shalini Singh, Fiji]	Accepted. The text was edited and this sentence deleted.
5091	5	137	2	137	3	This seems to suggest that the success of CBA is dependent on the enforcement of formal governance structures/processes and ignores the roles of informality in such initiatives [Debra Roberts and Durban Team, South Africa]	Accepted. Text is edited to acknowledge a range of socio-economic challenges that complicate adaptation response.
21153	5	137	5	137	20	Local and indigenous knowledge are important and these can be useful to identify and cope with non-climate stressors as well as a changing climate. Consider combining these two paragraphs to more seamlessly discuss the use of local and indigenous knowlege in developing comprehensive adaptation plans. [APECS Group Review, Germany]	Accepted. The text has been edited as suggested.
7921	5	137	6	0		Suggest change "see the inuitt" to "consider the Inuit" [Nina Hunter, South Africa]	Editorial
26765	5	137	22	0		I agree with the vision of MPAs as an important strategy in adapting to climate change. I think a point that could be put forward is that the reduction of non-climatic stressors through MPA protection can increase the resilience of marine species to climatic stress. This idea is well-discussed in the following section 5.5.2.4.3 in relation to fisheries (see also next comment). Here it could be stressed more. One nice example is Micheli et al. (2012, Plos One), which report how local protection enhanced the resilience of an abalone population to a climate-related mass-mortality event. [Marco Andreello, Canada]	Accepted. The text was revised and this concept was stressed in the fisheries and government sections of Table 5.8.
22557	5	137	27	137	34	Suggest strengthening the argument of the effectiveness of MPAs by including information and references from the Great Barrier Reef. Outlook Reports released in 2009 and 2014 both highlight the importance of MPAs as a management tool for resilience-based management, which is supported through the literature (such as McCook et al. 2010 and Mellin et al 2016). [Government of Australia, Australia]	Accepted. Mellin et al 2019 included in the assessment on MPAs in the fisheries section.

SROCC Second Order Draft Government and Expert Review Compiled Comments - Chapter 5							
Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
7923	5	137	29	0		Suggest remove comma after "is" so that the sentence reads better [Nina Hunter, South Africa]	Editorial
30281	5	138	0	138		when discussing options for reducing overfishing as a collateral way to enhance adaptation for fisheries, it might be advisable to highlight the benefits of reducing prevailing global overcapacity (see Sunken Billions Revisited, The World Bank, 2017), with the win-win-win of reduced costs, increases in biomass, and increases in landings while reducing fishing effort [Charlotte de Fontaubert, United States of America]	Accepted. This is discussed in this section and in the international governance on fisheries section 5.5.3.
14533	5	138	5	138	18	This section should mention the practical mechanisms for international fisheries management through which this could happen [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	Accepted. Text was edited to include flexible fishing effort allocation and adaptive frameworks
17103	5	138	5	138	18	In my understanding the big problem for developing world is not overfishing but we lack technology for fish in deep sea, this literature should suggest to provide/funding for infrastructure for fishing is a key for adaption for coastal communities [Government of United Republic of Tanzania, United Republic of Tanzania]	Accepted. Text was edited to reflect the need for financing.
7925	5	138	6	0		Suggest change "measures" to "measure" [Nina Hunter, South Africa]	Editorial
26679	5	138	7	138	18	There are two issues mixed in this paragraph: namely, reducing/eliminating overfishing and the modalities for doing so. If draconian management measures are implemented, they will actually exacerbate negative ecosystem impacts, but incentive aligning measures are put into place, there is the potential for creating more resilient fisheries and ecosystems. [Florence Poulain, Italy]	Taken into account.
26767	5	138	11	138	12	This paragraph presents a concept that was in part presented in the previous section 5.5.2.4.2, about mitigating non-climatic stressors to increase resilience to climatic stress. Here it is discussed in the context of fisheries, while in the preceding section it was discussed in the context of biodiversity conservation. I think marine protected areas (MPAs) could also be evoked here, as "sustainable and effective fisheries practices" may include some form of area-based management (be it fisheries closures, Locally managed marine Areas, Marine Protected Areas or Marine Reserves) [Marco Andreello, Canada]	Taken into account. Text was edited to assess the value of MPAs within fisheries.
7927	5	138	14	0		Suggest change "livelihood" to "the livelihoods" [Nina Hunter, South Africa]	Editorial
7929	5	138	16	0		Suggest remove "the" before "high agreement" [Nina Hunter, South Africa]	Editorial

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
22755	5	138	19	138	19	New paragraph "Food security linked to fisheries depends on stock recovery but also on access to and distribution of the harvest, as well as gender considerations (Béné et al., 2015). Hence considering granting preferential access to dependent coastal communities should be considered in examining policy options." Add to bibliography Béné C, Barange M, Subasinghe R, Pinstrip-Andersen P, Merino G, Hemre GI, et al. Feeding 9 billion by 2050. Putting fish back on the menu. Food Secur. 2015;7(2):261–74. [Greenpeace Group Review, Republic of Korea]	Accepted. Suggested text and citation inserted.
7931	5	138	20	0		Suggest insert "the" before "distribution" [Nina Hunter, South Africa]	Editorial
14535	5	138	20	138	35	Some of this is straying into personal opinion [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	Accepted. Text edited to be supported by peer-reviewed literature
26681	5	138	22	138	23	Redistribution of transboundary stocks will not destabilize existing fisheries agreements IFF the management regime accommodates this. Increasingly, this is being recognized and addressed. [Florence Poulain, Italy]	Accepted. Text is edited to reflect the importance of international agreements.
1809	5	138	25	0		The Pinsky et al 2018 paper focuses on the projection (climatic timescale). Near-term predictions can also be useful in this context. Therefore suggest changing the sentence to "...informed by reliable predictions (Payne et al 2017) and projections (Pinsky et al 2018) of species shifts and associated uncertainties". The Payne et al 2017 reference has already been cited previously. [Mark Payne, Denmark]	Accepted. Text edited as suggested.
15785	5	138	25	0		The Pinsky et al 2018 paper focuses on the projection (climatic timescale). Near-term predictions can also be useful in this context. Therefore, it is suggested to change the sentence to "...informed by reliable predictions (Payne et al 2017) and projections (Pinsky et al 2018) of species shifts and associated uncertainties". The Payne et al 2017 reference has already been cited previously. [EUCE, Belgium]	Accepted. Text edited as suggested.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
22759	5	138	26	138	28	International goals to maintain exploited fish stocks at levels capable of producing maximum sustainable yield (MSY) have been long suggested to represent levels of fishing effort which are too high to take into account ecosystem considerations, such as multispecies interactions, maintenance of biodiversity and genetic diversity, and reduction of bycatch and waste (Mace PM, 2001). Annex II of the legally binding 1995 UN Fish Stocks Agreement regards MSY as a limit to be avoided, not a management target. The impacts of climate change addressed in this report add arguments to review current MSY targets and rather establish lower, more precautionary, fishing mortality targets. Add to bibliography: Mace PM. A new role for MSY in single-species and ecosystem approaches to fisheries stock assessment and management. Fish Fish. 2001;2(1):2–32. [Greenpeace Group Review, Republic of Korea]	Accepted. Citation included in text
22757	5	138	27	138	30	Comment to "Other international fisheries arrangements, such as flexible fishing effort allocation with opportunities for countries to increase exploitation of resources by providing payment to other countries, may also improve the robustness of fisheries management." The sentence is unclear and confusing. Not clear what it advocates for and doesn't provide any real insight. The concept of "increasing exploitation of resources by providing payments" doesn't fit with the precaution argued for throughout the report. It should be deleted. [Greenpeace Group Review, Republic of Korea]	Accepted. This text was deleted.
26805	5	138	30	138	31	A bibliographic reference would be most useful on successful fisheries management arrangements to adapt to climate change [Tarub Bahri, Italy]	Taken into account. The literature at this stage is reporting on what will be required, rather than presenting evidence of how fisheries management has addressed climate change
21155	5	138	37	138	54	This paragraph is a bit disjointed and lacks a topic sentence. The first sentence implies that paragraph will talk about data accuracy, but most of the paragraph deals with community response to changes in fish populations. It maybe useful to rewrite this section such that there is a paragraph about monitoring and data (including monitoring of fish populations to detect the impacts of over fishing and pollution in addition to climate change) and a second paragraph about dependent human community vulnerability and response. Some of the material for the new second paragraph is already presented in the paragraph starting on line 56, so it may be appropriate to simply add to that paragraph rather than creating an additional paragraph. [APECS Group Review, Germany]	Accepted. Text edited as suggested.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
26571	5	138	43	138	45	See also Hare et al (2016) and Colburn et al (2016) : Hare, J.A., Morrison, W.E., Nelson, M.W., Stachura, M.M., Teeters, E.J., Griffis, R.B., Alexander, M.A., Scott, J.D., Alade, L., Bell, R.J., Chute, A.S., Curti, K.L., Curtis, T.H., and Griswold, C.A. 2016. A vulnerability assessment of fish and invertebrates to climate change on the Northeast UK continental shelf; Colburn, L., Jepson, M., Weng, C., Seara, T., Weiss, J., and Hare, J.A. 2016. Indicators of climate change and social vulnerability in fishing dependent communities along the Eastern and Gulf Coasts of the United States. Marine Policy, 74: 323-333. [Florence Poulain, Italy]	Taken into account. This text was deleted.
5093	5	138	50	138	54	Has the impact of these adaptation measures been assessed? [Debra Roberts and Durban Team, South Africa]	Taken into account. An assessment is provided
26573	5	138	52	138	52	Other adaptation measures can be found in the FAO report (2018); and are summarized in Poulain et al (2018) In: FAO report (2018) [Florence Poulain, Italy]	Accepted. Text edited to include this citation
22761	5	138	52	138	54	FADs should not be seen as an adaptation tool to climate change. The introduction and proliferation of FADs is primarily a response to overcapacity and result of competition within the tropical tuna sector. See for instance Torres-Irineo E, Gaertner D, Chassot E, Dreyfus-León M. Changes in fishing power and fishing strategies driven by new technologies: The case of tropical tuna purse seiners in the eastern Atlantic Ocean. Fish Res [Internet]. Elsevier B.V.; 2014;155:10–9. Available from: http://dx.doi.org/10.1016/j.fishres.2014.02.017 [Greenpeace Group Review, Republic of Korea]	Taken into account. FADs are included here as they are included in the literature
26807	5	139	4	139	4	do no tuse "manage ecosystems". Replace with "sustainably exploit fisheries resources and related ecosystems" [Tarub Bahri, Italy]	Accepted. Suggested text replaced
26513	5	139	11	139	16	I do not understand why one needs to state that "in the next 20-50 years North Atlantic area-based management tools will likely be affected". In that time frame all management tools will likely need adjustments in all areas, so the statement is unnecessary. To then say that until better analysis are made human impacts should be avoided is naive. The fact that management will be affected means that management will be adjusted, modified, etc. as knowledge emerges. The gathering of evidence goes in parallel with management changes, not sequentially [Florence Poulain, Italy]	Accepted. The last sentece of this paragraph was deleted.
26575	5	139	19	139	21	within an ecosystem approach to aquaculture? [Florence Poulain, Italy]	Accepted. Text edited for clarity.

SROCC Second Order Draft Government and Expert Review Compiled Comments - Chapter 5							
Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
26577	5	139	19	139	31	For climate change adaptation in aquaculture, refer to chapter 21 by Soto et al. Climate change and aquaculture: vulnerability and adaptation options; in FAO report (2018). [Florence Poulain, Italy]	Taken into account and citation used
10069	5	139	33	139	51	I fail to see how this could operate at any scale that would be meaningful in terms of mitigation. This might be a good idea for aquaculture but does not belong here. This paragraph should be removed. [Tommy Moore, United States of America]	Taken into account. This is now substantially reduced.
21183	5	139	33	139	51	Please add some introductory text to this paragraph to address the following Issues 1) Previously in this chapter climate change was said to increase upwelling. So why do we need artificial upwelling if upwelling is increasing? Please describe the problem this is trying to solve 2) Page 122 line 35-36 states that "enhanced upwelling" is not considered further as a mitigation measure". This whole paragraph seems to be considering upwelling as a mitigation measure. The two sections are therefore inconsistent and further justification is needed for this paragraph. [APECS Group Review, Germany]	Text revised and edited.
7933	5	139	40	0		Suggest change "to seaweeds culture" to "to the cultured seaweed" [Nina Hunter, South Africa]	Text edited
7935	5	139	46	0		Suggest remove "otherwise" so that the sentence reads better [Nina Hunter, South Africa]	Text edited
17219	5	139	47	139	47	Mis-spelled word "variables" should be "variables" [Shalini Singh, Fiji]	Text edited
30463	5	139	47	139	47	Detailed and permanent in situ monitoring of physical and chemical variables such as... [Michele Capobianco, Italy]	Text edited
7937	5	139	49	0		Suggest change "interventions" to "intervention"; insert "a" before "high" [Nina Hunter, South Africa]	Text edited
7939	5	139	50	0		Suggest insert "an" before "intervention"; insert "a" before "large-scale" [Nina Hunter, South Africa]	Text edited
5095	5	139	50	139	51	There are also potential governance huddles that need to be addressed in implementing such measures. [Debra Roberts and Durban Team, South Africa]	This is discussed in the broader context elsewhere.

SROCC Second Order Draft Government and Expert Review Compiled Comments - Chapter 5							
Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
9941	5	139	53	140	43	Transnational cooperation is crucial, but the interests of MNE, global banks etc. not always coincide with real adaptation and restoration processes. Tourism, coastal water extraction, mining, etc. is often linked to short term profits and not long-term adaptation of the local people. Weak governments often support this destructive behaviour, thus transnational cooperation requires beside an ethical code also international surveillance mechanisms to avoid further destruction and increase of dual vulnerability (natural and social). Most of the local communities exposed to new climate threats are unable to distinguish among maladaptation and real sustainable development. In this part the link with the SDG could help to create an interdisciplinary framework for the analysis. [Úrsula Oswald Spring, Mexico]	Taken into account. The assessment deals with such issues in the government section.
23269	5	140	0	0		education aspects to be conveyed in ES and SPM [Valerie Masson-Delmotte, France]	Taken into account and communicated with authors of ES and SPM>
7941	5	140	6	0		Suggest insert "the" before "implementation" [Nina Hunter, South Africa]	Editorial
26515	5	140	9	140	9	This is extremely naïve. The importance of cooperation in tackling climate change is not a consensus of coastal communities but of the world as a whole. The results of this cooperation would be (and are) contested by some and supported by others, both in coastal zones and in arid zones. [Florence Poulain, Italy]	Accepted. Text edited to reflect this.
7943	5	140	14	0		Parentheses should be removed around the references and placed around the years and "and" inserted between them [Nina Hunter, South Africa]	Editorial
30465	5	140	28	140	31	Technology for environmental monitoring, for example using drones (Clark, 2017), web-based coastal information systems (Mayerle et al., 2016; Newell and Canessa, 2017), Internet of Things and Machine Learning solutions promise to improve the local scale knowledge base, which should improve climate adaptation planning and resilience effort and environmental management decisions (Conde et al., 2015). [Michele Capobianco, Italy]	Accepted. Text edited as suggested.
7945	5	140	29	0		Suggest change "promise" to "promises" [Nina Hunter, South Africa]	Editorial
7947	5	140	30	0		Suggest change "effort" to "efforts" [Nina Hunter, South Africa]	Editorial
7949	5	140	38	0		Suggest remove comma and replace with full stop [Nina Hunter, South Africa]	Editorial
7951	5	140	42	0		Suggest insert "a" before "political" [Nina Hunter, South Africa]	Editorial
14537	5	140	42	140	43	This is hyperbole, and not neutral in its tone. There are no citations here to back up the need/urgent need for education. [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	Accepted. The text has been deleted.
14539	5	140	45	140	52	Examples of how fishers 'demonstrate a higher adaptive capacity' would be helpful [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	Accepted. The text has been edited for clarity

SROCC Second Order Draft Government and Expert Review Compiled Comments - Chapter 5							
Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
9943	5	140	45	141	53	This part treats too general the theme of education and does not distinguish among top-down and bottom-up, short-term and long-term learning, learning by doing etc. The hurricane season in 2005 in the Caribe allowed the people to learn from 3 level hurricanes to evacuate preventively and when the 5 level ones came they were personally trained to go to the refugees, have their papers and personal tools with them. Further, the governmental support and the training through TV avoided loss of humans and an organised evacuation process during a very active hurricane season. [Ürsula Oswald Spring, Mexico]	Taken into account. The section has been edited to strengthen the scope of the assessment
7953	5	140	46	0		Suggest change "accumulate" to "accumulate" [Nina Hunter, South Africa]	Editorial
7955	5	140	47	0		Suggest remove "messages" for clarity of reading [Nina Hunter, South Africa]	Editorial
7957	5	141	1	0		Suggest insert full stop before "Research" [Nina Hunter, South Africa]	Editorial
21185	5	141	7	141	9	Is it possible to strengthen this statement by using the confidence language and referencing studies that show that education influences how climate change is perceived and experienced? Alsp, considering deleting "and marine biodiversity and ecosystem palys and important role in this" Ths is additional clause adds confusion to the sentence and is not needed. [APECS Group Review, Germany]	Accepted. The assessment was strengthened through the development of Table 5.8.
7959	5	141	8	0		Suggest change "plays" to "play" [Nina Hunter, South Africa]	Editorial
7961	5	141	14	0		"People in rural coastal areas have less education" - compared to whom? Across the world? What proof of this? Please elaborate. [Nina Hunter, South Africa]	Accepted. Text deleted
7963	5	141	22	0		Suggest remove "which" for ease of reading [Nina Hunter, South Africa]	Accepted. Text deleted
21157	5	141	30	141	53	It may be worth noting in the context of local knowledge, that on the small-scale all environements and ecosystems might not be affected in the same way. Not all climate-change impacts lead to loss of locally explicit biodiversity, and on the small scale we might even see a positive impact (for example warming of previously cold areas might lead to more species being present, or opening of new arable land in areas that were previously too cold). In such cases developing broade scale knowlege (as opposed to local knowldeg) may be beneficial. This is somewhat touched upon in the second paragraph (line 45). It may be useful to state what gives fishers high adaptive capacity? Is it in depth local knowledge coupled with a broader awareness? [APECS Group Review, Germany]	Accepted. This topic has been expanded upon.
7965	5	141	34	0		Suggest remove "towards" for ease of reading [Nina Hunter, South Africa]	Editorial
7967	5	141	46	0		Suggest change "level" to "levels" [Nina Hunter, South Africa]	Editorial
7969	5	141	48	0		Suggest replace "recognise" with "to have recognised" [Nina Hunter, South Africa]	Editorial

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
17099	5	141	52	141	53	In the sentence that states "These instances, local knowledge acts to promote adaptation (medium confidence)", here I suggest we put high confidence because local communities have their own institutions of which the knowledge is tranfered from one generation to the other for a longer period of time and it is the only available institution to rely on before interventions. Due to limited government capacity to transform the whole community with scientific knowledge, it is likely with higher confidence that indigenous knowledge will continue to persist to the majority of the poor coastal peoples. [Government of United Republic of Tanzania, United Republic of Tanzania]	Accepted. This assessment has been strengthened in Table 5.8.
14541	5	141	53	141	53	Please name the three themes [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	Taken into account. This text was deleted.
7971	5	142	11	0		Who is "they"? If "Beck et al" is being referred to this needs to be stated. [Nina Hunter, South Africa]	Editorial
21187	5	142	11	142	14	How likely is this doubling or tripling of impacts? Please use the confidence level language here. [APECS Group Review, Germany]	Taken into acount.A confidence assessment is provided for this paragraph.
22763	5	142	22	142	24	Roberts et al., 2017 is quoted to highlight that "further research is required" in relation to MPAs while the paper essentially concludes that "marine reserves are a viable low-tech, cost- effective adaptation strategy that would yield multiple cobenefits from local to global scales." This is unbalanced. [Greenpeace Group Review, Republic of Korea]	accepted. The text has been edited to remove the lack of balance
26683	5	142	22	142	24	Did the Byrne et al paper include the costs of MPAs, and - if so - who pays? [Florence Poulain, Italy]	Accepted. Costs estimates provided, but it is beyond the scope of this report to speculate who pays.
21159	5	142	29	142	30	Please clarify what is meant by "0.2-4.6% of global population will be flooded"? Does "population" refer to actual number of individuals, proporation of landmass, or property? [APECS Group Review, Germany]	Taken into account. This text has been deleted
7973	5	142	31	142	35	Please provide references for this information [Nina Hunter, South Africa]	Editorial
7975	5	142	41	0		Suggest insert "the" before "literature" [Nina Hunter, South Africa]	Editorial
7977	5	142	48	0		Suggest insert "the" before "interdependency" [Nina Hunter, South Africa]	Editorial
7979	5	142	50	0		Suggest insert "the" before "adaptation" [Nina Hunter, South Africa]	Editorial
14543	5	143	2	143	20	Not appropriate to write 'presumably' - please remove or rephrase. [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	Rejected. "presumably" does not occur in the text in this section.
7981	5	143	11	0		Suggest insert "and" before "the severity" [Nina Hunter, South Africa]	Editorial
7983	5	143	13	0		Suggest change "affecting" to "affects" [Nina Hunter, South Africa]	Editorial
26579	5	143	31	143	33	Increasing occurrence and severity of storm is a climate change effect, rather than a limit to adaptation. [Florence Poulain, Italy]	Accepted. Text edited to reflect that these storms limit fishing time
26685	5	143	31	143	39	The paragraph begins about artisanal fisheries but this masks the fact that it deals with all types of fisheries. [Florence Poulain, Italy]	Accepted. The text is edited to address this

SROCC Second Order Draft Government and Expert Review Compiled Comments - Chapter 5							Chapter Team Response
Comment id	Chapter	From page	From line	To page	To line	Comment	
7985	5	143	34	0		Suggest write Great Barrier Reef with capitals; insert "the" before "adaptation response" [Nina Hunter, South Africa]	Editorial
7987	5	143	36	0		Suggest remove comma after "barriers" [Nina Hunter, South Africa]	Editorial
17105	5	143	44	143	46	To remove the word and before the word capacity [Government of United Republic of Tanzania, United Republic of Tanzania]	Accepted. This sentence was deleted
21189	5	143	57	144	5	The use of the phrase "weak cognitive ability" on line 2 implies that some how poor people living in coastal communities intrinsically do not have the same mental capabilities as people living elsewhere. Please consider deleting that phrase and replacing it with "lack of education". Or just deleting the phrase all together. It seems like poor form for this report to say that poor coastal people are somehow intrinsically less intelligent that other people, and that is what this sentence says as currently written. [APECS Group Review, Germany]	Accepted. This sentence was deleted
17107	5	144	1	144	5	Technology, energy availability and access are major limiting factors for adaptation to coastal communities in addition to the mentioned reasons. [Government of United Republic of Tanzania, United Republic of Tanzania]	Accepted. Text is edited to make reference to technology and equipment
26687	5	144	7	144	11	It is surprising that empowerment is not mentioned along with socio-economic, cultural and psychological barriers. [Florence Poulain, Italy]	Taken into account. Empowerment is dealt with in the coastal communities section and Table 5,8
17109	5	144	7	144	7	The sentence should read "Adaptation barriers, which are both internal and external, are progressively being discovered and are mainly technological, socio-economic, cultural and psychological. [Government of United Republic of Tanzania, United Republic of Tanzania]	Accepted. This sentence was deleted
17097	5	144	20	144	24	For successful planning stakeholder engagement process should be at all levels especially the primary level where direct beneficiaries resides. This happens mostly especially in developing countries, where the most affected communities are not well engaged at early stages of project development and this might affect successive sustainability of adaptation project. [Government of United Republic of Tanzania, United Republic of Tanzania]	Taken into account
33993	5	144	28	151	5	Section needs to be copyedited for proper English use (plurals, particles, etc). [Government of United States of America, United States of America]	Text rewritten
5097	5	144	30	146	51	There is no assessment of the information presented here. [Debra Roberts and Durban Team, South Africa]	Text rewritten
33995	5	144	32	144	33	Add ocean deoxygenation to this list. [Government of United States of America, United States of America]	Text rewritten

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
21161	5	144	32	144	34	Please reword this sentence it is very confusing. How can you have a governance structure in response to climate driven ocean acidification? Perhaps a better phrasing would be "Global, regional, national and subnational governance actions taken in response to climate driven ocean acidification and ocean warming are highly fragmented and like result in inconsistent results for marine ecosystems and dependent communities". [APECS Group Review, Germany]	Text rewritten
7989	5	144	35	0		Suggest change "response is" to "responses are" [Nina Hunter, South Africa]	Text rewritten
7991	5	144	36	0		Suggest insert "of" before "distinct"; insert "the" before "ocean" [Nina Hunter, South Africa]	Text rewritten
7993	5	144	39	0		Suggest remove "for the ocean" as already stated in "ocean governance structure"; change "is" to "are" [Nina Hunter, South Africa]	Text rewritten
7995	5	144	40	0		Suggest remove "the" before "climate change"; replace "Considering" with "With regard to" [Nina Hunter, South Africa]	Text rewritten
7997	5	144	41	0		Suggest change "structure is" to "structures are" [Nina Hunter, South Africa]	Text rewritten
26689	5	144	41	144	41	As previously queried, why is the scope limited to environmental and fisheries governance structures? [Florence Poulain, Italy]	Text rewritten
7999	5	144	42	0		Suggest replace "regime" with "regimes are" [Nina Hunter, South Africa]	Text rewritten
8001	5	144	43	0		Suggest insert "(2018)" after "Oral" [Nina Hunter, South Africa]	Text rewritten
33997	5	144	43	144	43	Strike "As mentioned by Oral". [Government of United States of America, United States of America]	Text rewritten
2645	5	144	43	144	44	As mentioned by Oral, legal framework for ocean acidification 'appears to fall between the cracks of the two principal regimes for climate change, the UNFCCC and ocean governance under UNCLOS' (Oral, 2018).' I think this could be made more precise. Climate change mitigation clearly falls to the UNFCCC; adaptation is more complicated, with both regimes having responsibility. [Brian Pentz, Canada]	Text rewritten
8003	5	144	44	0		Please insert page number for "Oral (2018)" reference [Nina Hunter, South Africa]	Text rewritten
14545	5	144	44	144	44	What international governance regime is being referred to? [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	Text rewritten
8005	5	144	45	144	48	This sentence does not make sense as it stands. Please rephrase to make understandable. [Nina Hunter, South Africa]	Text rewritten
33999	5	144	45	144	48	Rewrite for clarity. [Government of United States of America, United States of America]	Text rewritten
8007	5	144	49	0		Suggest insert "the" before "above-mentioned" [Nina Hunter, South Africa]	Text rewritten

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
2659	5	144	52	152	39	<p>I think there is an important issue that has not been included in this section. The section details governance challenges and issues, and then identifies 'key uncertainties and gaps (5.7, line 51 page 151)'. Specifically, lines 5-16 of page 152 note key uncertainties and gaps in 'Variance in human systems and effectiveness of response'.</p> <p>A critical issue that has not been discussed in the context of governance challenges and deficits is the extent to which current agreements will be undermined by climate change. The migration of marine species is covered earlier in the chapter; this should be accompanied by a discussion of implications to current governance agreements/arrangements. Many regional resource-sharing agreements are founded upon certain understandings of resource locations, migrations, and behaviour. Climate change is poised to influence these biological contexts. There is a reasonable chance that the stability of marine resource sharing agreements will be undermined by changing biological contexts. Thus even in areas where governance is well-defined, functional, and has delivered sustainable resource outcomes, climate change will create major governance issues. Section 5.4.2.1.3 outlines the potential of climate migrations to cause conflict; how conflict can be avoided, and stable governance agreements maintained, is among the most pressing issues of marine resource governance and should be included in section 5.7. [Brian Pentz, Canada]</p>	Text rewritten
8009	5	144	54	0		Suggest insert "The" before "international" [Nina Hunter, South Africa]	Text rewritten
14547	5	144	54	144	54	Needs to include some commentary on how climate change is (or could be) accounted for in environmental governance, and cite more examples - currently it is far too selective in terms of the obligations / legislation highlighted [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	Text rewritten

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
21163	5	144	54	145	13	This paragraph appears to have been written by a person who is not a native English speaker. The sentence construction makes it challenging to follow the argument. For example, the paragraph begins by arguing that current governance is not adequate to address climate change issues, but then goes on to state that the overall goal of such governance will be positive. Perhaps the intended sentiment is "While the governance regime has lofty goals for reducing emissions and positively impacting the ocean and coastal areas through a reduction of climate change impacts, it is uncertain if current legal and policy framework is sufficient to achieve these goals". This paragraph needs some editorial attention, the raised are likely sound but are very hard to understand. [APECS Group Review, Germany]	Text rewritten
8011	5	144	55	0		Suggest insert "the" before "current" [Nina Hunter, South Africa]	Text rewritten
34001	5	144	55	144	56	Copyedit. [Government of United States of America, United States of America]	Text rewritten
8013	5	144	56	0		Suggest remove "the" before "ocean" [Nina Hunter, South Africa]	Text rewritten
2643	5	144	57	145	1	Existing climate change related legal instruments do not adequately address the challenges the ocean and coastal areas will face'. Which legal instruments is this referring to? Is this at the regime level? Or is this referring to regional governance (i.e. RFMOs)? Or is this referring to governance of domestic waters? Or all of these jurisdictions? Are governance deficits the same in these various areas? [Brian Pentz, Canada]	Text rewritten
8015	5	145	2	0		Suggest insert "the" before "mitigation"; change "impact" to "impacts" [Nina Hunter, South Africa]	Text rewritten
8017	5	145	3	0		Suggest replace "full" with "adequate"? [Nina Hunter, South Africa]	Text rewritten
9819	5	145	3	145	4	Regarding ocean acidification, it did not get attention at all. [Government of France, France]	Text rewritten
8019	5	145	5	145	6	Suggest change "ocean did not get" to "oceans did not receive" [Nina Hunter, South Africa]	Text rewritten
8021	5	145	6	0		Suggest insert "the" before "UNFCCC" [Nina Hunter, South Africa]	Text rewritten
8023	5	145	8	0		Suggest insert "the" before "Kyoto" [Nina Hunter, South Africa]	Text rewritten
8025	5	145	9	0		Suggest change "ocean" to "oceans" [Nina Hunter, South Africa]	Text rewritten
8027	5	145	10	145	11	Please rephrase to make meaning clear: "submitted where national pledges for climate change mitigation and adaptation show" [Nina Hunter, South Africa]	Text rewritten
8029	5	145	12	0		Please insert a page reference for the direct quote [Nina Hunter, South Africa]	Text rewritten
8031	5	145	13	0		Suggest change "to the" to "on" [Nina Hunter, South Africa]	Text rewritten

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
9821	5	145	15	145	15	The characterization "environmental governance" is questionable since the UNCLOS is not dedicated to environmental protection only/primarily but more broadly the regulation of marine spaces and activities therein. This nuance should be integrated. [Government of France, France]	Text rewritten
22771	5	145	15	145	15	General comment on section 5.5.3.2.1. Environmental governance of ocean. Very unbalanced. CBD decisions, for instance, are quoted in relation to geoengineering, however no mention is made to global targets on Marine Protected Areas. Same goes for WSSD JPOI, etc. This section needs review, completion, and stronger language in relation to demonstrated lack of compliance with agreed targets. The CBD Aichi targets are mentioned in p147, para 3, under private stakeholders, but not here. [Greenpeace Group Review, Republic of Korea]	Text rewritten

SROCC Second Order Draft Government and Expert Review Compiled Comments - Chapter 5							
Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
2647	5	145	15	146	51	<p>This section (5.5.3.2 Climate Change Governance Regime) possesses some deficiencies that require further consideration and amendment.</p> <p>There is a lack of jurisdictional clarity. Domestic and international climate change adaptation are not effectively delineated, even though the two contexts are the responsibility of different institutions and possess different resource management/climate change adaptation challenges. Separating out these different jurisdictional contexts would improve the clarity and discussion in this section.</p> <p>Regional Fisheries Management Organizations (RFMOs) are the institutions responsible for ensuring marine living resources are managed sustainably on the high seas. They are thus responsible for ensuring that resources are exploited sustainably during climate change. These organizations are therefore critically important in the conversation of how the strategies, approaches, and policies used to manage marine living resources can be tailored or changed in order to adapt to climate change. The discussion of these organizations, however, is very brief and does not effectively represent their importance to climate change adaptation and marine governance, nor their capacity to address climate change. There is a passing comment on their role in acidification management (lines 45-50, page 145) and 'emerging challenges', but these comments do not effectively summarize the challenges RFMOs face in responding to climate change, how they currently seek to identify, account for, and address environmental and resource change. This discussion does not effectively summarize the deficits of climate change adaptation capacity that RFMOs possess (Pentz et al., 2018), or how the large body of literature on fisheries management strategies to climate change adaptation suggest these gaps and challenges could be addressed. These issues and challenges are crucial to any discussion of climate change adaptation and marine governance.</p> <p>Pentz, B., Klenk, N., Ogle, S., & Fisher, J. A. (2018). Can regional fisheries management organizations (RFMOs) manage resources effectively during climate change?. Marine Policy, 92, 13-20. [Brian Pentz, Canada]</p>	Text rewritten
2651	5	145	15	146	51	<p>The way in which this section is broken into subsections needs to be reconsidered. It separates out 'fisheries' from the environment - marine fisheries and their supporting ecosystems are, however, part of the environment. Section 5.5.3.2.1 is concerned with the governance of ocean acidification - this could be renamed 'adaptation to changing ocean chemistry' (or something along these lines); 5.5.3.2.2 could be renamed 'adaptation to changing resources and ecosystems'. This would eliminate the ambiguity/inaccuracy of the current subsection title strategy. [Brian Pentz, Canada]</p>	Taken into consideration
14549	5	145	15	146	6	<p>No discussion on the international mechanisms through which fisheries governance practices can / need to be modified [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]</p>	Text rewritten

SROCC Second Order Draft Government and Expert Review Compiled Comments - Chapter 5							Chapter Team Response
Comment id	Chapter	From page	From line	To page	To line	Comment	
9823	5	145	16	145	18	Quid of Archipelagic waters and the Area? [Government of France, France]	Text rewritten
8033	5	145	18	0		Suggest change "zone" to "zones"; "shelf" to "shelves" [Nina Hunter, South Africa]	Text rewritten
9825	5	145	20	145	22	It is Article 61, and not Article 6. [Government of France, France]	Text rewritten
8035	5	145	21	0		Suggest change "obligation" to "obligations"; insert "the" before "national" [Nina Hunter, South Africa]	Text rewritten
9949	5	145	22	147	28	Institutional consolidation and PPP: What type of development do we want? Professional fishery or small-scale subsistence fishery, oil exploitation in deep sea and mining or renewable energy from the sea? How to avoid the present economic development based on environmental destruction and pollution with GHG. How to promote a low-impact tourism, when in the beautiful beaches of the tropic MNE hotels with thousands of rooms emerge, which first clean the protecting mangroves and later the massive tourism destroys the coral reefs? International pressures to pay back debt services oblige governments in the South to accept these unsustainable project, but later have to deal alone with the negative effects of these development, while the profits are sent away and low paid jobs rest in the tropics. This chapter needs some arrangements, which allows the governments to deal better with these international pressures, but also mechanisms of control against corruption and government which are only interested in personal benefits. [Úrsula Oswald Spring, Mexico]	Text rewritten
8037	5	145	26	0		Suggest insert "the" before "ocean" [Nina Hunter, South Africa]	Text rewritten
8039	5	145	27	0		Suggest change "depending" to "dependent" [Nina Hunter, South Africa]	Text rewritten
8041	5	145	28	0		Suggest change "detail" to "detailed" [Nina Hunter, South Africa]	Text rewritten
8043	5	145	31	0		Suggest insert "the" before "most" [Nina Hunter, South Africa]	Text rewritten
17551	5	145	31	145	43	The Polar Code has helped create regulations for both Polar Regions, and the Arctic Council has established task forces looking at short-lived climate forcers, which are particularly impactful in the local region. [Kristin Campbell, United States of America]	Out of scope
17663	5	145	31	145	43	The Polar Code has helped create regulations for both Polar Regions, and the Arctic Council has established task forces looking at short-lived climate forcers, which are particularly impactful in the local region. At the same time, the Polar Code should extend its ban on bunker fuel in the Arctic as it does in the Antarctic because it would reduce the black carbon emissions that can reduce the albedo of ice and snow in the Arctic. [Durwood Zaelke, United States of America]	Out of scope

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
17665	5	145	31	145	43	While geoengineering is not covered in this report, this section could note some potential projects have proposed to rebuild and maintain Arctic sea ice as a means for increasing global albedo and limiting the regional warming in the Arctic. One looks to pump ocean water onto the sea ice surface to increase thickness over time and another hopes to increase the natural reflectivity of the sea ice through application of an eco-safe, reflective sand. Desch S. J., et al. (2017) Arctic ice management, EARTH'S FUTURE 5:107–127, 107 ("As the Earth's climate has changed, Arctic sea ice extent has decreased drastically. It is likely that the late-summer Arctic will be ice-free as soon as the 2030s. This loss of sea ice represents one of the most severe positive feedbacks in the climate system, as sunlight that would otherwise be reflected by sea ice is absorbed by open ocean. It is unlikely that CO2 levels and mean temperatures can be decreased in time to prevent this loss, so restoring sea ice artificially is an imperative. Here we investigate a means for enhancing Arctic sea ice production by using wind power during the Arctic winter to pump water to the surface, where it will freeze more rapidly. We show that where appropriate devices are employed, it is possible to increase ice thickness above natural levels, by about 1 m over the course of the winter. We examine the effects this has in the Arctic climate, concluding that deployment over 10% of the Arctic, especially where ice survival is marginal, could more than reverse current trends of ice loss in the Arctic, using existing industrial capacity. We propose that winter ice thickening by wind-powered pumps be considered and assessed as part of a multipronged strategy for restoring sea ice and arresting the strongest feedbacks in the climate system."); and Field L., et al. (2018) Increasing Arctic Sea Ice Albedo Using Localized Reversible Geoengineering, EARTH'S FUTURE 6:882–901, 882 ("The rising costs of climate change merit serious evaluation of potential climate restoration solutions. The highest rate of change in climate is observed in the Arctic where the summer ice is diminishing at an accelerated rate. The loss of Arctic sea ice increases radiative forcing and contributes to global warming. Restoring reflectivity of Arctic ice could be a powerful lever to help in the effort to limit global warming to 1.5°C. Polar ice restoration should be considered in planning of 1.5°C pathways. In this paper, a novel localized surface albedo modification technique is presented that shows promise as a method to increase multiyear ice using reflective floating materials, chosen so as to have low subsidiary environmental impact. Detailed climate modeling studying the climate impact of such a method reveals more than 1.5°C cooler temperatures over a large part of the	Out of scope
21165	5	145	32	145	43	On line 32 the Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter, 1972 is given the alias of (London Convention), but through the remainder of the paragraph it is called the London Protocol. Please be consistent. [APECS Group Review, Germany]	Text rewritten
8045	5	145	33	0		Suggest insert "The" before "1996" [Nina Hunter, South Africa]	Text rewritten
8047	5	145	34	0		Suggest change "wastes" to "waste"; change "to" to "in"; "the" before "protocol" [Nina Hunter, South Africa]	Text rewritten
9827	5	145	34	145	36	Specify that it entered into force in 2017. [Government of France, France]	Text rewritten
8049	5	145	36	0		Suggest remove "the" before "Annex"; insert "are" before "then" [Nina Hunter, South Africa]	Text rewritten
8051	5	145	38	0		Suggest change "amendment" to "amendments" [Nina Hunter, South Africa]	Text rewritten
8053	5	145	39	0		Suggest change "concern for" to "concerns relating to"; insert "The" before "International" [Nina Hunter, South Africa]	Text rewritten

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
21167	5	145	39	145	39	It would be useful to list some of the concerns related to research on ocean fertilization. Or please clarify which activities the concerns are related to and list some of the concerns. [APECS Group Review, Germany]	Text rewritten
9829	5	145	41	145	43	Correct that it entered into force in 2013. [Government of France, France]	Text rewritten
8055	5	145	42	0		Suggest insert "the" before "effectiveness" [Nina Hunter, South Africa]	Text rewritten
26691	5	145	45	145	47	There is a considerable leave from understanding the so-called question effectiveness of existing provisions and the need for a new and additional set of international regulations./ bureaucracy. It would be more effective to understand the failures and reasons for these failures before calling for additional regulations This would also facilitate synchronization. [Florence Poulain, Italy]	Text rewritten
8057	5	145	46	0		Suggest insert "the" before "changing" [Nina Hunter, South Africa]	Text rewritten
9831	5	145	47	145	50	Not in a binding way. See K. N. Scott, « Climate Change and the Oceans: Navigating Legal Orders», in M. H. Nordquist, J. N. Moore, R. Long (ed.), Legal order in the World's Oceans: UN Convention on the Law of the Sea (Leiden/Boston, Brill/Nijhoff, 2017. [Government of France, France]	Text rewritten
9833	5	145	52	145	54	But still not in a binding way. [Government of France, France]	Text rewritten
8059	5	145	53	0		Suggest insert "a" before "specific" [Nina Hunter, South Africa]	Text rewritten
34003	5	145	53	145	53	Define CBD COP. [Government of United States of America, United States of America]	Text rewritten
34005	5	145	53	145	55	Copyedit. [Government of United States of America, United States of America]	Text rewritten
8061	5	145	54	0		Suggest change "also increasing considering" to "are also increasingly considering" [Nina Hunter, South Africa]	Text rewritten
8063	5	145	55	0		Suggest change "are huge rooms" to "is huge room" [Nina Hunter, South Africa]	Text rewritten
8065	5	145	56	0		Suggest insert "the" before "changing" [Nina Hunter, South Africa]	Text rewritten
8067	5	145	57	0		Suggest insert "the" before "Convention" [Nina Hunter, South Africa]	Text rewritten
30283	5	146	0	146		when highlighting improvements of fisheries governance in areas beyond national jurisdiction, additional language should be included on the need to reform and improve Regional Fisheries Management Organizations (RFMOs), with several case studies leading the way (e.g. the Vessel Day Scheme for the Parties to the Nauru Agreement). [Charlotte de Fontaubert, United States of America]	Text rewritten

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
26517	5	146	0	148		It is surprising that a section on fisheries governance does not mention UNCLOS, the UN Fish Stocks Agreement, The Code of Conduct for Responsible Fisheries, the RFMOs that emerge from the above, the Post States Measures Agreement, the Ecosystem Approach, etc. Especially the lack of reference to RFMOs, who will have an enhanced role as a result of climate change is particularly surprising. Note as well that it is not clear that "a comprehensive reform of the fisheries governance in all levels "(l. 41-4.2) is either needed or feasible. For anyone involved in governance it is a naive and over-stretching statement. I believe it would need literature support (from the fisheries governance community directly) to deserve inclusion [Florence Poulain, Italy]	Text rewritten
8069	5	146	3	0		Suggest remove "the" [Nina Hunter, South Africa]	Text rewritten
9835	5	146	5	146	5	This section should mention the incidence of stocks moving through jurisdictions and marine spaces. [Government of France, France]	Text rewritten
22773	5	146	5	146	5	General comment on section 5.5.3.2.2. Fisheries governance. Very incomplete section. No mention of the UN Fish Stocks Agreement, of UNGA resolutions on bottom fisheries or on RFMOs performance reviews to give an example of areas where opportunities could be identified. For instance: full implementation of the ecosystem-based approach and precautionary approach as mandated by the UNFSA; full implementation of UNGA resolutions provisions on bottom fisheries to protect vulnerable deep sea ecosystems. RFMO performance reviews could start to assess how, if at all, RFMOs are incorporating the climate change perspective into their work. Etc. [Greenpeace Group Review, Republic of Korea]	Text rewritten
14551	5	146	5	146	51	Define 'altretamine' [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	Text rewritten
21191	5	146	5	146	51	There is no use of the calibrated confidence level language anywhere in this 2 paragraph section. Please add as appropriate, to assist readers with evaluating the significance of the statements. [APECS Group Review, Germany]	Text rewritten
26693	5	146	5	146	51	This section needs rewriting, as it is currently a list of aspirations. [Florence Poulain, Italy]	Text rewritten
8071	5	146	8	0		Suggest change "me" to "be" [Nina Hunter, South Africa]	Text rewritten
17221	5	146	8	146	8	Wrong word "me" should be "be" [Shalini Singh, Fiji]	Text rewritten
8073	5	146	10	0		Suggest change "particular" to "particularly" [Nina Hunter, South Africa]	Text rewritten
17223	5	146	10	146	10	Grammar correction "particular" should be "particularly" [Shalini Singh, Fiji]	Text rewritten

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
21169	5	146	10	146	11	It would be useful to reference the impacts of ocean acidification and hypoxi on primary production (section 5.2.2.5) as this has bottom up effects on commercially fished species [APECS Group Review, Germany]	Text rewritten
8075	5	146	12	0		Suggest insert "A" before "Changing"; change "problem" to "problems" [Nina Hunter, South Africa]	Text rewritten. No longer relevant
2649	5	146	13	146	14	This line refers to Regional fisheries management systems - this vernacular is not consistent with the institutions it is referencing. This language seems to be referring to Regional Fisheries Management Organizations (RFMOs) - these institutions are not really 'systems'. This language needs to be changed to RFMOs. [Brian Pentz, Canada]	Text rewritten. No longer relevant
2653	5	146	13	146	14	Regional fisheries management systems also need to address the emerging challenges (Brooks et al., 2013).' What emerging challenges, exactly? How can RFMOs address them? Are these challenges related to climate change? How? This line either needs substantial clarification and elaboration or needs to be removed. [Brian Pentz, Canada]	Text rewritten. No longer relevant
34007	5	146	14	146	18	Copyedit. [Government of United States of America, United States of America]	Text rewritten
8077	5	146	15	0		Suggest change "system" to plural [Nina Hunter, South Africa]	Text rewritten
8079	5	146	16	0		Suggest insert "the" before "adoption"; insert "a" before "flexible" [Nina Hunter, South Africa]	Text rewritten
8081	5	146	17	0		Suggest change "system" to plural; is "altretamine" the word that was intended? [Nina Hunter, South Africa]	Text rewritten
14553	5	146	17	146	17	Spell out what 'ABNJ' is [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	Text rewritten
17225	5	146	17	146	17	Word correction from "altretamine" to "alternative" [Shalini Singh, Fiji]	Text rewritten
8083	5	146	20	0		Suggest change "structure" to "structures" [Nina Hunter, South Africa]	Text rewritten
8085	5	146	21	0		Suggest insert "a" before "climate" [Nina Hunter, South Africa]	Text rewritten
8087	5	146	23	0		Suggest lowercase for "Fisher" [Nina Hunter, South Africa]	Text rewritten
8089	5	146	25	0		Suggest insert "the" before "regulatory" [Nina Hunter, South Africa]	Text rewritten
34009	5	146	27	146	30	Copyedit. [Government of United States of America, United States of America]	Text rewritten
8091	5	146	28	0		Suggest remove "within" [Nina Hunter, South Africa]	Text rewritten
8093	5	146	33	0		Please provide a page reference for this quote [Nina Hunter, South Africa]	Text rewritten
8095	5	146	34	0		Suggest replace "indemnified the following is" with "identified the following as" [Nina Hunter, South Africa]	Text rewritten
34011	5	146	34	146	34	"Indemnified" is not an appropriate word choice here. Perhaps "identified"? [Government of United States of America, United States of America]	Text rewritten
8097	5	146	39	0		Please provide a page reference for this quote [Nina Hunter, South Africa]	Text rewritten. No longer relevant

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
22775	5	146	40	146	40	International goals to maintain exploited fish stocks at levels capable of producing maximum sustainable yield (MSY) have been long suggested to represent levels of fishing effort which are too high to take into account ecosystem considerations, such as multispecies interactions, maintenance of biodiversity and genetic diversity, and reduction of bycatch and waste (Mace PM, 2001). Annex II of the legally binding 1995 UN Fish Stocks Agreement regards MSY as a limit to be avoided, not a management target. The impacts of climate change addressed in this report add arguments to review current MSY targets and rather establish lower, more precautionary, fishing mortality targets. Add to bibliography: Mace PM. A new role for MSY in single-species and ecosystem approaches to fisheries stock assessment and management. Fish Fish. 2001;2(1):2–32. [Greenpeace Group Review, Republic of Korea]	No considered as section is written
8099	5	146	46	0		What does "ABNJ" stand for? [Nina Hunter, South Africa]	Full form provided
17111	5	146	46	146	46	The abbreviation ABNJ need to be expanded. It has not been mention elsewhere [Government of United Republic of Tanzania, United Republic of Tanzania]	Full form provided
34013	5	146	46	146	46	Define ABNJ or avoid this acronym. [Government of United States of America, United States of America]	Text rewritten. No longer relevant
8101	5	146	49	0		Suggest replacing "going on" with "taking place" [Nina Hunter, South Africa]	Text rewritten. No longer relevant
26695	5	146	49	146	50	So what about the current negotiation is relevant to this section? [Florence Poulain, Italy]	Text rewritten. No longer relevant
9837	5	146	49	146	51	Correct : "For the conservation and sustainable use of marine biodiversity beyond the limits of national jurisdiction." [Government of France, France]	Text rewritten. No longer relevant
14555	5	146	50	146	51	Ocean acidfication effects over good and services has been documented (see Hilmi, Lemasson); please add these references in the text. [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	Text rewritten. No longer relevant
2655	5	146	53	147	55	This section on private sector stakeholders and partnerships, as presented, is not closely connected to climate change. It lays out the benefits of private sector involvement, but frames these benefits through improved resiliency to climate change, which is mentioned briefly at the end of the section. I think this is a good argument and should definitely be included, but I recommend the climate change resiliency framing be used to introduce the section to make its relevance to the report as clear as possible. [Brian Pentz, Canada]	p 147, l 5. MOVE l46-l51 to l5 p 147

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
26697	5	146	57	147	4	These two sentences seem to indicate that the set targets were set without consideration of cost-effectiveness or available financial resources or even funding modalities. If so, it doesn't seem well conceived, albeit well-intentioned. [Florence Poulain, Italy]	No, what is said is that to reach the targets, new sources of funding must be created. I agree we can remove the whole first sentence if clearer I 55 "the success ...
8103	5	147	3	0		Suggest remove "estimated to be" as it has already been stated that the figures are estimated [Nina Hunter, South Africa]	Yes agree
16171	5	147	4	147	4	"Spergel and Moye (2004) summarizes 8 categories of financing mechanisms used in protecting marine resources. They are government revenue allocations, grants and donations, tourism revenues, real estate and development rights, fishing industry revenues, energy and mining revenues and for profit investments linked to marine conservation. Citation: B. Spergel and M. Moye .2004. Financing Marine Conservation : A menu of options. Washington D.C.: WWF Center for Conservation Finance. " [Wenting Chen, Norway]	The reference shall be added to I 11 p 147
5099	5	147	6	147	55	It is not clear why other funding instruments have not been assessed besides the private sector and PPPs. Is there no role that funding from the global north could play in this context? [Debra Roberts and Durban Team, South Africa]	this chapter is to explore the role of private sector , not ODA
8105	5	147	7	0		Suggest change "reef" to "reefs" [Nina Hunter, South Africa]	ok
21171	5	147	7	147	8	The Katoomba group' also listed on line 25 of the same page and Pg 212 Ln 12 has an incomplete citation in the bibliography page 212 line 12 [APECS Group Review, Germany]	The Katoomba Group, 2010. Paying Poseidon: Financing the Protection of Valuable Ecosystem Services. Technical Report, Forest Trends, The Katoomba Group, and UNEP IISBN: 978-1-932928-42-6, 80 pages
25535	5	147	13	147	40	THIS MAY BE OPENING A PANDORA BOX BUT IT MIGHT BE FAIR TO MENTION THAT (i) PPPs ARE AS MUCH AND ARGUABLY MORE A POLITICAL CHOICE THAN A TECHNICAL TOOL (THIS IS ALSO TRUE OF MOST OF THE MARKET-BASED "SOLUTIONS", GREEN BONDS ETC.) (ii) THE EXPERIENCE WITH PPPs IS DISPUTED AT BEST, IN PARTICULAR IN DEVELOPPING COUNTRIES. SEE Wang, H., W. Xiong, G. Wu, and D. Zhu. 2017. "Public-Private Partnership in Public Administration Discipline: A Literature Review." Public Management Review 20 (2): 293-316. doi:10.1080/14719037.2017.1313445.[Taylor & Francis Online], [Web of Science ®], Graeme Hodge, Carsten Greve & Mhamed Biygautane (2018) Do PPP's work? What and how have we been learning so far?, Public Management Review, 20:8, 1105-1121, DOI: 10.1080/14719037.2018.1428410 WHICH INCLUDE MANY FURTHER REFERENCES [Christophe Deissenberg, Luxembourg]	Agree. We shall ADD "are expected to" address on I13, p147 + ADD on I 18. An extensive literature has documented the main risks and challenges regarding the development of PPPs (Delmon, 2008) including but not limited to monopoly risk of service providers, poor quality services, high tariffs, lack of government guidelines. Important steps have to be followed during the design, implementation and monitoring&evaluation of the PPP to avoid these issues (European Commission, 2003). Delmon, J., 2008. Private Sector Investment in Infrastructure: Project Finance, PPP Projects and Risk. . 2nd Edition, 2008. European Commission, 2003. Guidelines for Successful Public-Private Partnerships, European Commission. Directorate-General Regional Policy, technical report, 100 pp.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
8107	5	147	23	0		Suggest move bracket from before "European Commission" to "2003" [Nina Hunter, South Africa]	ok
26699	5	147	26	147	27	This is a chilling statement; namely, that such investments are profitable, which is the basis for making the investments. [Florence Poulain, Italy]	Please change to "robuste business models" INSTEAD OF "financial returns"
8109	5	147	32	0		Suggest replace "to use" with "of using" [Nina Hunter, South Africa]	ok
17113	5	147	38	147	38	There is a need to check consistence on referencing style. In some reference the brackets are on the year and in other reference you find brackets in the whole reference "Rinkevich (2015b)" [Government of United Republic of Tanzania, United Republic of Tanzania]	ok
14557	5	147	38	147	39	This appears to be an opinion, not backed up by any references. [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	please add the follwing reference : Bovarnick, A., Knight, C., Stephenson, J., 2010. Habitat Banking in Latin America and Caribbean: A Feasibility Assessment. United Nations Development Programme, 2010.
8111	5	147	39	0		Suggest remove "a" before "long-term" [Nina Hunter, South Africa]	ok
8113	5	147	40	0		Suggest remove "it" before "is done" [Nina Hunter, South Africa]	ok
34015	5	147	42	147	48	Is this a discussion about EMPAs or MPAs? The paragraph morphs from EMPAs to MPA. [Government of United States of America, United States of America]	ok EMPA is limited to this paragraph
22777	5	147	46	147	48	This kind of clear statements on MPAs should feature throughout the document and not only here under private partnerships (re. "When properly managed, MPAs have proven to control overfishing, reduce user conflicts, increase community support and improve enforcement of water quality regulations"). [Greenpeace Group Review, Republic of Korea]	agree - see comment n°2655 -
26701	5	147	46	147	48	Source? This begs the questions of what is proper management of MPAs., control (versus displacement) of overfishing, etc. See lines 54 - 55 on page 147. [Florence Poulain, Italy]	Halpern, 2003 - I 47+150 have been grouped
22779	5	147	53	147	55	This is totally uncalled for and selective reading. In addition to inconsistent with the rest of the document, let alone abundant literature. The sentence "A potential obstacle in the further development of this tool are results showing that the management instruments employed in MPAs, in general, often fail to achieve their conservation objectives (Miller and Russ, 2014; Gill et al., 2017)" should be deleted. [Greenpeace Group Review, Republic of Korea]	Please remove l53-56

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
16173	5	147	55	147	55	<p>"Financial mechanism have been found not been well matched with funding needs partly due to poor financial planning. Through a survey by 135 individuals working across at least 19 countries, 49% of respondents did not have a finance strategy for marine conservation program and another 25% are unsure if the organisation had a finance strategy. By reviewing the history of financial planning for marine conservation work, Boes et al (2015) found finance is disconnected from conservation planning without stakeholders inputs. As most market based instruments have social cultural and political implications (reference therein, Boes et al 2015., the finance mechanisms need to be considered during early planning phase.</p> <p>Whether the business is willing to engage in the conservation activities and the conservation funding gap depend on how business objectives are connected with the social objectives of restoration with. (Fig 3 from the article is useful. I cannot paste it in in the comment here.). Citation: Boes, M, R. L. Pressey, N. Stoeckl. 2015. Marine conservation finance: the need for and scope of an emerging field. Journal of Ocean & Coastal Management, 114:116-128" [Wenting Chen, Norway]</p>	Please remove 153-56 & ADD line 5: A recent study conducted on 218 MPAs worldwide highlighted that 65% of the MPAs have reported inadequate budgets for basic management and 90% of the MPAs reported inadequate staff capacity (Gill et al 2018), Gill, D.A., Mascia, M.B., Ahmadi, G.N., Glew, L., Lester, S.E., Barnes, M., Craigie, I., Darling, E.S., Free, C.M., Geldmann, J., Holst, S., Jensen, O.P., White, A.T., Basurto, X., Coad, L., Gates, R.D., Guannel, G., Mumby, P.J., Thomas, H., Whitmee, S., Woodley, S., Fox, H.E., 2017. Capacity shortfalls hinder the performance of marine protected areas globally. Nature 543, 665-669.
26519	5	148	0	149		<p>OA: Is there a governance gap? Is a catchy title, but what does one govern other than reduction of emissions that cause OA? The text points more towards a gap in considering OA in climate change discussions and negotiations, which is right. But to use the term governance is to me confusing and adds unnecessary complexity to the section. [Florence Poulain, Italy]</p>	Taken into account. Text edited
9839	5	148	1	148	1	<p>Why focusing solely on acidification in this paragraph? The content appears to be vague and incomplete in regards of the relationships between ocean and climate governance. [Government of France, France]</p>	Taken into account. Text edited
2657	5	148	1	148	15	<p>5.5.3.4 is brief, vague, contains no references, and does not effectively summarize the preceding sections or contain enough information to stand on its own. This section either requires a fundamental rewrite or should be removed. [Brian Pentz, Canada]</p>	Taken into account. Text edited
14559	5	148	3	148	15	<p>Again, just seems to be an opinion piece, which I'm not sure can be backed up (at COP24 OA was quite prominent) [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]</p>	Taken into account. Text edited

SROCC Second Order Draft Government and Expert Review Compiled Comments - Chapter 5							Chapter Team Response
Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
34017	5	148	3	148	6	No data to support this statement. Changes to ecosystems beyond changes in chemistry have not been documented. [Government of United States of America, United States of America]	Taken into account. Text edited
8115	5	148	4	0		Suggest remove "the" before "calcareous" [Nina Hunter, South Africa]	Taken into account. Text edited
34019	5	148	6	148	7	This sentence needs to be in the future tense, such as "may be very substantial". No evidence for large effects of OA that are happening right now. [Government of United States of America, United States of America]	Taken into account. Text edited
21193	5	148	6	148	8	Please support these two sentences with a reference and confidence level [APECS Group Review, Germany]	Taken into account. Text edited
8117	5	148	7	0		Suggest remove "the" before "ocean" [Nina Hunter, South Africa]	Taken into account. Text edited
10763	5	148	8	149	12	Is that really useful in an IPCC assessment? Should be cut. [Jean-Pierre Gattuso, France]	Taken into account. Text edited
26703	5	148	10	148	11	If ocean acidification is a result of other activities, then presumably one wants international instruments directed towards those activities and not the outcomes of those activities. [Florence Poulain, Italy]	Taken into account. Text edited
8119	5	148	12	0		Suggest change "aiming" to "aimed" [Nina Hunter, South Africa]	Taken into account. Text edited
8121	5	148	15	0		Suggest change "in taking actions" to "to taking action" [Nina Hunter, South Africa]	Taken into account. Text edited
9841	5	148	20	148	20	Why is this only for ocean acidification? Does it mean that there is no governance gap for dealing with temperature change and deoxygenation? [Government of France, France]	Taken into account. Text edited
14561	5	148	20	149	31	I'm not sure what the purpose of this box is, it does not seem to fit with the rest of the text. It comes close to sounding like an opinion piece or an attempt to drive policy [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	Taken into account. Text edited
14563	5	148	20	149	31	There are several published papers that refer to the economic consequences of ocean acidification for commercial species, these should be added and referenced in the text (e.g. Mangi, Cooley, Fernandes) [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	Taken into account. Text edited
13075	5	148	20	149	33	The special case of ocean acidification in Box 5.5 (Policy Responses to Ocean Acidification: Is there a Governance Gap?) including perception on governance level was described quite well. [Government of Germany, Germany]	Taken into account. Text edited
23271	5	148	22	148	32	This is not written in the style of an assessment grounded in the analysis of evidence. Reconsider framing of question. Box missing an answer to the question. [Valerie Masson-Delmotte, France]	Taken into account. Text edited
14565	5	148	30	148	31	This sentence refers to the lack of inclusion of OA in current policies. Recommend including a positive message detailing ways in which OA could be added to tackle this issue rather than be dismissed. [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	Taken into account. Text edited
5101	5	148	45	148	45	Drop "IAEA" as acronym was used only once in the chapter [Debra Roberts and Durban Team, South Africa]	Taken into account. Text edited

SROCC Second Order Draft Government and Expert Review Compiled Comments - Chapter 5							
Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
14567	5	148	47	148	48	The logic or flow of this section is unclear, please explain what the policy framework and general assembly are. A well thought out summary table might help to bring out the key points / arguments. [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	Taken into account. Text edited
14573	5	149	1	149	5	There are several experiments that have demonstrated the importance of pH changes across pollutants, metals and the toxicity of low pH across several contaminants. This evidence should be added and the relevant references cited. [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	Taken into account. Text edited
14575	5	149	10	149	11	It is important to document the current initiatives to support OA monitoring. The Global Network is only a vehicle to share and store information. This section should emphasize the need to support ongoing monitoring programmes to understand variability in the carbonate system. Equally important is the sample analysis, which should be routinely QA/QC to ensure the results and the analysis are compatible for integration and comparability across a network such as GOA-ON. [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	Taken into account. Text edited
17115	5	149	13	149	13	The words "adapting human activities" should be "reducing human activities" such as reducing uptake of fertilizers in farming especially near coastal strips. [Government of United Republic of Tanzania, United Republic of Tanzania]	Taken into account. Text edited
14577	5	149	19	149	22	The study of socio-economic impacts with regards to OA has been covered by work conducted by Mangi, Narita, etc. Some citations are needed in this section to showcase the importance and the benefits of understanding the magnitudes of such effects. [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	Taken into account. Text edited
25313	5	149	19	149	31	This paragraph ends abruptly; how about some statement concerning the effectiveness or success to date of FOARAM, EU statements, or GOA-ON? [Sarah Cooley, United States of America]	Taken into account. Text edited
17117	5	149	23	149	23	The work "many" in the sentence may be removed [Government of United Republic of Tanzania, United Republic of Tanzania]	Text rewritten. No longer relevant
14579	5	149	28	149	29	"extra-ordinary" delete as too easily misinterpreted. [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	Text rewritten. No longer relevant
8123	5	149	29	0		Suggest remove colon [Nina Hunter, South Africa]	Text rewritten. No longer relevant
10761	5	149	36	0		5.5.3.5 could be cut and focused on the assessment. [Jean-Pierre Gattuso, France]	Text rewritten to focus on assessment
14569	5	149	36	151	5	Use of words 'troubling phenomenon' and 'dangerous' are not neutral. [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	Text rewritten. No longer relevant
8125	5	149	38	0		Suggest insert "the" before "policy framework" [Nina Hunter, South Africa]	Text rewritten. No longer relevant
22781	5	149	38	149	45	UNGA resolutions on acidification are quoted. The document should equally identify others, namely the provisions on 61/105 and subsequent resolutions on the protection of vulnerable marine ecosystems. [Greenpeace Group Review, Republic of Korea]	Text rewritten. No longer relevant
5103	5	149	38	151	5	There is no assessment of the information presented here. [Debra Roberts and Durban Team, South Africa]	Text rewritten.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
21173	5	149	39	151	5	On line 38, add "The United Nations" before 'General Assembly' and "and its member States' after such that the context of the capitalized 'States' through out this section is clear. 'States' in this section refers to member nations of the UN General Assmebly. As currently written this is would not be clear to someone who does not egualrly engage with this body. [APECS Group Review, Germany]	Text rewritten. No longer relevant
8127	5	149	54	0		Suggest change "continued" to "continues" [Nina Hunter, South Africa]	Text rewritten. No longer relevant
14571	5	149	54	149	55	Suggest that the importance of understanding OA effects on commercial species, to safeguard stocks and to warrant aspts of food security should be added to this section to show the importance of proactively working towards this common goal. [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	Text rewritten. No longer relevant
25315	5	150	8	150	12	And? This paragraph needs more information or needs to be cut. It mentions a workshop but fails to explain how that advanced the situation. Likewise, the text surrounding it on this page also needs to be synthesized better to show how international policy has called for changes and is or is not succeeding. [Sarah Cooley, United States of America]	Text rewritten. No longer relevant
26705	5	150	46	150	46	What is the source of this estimate of 3 billion people? [Florence Poulain, Italy]	Text rewritten. No longer relevant
21195	5	150	46	150	52	Please reword this paragraph. It's meaning is unclear. The firs sentence is unnecesarily long and complicated. Additionally the IUU acronym is spelled out here but the acronym itself needs to be given in parenthesis (IUU) [APECS Group Review, Germany]	Text edited
8129	5	150	56	0		Suggest change "increase" to "increased" [Nina Hunter, South Africa]	Text edited
8131	5	150	57	0		Suggest change "did" to "do" [Nina Hunter, South Africa]	Text edited
23273	5	151	0	151		I am not convinced by the added value of this synthesis section and prefer that this is used to shape the ES. It does not use the confidence language as in the text. Please use it to sharpen the ES and improve its storyline. [Valerie Masson-Delmotte, France]	taken into account - Text changed and confidence and assessment of the text brought into account.
14581	5	151	10	151	10	"raises questions abouth the ability" - not neutral text. [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	Taken into account. Text edited
13077	5	151	10	151	11	The text says that "This chapter has documented an extra-ordinary array of changes that have been observed in the open ocean and coastal seas.", but it seems that these are limited to the perspectives of human use or feedback to humans. Please clarify. [Government of Germany, Germany]	Taken into account - text revised to make clearer that we mean changes in physical and biogeochemical, and also that human systems have changed
26707	5	151	11	151	12	And vice versa -- the ocean is changing and humans are being affected by these changes - just as much as human communiities are changing and thus changing the state of the ocean. [Florence Poulain, Italy]	Taken into account - text revised to make clearer that we mean changes in physical and biogeochemical, and also that human systems have changed

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
778	5	151	18	151	22	The statement is too abstract. I think adding some example variables that can or cannot be directly attributed to anthropogenic forcing will help. [Mengxi Wu, United States of America]	Taken into account - text revised and new figure included.
8133	5	151	22	0		Suggest change "depedent" to "dependent" [Nina Hunter, South Africa]	Accepted - correction adopted
14585	5	151	23	151	25	A1 is ok but the rest require effort to improve clarity - currently it is clear or bitesized and so really hard to draw out any specific key messages. [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	Taken into account - text revised to improve clarity.
8135	5	151	24	0		Suggest change "experiment" to "experiments" [Nina Hunter, South Africa]	Accepted - correction adopted
9843	5	151	25	151	27	Missing the notion of ecosystem functions [Government of France, France]	Accepted - text modified to include function
8137	5	151	27	0		Suggest change "emission" to "emissions" [Nina Hunter, South Africa]	Accepted - correction adopted
8139	5	151	28	0		Suggest remove "all" as it has already been stated in line 27 [Nina Hunter, South Africa]	Accepted - correction applied
34021	5	151	28	151	28	Strike "all". [Government of United States of America, United States of America]	Accepted - correction applied
34023	5	151	29	151	29	Change to "increased atmospheric CO2" to account for ocean acidification. [Government of United States of America, United States of America]	Taken into account - ocean acidification is now mentioned as a driver
14583	5	151	36	151	36	For clarity, change sentence to "The change in risk level for the recent past and long term future is assessed by combining ecological and physiological knowledge...." [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	Accepted - suggestion implemented at an earlier set of lines
8141	5	151	44	0		Suggest insert "a" before "significant" [Nina Hunter, South Africa]	Accepted - correction adopted
22765	5	151	56	152	3	Results of Figure 5.1 could be stressed more around the impact that may seem subtle from the beginning but may have increasing implications with time therefore it is necessary to build knowledge and take precautionary action. Additionally the complexity of the system should be raised to add to this point. [Greenpeace Group Review, Republic of Korea]	Taken into account - we have noted the system is complex, illustrated the global and regional scales of chang.
780	5	152	5	152	39	I think it is better to put these knowledge gaps in the order of physical and biogeochemical - biological - human, because this is the order of different sections. [Mengxi Wu, United States of America]	Accepted - bullet points were reordered.
15837	5	152	5	152	39	This would benefit from having a list of more detailed research needs summarised, for example, in a table format, given that this section raises key points for research targets and focusing of R&D effort. [EUCE, Belgium]	Taken into account - we are under significant page constraints and so have to shorten this section. A table of the research experiments has not been added, and is at the margins of the scope of this report.
26709	5	152	15	152	16	A more complete solution would be to establish studies that try to understand why humans drive climate change as mentioned on line 49, page 152, so that solutions to address the underlying causes (and not just the symptoms) could be developed. [Florence Poulain, Italy]	Taken into account - attribution of the causes is indeed one of the aims of this report, and requires superior records and data in the human systems than we currently have.
1805	5	152	17	0		In addition to the listed uncertainties, I would suggest adding the effects of interactions between multiple stressors. Furthermore, as organisms are almost always studied independently of the rest of the ecosystem, there is a clear lack of knowledge about ecosystem effects and "regime-shifts" generated by interactions between organisms. [Mark Payne, Denmark]	Taken into account - multiple stressors are now noted

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
15787	5	152	17	0		In addition to the listed uncertainties, it is suggested adding the effects of interactions between multiple stressors. Furthermore, as organisms are almost always studied independently of the rest of the ecosystem, there is a clear lack of knowledge about ecosystem effects and "regime-shifts" generated by interactions between organisms. [EUCE, Belgium]	Taken into account - multiple stressors are now noted
22767	5	152	17	152	19	Suggestion for authors to add: a) the need to further our understanding, and b) human activities should act on precautionary principle [Greenpeace Group Review, Republic of Korea]	Rejected - "precautionary principle" is completely laudable for building resilience but is verging on policy prescriptive and so out of scope.
9845	5	152	17	152	24	While knowledge is known about some organismal groups, there are others for which we are totally ignorant, eg, how will parasites be affected? how about viruses? It will therefore be important to aim for a holistic understanding of the response of the entire ecosystem (including viruses) rather than just a handful of organismal groups because organisms do not live in isolation. [Government of France, France]	Taken into account - these types of organisms are now acknowledged specifically
10765	5	152	17	152	24	I would like to recall the arguments developed by Riebesell & Gattuso (2015) in the context of ocean acidification but which apply also to other drivers. Move from effects of single drivers to multiple drivers, from individuals to community and ecosystems, and from short term to long term experiments. The later is to address the lack of understanding of adaptive processes which must be mentioned in this section. Riebesell U. & Gattuso J.-P., 2015. Lessons learned from ocean acidification research. Nature Climate Change 5:12-14. [Jean-Pierre Gattuso, France]	Taken into account - noted multiple drivers, and single organisms to communities.
15839	5	152	17	152	24	The uncertainty relating to data gaps in biological processes and monitoring are not covered deeply enough. It would be useful to have a deeper discussion of the research gaps that need addressing (many of them mentioned in this chapter, but scattered/throughout) - this is particular relevant as biological processes cover changes to biological cycles/food webs and subsequently biodiversity, and have a direct effect on key food production sectors, notably aquaculture and fisheries, with the potential to affect the livelihoods and food security. Furthermore, the cover of such impacts in the current report is rather soft and would benefit from added information on socio-economic impacts (as this would further draw attention to the need to address climate change). [EUCE, Belgium]	Taken into account - we have added some additional factors around biological processes

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
30467	5	152	24	152	24	Big Data and Machine Learning solutions might help bridging the gap in scientific understanding for a number of marine environments. [Michele Capobianco, Italy]	Rejected - while we agree with the sentiment we think this point is out of scope for this report
8143	5	151	46	0		Suggest insert "a" before "critical" [Nina Hunter, South Africa]	Accepted - as suggested
10767	5	152	25	0		Poor capabilities in predictive modeling of coastal areas. [Jean-Pierre Gattuso, France]	Accepted - and text modified
782	5	152	25	152	39	This paragraph can also mention the high model uncertainty in projecting some nutrients (e.g., iron) and primary production and the poor representations of processes such as atmospheric deposition. [Mengxi Wu, United States of America]	Taken into account - the text has been clarified that these types of processes are also included.
8145	5	152	38	0		Suggest change "needs" to "need" [Nina Hunter, South Africa]	Accepted - as suggested
3555	5	152	41	152	41	This sentence states "See Cross-chapter Box 5 'Southern Ocean Circulation: Drivers Changes and Implications". However, it is not clear why this is here? Are there additional gaps in our knowledge listed in that Box? If so, mention that here as the motivation for referencing Box 5. [Sonya Legg, United States of America]	Taken into account - the reference to the cross chapter box is there for information, it can be found in chapter 3
1513	5	152	46	0		Good to have the figure. Could be improved by having larger fonts and sizes of images, and also to include other ecosystems such as mangroves [Chandani APPADOO, Mauritius]	Taken into account. Figure text resized. Ecosystems reflect those in the text, which does not include mangroves.
1515	5	152	46	0		Can also include a figure or table highlighting on the effects of climate change on life in the sea. This is important to create impact and also like a take home message. [Chandani APPADOO, Mauritius]	Taken into account. FAQ 5.1 Fig 1 does this in line with text.
22769	5	152	46	152	46	Suggestion to add questions: a) Where we should focus more to understand deep sea ecosystems; b) What are the intergovernmental interventions we could consider currently? [Greenpeace Group Review, Republic of Korea]	Accepted. Final sentence reflects intergovernmental interventions. Deep sea reef research referred to in paragraph 2
14587	5	152	46	153	39	Recommend separating out the Caribbean from Latin America as they are very different regions. Better to group Caribbean with other SIDS in terms of challenge faced/exposure. Population and built environment in Caribbean is similar levels to that for Pacific islands (~57% in risk prone coastal areas as stated in line 12 of same paragraph) with most located within 1-1.5km of coastline. [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	Accepted. Paragraph 2 edited to acknowledge regional differences in impacts.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
16803	5	152	46	153	39	We appreciate the summary of climate change effects on life in the sea provided in FAQ5.1. A few thoughts and suggestions: the section on coral reef degradation could mention the fact that tropical coral reefs are nurseries for many fish and other marine species. That may convey their ecological importance better than a simple reference to "biodiversity". On p 153 ln19, the formulation "losses may be partly offset" is very odd in the context of regionally differentiated impacts. The whole para should be edited for clarity and less "model-result" focus. In the para starting ln 23, we miss a reference to risks to food webs through impacts on species on lowest trophic level. Throughout FAQ5.1, there is hardly any reference to ocean acidification, and none to marine heat waves - is this by design? Finally, the three lines on (economic) consequences for human societies are a little out of context, and quite strongly worded given no evidence is provided. It is also, strictly speaking, not within the scope of the FAQ (life in the sea). We'd suggest to simply delete the paragraph, as we do not really see how its strong claims can be substantiated within the scope of this FAQ. For Figure 1, please make sure that your wording is consistent with the glossary, especially for the terms "impact" (caption). [Government of Germany, Germany]	Accepted, First sentence edited to acknowledge importance of tropical coral reefs. P153 ln 19 edited for clarity. ln23 edited to include micro-organisms. Due to constraints with length of FAQ we picked out the most pressing and (likely) needed impacts to focus on coral bleaching and fisheries impacts, yes, by design. We disagree about humans not having a presence in the sea, and certainly feel that readers will want to make the connection between impacts in the sea and themselves. Consequently, we keep the paragraph but link to the relevant section in Ch5. Text has changed to ensure impact use is consistent with glossary, but in the caption, reference to human impacts is considered not to conflict with the IPCC usage of the term i.e. The glossary guides on the usage of climate change impacts, but this term is not for the exclusive use of climate change. It is possible to also have human impacts.
23275	5	153	0	153		Nice FAQ. Only point : why insist on storminess here (caption of figure) while assessment very cautious about changes in storminess? [Valerie Masson-Delmotte, France]	Accepted. Caption and image edited to remove reference to increasing storm damage, and rather reflects interactions of climate change impacts with storm damage.
9847	5	153	5	153	6	This sentence is not exact. It could be deleted. [Government of France, France]	Taken into account. Sentence edited to increase accuracy.
21175	5	153	13	153	17	This section concentrates specifically on fish and how climate change affects fish populations and fisheries, with over-fishing, acidification and temperature being mentioned as stressors. It may be useful to expand this by a sentence or two stating that the entire ecosystem will be disturbed by these and other stressors. Fish populations will be sensitive to loss of their food source/prey and by loss of species at the bottom of the food chain, something that is not mentioned here [APECS Group Review, Germany]	Taken into account. Text edited to reflect impacts on other ecosystems and humans. Including details of these impacts is not possible due to word count constraints.
1807	5	153	19	0		"Losses may be partly offset..." should be changed to "Losses on the global scale may be partly offset..." - lots of cod in the Barents Sea is not much use to subsistence fishers in the horn of africa! [Mark Payne, Denmark]	Taken into account. Text is edited in response to Comment 16803, addressing this comment too.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
15789	5	153	19	0		"Losses may be partly offset..." should be changed to "Losses on the global scale may be partly offset..." - lots of cod in the Barents Sea is not much use to subsistence fishers in the Horn of Africa! [EUCE, Belgium]	Taken into account. Text is edited in response to Comment 16803, addressing this comment too.
26711	5	153	32	153	32	If the basis for the people in these regions having the least adaptive capacity is not explained, then it simply sounds condescending. This must be addressed in terms of governance challenges, rule of law, political economy and economics. [Florence Poulain, Italy]	Accepted. Text edited to reflect the high dependencies of some communities upon natural resources.
25537	5	153	33	153	33	limiting warming to well below 2°C. WHY NOT USE THE 1.5 DEGREE BENCHMARK? [Christophe Deissenberg, Luxembourg]	Accepted. Text edited to reflect 1.5 C
3981	5	153	34	153	39	At the intersection of 'ocean de-oxygenation' and 'Coral reefs', the diagram for 'storm damage' looks more like wave damage. Maybe a wind or hurricane sketch might be a better option than waves? [Aakash Sane, United States of America]	Rejected. Hurricanes, and their winds, create the waves which actually damage the reefs, hence this icon used.
10289	5	153	35	153	36	FAQ 5.1, Figure 1. texts/labes better be enlarged for better readability [Jinsoon Park, Republic of Korea]	Accepted.
21753	5	153	35	153	36	FAQ 5.1, Figure 1. texts/labes better be enlarged for better readability [Government of Republic of Korea, Republic of Korea]	Accepted.
1847	5	153	35	153	39	(1) Resulting consequence for Coral reefs: isn't economic loss from reduced tourism expected here? (2) Resulting consequence for Polar seas: Why is reduced nutritional health restricted to indigenous people if bioaccumulation of pollutants impacts species that are fished and then distributed globally? [Lydia Kapsenberg, Spain]	Noted. Word count constraints do not allow for such details, hence we cannot edit that text to include these suggestions.
31731	5	153	36	0		FAQ5.1, Figure 1. Increase font size. [Hans-Otto Poertner and WGII TSU, Germany]	Accepted.
30171	5	154	59	154	59	Please, also include the following reference in here (right above Alava et al., 2017.....): Alava, J.J., Cisneros-Montemayor, A.M., Sumaila, R., Cheung, W.W.L. 2018. Projected amplification of food web bioaccumulation of MeHg and PCBs under climate change in the Northeastern Pacific. Scientific Reports 8:13460 DOI:10.1038/s41598-018-31824-5 [Juan Jose Alava, Canada]	Taken into account
9849	5	156	17	156	17	Herndl [Government of France, France]	Edited
12185	5	166	8	166	8	No journal title, volume or pages listed for Crooks et al. 2011. [Christopher Vivian, United Kingdom (of Great Britain and Northern Ireland)]	Edited
21079	5	166	57	166	58	Reference lacks of additional information of the document. (eds., book, journal info, etc). [APECS Group Review, Germany]	Edited

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
30173	5	168	47	168	47	Please add the following reference here (above Desforbes et al. 2016): Desforbes, J.P., Hall, A., McConnell, B., Rosing-Asvid, A., Barber, J.L., Brownlow, A., De Guise, S., Eulaers, I., Jepson, P.D., Letcher, R.J., Levin, M., Ross, P.S., Samarra, F., Vikingson, G., Sonne, Christian, Dietz, R. 2018. Predicting global killer whale population collapse from PCB pollution. Science 361(6409): 1373-1376. [Juan Jose Alava, Canada]	Taken into account
21077	5	175	1	175	2	Reference of Gattuso et al 2018 needs to be updated. It was published now in a different journal: Gattuso, J. P., Magnan, A. K., Bopp, L., Cheung, W. W., Duarte, C. M., Hinkel, J., ... & Billé, R. (2018). Ocean solutions to address climate change and its effects on marine ecosystems. Frontiers in Marine Science, 5, 337. [APECS Group Review, Germany]	Edited
4181	5	175	6	175	9	Gehlen et al reference appears twice, a and b, but it's the same ref [Carles Pelejero, Spain]	Edited
29141	5	176	56	176	56	A reference to the study by Gruber et al., 2018 cited in the text in page 22 is missing in the reference list. [Pedro J. Llanillo, Chile]	Edited
11973	5	180	46	180	47	Change font [Wolfgang Kiessling, Germany]	Edited
11975	5	180	53	180	55	Change font [Wolfgang Kiessling, Germany]	Edited
26779	5	183	56	183	57	Insert: Jutfelt, F., T. Norin, R. Ern, et al., 2018: Oxygen- and capacity-limited thermal tolerance: blurring ecology and physiology. Journal of Experimental Biology 221, jeb169615. [Lars Tomanek, United States of America]	Edited
16977	5	186	31	186	31	Krumhans should be Krumhansl [Hege Gundersen, Norway]	Edited
3673	5	186	48	186	48	update citation: Kuwae, T. and M. Hori, 2019: Blue Carbon in Shallow Coastal Ecosystems: Carbon Dynamics, Policy, and Implementation, Springer Nature, DOI: 10.1007/978-981-13-1295-3 [Tomohiro Kuwae, Japan]	Edited
4191	5	186	51	186	54	Duplicated reference [Carles Pelejero, Spain]	Edited
12187	5	186	53	186	54	Kwiatkowski et al. (2017b) is identical to Kwiatkowski et al. (2017a). [Christopher Vivian, United Kingdom (of Great Britain and Northern Ireland)]	Edited
4185	5	188	44	188	47	Duplicated reference, the right one is the 2018 ref. Check the main text for Levin 2017 citations that should be Levin 2018 [Carles Pelejero, Spain]	Edited
9157	5	193	32	193	33	The Melet et al. 2015 reference (cited in page 20, lines 26-28) should be corrected to: A. Melet, R. Hallberg, A. Adcroft, M. Nikurashin, S. Legg, 2015. « Energy flux into internal lee waves: sensitivity to future climate changes using linear theory and a climate model ». Journal of Climate, vol 28, pp. 2365–2384, doi: 10.1175/JCLI-D-14-00432.1. [Angelique Melet, France]	Edited
10291	5	201	46	201	46	sizes of the text should be equal [Jinsoo Park, Republic of Korea]	Edited
21755	5	201	46	201	46	Sizes of the text should be equal. [Government of Republic of Korea, Republic of Korea]	Edited

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
11977	5	201	46	201	47	Change font [Wolfgang Kiessling, Germany]	Edited
11979	5	203	11	203	12	Title of paper wrong: Correct reference is: Riebesell U, Bach Lennart T, Bellerby Richard GJ, Monsalve JRafael B, Boxhammer T, Czerny J, Larsen A, Ludwig A, Schulz Kai G (2017) Competitive fitness of a predominant pelagic calcifier impaired by ocean acidification. Nature Geoscience 10:19-23 [Wolfgang Kiessling, Germany]	Edited
30175	5	206	29	206	29	Please, add the following reference here: Scheuhammer, A., Braune, B., Chan, H. M., et al. (2015). Recent progress on our understanding of the biological effects of mercury in fish and wildlife in the Canadian Arctic. Science of the Total Environment, 509– CRC Press Boca Raton. [Juan Jose Alava, Canada]	Edited
26781	5	206	52	206	53	Insert: Schulte, P. M., 2015: The effects of temperature on aerobic metabolism: towards a mechanistic understanding of the responses of ectotherms to a changing environment. Journal of Experimental Biology 218, 1856-1866. doi:10.1242/jeb.118851. [Lars Tomanek, United States of America]	Edited
26783	5	209	31	209	32	Insert: Sokolova, I. M., M. Fredrich, R. Bagwe, G. Lannig and A. A. Sukhotin, 2012: Energy homeostasis as an integrative tool for assessing limits of environmental stress tolerance in aquaitc invertebrates. Marine Environmental Research 79, 1-15. [Lars Tomanek, United States of America]	Edited
26785	5	209	32	209	33	Insert: Somero, G. N., B. Lockwood and L. Tomanek, 2017. Biochemical Adaptation: Responses to Environmental Challenges from Life's Origins to the Anthropocene. Sinauer Associates Inc, Sunderland, Massachusetts. [Lars Tomanek, United States of America]	Edited
11981	5	209	49	0		Journal reference incomplete - check also other instances of Proceedings of the Royal Society B: Biological Sciences [Wolfgang Kiessling, Germany]	Edited
26787	5	210	13	210	14	Insert: Stillman, J. H., 2003: Acclimation capacity underlies susceptibilityto climate change. Science 301: 65. [Lars Tomanek, United States of America]	Edited
16619	5	210	27	210	28	While the online version of this was published in 2011, the print version of this article was actually published in 2012 and I think the reference should be Stramma et al., 2012. [David Janssen, Switzerland]	Edited
9955	5	210	49	0		This reference should be updated to: Sutton, A. J. et al., 2018: Autonomous seawater pCO2 and pH time series from 40 surface buoys and the emergence of anthropogenic trends. Earth Syst. Sci. Data Discuss., 2018, 1-23, doi:10.5194/essd-2018-114. [Adrienne Sutton, United States of America]	Taken into account

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
258	5	211	22	211	23	Looking at the context, I believe that Talley et al., (2016a) be a different literature; Feely et al., 2014, The US Repeat Hydrography CO2 Program (GO-SHIP): Accomplishments from the first decadal survey. A US CLIVAR and OCB Report, 2014-15, US CLIVAR Project Office, 2014. [Katsuro Katsumata, Japan]	Taken into account
26789	5	212	48	212	49	Insert: Tomanek, L., 2010: Variation in the heat shock response and its implication for predicting the effect if global climate change on species' biogeographical distribution ranges and metabolic costs. Journal of Experimental Biology 213, 971-979. [Lars Tomanek, United States of America]	Taken into account
26791	5	212	49	212	50	Insert: Tomanek, L., and G. N. Somero, 1999: Evolutionary and acclimation-induced variation in the heat-shock responses of ocngeneric marine snails (Genus Tegula) from different thermal habitats: implications for limits of thermotolerance and biogeography. Journal of Experimental Biology 202, 2925-2936. [Lars Tomanek, United States of America]	Taken into account
30177	5	216	23	216	23	Please, add the following reference here: Wiener, J., Bodaly, R., Brown, S., et al. (2007). Monitoring and evaluating trends in methylmercury accumulation in aquatic biota. In R. Harris, D. P. Krabbemhoft, R. Mason, M. W. Murray, R. Reash & T. Saltman (Eds.), Ecosystem responses to mercury contamination (pp. 87–122). FL: CRC Press Boca Raton. [Juan Jose Alava, Canada]	Taken into account
24877	5	220	0	0		add line: Irminger Sea (A25 OVIDE) / 0.0184 / 0.0008 García-Ibáñez et al. 2016 1991-2016 merged ship occupations García-Ibáñez et al. 2016 Biogeosciences, 13, 3701–3715, 2016 www.biogeosciences.net/13/3701/2016/ [Fernandez Fiz, Spain]	Taken into account
24879	5	220	0	0		add line: Iceland Sea (A25 OVIDE) / 0.0159 / 0.0015 García-Ibáñez et al. 2016 1991-2016 merged ship occupations García-Ibáñez et al. 2016 Biogeosciences, 13, 3701–3715, 2016 www.biogeosciences.net/13/3701/2016/ [Fernandez Fiz, Spain]	Taken into account

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
10769	5	220	3	0		<p>This table is incomplete. Several papers described time series after Williams et al. Published their synthesis. I have restricted the list below to papers providing observations, with a duration of about 10 years or more. Among the missing ones are:</p> <p>Salisbury J. E. & Jönsson B. F., 2018. Rapid warming and salinity changes in the Gulf of Maine alter surface ocean carbonate parameters and hide ocean acidification. <i>Biogeochemistry</i> 141:401-418.</p> <p>Merlivat L., Boutin J., Antoine D., Beaumont L., Golbol M. & Vellucci V., 2018. Increase of dissolved inorganic carbon and decrease in pH in near-surface waters in the Mediterranean Sea during the past two decades. <i>Biogeosciences</i> 15:5653-5662.</p> <p>Watanabe Y. W., Li B. F. & Wakita M., 2018. Long-term trends of direct-and indirect-anthropogenic effects on changes in ocean pH. <i>Geophysical Research Letters</i> 45:9106-9113.</p> <p>Law C. S., Bell J. J., Bostock H. C., Cornwall C. E., Cummings V. J., Currie K., Davy S. K., Gammon M., Hepburn C. D., Hurd C. L., Lamare M., Mikaloff-Fletcher S. E., Nelson W. A., Parsons D. M., Ragg N. L. C., Sewell M. A., Smith A. M. & Tracey D. M., 2017. Ocean acidification in New Zealand waters: trends and impacts. <i>New Zealand Journal of Marine and Freshwater Research</i> 1-41.</p> <p>Kapsenberg L., Alliouane S., Gazeau F., Mousseau L. & Gattuso J.-P., 2017. Coastal ocean acidification and increasing total alkalinity in the northwestern Mediterranean Sea. <i>Ocean Science</i> 13:411-426.</p> <p>Bates N. R., 2017. Twenty years of marine carbon cycle observations at Devils Hole Bermuda provide insights into seasonal hypoxia, coral reef calcification, and ocean acidification. <i>Frontiers in Marine Science</i> 4:362.</p> <p>Hauri C., Doney S. C., Takahashi T., Erickson M., Jiang G. & Ducklow H. W., 2015. Two decades of inorganic carbon dynamics along the West Antarctic Peninsula. <i>Biogeosciences</i> 12:6761-6779. [Jean-Pierre Gattuso, France]</p>	This is intended to provide examples of observational datasets, and not aim for a comprehensive metadata of all available time series.
31733	5	223	10	0		<p>Appendix 5.A, Figure 1. Caption needs more explanation. For example how is the square in the map connected with the graph? The line is not connected. [Hans-Otto Poertner and WGII TSU, Germany]</p>	Materials re-written.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
13079	5	224	2	224	3	<p>Relating to Step 1: "The HSI is computed using ... IPSL, MPI and GFDL model under RCP8.5". Since the RCP8.5 is a scenario of projected changes, this step seems only the explanation of how the habitat models were projected onto the future, but it says nothing about how the habitat models were trained or calibrated with past historical data. Thus, the computation of the habitat suitability index is not detailed enough. It is also not clear where the observations of fish distribution and environmental variables are coming from. Are the North Sea cod data coming from IBTS or commercial fisheries? Was the historical run of RCP8.5 used to train the habitat models instead of observations of environmental variables? This surely would not have been right, since the ESMs are coupled atmosphere-ocean models, which do not reproduce the past inter-annual and decadal variability contained in the fishery observations. Moreover, ESMs have well known regional biases which would mask the real climate-fish relation. Were those regional bias removed with environmental observations before matching fish and environmental data? If I am misunderstanding something please rewrite for clarity, otherwise I would say that the statements of Box 5.1 relating the ToE deserve (roughly) a medium to low confidence? On my own experience, fish habitat models calibrated with ESMs or GCMs are so unrealistic that you cannot really make any serious statement with them! And I am actually speaking about the same case as one of those discussed here, i.e., an habitat model of North Sea cod calibrated with MPIOM output data. We decided at the end to use observations of temperature for the calibration (under review in ICESJMS). [Government of Germany, Germany]</p>	Deleted (Box figure and appendix). Comments no longer relevant.
13081	5	233	4	233	4	<p>I was wondering all the time how the habitat models from Box 5.1 were calibrated and only found the answer in this appendix by chance. Did I overlook a cross-reference to this appendix in Box 5.1? Otherwise please insert one. [Government of Germany, Germany]</p>	Deleted (Box figure and appendix). Comments no longer relevant.