SROCC First Order Draft Expert Review Comments - Chapter 5							
Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
140	5	0	0	0	0	No mention of harmful algal bloom toxins in this chapter. Ciguatera, domoic acid, and paralytic shellfish poisoning should get at least a mention as (low confidence) possibly increasing with climate change. [Matthew Gribble, USA]	We have now added a box on Harmful Algal Bloom and its impacts under cliamte change.
142	5	0	0	0	0	Would be good to mention indigenous traditional art motifs and include one as a figure [Matthew Gribble, USA]	We have a section dedicated to indigenous culture, including arts. Unfortunately, given the limited space, the chapter could not include an indigenous art as illustration.
1376	5	0	0			Leith, P., O'Toole, K., Haward, M., Coffey, B., Rees, C., Ogier, E. 2014. Analysis of Operating environments; A diagnostic model linking science, society and policy for sustainability. Environmental Science & Policy 39: 162-171. [Marcus Haward, Australia]	Taken into account as part of the content in Section 5.5
1378	5	0	0			Leith. P., O'Toole, K., Haward, M., and Coffey, B. 2017. Enhancing Science Impact: Bridging Research, Policy and Practice for Sustainability. CSIRO Press, Melbourne [Marcus Haward, Australia]	Taken into account as part of the content in Section 5.5
1500	5	0	0			GENERAL COMMENT ON THE CHAPTER: The Mediterranean Sea is mentioned several times, especially with reference to its increasing temperature and salinity. However there is no relevant literature cited with respect to this statement. The report should enhance the description of what is happening in the Mediterraenaen Sea, in terms of modification of the hydrological cycle and to the rapid warming of its water masses, because even if it is a small sea it is quite important for a number of reasons: 1) milions of citizens living along its coasts, 2) high % of global Maritime traffic crossing it, 3) it has been recongized as a hot spot for global climate change, 4) milions of tourists every year. If the changing Mediterranean is not described in the report, then at least when mentioning it concerning its warming and salting trends, the references should be included. Here are some examples, but the list is not exhaustive: • Naranjo, C., J. García-Lafuente, S. Sammartino, J. C. Sánchez-Garrido, R. Sánchez-Leal, and M. Jesús Bellanco. 2017. Recent changes (2004–2016) of temperature and salinity in the Mediterranean outflow, Geophys. Res. Lett., 44, 5665–5672, doi:10.1002/2017GL072615. • Schroeder K, Chiggiato J et al., 2017. Rapid response to climate change in a marginal sea. Scientific Reports 7, 4065, doi:10.1038/s41598-017-04455-5 • Schroeder K., Chiggiato J et al., 2016. Abrupt climate shift in the Western Mediterranean Sea. Sci Rep 6:23009. • Rixen M, Bekers, JM et al., 2005. The western Mediterranean deep water: a proxy for climate change. Geophys Res Lett 32: L12608. • Skliris N., J. D. Zika, L. Herold, S. A. Josey, R. Marsh. 2017. Mediterranean Sea water budget long-term trend inferred from salinity observations. Clim Dyn (2018). https://doi.org/10.1007/s00382-017-4053-7. [Katrin Schroeder, Italy]	Taken into account.
1652	5	0	0			When writing about coral reefs, please clearly distinguish between tropical and cold water coral reefs. (Is "shallow" always "tropical" corals and "deep" always "cold water" corals?) Also please be consistent with the use of terms, both within this report and also with SR15. [Aurora Stenmark, Norway]	The text was altered as suggested by the reviewer.
2142	5	0	0			I find that it is a very extensive document, and very profuse in many details. It is true that carbon only focuses specifically on the point "5.2.13 Changes in Ocean Carbon" but then the OA appears in many other epigraphs [Fiz Fernandez Perez, Spain]	Taken into account

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3608	5	0	0	0	0	Chapters on Oceans and Coasts are generally well written and scientifically sound. However, for both Chapters there are very few references to Africa Continent - See some references, as included: Diop S. and Scheren P.A., 2016. Sustainable oceans and coasts: Lessons learnt from Eastern and Western Africa; Estuarine, Coastal and Shelf Science xxx; http://dx.doi.org/10.1016/j.ecss.2016.03.032 Diop, E.S., 1990. La côte Ouest-Africaine: du Saloum (Senegal) a la Mellacoree (Rep de Guinee). Coll. Etudes et Theses; Editions de l'ORSTOM e Paris, 2 vols plus illustrations and map plates, 379p. Diop, E.S., Gordon, C., Semesi, A.K., 2002. Mangroves of Africa. In: de Lacerda, L.D. (Ed.), Mangroves Ecosystems: Functions and Management. Springer Verlag Environmental Science Series, Berlin, pp. 61 to 121. Diop, S., Arthurton, R., Scheren, P., Kitheka, J., Koranteng, K., Payet, R., 2011. The coastal and marine environment of Eastern and Western Africa: challenges to sustainable management and socioeconomic development. In: Wolanski, E., McLusky, D.S. (Eds.), Treatise on Estuarine and Coastal Science, vol. 11. Academic Press, Waltham, pp. 315 to 335. Diop, S., Barusseau, J.-P., Descamps, C., 2014. The Land/Ocean Interactions in the Coastal Zone of W and C Africa. Estuaries of the World Series -XXII. Springer International. Diop, S., Scheren, P., Machiwa, J., 2016. Estuaries: a Lifeline of Ecosystem Services in theWestern Indian Ocean. Estuaries of the World Series. Springer International. [E. Salif Diop, Senegal]	Taken into account
3610	5	0	0	0	0	For both chapters , quite few references to SDG's 14 on Sustainable Oceans and Coasts towards 2030 main goal where international community is being engaged today. Issues of increasing vulnerability of the world coasts and oceans to multiple anthropogenic stresses to put forward. [E. Salif Diop, Senegal]	Taken into account.
4058	5	0	0			General comment: It is a strength of the chapter and the special report that impacts and consequences of non-climate human stressors on marine biodiversity and ecosystems are discussed in association with climate related impacts. Since it is the full picture of stressors that the species and ecosystems respond to it would be too simplistic to just consider anthropogenic climate stressors. [Aurora Stenmark, Norway]	Noted
4060	5	0	0			General comment: It is a strength the chapter that physical and chemical processes behind climate change consequences, such as oxygen levels, salinity, and ocean acidification, are explained in the text before reporting observations and future projections of these changes. [Aurora Stenmark, Norway]	Noted
4062	5	0	0			General comment: Please consider restructuring the text in a way that presents a clear distinction between i) expected changes and impacts based on trajectories up until present day (i.e. modelling historical data), ii) actual observed changes and impacts up until today in natural and social systems, iii) changes and impacts where evidence comes from experiments rather than observations in the field, iv) expected changes and impacts based on projections and scenarios for the future (i.e. modelling the future). [Aurora Stenmark, Norway]	Taken into account when revising the chapter
5012	5	0	0			Changes in Regional Seas are largely not discussed. I will include some Mediterranean references and would suggest that other experts to do the same for other basins when appropriate (e.g. different climatic response if compared with global one) [Alessandro Crise, Italy]	Taken into account. The revised chapter attempts to highlight regional differences when needed.

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5610	5	0	0			this review was prepared in collaboration with Coen Berntsen Tosac Kettler, Jasper de Jong, Maarten Muller, Frederik Felius, Rupert Holzinger all IMAU, UU [Roderik Van De Wal, Netherlands]	This is not a comment on the manuscript.
10998	5	0	0			The Chapter 3 authors should read this Chapter, consequences of climate impacts are clearly stated [Connie Lovejoy, Canada]	This is not a comment on the manuscript.
11034	5	0	0	0	0	My general comment on the sections that I have read are as follows: 1) I have questions on how the level of confidences and likelihood of an outcome have been assessed throughout the chapter. In IPCC Assessment Report (e.g. AR5), the confidence level and likelihood of an outcome are based on coordinated assessment efforts (e.g. CMIP) with clear established and common protocols based for instance on ensemble of models simulation and the analysis of large data sets of mainly physical variables. The procedure is less clear here and is probably more challenging to establish for the assessment of, for instance, biological systems. Also, in some parts (see details in the list of comments), outcomes presented with a high level of confidence seem to be in fact the result of one paper, or are contradicted in other sections. 2) Some parts of the executive summary do not have the necessary global meaning but appear as being specific, are only partly supported in the main text, are not really an assessment. (see details below) 3) Some sections are confused, lack of integration and the main messages do not clearly appear. [Marilaure Gregoire, Belgium]	We have now taken these comments into account when revising the chapter.
11754	5	0	0	0	0	Collecting more information becomes more complete. [Hanieh Zargarlellahi, Iran]	Taken into account when revising the chapter
13918	5	0	0			When introducing a new concept, such as "gyre", "heat flux", "flux field", "advection" , "Clausius-Clapeyron relationship", "atmospheric boundary layer", give it a brief explanation. [Debra Roberts and Durban Team, South Africa]	Technical terms that are not commonly understand are defined in the SOD .
13920	5	0	0			What is lability in this context? [Debra Roberts and Durban Team, South Africa]	This is now clarified
13922	5	0	0			Section 5.3.2 could do with a fresh look. Lots of vague statements and repetition. [Debra Roberts and Durban Team, South Africa]	Taken into account. This section has been revised accordingly
13924	5	0	0			There should be an entire section dedicated to biodiversity. With figures, observations, statistics. Currently biodiversity is treated as a factor of provisioning services, recreational services, economics, etc. but not in its own right. What has been published in this area? And exactly how will climate affect it? Section 5.2 is called "5.2 Changing Oceans and Biodiversity" but the text is almost completely oceanography, with only a nod to ecosystems and primary production, and only one Box on a few example species. Are there no data on what is happening to biodiversity? The word Biodiversity gets mentioned fairly often, but the subject does not get properly dealt with. [Debra Roberts and Durban Team, South Africa]	Taken into account. We interpret biodiversity as defined in the Convention on Biological Diversity, which emcompasses aspects from genetic, population, species to ecosystem levels. We attempt to better balance the assessment on these different aspects in SOD, and where there are specific focuses, we also explained the justification.
14014	5	0	0			This chapter, overall, could use VERY, very, very significant editing. I would recommend that this chapter not be longer than 60 pp maximum. This will require an effort to distill the core findings including, importantly, highlighting new findings since the IPCC AR5. I am guessing that most of this content is reflected in AR5 or will be covered in AR 6. As it stands now, this chapter alone is a slog to read. And it probably has too many figures. [Elizabeth Jewett, USA]	Taken into account in preparing the SOD.

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14018	5	0	0			It may make more sense to organize the chapter by geographic region as many of the subsections then delve into regional differences. It might make it easier for readers to follow the content if, for instance, all the Southern Ocean information were grouped together. [Elizabeth Jewett, USA]	Taken into account in preparing the SOD.
17886	5	0	0			The term "signal" is used throughout this chapter (and used much less in other chapters of this draft). It is ambiguous what is meant by signal. For example, does this mean a detected or attributed trend? If so, suggest using detection (detected) or attribution (attributed) instead of signal, and -- of course -- providing reference to studies on detection/attribution supporting the statement. If it means something other than detection/attribution, suggest stating what it means more clearly (e.g. is it simply that there is a trend in observations?). [Haroon Kheshgi, USA]	Taken into account in preparing the SOD.
17906	5	0	0			Regarding climate change mitigation, need to include the potential of CO2 captured by seaweed cultivation. According to study in Indoensia, for example, potency of carbon sequestration in Gerupuk Bay, Lombok Island reached 6656,51 tons C/year for K. alvarezii and 19,339.02 tons C/year for G. gigas cultivated using long-line system (Erlania et la., 2013). (doi: 10.15578/iaj.9.1.2014.65-72) [Erlania Erlania, Indonesia]	Taken into account in preparing the SOD.
17908	5	0	0			Other study undertaken by Erlania & Radiarta (2015) in Gerupuk Bay, Lombok Island, West Nusa Tenggara Province using four seaweed variants, including Kappaphycus alvarezii var., Tambalang and Maumere, K. striatum and Eucheuma denticulatum, were cultivated with long-line system for three cultivation periods. The results showed that E. denticulatum had the highest carbon sequestration rate and significantly different compared to the other variants for every cultivation period. Different seaweed variants have different capacity on carbon sequestration. The total yield of seaweed aquaculture could simply describe the amount of CO2 absorbed by seaweed cultivation. CO2 absorption analysis resulted based on cultivation periods could be applied to compose an alternative strategy for management of sustainable seaweed aquaculture, with even optimal production and positive contribution to the environment. Gerupuk Bay could support 321 units of long-line for sustainable seaweed cultivation based on its 157.71 ha of carrying capacity. (doi: 10.17265/2332-8223/2015.06.006) [Erlania Erlania, Indonesia]	Taken into account in preparing the SOD.

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17910	5	0	0			Some study showed that there is an important feature of seaweed that can prevent CO2 releasing from seaweed biomass back into the atmosphere. CO2 can be transformed into a refractory form of organic substances - substances which slowly decompose or even resistant to the decomposition process because of cell structure particularity - in seaweeds. These contents have cause seaweeds not easily defragmented and release CO2 even they convert into other products. A wide range of seaweed species has diverse contents like agars, carrageenans, xylans, alginates, and mannans which provide them distinct cell wall with macromolecular structural complexity and may distinguish the rates of the decaying process (Domozych, 2001; Trevathan-tackett et al., 2015). Hill et al. (2015) also state that most seaweed species creates calcium carbonate (CaCO3) which is retained for a long time after their live cells have decomposed. In addition, even some seaweed species require quite a high temperature in order to be degraded because of their specific composition. Trevathan-tackett et al. (2015) proved that seaweed species have less portion of mass loss when exposed by temperature more than 300 oC rather than some vascular plants tested. Both special composition and complex cell walls structure are the fundamental aspects of seaweeds' cell stability which encourages the long-storage possibility of CO2 in form of organic matters (Trevathan-tackett et al., 2015). Finally, combining these characters can significantly prevent CO2 emitted back to the atmosphere, and seaweed is undoubtedly taken into account of carbon sink agent (Hill et al., 2015). doi: 10.1002/9780470015902.a0000315.pub3; doi: 10.1002/lno.10128; doi: 10.1890/15-0149.1.sm [Erlania Erlania, Indonesia]	Taken into account in preparing the SOD.
19092	5	0	0			Missing information on limits to adaptation and loss and damage in marine ecosystems. Tropical coral reef dieback is just one out of many examples here. [Carl-Friedrich Schleussner, Germany]	Taken into account in preparing the SOD.
19096	5	0	0			The way the chapter deals with blue carbon is worrying in particular the suggestion of linking it to political processes. Cardinal issues like accounting (or double counting...) are not addressed. The challenges of accounting AFOLU based carbon emissions in the UNFCCC and the resulting peverse incentives and pitfalls should be a warning here. [Carl-Friedrich Schleussner, Germany]	Taken into account in preparing the SOD.
20984	5	0	0			sections 5.5 and 5.6 need to emphasize more on policy implications and on tools that have been recently developed for the integrated management of marine resources. For instance see Tsani and Koundouri, A methodological note for the development of integrated aquaculture production models with P. Koundouri, Frontiers in Marine Science, 4:406, (2018). [Stella Tsani, Greece]	Taken into account in preparing the SOD.
22196	5	0	0	0	0	This is a long report of 209 pages. The authors have done much of the hard work of pulling the information together, but the assessment of the work I find is weak in a lot of places and would need attention in the revision. The presentation of blue carbon is in my view not warranted by the small size of their mitigation potential, even though recognising their co-benefit is good. The chapter is missing critical information on the carbon cycle, especially since AR5. Details are provided in my specific comments. I have focused my review on the carbon cycle. [Corinne Le Quere, UK]	Taken into account. The sections related to carbon cycle is revised in SOD.

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23022	5	0	0	0		Granted, this is perhaps the most challenging chapter of all. But this version is far from where it needs to be. The issues range from overconfident statements, severe imbalance in terms of topics and coverage, unfortunate errors with regard to the citations, to unsupported and even wrong statements. [Nicolas Gruber, Switzerland]	Taken into account in preparing the SOD.
23222	5	0	0			Have the authors taken account of the feedback of the ecosystem changes to the physical properties of ocean? For example, the growth of phytoplankton decreases the light penetration into the seawater, which will aaffect the water temperature,through It might be slight. [Dongxiao Wang, China]	Taken into account in preparing the SOD.
23306	5	0	0			I found that text of the Executive Summary to be too rough for reviewers to provide comments on the scientific content, as the wording is too imprecise. Additionally, editing for grammar and flow is necessary, much beyond copyediting. It is often unclear whether the wording indicates the need for scientific revisions or simply improved grammar, as the intended meaning of the words is not immediately evident. [Ryan Rykaczewski, USA]	Taken into account in preparing the SOD.
24060	5	0	0			Be consistent in the use of terms (e.g. WG1 vs WGI) [Hans-Otto Poertner and WGII TSU, Germany]	The text was altered as suggested by the reviewer.
24062	5	0	0			Beside the main chapter introduction 5.1, this chapter has two more sections entitled "Introduction" (5.2.1.1 & 5.2.2.1). I suggest changing the titles of the two subsections to avoid confusion [Hans-Otto Poertner and WGII TSU, Germany]	Taken into account in preparing the SOD.
24064	5	0	0			be consistent in the use of full terms vs acronyms. Define at first mention and use acronym only in the following text [Hans-Otto Poertner and WGII TSU, Germany]	Taken into account in preparing the SOD.
24066	5	0	0			Whenever referring to information discussed in other chapters please provide details in which section of the chapter [Hans-Otto Poertner and WGII TSU, Germany]	Taken into account in preparing the SOD.
24068	5	0	0			please follow the SROCC styleguide for figure numbering and use lower case letter for different panels (a,b,c,...) [Hans-Otto Poertner and WGII TSU, Germany]	Taken into account in preparing the SOD.
24070	5	0	0			confidence language should be always in italics; please check [Hans-Otto Poertner and WGII TSU, Germany]	Taken into account in preparing the SOD.
24072	5	0	0			please avoid excessive self-citation, there are e.g. 9 references of Rinkevich/Rinkevich et al on reef restoration. This assessment should consider the broad range of literature and not only the scientific results published from the authors [Hans-Otto Poertner and WGII TSU, Germany]	Taken into account in preparing the SOD.
24074	5	0	0			Refer to SR15 wherever appropriate [Hans-Otto Poertner and WGII TSU, Germany]	Taken into account in preparing the SOD.
24076	5	0	0			make use of likelihood to quantify the uncertaincy [Hans-Otto Poertner and WGII TSU, Germany]	Taken into account in preparing the SOD.
24078	5	0	0			some information is repetitive across different subsections; consider restructuring of sections [Hans-Otto Poertner and WGII TSU, Germany]	Taken into account in preparing the SOD.
24080	5	0	0			overall amount of figures should be reduced [Hans-Otto Poertner and WGII TSU, Germany]	Taken into account in preparing the SOD.
24082	5	0	0			some of the tables, e.g. Table 5.10, should be moved to the supplementary material [Hans-Otto Poertner and WGII TSU, Germany]	The table has been moved to supplementary material in SOD
24084	5	0	0			the entire chapter needs to be shortened and condensed; focus on what's new since AR5 and on issues that are relevant for policy makers [Hans-Otto Poertner and WGII TSU, Germany]	Taken into account in preparing the SOD.
24086	5	0	0			introduce all acronyms at first mention [Hans-Otto Poertner and WGII TSU, Germany]	Acronyms are defined on first use in SOD

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24438	5	0	0			this chapter has a large number of figures, are they all necessary to deliver key messages? [Hans-Otto Poertner and WGII TSU, Germany]	Number of figure reduced in SOD.
24596	5	0	0			traceability in executive summary to be checked [Hans-Otto Poertner and WGII TSU, Germany]	Taken into account in preparing the SOD.
24598	5	0	0			Ocean physicochemistry and associated system changes are predominant in the first 30 pages. Better integration of WGI and WGII material with an assessment of vulnerabilities would be useful to bring policy relevant material up front as needed and support a more quantitative assessment due to early connection of relevant material. [Hans-Otto Poertner and WGII TSU, Germany]	Taken into account in preparing the SOD.
24600	5	0	0			AR5 as the point of departure is often not clearly defined which might allow cutting back on some background material. [Hans-Otto Poertner and WGII TSU, Germany]	Taken into account in preparing the SOD.
24604	5	0	0			Fact check by chapter scientist and LA s needs to verify correct allocation of literature to statements in the text. [Hans-Otto Poertner and WGII TSU, Germany]	Taken into account in preparing the SOD.
24606	5	0	0			It appears that the chapter contains an impressive amount of information, but also is composed of pieces that do not necessarily form a coherent storyline. This should be revisited and integration enhanced. Overly discipliary sections should be moved to OSM. [Hans-Otto Poertner and WGII TSU, Germany]	Taken into account in preparing the SOD.
24610	5	0	0			A comparative treatment of risks across sectors, e.g. by constructing burning ember diagrams, considering adaptation capacity and limits would provide a useful closure to the chapter. [Hans-Otto Poertner and WGII TSU, Germany]	Taken into account in preparing the SOD.
24684	5	0	0			Text on technological mitigation approaches specific for oceans needs to be balanced with WGIII assessment. [Hans-Otto Poertner and WGII TSU, Germany]	Taken into account in preparing the SOD.
22016	5	72	29	72	29	change 'regulation' to 'regulatory' [Bryony Caswell, UK]	The text was altered as suggested by the reviewer.
21970	5	0	31		35	Okay so richness increase at high latitudes but within that process there will be species extinctions because the system wont be able to support all these species - those that cant shift and those that cant compete will become extinct. E.g. see Perreira et al. 2010 (Science, 330, 1496-1501) and Cheung et al. 2009 (https://doi.org/10.1111/j.1467-2979.2008.00315.x) Need to mention this - species richness increasing is often interpreted as a good thing - but it isnt so simple in this case [Bryony Caswell, UK]	Taken into account. This is explained in SOD
10768	5	0	49		50	The following statement is very strong: “Thus, human activities and their consequences, including climate change, are substantially degrading all coastal ecosystem services that are important to human wellbeing (very high confidence)”.There is a huge body of literature (The Commons by Elinor Ostrom and others) that shows successful outcomes in the interaction between human and the environment. Suggest the authors to refer to that. [Coswig Kalikoski Daniela, Italy]	Taken into account. The assessment in this chapter highlights that observed and projected degradation of coastal ecosystem services can be partly attributed to human activities.

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2854	5	1	0			There is quite a lot of text dealing specifucally with the (Ant)arctic. This is not an issue per se, but I (a Ch 3 LA) see a need for interaction and cooperation between chapters 3 and 5. This is especially the case where Ch 5 has figures, full paragraphs or even a sub-section on polar regions. It is most important to avoid direct contradiction and I don't think there is much of that. The issues are more who covers what, to avoid unnecessary repetition and to refer adequately between chapters. Ch 5 does refer to Ch 3 several places, but together we have to make sure that what they in Ch 5 say we write matches with what we actually write in Ch 3, and vice-versa, also after revisions. As a Ch 3 LA this is also my responsibility. [Geir Ottersen, Norway]	Thanks for the suggestion. We will refer to the "tragedy of commons" by Elinor Ostrom
4638	5	1	0		70	There is a complte underrepresentation of coastal acidification on pelagic and benhic costal calcifiers - this needs to be added in the report [Nina Bednarsek, USA]	Taken into account in preparing the SOD.
14008	5	1	0	209		It is 72 pages into a 107 page chapter before issues related to human systems emerge - this makes the chapter extremely daunting reading for any policymaker. Some level of integration between the physical science and human/social science aspects of the chapter would be highly desirable. [Debra Roberts and Durban Team, South Africa]	Taken into account in preparing the SOD.
16642	5	1	0	50		General comment - there is considerable variability in the use of citations to support statements (some have none; some have many). Consistency required here, perhaps with rationale - for example, are more citations required when confidence is high or low? [Cliff Law, New Zealand]	The outline has been consequently modified (thanks to that comment)
22992	5	1	0			generally chapter 5 (and 1) seems to down play the role that the oceans play in sequestering carbon. Heat and pH seem to be the main messages. Whereas the oceans are the second largest carbon pool on earth (second to the Earth's crust) and in addition their annually absorb 25% of anthropogenic emssinos.The oceans contain ~38,000 Pg C and so exert a dominant control on atmospheric levels. This oceanic sink can be measured (but is highly variable), is a key component in balancing global carbon budgets and likely to decrease in the future (due to decreasing pH and rising water temperature). Surely this important role that the oceans play needs to be conveyed. I would suggest that this key role is highlighted in this chapter. [Jamie Shutler, UK]	Taken into account in preparing the SOD.
11652	5	1	1			Compared to ecosystem services, only a small portion of text is devoted to a major physico-chemical service of the ocean, namely the uptake of anthropogenic carbon. The associated mechanisms are not discussed in a comprehensive way. In this sense the balance of the chapter should be a bit improved. [Fortunat Joos, Switzerland]	Taken into account in preparing the SOD.
12834	5	1	1	1	1	Chapter appears to be somewhat lacking on information and evidence on changes in species distrubution / range shifts due to warming. (only 5.2.3.3.1 has range shifts of fish) [Stephen Cornelius, UK]	Assessment of evidence of range shifts of wider range of organisms is included in SOD

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16276	5	1	1	148	57	As I'm reading along, now at p. 17, this whole work is much more pedagogical and much much longer than was tolerated by the IPCC TSU for AR5 or AR4. Also Chapter 3 is much much tighter, good example of where to aim for this chapter. This is a synthesis of updated material since AR5. As such it does not need all this information. I think you are going to have to cut it significantly. Having gone through this exercise twice (AR4 and AR5), I know how painful it is to cut contributions, but it can be done and the product will be much better for it. [Lynne Talley, USA]	Taken into account in preparing the SOD.
18406	5	1	1	209	43	While I recognize that the focus of this chapter is on marine ecosystems, even a cursory mention of submerged cultural resources would be beneficial. ILK is (somewhat understandably) not discussed in this chapter (only small mentions on 5-116), but a complete absence of any discussion on climate change risks to underwater cultural heritage (especially considering many countries' adoption of the UNESCO Convention on the Protection of Underwater Cultural Heritage) is an oversight that should be addressed. [Jeneva Wright, USA]	ILK is adressed PP. 7,92,95-96, 116,127,130 and 137. And table P. 116
16552	5	1	2	1	2	The title is not correct English. Should be either " Changing OceanS...." or "THE Changing Ocean....". Also, the dependent comunities are not changing so the title should be changed to "AND THEIR dependent communities" [Cliff Law, New Zealand]	The chapter team is not allowed to alter the title as it is officially approved by the IPCC
16554	5	1	7	1	23	Inconsistent abbreviating (United Kingdom, U.K.) [Cliff Law, New Zealand]	The text was altered as suggested by the reviewer.
24088	5	1	12	1	23	Provide countries for all CAs [Hans-Otto Poertner and WGII TSU, Germany]	The text was altered as suggested by the reviewer.
24402	5	1	12	1	23	Add countries for all Contributing Authors [Hans-Otto Poertner and WGII TSU, Germany]	The text was altered as suggested by the reviewer.
2698	5	1	13	1	18	Nadine Le Bris is listed twice [Kirk Sato, Japan]	The text was altered as suggested by the reviewer.
16556	5	1	36	1	55	I would expect the Boxes to be shown in Italics and the sub-sections in Bold font, as the boxes are examples of the science discussed in the sub-sections [Cliff Law, New Zealand]	Taken into account in preparing the SOD.
16558	5	1	46	1	46	Why doess"Human-natural" have a capital on human but not natural? [Cliff Law, New Zealand]	The text was altered as suggested by the reviewer.
1134	5	1	50			Add "Ocean-based Restoration" [William Clarke, Australia]	The focus on the ocean has been highlighted in the introduction section of the chapter as well as the specific subsections.
16560	5	2	6	2	7	This would be better writen as "How does the interaction of multiple climate-related and human-induced stressors act to affect ecosystems?" [Cliff Law, New Zealand]	Taken into account in preparing the SOD.
5014	5	3	0	6	20	Some of (but not all) statements heading each paragraph (in bold in the text) have been rated in terms of confidence. Please homogenise the approach. Personally I'm in favour of keeping only a higher granularity, phrase-related likelihood assessment within the text (e.g. in the paragraph at pg 3-row 3, p3-row13). [Alessandro Crise, Italy]	Taken into account in preparing the SOD.
14016	5	3	0	6		For instance, for every section of the Executive Summary, it would be good to put these findings in the context of the AR5. Is this new to being considered by the IPCC or was it covered before? This will be important for people who are not intimiately familar with the core assessments. This will also help inform AR 6 if it indicates which of these findings should be covered by the AR 6. [Elizabeth Jewett, USA]	Given the tight page limit of the Executive Summary, point-of-departure from AR5 could not be presented in every executive summary statement. However, it is stated in the main text.
12832	5	3	1	6	17	the executive summary has longer, harder to read paragraphs than some of the other chapters. [Stephen Cornelius, UK]	Taken into account in preparing the SOD.

SROCC First Order Draft Expert Review Comments - Chapter 5							
Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
13706	5	3	1	3	1	Is is necessary to add 'and last AR5 assessment report'? Since 2004 to present day encompasses the year in which AR5 was published. If you must keep that part of the sentence, suggest deleting 'last' since there is only one AR5 and should read 'The oceans have continued to warm unabated since 2004 and AR5. [Debra Roberts and Durban Team, South Africa]	Taken into account in preparing the SOD.
17366	5	3	1	3	1	Note previous comment on Ch. 3 p. 77, which is inconsistent with research presented thoughout Chapter 5 on projections related to polar ocean fisheries especially. [Pamela Pearson, USA]	Polar aspects is not generally assessed in chapter 5, even if Arctic and Antarctica are oceans: they will be considerd in chapter 3
24508	5	3	1	6	17	Please focus on impacts, consequences for societies and options for mitigation and adaptation in the Executive Summary to increase its relevance for policymakers and include policy-relevant information in the first one or two sentence of each paragraph. [Hans-Otto Poertner and WGII TSU, Germany]	Taken into account
21870	5	3	2	3	3	Warming still dominates..' is this a reference to the mechanism? Not clear [Bryony Caswell, UK]	The text was altered as suggested by the reviewer.
1648	5	3	3	3	4	In its current form, the first two sentences do not give immediate meaning. Please consider to rewrite. First sentence: AR5 was published in 2013/2014 not 2004. Second sentence: Please spesify if you mean anthropogenic globalwarming. [Aurora Stenmark, Norway]	The text was altered in SOD.
12830	5	3	3			"The oceans have continued to warm unabated since 2004 and last AR5 assessment report." - suggest a stronger start to this chapter, it has been warming much longer than since previous reports? [Stephen Cornelius, UK]	The text was altered in SOD.
16562	5	3	3	3	3	and THE last AR5 assessment report [Cliff Law, New Zealand]	The text was altered as suggested by the reviewer.
22234	5	3	3	3	3	It sounds redundant to say 'since 2004 and last AR5 assessment report' as AR5 is after 2004. [Debora Ley, Guatemala]	The text was altered in SOD.
23308	5	3	3	3	3	“Unabated” means without a decrease in rate. However, the rate of warming does vary. For short periods of time, the heat content of the ocean might decrease. For example, the figure on page 11 suggests the ocean heat content in 2009 was less than that in 2008, and so we wouldn’t say the warming has been unabated. It is acceptable to say “has continued to warm since 2004,” but the word “unabated” makes for too bold of a statement and implies that there is never a decrease in heat content. [Ryan Rykaczewski, USA]	The text has been modified to emphasize that the changes in ocean heat content over Argo era are a continuation of long term changes, essentially making the point that there has been no hiatus of ocean warming. We stand by the word "unabated" for these multi-year trends.
23310	5	3	3	3	4	What is meant by the sentence “warming still dominates the increase in heat energy.” This statement sounds vague and perhaps trivial. What are the other potential consequences of an increase in heat energy aside from warming? [Ryan Rykaczewski, USA]	We have clarified that this is ocean warming, which dominates the warming of other components or the latent heat changes associated with net ice melt.
16564	5	3	4	3	4	"Warming still dominates the increase in heat energy stored in the climate system." - the interpretation of this statement is unclear. Warming is the increase in heat energy; what other factors can dominate the increase in heat energy? [Cliff Law, New Zealand]	We have clarified that this is ocean warming, which dominates the warming of other components or the latent heat changes associated with net ice melt.
17892	5	3	4	3	4	I was not able to find support for 1-2% in section 5.2.1.4. There was one reference for 2% (apparently with estimation uncertaingy of + or - 1%) on page 22 line 29, although the time range was not clearly stated on that page. I also note that no confidence is given for this statement. Suggest modifying this sentence to reflect the underlying assessment. [Haroon Kheshgi, USA]	The text was altered in SOD.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
16566	5	3	5	3	6	"trend signal" use one but not both [Cliff Law, New Zealand]	The text was altered as suggested by the reviewer.
21872	5	3	5	3	6	trend signal' can't it be one or the other? A trend or a signal? [Bryony Caswell, UK]	The text was altered as suggested by the reviewer.
16568	5	3	6	3	6	"forcing" rather than "forcings"? [Cliff Law, New Zealand]	The text was altered as suggested by the reviewer.
11132	5	3	7	3	7	replace "upper ocean heat content (0-700 m)" with "upper ocean (0-700 m) heat content" [Inseong Han, Republic of Korea]	The text was altered as suggested by the reviewer.
13708	5	3	8	3	8	Shouldn't it be 'resulting' instead of 'resulted'? [Debra Roberts and Durban Team, South Africa]	The text was altered as suggested by the reviewer.
16184	5	3	8	3	8	resulting' [Lynne Talley, USA]	The text was altered as suggested by the reviewer.
16570	5	3	8	3	8	"resulting" not "resulted" [Cliff Law, New Zealand]	The text was altered as suggested by the reviewer.
17450	5	3	8	3	8	"resulted" should be "resulting" [Sonya Legg, USA]	The text was altered as suggested by the reviewer.
20254	5	3	8	3	9	The sentence "There is evidence for warming resulted from human-induced greenhouse gas emission in some individual ocean basins…" should be modified to read: "There is evidence for warming resulting from human-induced greenhouse gas emissions in some individual ocean basins…" [Michelle A. North, South Africa]	The text was altered as suggested by the reviewer.
21874	5	3	8	3	8	resulting' not 'resulted' OR 'there is evidence that warming resulted from…' AND emissions plural [Bryony Caswell, UK]	The text was altered as suggested by the reviewer.
21876	5	3	8	3	9	Its not clear what is meant here - sounds like warming in only those basins - context needs addressing [Bryony Caswell, UK]	Taken into account in preparing the SOD.
228	5	3	9	3	10	Parts of the abyssal ocean are actually cooling. Why are just the warming regions and trends mentioned here? Avoid biassed reporting [Sebastian Luening, Portugal]	In executive summary, we focus on the global trend while the regional differences are discussed in the text.
1136	5	3	9			Abyssal waters might be cooled to offset part of this warming using ice thickening technology and wind power to generate frigid brine rich in both CO2 and O2. [William Clarke, Australia]	Rejected - Speculation about aggressive geoengineering approaches is outside of the scope of this chapter.
21106	5	3	9	3	9	In contrast to the quantitative likelihood categories described in Footnote 1, the summary terms in Footnote 2 are much harder to assess objectively. The use of these terms from Footnote 2 in Chapter 5 seems also to have a high degree of variability from topic to topic and paragraph to paragraph. It does not give the impression that the corresponding probabilities have been examined in any rigorous way. Instead it can give the feeling that the individual contributors have used different criteria in choosing whether or not to use these terms and what the various terms represent in terms of certainty when they have chosen to use them. [Roger Samelson, USA]	We follow the standard IPCC confidence assessment and langugage protocol for the inclusion of uncertain langugage in assessment of confidence.
1138	5	3	10			Overall ocean warming might be reversed using combinations of ocean brightening with nanobubbles (fiztops), marine cloud brightening using fluidic oscillators, and buoyant flake ocean fertilisation to brightem both the ocean surface and marine clouds with DMS-generated cloud condensation nuclei (CCN), see https://unfccc.int/documents/65014 and https://www.climate-restoration-foundation.com [William Clarke, Australia]	Rejected - Speculation about aggressive geoengineering approaches is outside of the scope of this chapter.
1790	5	3	10	3	11	It is worth mentioning the causes for this increase. [Meer Ali, India]	Taken into account in preparing the SOD.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
24660	5	3	10			One wonders how continued warming of the oceans (and the planet) is compensated for at some point by ocean CO2 uptake and then stabilized atmospheric CO2 levels, see 1.5 report. In other words, the inertia of the system is not quite clear. [Hans-Otto Poertner and WGII TSU, Germany]	Taken into account in preparing the SOD and reflected in the chapter text.
21878	5	3	11	3	11	stabilizes' not 'has been stabilized' [Bryony Caswell, UK]	The text was altered as suggested by the reviewer.
5016	5	3	12			to take up 3 or 6 times'. This cannot be a matter of choice: either is a fork 'to take up from 3 to 6 times' or depends on specific simulations. In any case I suggest to clarify this sentence. [Alessandro Crise, Italy]	The text has been altered to make it clear that these two values refer to the RCP2.6 and RCP8.5 scenarios, respoectively.
5018	5	3	12			Either define ZJ moving here the footnote 4 presently located at the bottom of page 8 or use instead 10 ^21 J [Alessandro Crise, Italy]	The text was altered as suggested by the reviewer.
9230	5	3	12	3	12	For the executive summary, I think you should explain ZJ [APECS Group Review, Germany]	The text was altered as suggested by the reviewer.
12810	5	3	12	3	12	500 zetta Julues (half a yotta Joule) sounds like a very large number but I am sure it will be hard for a policy maker to understand. Perhaps express in terms of percentage of excess energy (i.e. 90% as stated in Chapter 1)? [Collins Matthew, UK]	Taken into account in preparing the SOD.
16572	5	3	12	3	12	I have no idea what "the roughly 500 ZJ" means [Cliff Law, New Zealand]	The text here has been altered to read 500x10^21 J.
22994	5	3	13	3	13	"already taken up since the 20th century", This is confusing. Do authors mean since the beginning of the 20th century? Over the 20th century? since the end of the 20th century? Need to be exact here on period as this has implications for climate sensitivity and communication to public. [Yassir Eddebbar, USA]	The text here has been clarified to indicate that this is since the start of the 20th century (i.e. since the year 1901).
23508	5	3	13			Change 'taken up' for a synonym (e.g. absorbe), so that it is less repetitive. [Laura Lorenzoni, USA]	Taken into account in preparing the SOD but decide to keep the formulation of the sentence as it is clearer.
12812	5	3	15	3	20	Wouldn't it be nice to compare observational estimates of global P-E+R with observational estimates of salinty somehow? Sort of freshwater budget closure. [Collins Matthew, UK]	A full analysis of the evolving hydrological cycle is beyond the scope of this special report. We expect this issue to be addressed in AR6.
16574	5	3	15	3	17	The 2nd sentence (Line 16-18) effectively repeatds the first (Lines 15-16) [Cliff Law, New Zealand]	Taken into account in revising the Executive Summary
21880	5	3	17	3	18	change to 'have changed over the oceans' [Bryony Caswell, UK]	No longer relevant in SOD
11134	5	3	19	3	19	"since 1960 " may need to be "since 1950s". Please check. [Inseong Han, Republic of Korea]	No longer relevant in SOD
23024	5	3	20	3	20	There is also increasing evidence that changes in sea-ice and sea-ice transport contribute to changes in salinity (e.g., Haumann et al., 2016; Abernathey et al., 2016) [Nicolas Gruber, Switzerland]	Taken into account in preparing SOD
22472	5	3	21	3	31	Transport of what: water, heat? the transport by the Gulf Stream is not only linked to the AMOC and this sentence may feed the imprecise facts that one can read in the outreach literature. Furthermore, I think the sentence is eaningless. Change to "northward transport of heat". [Juliette Mignot, France]	No longer relevant in SOD
1140	5	3	22			High latitude freshening might be slowed or even reversed using ice thickening. [William Clarke, Australia]	Rejected - Speculation about aggressive geoengineering approaches is outside of the scope of this chapter.
18624	5	3	22	3	27	this statement of the ES is important. It merits to be clearer and could be improved by providing quantitative assessment and distinguish what comes from observations and what comes from models [Roland Seferian, France]	Taken into account in preparing SOD
21202	5	3	22	3	27	Might be worth to pu this into context with evneutally increased storm events and the overall impact [Momme Butenschön, Italy]	Taken into account in preparing SOD

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
21882	5	3	22	3	23	change to 'are both intensified making the surface ocean lighter…' [Bryony Caswell, UK]	No, the proposed text change would change the meaning of the sentence. The existing text is correct.
24510	5	3	22	3	38	These two paragraphs may not be suitable for the main audience of Executive Summaries (i.e. people with limited expert knowledge). I would suggest to merge and simplify them, ensuring that the main effects of stratification and reduced mixing as well as their causes are understood. [Hans-Otto Poertner and WGII TSU, Germany]	The text was altered as suggested by the reviewer.
21884	5	3	23	3	23	what is at a faster rate than the deep ocean? Unclear [Bryony Caswell, UK]	The text is now clarified in SOD
16576	5	3	24	3	24	"THE deep ocean" [Cliff Law, New Zealand]	The text was altered as suggested by the reviewer.
16578	5	3	24	3	24	I'm not sure that re-oxygemnation is a word or that it is appropriate here. This sentence should read "carbon uptake, oxygenation, and nutrient cycles" [Cliff Law, New Zealand]	Text edited
22172	5	3	24	3	24	The comment that reduce stratification will affect carbon uptake is not documented in the changes in ocean carbon section. In general it is not straightforward that stratification will lead to less uptake (which is suggested by the sentence, though not spelled directly) because stratification also keeps carbon-rich waters at depth. [Corinne Le Quere, UK]	Taken into account in preparing SOD
21886	5	3	25	3	25	have' plural not 'has' [Bryony Caswell, UK]	The text was altered as suggested by the reviewer.
16580	5	3	26	3	26	replace "top most" with "upper" [Cliff Law, New Zealand]	The text was altered as suggested by the reviewer.
12814	5	3	29	3	32	Cross reference to chapter 6 [Collins Matthew, UK]	No longer relevant in SOD
22964	5	3	29		38	this paragraph is missing the implications for carbon transport and the carbon sink [Jamie Shutler, UK]	This paragraph has been removed from the executive summary due to space restrictions on the key messages that could be highlighted, thereby freeing up space for more novel findings in other sections.
23026	5	3	29	3	38	I was expecting here stronger statements with regard to changes in tthe ocean's large-scale circulation. For many aspects, these changes will be likely more important than the changes in the ocean's mesoscale fields. [Nicolas Gruber, Switzerland]	This paragraph has been removed from the executive summary due to space restrictions on the key messages that could be highlighted, thereby freeing up space for more novel findings in other sections. AMOC changes are discussed in Chapter 6, and Southern Ocean circulation changes are now in a cross-chapter box.
23034	5	3	29	3	38	I consider it very important to put the long-term changes in the context of shorter-term variability. For example, there is no discussion of the role of decadal variability in ENSO and it s role for the hiatus, etc. [Nicolas Gruber, Switzerland]	This paragraph has been removed from the executive summary due to space restrictions on the key messages that could be highlighted, thereby freeing up space for more novel findings in other sections. AMOC changes are discussed in Chapter 6, and Southern Ocean circulation changes are now in a cross-chapter box.
1142	5	3	30			AMOC might be strengthened using ice thickening. [William Clarke, Australia]	Rejected - Speculation about aggressive geoengineering approaches is outside of the scope of this chapter.
1642	5	3	30	3	32	This is an important message, particularly for policy makers. Therefore, we miss more information on this topic in the chapter itself. E.g. in the sections 5.2.1.2.2 and 5.2.1.2.3, the readers are mostly redirected to chapter 3 and 6. [Aurora Stenmark, Norway]	Not key assessment for our chapter, thus referred to other chapters with such focuses

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
9232	5	3	30	3	32	It's not just a projected decrease, but also a decrease observed by Caesar et al. and Thornalley et al. 2018 as you correctly state on page 10. [APECS Group Review, Germany]	This paragraph has been removed from the executive summary due to space restrictions on the key messages that could be highlighted, thereby freeing up space for more novel findings in other sections. AMOC changes are discussed in Chapter 6, and Southern Ocean circulation changes are now in a cross-chapter box.
14020	5	3	30	3	31	In the US Climate Science Special Report, we got pushback against the "very likely" assessment of the likelihood of the AMOC slowing due to climate change, mostly because of lack of direct evidence. I know that some very new papers came out which provide additional modeling evidence for a slowing AMOC. I would just suggest re-checking the likelihood assessment of this. [Elizabeth Jewett, USA]	This paragraph has been removed from the executive summary due to space restrictions on the key messages that could be highlighted, thereby freeing up space for more novel findings in other sections. AMOC changes are discussed in Chapter 6, and Southern Ocean circulation changes are now in a cross-chapter box.
12210	5	3	31	3	31	The mention of the Gulf stream here is not substantiated by the main text (which mentions AMOC) and can only contribute to the public confusion about the "Gulf Stream will stop controversy". Regularly fueled by unfortunate articles of colleagues in search of publicity, this controversy has to be regularly extinguished in the media by reminding people that as long as the Earth spins, there will be a Gulf Stream. I would hope the IPCC will not feed this controversy. I therefore suggest replacing "northward transport of the Gulf Stream" by "northward transport in the North Atlantic". [Eric Guilyardi, France]	This paragraph has been removed from the executive summary due to space restrictions on the key messages that could be highlighted, thereby freeing up space for more novel findings in other sections. AMOC changes are discussed in Chapter 6, and Southern Ocean circulation changes are now in a cross-chapter box.
18626	5	3	31	3	31	my understanding of the recent literature it might be better to give a confidence statement for the AMOC decline as the changes in gulfstream because there is a good agreement between models but future changes remains poorly constrained in regards of the inter-model spread. [Roland Seferian, France]	This paragraph has been removed from the executive summary due to space restrictions on the key messages that could be highlighted, thereby freeing up space for more novel findings in other sections. AMOC changes are discussed in Chapter 6, and Southern Ocean circulation changes are now in a cross-chapter box.
22514	5	3	31	3	31	Transport of what: water, heat? the transport by the Gulf Stream is not only linked to the AMOC and this sentence may feed the imprecise facts that one can read in the outreach literature. Furthermore, I think the sentence is eaningless. Change to "northward transport of heat". [Juliette Mignot, France]	This paragraph has been removed from the executive summary due to space restrictions on the key messages that could be highlighted, thereby freeing up space for more novel findings in other sections. AMOC changes are discussed in Chapter 6, and Southern Ocean circulation changes are now in a cross-chapter box.
9234	5	3	33	3	33	Southern Westerly Winds instead of Southern Ocean winds. E.g. Rusell et al., 2006 JCLI 19, 6382-6390 [APECS Group Review, Germany]	This paragraph has been removed from the executive summary due to space restrictions on the key messages that could be highlighted, thereby freeing up space for more novel findings in other sections. AMOC changes are discussed in Chapter 6, and Southern Ocean circulation changes are now in a cross-chapter box.
5020	5	3	34	3	36	The statement can be misleading (see my detailed comments regarding pg 18). The local response intensity the to general changes in sea level and stratification is strongly site-dependent . I would suggest therefore to use likely instead of very likely. [Alessandro Crise, Italy]	This paragraph has been removed from the executive summary due to space restrictions on the key messages that could be highlighted, thereby freeing up space for more novel findings in other sections. AMOC changes are discussed in Chapter 6, and Southern Ocean circulation changes are now in a cross-chapter box.
16182	5	3	36	3	36	likely to lead [Lynne Talley, USA]	The text was altered as suggested by the reviewer.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
16582	5	3	36	3	36	"TO lead…" [Cliff Law, New Zealand]	The text was altered as suggested by the reviewer.
16584	5	3	36	3	36	should read "and so affect ecosystems" [Cliff Law, New Zealand]	The text was altered as suggested by the reviewer.
17452	5	3	36	3	36	insert "to" after "likely" [Sonya Legg, USA]	The text was altered as suggested by the reviewer.
13710	5	3	37	3	37	Insert 'to' before 'lead' [Debra Roberts and Durban Team, South Africa]	The text was altered as suggested by the reviewer.
21104	5	3	37	3	37	"likely to lead to" [Roger Samelson, USA]	The text was altered as suggested by the reviewer.
21888	5	3	37	3	37	change to '…vertical diffusion of gases such as oxygen and thus will affect ecosystems.' [Bryony Caswell, UK]	No longer relevant in SOD
23492	5	3	37	3	38	5.2.1.2.3 is cited two times at the end of the subsection [Soeren Thomsen, France]	The text was altered as suggested by the reviewer.
24090	5	3	38	3	38	5.2.1.2.3 is listed twice [Hans-Otto Poertner and WGII TSU, Germany]	The text was altered as suggested by the reviewer.
3550	5	3	40	3	45	The oceans are already increasing their acidity. Anthropogenic trends at local scales in carbon speciation variables, including acidity (pH), calcite and aragonite saturation states ΩCAL and ΩARAG) are emerging rapidly from the background variability (high confidence) {5.2.1}. The anthropogenic pH signal has already emerged over the entire ocean. We have observations from 40 mooring that will soon be submitted for publication, that tell us that the ToE varies with location, with significantly	This is considered in preparation for SOD
12816	5	3	40	3	46	Perhaps this is obvious but it would be good to point out which aspects of ocean change are directly CO2 driven and hence cannot be mitigated by geoengineering. [Collins Matthew, UK]	This is considered in preparation for SOD
16586	5	3	40	3	40	"carbon speciation variables" should be replaced by "the carbonate system" [Cliff Law, New Zealand]	No longer relevant in SOD
18628	5	3	40	3	46	it might be useful to distinguish observations and model results. It guess this ES statement mostly rely on observations because it concerns recent past but it is not clearly stated [Roland Seferian, France]	This is considered in preparation for SOD
20542	5	3	40	4	2	I would mention pCO2 trends and projection and not only pH even in the exectutive summary [Chiara Lombardi, Italy]	Given the tight page limit and the need to be understandable by non-experts, we choose to focus on pH
23028	5	3	40	3	46	The OA related statement should start with the most recent observational evidence and only then transition to the issue of time of emergence. [Nicolas Gruber, Switzerland]	This is considered in preparation for SOD
23126	5	3	40	3	40	I miss here a statement about the role of the ocean as a sink for atmospheric CO2. There has been substantial progress on this issue since AR5 that is worth of a bullet in the executive summary. Furthermore, it also makes a natural transition to the OA related statement that follows. [Nicolas Gruber, Switzerland]	Accepted
24980	5	3	40	3	42	Please replace by an explanation of ocean acidification and its impacts that the main audience of the Executive Summary (i.e. people with limited expert knowledge) is able to understand and find relevant. I would suggest to address ocean acidification in the SPM, but this statement does not offer itself to be lifted from the chapter for this purpose because it is too technical. [Hans-Otto Poertner and WGII TSU, Germany]	Taken into account in revising the Executive Summary
1650	5	3	41	3	45	Please consider to avoid using terminology such as "omega CAL" and "omega ARAG", which is unfamiliar for many readers. [Aurora Stenmark, Norway]	The text was altered as suggested by the reviewer.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
16588	5	3	41	3	41	replace "aragonite" with "carbonate" [Cliff Law, New Zealand]	No longer relevant in SOD
22962	5	3	41			this is misleading. pH isn't a scale of acidiity, its basity. The oceans aren't acidic and are never likely to be. Please check this phrasing with lead authors N. Gruber and P. Williamson who are knowlegeable about ocean acidification. [Jamie Shutler, UK]	This is considered in preparation for SOD
1144	5	3	42			Surface ocean acidification might be reversed by the use of buoyant flake ocean fertilisation. The Indian Government has undertaken lab experimentation with the technology and proposes mesocosm trials in territorial waters in 2019. The krill carbon pump looks particularly prospective for sequestering CO2 as fertilisation-enhanced fecal pellet biomass below 1,000m depth, see http://rspb.royalsocietypublishing.org/content/284/1869/20172015 and https://www.sciencedaily.com/releases/2006/02/060206230630.htm [William Clarke, Australia]	Rejected - Speculation about aggressive geoengineering approaches is outside of the scope of this chapter.
1146	5	3	42			There are 350-500Mt of Euphausia superba krill in the Southern Ocean alone, see http://www.antarctica.gov.au/about-antarctica/wildlife/animals/krill and https://en.wikipedia.org/wiki/Antarctic_krill. The fecal pellets they release in the deep would likely sequester several gigatonnes per year of carbon. This might be multiplied following nutrient supplementation with iron and siliica. This carbon represents carbonic acid neutralised and removed from the surface waters of the Southern Ocean. [William Clarke,	Rejected - Speculation about aggressive geoengineering approaches is outside of the scope of this chapter.
14022	5	3	42	3	42	I would change this sentence to read "background variability open ocean waters… because we are finding that this is not true for most coastal waters. [Elizabeth Jewett, USA]	This is considered in preparation for SOD
	5	3	42	3	42	This is very bold statement that I do not see the evidence for. This is based on a single coarse-resolution modeling study that quite certainly underestimates the level of variability in space and time. This leads to a too early estimation of the ToE. [Nicolas Gruber, Switzerland]	This is considered in preparation for SOD
23032	5	3	42	3	45	Again, I don't see the evidence for this statement. [Nicolas Gruber, Switzerland]	This is considered in preparation for SOD
14024	5	3	43	3	44	Again, as indicated in the comment above, the signal has ONLY emerged in the open ocean surface waters. Maybe this should read: …emerged for the entire OPEN ocean surface waters" Also, there is ONLY high confidence that the ocean has transition to a new state for the open ocean surface waters only. If you don't change to focus on open ocean waters, you really should change the confidence to Medium. [Elizabeth Jewett, USA]	This is considered in preparation for SOD
17890	5	3	43	3	43	Emerged over the entire ocean seems to be an overstatement. As noted in the sentence below this statement, this has occurred for the average over the surface ocean, but this is different than everywhere in the ocean. Given that is unclear what this sentence means, and since the next sentence clearly conveys the finding for the surface, suggest deleting this sentence. [Haroon Kheshgi, USA]	This is considered in preparation for SOD
21890	5	3	44	3	44	lower than one standard deviation? Or more than one? [Bryony Caswell, UK]	No longer relevant in SOD

SROCC First Order Draft Expert Review Comments - Chapter 5							
Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
20988	5	3	46			This statement should clarify that emission scenarios are the most important control of ocean pH "change" or "trends" relative to… As currently stated, it could be interpreted that CO2 emissions have a larger influence on ocean pH seasonality or interannual variability, for example, more so than natural forcings do. [Adrienne Sutton, USA]	This is considered in preparation for SOD
10944	5	4	1	6	17	Climate change is always mentioned without specifying what is meant by "climate change" Do you mean warming? Or is it referred to other pressures that derived from climate change like sea level rise, changes in meteorological conditions, acidification, change of circulation, deoxygenation, … Sorry if it was defined in another chapter. [Marilaure Gregoire, Belgium]	We use the standard definition of "climate change" in IPCC, that is also used in its other assessment and is specified in the glossary.
21892	5	4	2	4	2	surely '(virutally certain)' should come before the corss reference? [Bryony Caswell, UK]	The text was altered as suggested by the reviewer.
22174	5	4	3	4	3	I expected here a substantive paragraph detailing what is happening to the ocean carbon uptake, in the past and in the future, including carbon-climate feedbacks throuogh changes in ocean physics and through changes in ecosystems. It is a major omission from this chapter that carbon feedbacks are not even discussed. Particularly that a lot is said about the impact of climate change on ocean ecosystems, but not on the consequences for carbon uptake (except through blue carbon which are wrong and I will comment on separately). [Corinne Le Quere, UK]	Accepted. An executive summary message on ocean carbon updated is included in SOD.
10926	5	4	4	4	5	This is not certain that 100% of the changes are attributed to humans. Some studies have shown that a part of thse changes (potentially quite significant in some regions like the TRopical Pacific) are attributed to natrural variability (e.g. PDO). Please make this nuance because as it is formulated it is like 100 % of the changes are without any doubt due to humans . Besides, no statement is made for the coastal area although they are reviews (e.g. Diaz and Rosenberg, 2008, Breitburg et al., 2018) that have assessed the deoxygenation in the global coastal zone. I would suggest to add a reference to that as well because this is an important feature (with high confidence) of our oceans with impact on biodiversity and biogeochemsitry. This is mentioned in several places in the main text. [Marilaure Gregoire, Belgium]	Accepted. This is now considered in SOD.
11136	5	4	4	4	4	replace "1970's" with "1970s" [Inseong Han, Republic of Korea]	The text was altered as suggested by the reviewer.
11138	5	4	4	4	4	The summary need to be modified to include future projection: for example, "Observed global oxygen concentration have decrased by 1-2% and is projected to continue to decrase by 2010" [Inseong Han, Republic of Korea]	Accepted. This is now included in SOD.
11298	5	4	4	4	4	global ocean oxygen concentrations have decreased - as it reads it could be understood as global oxygen (atmosphere and ocean) [Croot Peter, Ireland]	Accepted. This is now revised.
16186	5	4	4	4	10	There are also oxygen increases in southern hemisphere thermoclines, likely due to increased ventilation driven by increased circulation driven by stronger SH westerlies, attributable to human influence. So not suggesting that the paragraph be changed, but put on notice that in the detailed text, these subtleties are not missed. [Lynne Talley, USA]	Accepted. This is now considered in SOD.
20256	5	4	4	4	8	Is this referring to atmospheric oxygen or oxygen saturation in the oceans? [Michelle A. North, South Africa]	Clarified in SOD
21204	5	4	4	4	10	As a quantification of the extend of OMZ is given, the definition of OMZ used should be given (maybe in a footnote) [Momme Butenschön, Italy]	Detailed explanation of oxygen minimum zone is given in the chapter text that the executive summary has referred to.

SROCC First Order Draft Expert Review Comments - Chapter 5							
Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
22178	5	4	4	4	10	Ths bullet needs to comment on the inconsistency between model projection and observed past decadal trends in the tropics. The tropical oxygen is observed to decrease. The CMIP5 models project oxygen decrease. I don't think this issue has been resolved, and therefore we don't understand the processes and we cannot trust the model projections for that particular variable and area. The corresponding text mentions this but not very clearly. [Corinne Le Quere, UK]	This is now clarified.
22996	5	4	4	4	4	This statement must be updated with the most recent literature and estimates: "Observed global oxygen concentrations have decreased by 1–2% since 1970's", should read: "Observed global oxygen concentrations have decreased by more than 2% since 1960'" (based on cited paper Schmidtko et al., 2017). or synthesis of estimates. It would be useful to add numbers (4.8 ± 2.1 Pmol lost since 1950 (Schmidtko et al 2017), or rates of loss per year or decade, e.g. −243 ± 124 T mol O2 per decade in upper 1000 m based on Ito et al 2017) and regions of highest loss, and state that regions with greatest loss are also already low in O2 (.i.e. tropical Pacific OMZs). [Yassir Eddebbar, USA]	This is considered in preparation for SOD
24664	5	4	4			It would seem the section on oxygen loss needs updating, however, the issue may be that AR5 as the point of departure is not clearly defined. [Hans-Otto Poertner and WGII TSU, Germany]	This is now updated in SOD.
21896	5	4	5	4	6	Bypasses the 'human influences' such as the anthropogenic eutrophication that has caused these large increses in the number of deoxygeanted systems - surely this deserves a passing mention? Or cross ref [Bryony Caswell, UK]	Taken in consideration in preparation of SOD
22998	5	4	5	4	5	This statement: "These changes are attributed to human influence."should be stated with medium conifidence, since the expansion of the tropical OMZs may contain a significant natural variabilty component associated with the PDO (Duteil et al 2014; 2018). Observations in the tropical Pacific are also sparse (Ito et al 2017), and models show substantial biases in representing OMZ spatial structure and changes (Oschlies et al 2018). Thus, this statement should contain a reference to the role of natural variabilty, or at least the existence of large variabilty superimposed on longterm trends. This section should acknowledge the larger uncertainties found in O2 trends and projections, vs other more robust observations and projections (e.g. warming and pH). Overall, the Oxygen sections (in ES and pg 22) need to better address the uncertainties arising from biases and sparse observations. [Yassir Eddebbar, USA]	Accepted. This is now included in SOD.
23036	5	4	5	4	5	This statement needs to be given low confidence. It is a single study and there are some important methodological issues that make this estimation uncertain. Of course, this is what we expect, but sampling is sparse and we do not have a good idea how biased our sampling is, particularly with regard to the interannual to decadal variability. Places where studies looked at this issue a bit closer tended to show quite a high level of spatial and temporal variations, e.g North Atlantic, North Pacific. [Nicolas Gruber, Switzerland]	Accepted. Low confidence is given to regional scale projection.
10928	5	4	8	4	10	Please specify in which scenario and the level of confidence. Moreover, I have never seen so huge changes (i.e; decrease of 20-40 %) please give a reference as I was not able to find details in section 5,2,1,4 about these numbers. [Marilaure Gregoire, Belgium]	No longer relevant in SOD
16590	5	4	8	4	8	"the seafloor, AT depths…" [Cliff Law, New Zealand]	The text was altered as suggested by the reviewer.

SROCC First Order Draft Expert Review Comments - Chapter 5							
Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
21894	5	4	9	4	10	which areas? It would be useful to have some information in the executive summary for the extreme changes [Bryony Caswell, UK]	No longer relevant in SOD
23000	5	4	9	4	10	What regions will have 20-40% decrease? Must be specific here: Tropical Pacific? Tropical Atlantic? [Yassir Eddebbar, USA]	No longer relevant in SOD
16592	5	4	10	4	10	replace "having a decrease of.." with "decreasing by…' [Cliff Law, New Zealand]	The text was altered as suggested by the reviewer.
3240	5	4	12		14	The Statement 'Ocean primary productivity has declined' is too strong, misleading and not necessarily correct. Does this refer to a total global decline in primary productivity (is does not say). There is much evidence that in many regions of the world's oceans are actually increasing in primary production. See discussion on page 24 [Martin Edwards, UK]	Taken into acount in the new formulation of the paragraph.
12162	5	4	12	4	13	The statement about long-term declines in phytoplankton primary production and chlorophyll does not appear clearly supported in the main body of the report in sections 5.2.1.5 and 5.2.2. Please also see discussions provided about this in the review comments below, and in particular comments #13, #16, #19. [Marie-Fanny Racault, UK]	Taken into acount in the new formulation of the paragraph.
21898	5	4	12	4	20	Needs to link to coastal which is not because of anthropoogeic eutrophication [Bryony Caswell, UK]	Sorry, unsure what the reviewer suggest.
22176	5	4	12	4	13	This is quite a bold statement, for something that is said by IPCC for the first time (as far as I know). I would expect here a measure of size and a measure of confidence, following the IPCC guidelines on the treatment of uncertainties, considering the type of evidence and their agreement. https://www.ipcc.ch/pdf/supporting-material/uncertainty-guidance-note.pdf [Corinne Le Quere, UK]	Taken into acount in the new formulation of the paragraph.
23038	5	4	12	4	12	I don't think that this statement is tenable. This statement is mainly based on the work by Boyce and colleagues. There is a lot of concern in the community about this work and the associated uncertainties. What is the basis here for overcoming these concerns? [Nicolas Gruber, Switzerland]	Taken into acount in the new formulation of the paragraph.
23312	5	4	12	4	15	This statement regarding declines in global ocean productivity since 1950 contradicts what is written in the text on page 24 (lines 29-45). This summary states that there have been declines since 1950, while the text notes that trends are near zero (but can be higher or lower at regional scales and over shorter periods of time). I would certainly not say that there is “converging evidence concluding overall declines” since the 1950s, especially since we have very few data extending back to the 1950s. This statement also contradicts what is shown in Box 5.1, Figure 1E (where the anthropogenic change in net primary production will not be distinguishable from the noise until after the year 2100). [Ryan Rykaczewski, USA]	Taken into acount in the new formulation of the paragraph.
23510	5	4	12		20	This is a debatable point -see Gregg et al. (2017) regarding chla trends. Having said this, perhaps it is more important to highlight that though Chla is changing unevenly around the globe, there is evidence of shifts in phytoplankton composition, which in turn impact higher trophic levels. [Laura Lorenzoni, USA]	Taken into acount in the new formulation of the paragraph.
18630	5	4	16	4	20	it is need to explain the link between chlorophyll and organic matter production. [Roland Seferian, France]	Taken into cosideration in the revision.
21208	5	4	17	4	18	Decrease in catch in the tropical ocean is projected to BE amongst the highest IMPACTS? [Momme Butenschön, Italy]	The relationship with changes in primary production and catch is discussed in another paragraph.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
1148	5	4	18			Primary production should increase following nutrient supplementation using buoyant flakes that provide safe, ultra-slow release nutrients missing in the surface waters of oligotrophic oceans. Although reactive nitrogen would not be disseminated, iron, phosphate, silica and trace elements would allow diazotrophs to generate it. [William Clarke, Australia]	Taken in consideration, regional variations due to different processes are now highlighted.
10930	5	4	18	4	20	So, some models disagree that global primary production is decreasing (last sentence of the statement)? I have the feeling that the statement on primary production trend is not enough supported by robust evidences and is not really appropriate for an exectutive summary where statement of at least moerate confidence should appear as a message for the community. Is this finding in agreement with the IPCC AR5 report? Looking at the AR5 IPCC report, I was not able to find a reference to a trend in PP. Some authors hypothesized that acidifcation will have a fertilizing effect on PP, others that rising temperature will promote PP. There is still a debate on that and this is clearly relected from the main text (as I mentioned in my comments below). [Marilaure Gregoire, Belgium]	Taken into acount in the new formulation of the paragraph.
16594	5	4	18	4	20	Does temperature enhancement of growth cause a decline in organic matter production? [Cliff Law, New Zealand]	Taken into acount in the new formulation of the paragraph.
21206	5	4	19	4	19	Temperature enhancement of phytoplankton growth only or metabolc rates in general? [Momme Butenschön, Italy]	Taken into acount in the new formulation of the paragraph.
24094	5	4	20	4	20	Section 5.2.2.2.2 only deals with the deep sea, not with OM production [Hans-Otto Poertner and WGII TSU, Germany]	Reference to appropriate section of the chapter is now made in SOD
10934	5	4	22	4	31	This part is strong, arguing that ALL coastal ecosystemls are under pressure. I am not sure that it is the case and this statement should be supported by an extensive review of all coastal ecosystems. It seems that the example is given for Kelp but what about all the other ones? Giving some examples is not suffiicent. I would more say: Sea level rise and the resulting erosion affect coastal ecosystems like ... [Marilaure Gregoire, Belgium]	Taken into acount.
16596	5	4	22	4	25	This lead sentence should be rewritten [Cliff Law, New Zealand]	The text was altered as suggested by the reviewer.
10932	5	4	23	4	23	Please clarify what do you mean by non-climatic human activities? Human activities that do not directly impact on the climate? And "what is observable and projected climate impacts" What have "observable and climate impacts" non-climatic human activities? [Marilaure Gregoire, Belgium]	Text revised
21900	5	4	24	4	25	Shifting distiburtions of what? [Bryony Caswell, UK]	No longer relevant in SOD
21902	5	4	24	4	24	Extensive reductions in habitat area [Bryony Caswell, UK]	No longer relevant in SOD
9236	5	4	27	4	29	Normally, organisms are more vulnerable to environmental disturbances (e.g storms), when they are colonizing a new location. Thus, extreme events might prevent organisms' poleward shift and instead promote a reduction of these habitats. [APECS Group Review, Germany]	In the assessment, the literature suggest exacebration of biological responses due to extreme events, which is reflected in the Executive Summary
24096	5	4	27	4	27	Section 5.2.2.3.4 only deals with sea grass, not with Saltmarshes (5.2.2.3.2) or Sandy beaches [Hans-Otto Poertner and WGII TSU, Germany]	The text was altered as suggested by the reviewer.
3340	5	4	28	4	28	Again, coastal lagoons can harbour both types of ecosystems [Castor Muñoz Sobrino, Spain]	Also it is unclear it's relevance to the specific text, the comment has been taken into consideration.

SROCC First Order Draft Expert Review Comments - Chapter 5							
Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
20258	5	4	29	4	29	What is meant by "enhanced grazing by warming"? [Michelle A. North, South Africa]	Clarified in SOD
21904	5	4	29	4	30	Change to '...enhanced grazing pressure (due to warming)...' [Bryony Caswell, UK]	The text was altered as suggested by the reviewer.
21906	5	4	30	4	31	...result in increased physical and physiological...'? [Bryony Caswell, UK]	Clarified in SOD
640	5	4	33	4	41	This paragraph provides very little information on the past and projected impacts of climate change, possibly in conjunction with other stressors, on coral reef ecosystems. Why are events such as the mass bleaching of corals at the Great Barrier Reef during recent marine heat waves not adequately covered? [Hans-Martin Füssel, Denmark]	Taken into consideration in SOD
10936	5	4	33	4	41	This section is not an assesmsent and lacks of quantitative information (e.g. percentage of reefs affected by bleaching). This does not give an assessment of the state of coral reefs but rather mention some very vague findings that appear disconnected.(i.e. one for shallow corals, one for deep corals affected by acidifcation, one for the potential restoring). I would have expected to have objective analysis on the percentage of corals affected by climate changes and other human pressures, what is the main pressures (warming, acidification, others). [Marilaure Gregoire, Belgium]	The text was altered as suggested by the reviewer.
11514	5	4	33	4	41	The leading sentence of this paragraph (in bold) refers to vulnerability to climate change impacts, whereas the key example given relates to acidification and not to climate change per se. A simple fix would be to refer to vunerability to both climate change and ocean acidification in the bold text in the leading sentence of the paragraph. [Taehyun Park, Republic of Korea]	Ocean acidification is inclusive as an element in the term climate change in this context.
12818	5	4	33	4	41	Cross reference to chapter 6 [Collins Matthew, UK]	The text was altered as suggested by the reviewer.
16412	5	4	33	4	41	A natural soltuion to what? [Coswig Kalikoski Daniela, Italy]	The text was revised
16414	5	4	33	4	41	Should the report not mention possible solutions, such as transplanting coral seedlings from heat-resistant strains or genetically-modified strains? [Coswig Kalikoski Daniela, Italy]	The text was revised
18632	5	4	33	4	33	almost no major is a bit akward. If there are exception it might worth highlighting them. [Roland Seferian, France]	The text was altered as suggested by the reviewer.
22180	5	4	33	4	34	This top line is quite weak given the overwhelming negative effect of warming on corals. They are not just vulnerable, they are dying. I would suggest the language is considerably strengthened. [Corinne Le Quere, UK]	Taken in consideration in preparation of SOD
24512	5	4	33	4	34	Suggest to rephrase e.g. "Almost all major coral reef systems in shallow and in deep water are vulnerable to climate change, but sensitivities differ clearly between regions." because this statement might be quoted out of context (like a headline statement) and will be easier to understand without the double negation. Clarify if both warm- and cold-water corals are included. [Hans-Otto Poertner and WGII TSU, Germany]	The text was altered as suggested by the reviewer.
14026	5	4	36	4	38	My understanding is that deep water coral reefs are actually fairly resistant to low saturation states - more than we originally thought. At NOAA, we have tested some of these species and are finding they can exist in waters with a saturation state below 1. [Elizabeth Jewett, USA]	The text was revised
16598	5	4	36	4	36	Surely they are a refuge for reef organisms from degraded reefs, rather than the degraded reefs themselves [Cliff Law, New Zealand]	The text was revised
16600	5	4	38	4	41	Sentence requires punctuation [Cliff Law, New Zealand]	The text was altered as suggested by the reviewer.

SROCC First Order Draft Expert Review Comments - Chapter 5							
Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
21908	5	4	38	4	41	Unclear and rambling. Change to More climate change resilient reefs may nautrally arise, that support coral taxa that are more resistnat to stress or have the capaityy to recover rapidly, and these offer hope for...' Because I don't believe that a reef that has never been bleached will be reislient to bleaching which is what the current sentence formulation implies. [Bryony Caswell, UK]	Taken in consideration in preparation of SOD
1150	5	4	40			A more effective method of saving coral from bleaching might be to employ moored and solar-powered fiztop units to generate long-lived nanobubbles in the surfactant-rich skin of the ocean to brighten it imperceptibly, thereby cooling it and the planet (via free floating fiztops on the high seas). [William Clarke, Australia]	This does not reflect the results of the assessment.
16602	5	4	43	4	44	"The strong positive relationship between annual Particulate Organic Carbon (POC) flux and abyssal sediment community oxygen consumption combined with projected changes in biomass suggests" - is this justification required in this first sentence? [Cliff Law, New Zealand]	Yes
18634	5	4	43	4	49	This ES statement is difficult to read. Besides "suggests" does not reflect a "medium confidence". This is misleading. [Roland Seferian, France]	The text was altered as suggested by the reviewer.
21910	5	4	43	4	47	Add full stop after 'functional changes' start new sentence 'These changes will...' [Bryony Caswell, UK]	The text was altered as suggested by the reviewer.
22182	5	4	43	4	48	This is not an executive summary sentence, this reads like a bit of text that belongs in the main chapter. It was also very difficult to understand [Corinne Le Quere, UK]	The text was altered as suggested by the reviewer.
24092	5	4	43	4	47	This is a very long sentence and a bit hard to follow. Would it be possible to reduce the length (e.g. move "which covers 56% of the ocean floor" to the following sentence (not in bold)) [Hans-Otto Poertner and WGII TSU, Germany]	The text was altered as suggested by the reviewer.
24514	5	4	43	4	49	Without any further explanation and context, the audience of the Executive Summaries may not be able to understand this paragraph and the relevance of details adressed here. Suggest to simplify so that it becomes clear that processes in the deep sea are affected by climate change and can in turn affect the carbon cycle. [Hans-Otto Poertner and WGII TSU, Germany]	The text was altered as suggested by the reviewer.
24662	5	4	46			A more specific statement on how the carbon cycle will change would be very useful. [Hans-Otto Poertner and WGII TSU, Germany]	The text was altered as suggested by the reviewer.
11068	5	4	48	7	48	.."lead to community changes..." suggest to add : change marine biodiversity and ecosystem , thus affect the the production of marine product and reduction in marine food which evidently attributed to marine product and food security in near future. The presence of marine species and its seasonality in certain coastal sea and deep sea is being influenced by the climate change , this evidenced along the Borneo Island coastal region . [Kim Lian Chan, Malaysia]	This comment is not directly relevant in this executive summary message.
24098	5	4	49	4	49	There is no section 2.2.6.10 [Hans-Otto Poertner and WGII TSU, Germany]	The text was altered as suggested by the reviewer.
670	5	4	51	4	57	Zooplanktons be changed as 'Zooplankton" [Kathiresan Kandasamy, India]	The text was altered as suggested by the reviewer.
672	5	4	51	4	57	Not only vertebrates but also invertebrates are vulnerable to warming in terms of distribution, phenology and biomass production [Kathiresan Kandasamy, India]	Taken in consideration in preparation of SOD
10938	5	4	51	4	57	please clarify what you mean by animal biomass: [Marilaure Gregoire, Belgium]	Since animal biomass refers to its literal meaning here - biomass of animals in the ocean. Therefore, we decide not to add a definition for this term.

SROCC First Order Draft Expert Review Comments - Chapter 5							
Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
22184	5	4	51	4	55	The top sentence would be more powerful if it was simpler. Perhaps put a period after 'primary production' and keep only the top message as bold. Also do you need 'net'? nobody knows what this means without context. [Corinne Le Quere, UK]	Taken in consideration in preparation of SOD
22966	5	4	51		55	sentence seems confused. It seems to imply that marine mammals are primary producers (and they are not) [Jamie Shutler, UK]	Taken in consideration in preparation of SOD
10956	5	4	52	4	52	The authors say:'There is unequivocal evidence that distribution and phenology is responding to warming and changes in net primary production across all ecosystems and taxonomic groups from microbes to marine mammals (very high confidence) ': I do not agree that Chapter 5 is providing unequivocal evidence of changes in phenology and net ^primary production across all ecosystems. [Marilaure Gregoire, Belgium]	Taken in consideration in preparation of SOD
16606	5	4	53	4	54	"equatorward range boundary" is unclear terminology [Cliff Law, New Zealand]	The text was altered as suggested by the reviewer.
6492	5	4	55	5	1	It is unclear form this sentence whether the reference to vertebrates is correct given the typo "othe vertebrates". Is there something missing that may e.g. refer to other invertebrates (other than zooplankton)? [Ana Queiros, UK]	The text was altered as suggested by the reviewer.
16188	5	4	57	4	57	other' [Lynne Talley, USA]	The text was altered as suggested by the reviewer.
20260	5	4	57	4	57	"other" is missing an 'r' [Michelle A. North, South Africa]	The text was altered as suggested by the reviewer.
24100	5	4	57	4	57	The Section about vertebrates is 5.2.3.3 [Hans-Otto Poertner and WGII TSU, Germany]	The text was altered as suggested by the reviewer.
24666	5	4	57			why "other" vertebrates, none were mentioned so far. [Hans-Otto Poertner and WGII TSU, Germany]	No longer relevant in SOD
21920	5	5	0	5		change to 'small' or 'narrow' 'biogeographic range' [Bryony Caswell, UK]	No longer relevant in SOD
2122	5	5	1	5	1	"...is slower that the rate..." should read "...is slower than the rate...". [Michio Kawamiya, Japan]	The text was altered as suggested by the reviewer.
14028	5	5	1	5	1	change from "that" to "than" [Elizabeth Jewett, USA]	The text was altered as suggested by the reviewer.
16190	5	5	1	5	1	than' [Lynne Talley, USA]	The text was altered as suggested by the reviewer.
21916	5	5	1	5	2	Consider changing to 'For taxa with slower evolutionary adaptation than the rate of climate change...' because we know it varies between taxa - 'if its slower' seems to imply we don't know anything about adaptation [Bryony Caswell, UK]	No longer relevant in SOD
24668	5	5	1			Under the current rate of change, observations of moving species seem to indicate that the rate of evolutionary adaptation is slower indeed? [Hans-Otto Poertner and WGII TSU, Germany]	Agreed. This is reflected in the main text too.
11040	5	5	2	5	4	I wouldn't classify this statement as 'high confidence' as the most productive areas - coastal regions - have poor coverage by this ensemble of global models. I would classify this as low confidence. Additionally, the regions that are projected to have the biggest increases - high latitudes - have the greatest uncertainty and lack of processes represented in earth system models. [Tyler Eddy, Canada]	Taken into consideration. Confidence level is adjusted.
16604	5	5	2	5	3	"with potential animal biomass projected to decrease by 4.8% and 17.2% under RCP2.6 and 8.5," is this total marine biomass or regional? [Cliff Law, New Zealand]	It is global total. This is now clarified.
22968	5	5	3		4	multiple missing capital letters. Earth is a proper noun. [Jamie Shutler, UK]	The text was altered as suggested by the reviewer.
16608	5	5	5	5	5	"species WILL IMPACT predators" [Cliff Law, New Zealand]	The text was altered as suggested by the reviewer.

SROCC First Order Draft Expert Review Comments - Chapter 5							
Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
16610	5	5	5	5	7	"...and reptiles, WITH species with specialized ecology, such as diet requirement, small range size and specific habitat requirement, being THE most vulnerable" [Cliff Law, New Zealand]	The text was altered as suggested by the reviewer.
21918	5	5	5	5	6	and fish! which may not be charismatic megafauna but are commercially important. Change to '...key prey species impacts predators, including fish, marine mammals...' [Bryony Caswell, UK]	No longer relevant in SOD
16192	5	5	6	5	6	being' should be 'are' [Lynne Talley, USA]	The text was altered as suggested by the reviewer.
21922	5	5	7	5	9	Consider revising this list - endocrine disruptors (not exclusively POPs) are the major threat, Hg is unusually in low concentrations (bad for humans but doesnt usually kill marine taxa), and emerging pollutants such as nanoparticles and pharmaceuticals are a real future threat. As are organic enrichment and other stressors such as habitat loss, overfishing to name just a few [Bryony Caswell, UK]	The text was altered as suggested by the reviewer.
24974	5	5	7			The risk of pop declines is compounded by many things, not just POPs. Eg, in the Arctic, risk also compounded by other human industrial activities like offshore oil and gas (oil spills, underwater noise, disturbance from air and ship traffic, etc.) [Elizabeth Speer, USA]	No longer relevant in SOD
21210	5	5	8	5	8	I'd add recreation, which maybe is more tangible than aesthetic appeal [Momme Butenschön, Italy]	Taken in consideration in preparation of SOD
24102	5	5	9	5	9	Section 5.3.2.1.3 is about Human security and conflicts, not about distribution of key species [Hans-Otto Poertner and WGII TSU, Germany]	The text was altered as suggested by the reviewer.
14030	5	5	11	5	11	"flow in important ecosystem service" doesn't make sense. Reconsider the wording here. [Elizabeth Jewett, USA]	The text was altered as suggested by the reviewer.
16194	5	5	11	5	11	flow in ecosystem services': this is jargon of some sort. I have no clue what it means - what flow (apparently not a fluid), what services. Use normal phrases. [Lynne Talley, USA]	The text was altered as suggested by the reviewer.
16416	5	5	11	5	15	Fisheries catches ...are already affected by warming ...(high confidence). I believe the confidence level is too high for the evidence - Causality is not demonstrated. [Coswig Kalikoski Daniela, Italy]	Taken into consideration. Confidence level is adjusted.
16612	5	5	11	5	11	"flow OF important ecosystem...." [Cliff Law, New Zealand]	No longer relevant in SOD
17454	5	5	11	5	11	"flow": since this word is used in a physical context for ocean transport, I suggest using something else here. What about "availabilty of" instead of "flow in"? [Sonya Legg, USA]	Accepted. This is now revised.
21924	5	5	11	5	12	..is projected to effect all ecosystem services in the future.' [Bryony Caswell, UK]	The text was altered as suggested by the reviewer.
24958	5	5	11	5	11	“Climate change is already…”. Would the authors consider changing this to “Increase in sea level…” or “increase in sea level and warming of waters…”. Writing “Climate change” is more vague and potentially lowers confidence because then attribution to anthropogenic carbon emissions may be needed. [Elizabeth Weatherhead, USA]	Taken into consideration in SOD
16614	5	5	12	5	14	Fisheries catches and their composition are already affected by warming VIA decrease in net primary production, reduction in fish stock’s reproductive successes and increase of warm water species" As written this sentence is unclear whethe the decrease in NPP is linked to the warm water species, or if hte latter refers to fish. [Cliff Law, New Zealand]	Taken into consideration in SOD

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
17692	5	5	13	5	13	'Panels (a,b,c and d) are from Bojinski et al. (2014)'. These panels don't appear in the cited reference, please give the correct reference. [Simon Josey, UK]	Sorry, unsure what the reviewer referred to.
24104	5	5	13	5	24	Where can most of this info be found (only deep sea is referenced in this section) [Hans-Otto Poertner and WGII TSU, Germany]	Reference to secton corrected.
11042	5	5	14	5	17	Again, I would classify this statement as low confidence for the same reasons as my previous comment. Additionally, we don't know how fishers will fish in the future without likely future fishing scenarios, which presently are in their infancy. [Tyler Eddy, Canada]	No longer relevant in SOD
21926	5	5	14	5	14	what do you mean by ' increase in warm water species'? Their prey or the fish themselves? It is important here to point out that major species range shifts are ocurring (with latitude and water depth)in fish and their prey [Bryony Caswell, UK]	This is now clarified.
21930	5	5	14	5	17	Also, worthy of note are the projected changes in fish size see Cheung et al. 2012(Nature Climate Change volume 3, pages 254–258) (and Pauly and Cheung 2017 https://doi.org/10.1111/gcb.13831) projectsion that fish will decreas in size by around 25% due to decreasing ocean oxygen concentrations. [Bryony Caswell, UK]	Taken into consideration in SOD
16616	5	5	16	5	16	replace "under projected decrease in..." "in response to prpjected decreases in...." [Cliff Law, New Zealand]	The text was altered as suggested by the reviewer.
1152	5	5	17			Combinations of buoyant flake nutrient supplementation, fiztops, marine cloud brightening using fluidic oscillators, and ice thickening should be able, in time, to reverse global warming, stratification, acidification and fishery decline. [William Clarke, Australia]	Sorry, unsure which part of the text the reviewer referred to.
10940	5	5	17	5	17	The authors mention "medium confidence". I would like to know how this level of confidence is estimated (in general not only for that point). In IPCC, they have ensemble of models and analyse huge data sets and so it is possible to estimate probability of occurrence. How is it perform here? Are all the statements mentioned in the executive summary refelect the findings of different studies performed according to pre-defined methodlogy? or is it possible that some finding only relfect the results of one publication? In particular for that stamenet, how many studies come to the conclusions that we will have a drecrease of 3 millions tones /degree of tempertaure increase comapred to 1950-1960? [Marilaure Gregoire, Belgium]	No longer relevant in SOD
14032	5	5	17	5	17	"Decrease in catch in the tropical ocean is projected to amongst the highest" - doesn't make sense. [Elizabeth Jewett, USA]	The text was altered as suggested by the reviewer.
16196	5	5	17	5	18	projected to amongst' is missing a verb [Lynne Talley, USA]	The text was altered as suggested by the reviewer.
16418	5	5	17	5	18	Careful. Models predict "catch potential", not realised catch. To say that catch will decrease in the tropical ocean is assuming that realised catch will follow the trend of potential catch, without considering the role of management (past, present and future). This may be the case, but one must not take shortcuts in stating facts [Coswig Kalikoski Daniela, Italy]	This is now clarified in SOD.
17848	5	5	17	5	18	This sentence is incomplete: 'Decrease in catch ... is projected to amongst the highest.' projected to what? [Roberta Hansman, France]	The text was altered as suggested by the reviewer.
21928	5	5	17	5	18	Word missing should read 'to be amongst' [Bryony Caswell, UK]	The text was altered as suggested by the reviewer.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
10942	5	5	18	5	24	"This is evidenced from reduction in nutrient cycling in the deep sea floor ecosystems through warming-induced reduction in biodiversity". Is it a well accepted finding for deep sea ecosystem that biodiversity and nutrient cycling are decreasing as a results of warming? or is it an example? Storms are mentioned as a pressure on coral reef although not mentioned above in the specific item on corals. [Marilaure Gregoire, Belgium]	This is now clarified in the new version of the paragraph.
16618	5	5	18	5	18	"amongst the highest REGIONAL DECLINES." [Cliff Law, New Zealand]	The text was altered as suggested by the reviewer.
16620	5	5	19	5	24	This sentence is too long, and porly worded [Cliff Law, New Zealand]	The text was altered as suggested by the reviewer.
22094	5	5	19	5	19	Should be 'supporting services' not 'support services' [Bryony Caswell, UK]	The text was altered as suggested by the reviewer.
21932	5	5	20	5	21	deoxygenation? Acidification? Its not simply warming [Bryony Caswell, UK]	Multiple climate drivers are now considered.
16198	5	5	21	5	21	tourist' [Lynne Talley, USA]	The text was altered as suggested by the reviewer.
21938	5	5	21	5	22	Coral reefs are also being degraded by other human actiivities [Bryony Caswell, UK]	The text was revised
676	5	5	22	5	24	It is not clear "...seqestration 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 [Kathiresan Kandasamy, India]	The text was altered as suggested by the reviewer.
16200	5	5	22	5	22	warming' [Lynne Talley, USA]	The text was altered as suggested by the reviewer.
21934	5	5	22	5	22	warming singular [Bryony Caswell, UK]	The text was altered as suggested by the reviewer.
21936	5	5	22	5	24	poorly worded - reduced sequestration of carbon in salt marshes through reduced habitat avaialability? Not a process im aware of. Habitat is lost due to urbanisation and climate change perhaps as well which means less habitat for fauna, and less carbon sequestration. Is this the meaning? unclear [Bryony Caswell, UK]	This is now revised and clarified.
674	5	5	23	5	23	Not only saltmarshes for reduction in carbon stock and sequestraon but also mangroves and seagrasses. [Kathiresan Kandasamy, India]	No longer relevant in SOD
132	5	5	26	5	38	Summary of impacts of sea surface temperature rise and Vibrio pathogenecity is confusing. You should spend more than one sentence explaining how changes on the pathogen abundance are "highly confidence" but health implications are "low confidence". Perhaps a note on other determinants of infection risk that moderate the abundance to disease relationship? [Matthew Gribble, USA]	Taken in consideration in preparation of SOD
134	5	5	26	5	38	Discussion of fish nutrients should also include discussion of contaminants, including mercury and POPs (medium confidence) and harmful algal bloom toxins, for example frequency of ciguatera fish poisoning may increase (medium confidence). [Matthew Gribble, USA]	Taken into acount in the new formulation of the paragraph.
3242	5	5	26		38	There is no mention of Harmful Algal Blooms in this summary and there should be [Martin Edwards, UK]	Taken into acount in the new formulation of the paragraph.
9238	5	5	26	6	38	It would be helpful to add references linked to the inability to meet Sustaianble Development Goals (SDG) into the Executive Summary. [APECS Group Review, Germany]	No longer relevant in SOD

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11062	5	5	26	5	27	climate change is expected to substantially impact the health and economic security of coatal human communities ….the context of show the issues of diseases and incomes of the coastla community, there therefore, economics security should be included. [Kim Lian Chan, Malaysia]	Taken into acount in the new formulation of the paragraph.
21940	5	5	26	5	28	and potable water [Bryony Caswell, UK]	Not the main focus arises from our assessment
23044	5	5	26	5	38	This statement does not seem policy neutral to me. It singles out a particular group of people rather than focusing on what is really the issue at hand, i.e. poverty. [Nicolas Gruber, Switzerland]	Taken into acount in the new formulation of the paragraph.
24960	5	5	26	5	26	“Climate change is expected to…”. Would the authors consider changing this to “Sea level is expected to….” or something similar. Writing “Climate change” is both more vague and potentially lowers confidence because then attribution to anthropogenic carbon emissions may be needed. [Elizabeth Weatherhead, USA]	No, because attribution to a single variable to the impacts of human wellbeing is difficult.
13156	5	5	27	5	27	what is the "Global South"? [Baerbel Hoenisch, USA]	The text has been altered to clarify this.
16622	5	5	27	5	27	"Indigenous people and the Global South" - why are these words capitalised? What is the Global South? See also Line 32 [Cliff Law, New Zealand]	The text has been altered to clarify this.
16624	5	5	27	5	27	"through elevated risks on health" should be "via elevated health risks…" [Cliff Law, New Zealand]	The text has been altered.
3732	5	5	30	5	30	Replace "bateria" with "bacteria" [Serhat Sensoy, Turkey]	The text was altered as suggested by the reviewer.
11044	5	5	30	5	31	As above, I would suggest low confidence. Additionally, Indigenous communities at high latitutes could experience an increase in fisheries catches. [Tyler Eddy, Canada]	No longer relevant in SOD
20530	5	5	30	5	30	"bacteria" insterad of "bateria" [Shin-Ichi Ito, Japan]	The text was altered as suggested by the reviewer.
16626	5	5	31	5	31	"are as projected by models" why is this included here, when a large number of findings in this report are projections that are based upon models? [Cliff Law, New Zealand]	The text was altered as suggested by the reviewer.
11064	5	5	34	5	39	In order to present a more holistic perspective, It should also informed that man made activities such as fish bombing activities posed serious threats and affect the ocean ecosystem badly , not just climate change ? [Kim Lian Chan, Malaysia]	Overfishing, including the use of destructive fishing method, is now noted.
16628	5	5	34	5	34	"Global degradation and loss of corals, AND erosion of beaches" [Cliff Law, New Zealand]	The text was altered as suggested by the reviewer.
16630	5	5	34	5	38	Why are their no levels of confidence in these sentences? [Cliff Law, New Zealand]	Confidence level is added in the new formulation of the paragraph
22670	5	5	35	5	38	It is not clear who is meant by "their health risk". The health risk is also enhanced in Inuit communities due to elevated exposure to contaminants in their diet (which includes marine mammals), which is further enhanced by climate change impacts. Please see the AMAP 2015 Human Health Assessment (available at www.amap.no). [Eva Kruemmel, Canada]	It refers to the human society in general, but the paragraph new also highlighted the particularly high risk for marginalized communities.
24106	5	5	35	5	35	5.3.2.2.2 is about food security, not about tourism (do you mean 5.3.2.2.3?) [Hans-Otto Poertner and WGII TSU, Germany]	Corrected references to sections arenow provided in SOD.
21942	5	5	38	5	38	add 'as seen in other indigenous communities' to the end of the sentence [Bryony Caswell, UK]	No longer relevant in SOD
13158	5	5	40	5	40	please define "blue carbon" [Baerbel Hoenisch, USA]	Blue carbon ecosystems are now specified

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
19090	5	5	40	5	51	Discussion on blue carbon should include information on uncertainties in measuring carbon sequestration and in the risk of impermanence of blue carbon sequestration, particularly in light of increasing climate change impacts on the oceans. The value of coastal ecosystems as an adaptation option should have more prominance. Additionally, the distinction between anthropogenic sequestration / emissions and natural sequestration and storage should be made clear. [Carl-Friedrich Schleussner, Germany]	Taken into acount in the new formulation of the paragraph.
22186	5	5	40	5	42	I am really not impressed by the blue carbon narrative (here and generally). The big advantage of blue-carbon is that is has co-benefits and generally goes in the same direction as mitigation. However the numbers are so desperately small that the efforts really only make sense in the context of the SDGs, not in the context of climate mitigation. The high profile of blue carbon in this report is not warranted by the numbers, and this should be spelled clearly in this report. [Corinne Le Quere, UK]	Taken into acount in the new formulation of the paragraph.
23046	5	5	40	5	51	There are many reasons for protecting coastal ecosystems - the argument about preserving it for the purpose of enhancing carbon stocks is not one of them, in my opinion. [Nicolas Gruber, Switzerland]	Taken into acount in the new formulation of the paragraph.
24670	5	5	40			Bullet point text needs clarifications, flow of reasoning is unclear, especially last sentence. Did chapter team discuss the new concept "Nature's contribution to people" rather than ecosystem services? NCP us under discussion in IPBES and in SRCCL. [Hans-Otto Poertner and WGII TSU, Germany]	The concept of NCP is discussed in SOD
11670	5	5	41	6	6	"solutions" for what? This paragraph overstates the potential of these ecosystem to solve the problem of global warming. A much more balanced text is needed. It should not be claimed that these ecosystems can mitigate fossil emissions. [Fortunat Joos, Switzerland]	Taken into acount in the new formulation of the paragraph.
11672	5	5	41	5	51	These blue ecosystems are not responsible for up to 30% of the net anthropogenic carbon uptake. Productivity or gross fluxes of carbon should not be confused with net fluxes. As stated in Gasttuso et al., 2015: only reducing CO2 emissions addresses the fundamental problem [of climate change]; the others [eg. blue carbon] merely delay or decrease impacts. The implication that blue carbon ecosystems may mitigate anthropogenic CO2 is also in conflict with Table 5.7 that list (rightly low, very low potential for carbon sequestration) [Fortunat Joos, Switzerland]	Taken into acount in the new formulation of the paragraph.
21944	5	5	41	5	41	a natural soltuion to what? [Bryony Caswell, UK]	For climate change. Since the report and the narrative throughout the executive summary is about climate change, so we do not find the need to reiterate it.
21946	5	5	41	5	41	Blue carbon' needs explaining, I would not assume everyone knows the meaning of this buzzword [Bryony Caswell, UK]	Blue carbon ecosystems are now specified

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
21560	5	5	42	5	45	Global estimates of carbon sequestration by seagrass meadows have been shown to be incorrect and much too high (Johannessen & Macdonald, 2016 Environmental Research Letters 11: 113001; Johannessen & Macdonald 2018 Environmental Research Letters 13: 028002; Johannessen & Macdonald 2018 Environmental Research Letters 13: 038002). The global estimates are based on a naive interpretation of how marine sediments process and sequester carbon, which neglects six decades of published marine geochemical literature (see references in above citation). [Robie Macdonald, Canada]	Taken into acount in the new formulation of the paragraph.
21948	5	5	42	5	43	provisioning' not 'provision' [Bryony Caswell, UK]	The text was altered as suggested by the reviewer.
23040	5	5	43	5	49	This seems overconfident to me. Although we do expect a decrease in export production over most of the ocean, the confidence that this actually leads to a decrease in the POC flux to the ocean's sea floor cannot be particularly high. For example, a simple shift in the origin and nature of the organic matter and its associated ballast material can easily offset the effect of reduced export. This needs to be much more carefully worded. [Nicolas Gruber, Switzerland]	Taken into acount in the new formulation of the paragraph.
22188	5	5	44	5	44	I am frankly shocked and disappointed to read the statement that 'blue carbon ecosystem contribute 3-30% of oceanic CO2 uptake' in this report. This is simply wrong. I tried to trace the information in this report, and the number comes from a policy document, which is not even a peer-reviewed journal. Certainly 'blue carbon ecosystems' are not responsible for that uptake. Possibly coastal ocean regions are, but that is because of their physical dynamics, not because of their ecosystem properties. There seems to be misunderstanding or lack of clarity on the processes that drive the uptake of anthropogenic carbon here, mixing productivity with carbon uptake and sequestration. The information needs to be re-assessed with critical eyes. [Corinne Le Quere, UK]	Taken into acount in the new formulation of the paragraph.
23048	5	5	44	5	44	"3 to 30%" of ocean carbon uptake. I don't see any evidence that would substantiate this statement. In the main text, the authors refer to a policy brief, which itself does not provide the underlying evidence for this statement. In fact, it would be really amazing if these ecosystems were able to absorb, on net, such a large amount of C every year while their area is actually shrinking. The majority of numbers that are floating around are not really correct, as they often neglect leaching, lateral transport and many other processes that decouple CO2 uptake and remineralization. [Nicolas Gruber, Switzerland]	Taken into acount in the new formulation of the paragraph.
16632	5	5	45	5	47	"Successful implementation……." this sentence requires punctuation [Cliff Law, New Zealand]	The text was altered as suggested by the reviewer.
21950	5	5	45	5	46	word missing after 'measures currently' [Bryony Caswell, UK]	The text was altered as suggested by the reviewer.
21408	5	5	47	5	47	For accuracy suggest replacing “net zero emissions target of the Paris Agreement” with “aim of Parties the Paris Agreement to achieve the balance between anthropogenic emissions by sources and removals by sinks of greenhouse gases by the second half of the 21st century.” [Alice Alpert, USA]	We think the original formulation is more easily understood by general readers, thus we maintain that in the SOD.
678	5	5	48	5	48	terms "restoration and rehabilitation" mean the same and hence, instead of restoration , the term "afforestation" be added [Kathiresan Kandasamy, India]	The text was altered as suggested by the reviewer.
21912	5	5	48	5	49	reduced biomass in 'these areas' as I presume you only know this for seamounts [Bryony Caswell, UK]	We now also included a statement about all abyssal sea floor

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
6494	5	5	49	6	6	There may be missing qualifiers within this section, with regard to the degree of confidence placed in these assertions. Recent published work has highlighted large uncertainties around the present understanding of the blue carbon potential of seaweed and other, connected, organic carbon sinks in the coastal and open ocean. Questions have also been placed around whether managing these sinks is indeed less feasible than managing the traditionally considered blue carbon habitats in the coastal ocean. See for instance: Krause-Jensen et al. 2018 Biology Letters 14: DOI: 10.1098/rsbl.2018.0236; Smale et al 2018 Front Ecol and Env 16: DOI: 10.1002/fee.1765; Krause-Jensen and Duarte 2016 Nature Geoscience 9: DOI 10.1038/ngeo2790. In addition, several initiatives are currently underway around the world to address existing uncertainties and data availability. It would therefore suggest that this section (as well as section 5.4.1.2) requires revision: it is not in line with current understanding nor does it reflect a consensual view within this research community. This view is repeated in section 5.3.1.1.2. and Table 4. [Ana Queiros, UK]	Taken into account
21952	5	5	50	5	50	word missing add 'systems' after 'blue carbon' [Bryony Caswell, UK]	The text was altered as suggested by the reviewer.
23042	5	5	51	5	57	This is another overconfident statement. The actual evidence is not that strong. For example, we do not have direct observations of range shifts for many marine taxa. What we have is an EXPECTED range shift based on various types of (statistical) models. [Nicolas Gruber, Switzerland]	In the chapter, we provided overwhelming evidence of observed range shifts from historical periods that can be attributed to warming. Along with other lines of evidence from physiological principles, experiments and projections, this result in high confidence for the statement on range shift.
18636	5	5	53	5	57	it might be good to provide a confidence statement [Roland Seferian, France]	The text was altered as suggested by the reviewer.
22190	5	5	53	6	6	This paragraph should be deleted and the previous paragraph should provide a proper assessment, with numbers, of the role of blue carbon (as per my previous comment). Then a sentence comparing that size with global emissions could be included in the paragraph on blue carbon. The mere presence of this paragraph on its own suggests that blue carbon even compares with conventional mitigation efforts. They are many orders of magnitude appart. [Corinne Le Quere, UK]	Considered and revised
23050	5	5	53	5	56	In my opinion, it is not IPCC's task to make such policy prescriptive statements. This needs to go. [Nicolas Gruber, Switzerland]	Considered and revised
11516	5	5	54	5	55	"Even if blue carbon ecosystems could be restored to their 1990 extent (unlikely, because of the nature of much coastal development), globally, it cannot replace the need for the very rapid phase-out of fossil fuels," This sentence might indicate that ocean's blue carbon's pacity is limited to coastal development. It's true that non of the intervention could replace the phase out of fossil fuels. But such wording might also give priority to the fossil fuel solution than indicating climate change is worthy of all possible actions including protecting oceans. [Taehyun Park, Republic of Korea]	In the scoping document, the chapter team is tasked specifically to assess the role of blue carbon, mangrove restoration and other nature-based solutions. Hence key messages in respond to that are reasonable expectation
16202	5	5	54	5	54	it ' should probably be 'this' [Lynne Talley, USA]	The text was altered as suggested by the reviewer.
21954	5	5	55	5	56	add 'greenhouse gas' before 'emissions' [Bryony Caswell, UK]	The text was altered as suggested by the reviewer.
16634	5	5	56	5	56	"However, THEY HAVE GREAT potential importance at a national level...." [Cliff Law, New Zealand]	The text was altered as suggested by the reviewer.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
16636	5	5	57	5	57	"co-benefits OF..." [Cliff Law, New Zealand]	The text was altered as suggested by the reviewer.
21562	5	5	57	6	2	Restoring coastal meadows for the ecosystem services that they provide would indeed be a "no regrets" policy, as stated, so long as this activity is not used to offset increased carbon emissions elsewhere. Without a responsible accounting for the actual rate of carbon sequestration (see Johannessen & Macdonald 2016 Environmental Research Letters 11: 113001, and comment above), there is a risk that overblown estimates will be used to offset emissions elsewhere, leading to a net increase in carbon emissions to the atmosphere. [Robie Macdonald, Canada]	Taken into acount in the new formulation of the paragraph.
21914	5	5	57	5	57	typo, should be 'other' [Bryony Caswell, UK]	The text was altered as suggested by the reviewer.
21956	5	5	57	5	57	replace 'on' with 'for' [Bryony Caswell, UK]	The text was altered as suggested by the reviewer.
16638	5	6	1	6	2	"other, higher magnitude, mitigation measures." - unclear what this refers to [Cliff Law, New Zealand]	The text was altered as suggested by the reviewer.
16640	5	6	1	6	2	"as emphasised in the recent literature" surely this applies to most of the research described in this report? [Cliff Law, New Zealand]	The text was altered as suggested by the reviewer.
21958	5	6	1	6	2	I'm not confident this will always be the case at the local level.Restoring extensive mangroves or seagrass is bound to impact locla fisheries and fishers negatively to some extent and may have other social impacts. I think you should rephrase to 'will probably have only minor negative effects' or similar. [Bryony Caswell, UK]	The paragraph considered restoration of coastal blue carbon ecosystem CAN BE a 'no regret' solution. We think this has already provides room for additional considerations that are needed to fully evaluate the effectiveness of such measure to support sustainable development.
11632	5	6	3	6	4	This sentence is completely unclrear and the intended message seems not supported by science? Which production? Three (?) biological carbon pumps ? No role for biogenc particles and their gravitational settling? [Fortunat Joos, Switzerland]	Taken into acount in the new formulation of the paragraph.
23052	5	6	3	6	3	"only 1% of that production is removed from circulation": Very unclear sentence. While I agree that ocean fertilization will not do the trick, the CO2 uptake efficience of ocean fertilization can actually be quite high (see e.g. Jin et al., (2008) [Nicolas Gruber, Switzerland]	Taken into acount in the new formulation of the paragraph.
21960	5	6	8	6	9	Explain with a few words what EBA is [Bryony Caswell, UK]	This is now explained
24518	5	6	8	6	17	Can this be made less abstract and more specific so that this paragraph becomes more useful for the audience of the Executive Summary and the SPM that will developed from it? [Hans-Otto Poertner and WGII TSU, Germany]	Taken into acount in the new formulation of the paragraph.
1154	5	6	11			The above methods could form part of the hard engineering responses supported by ecosystem adaptation approaches. [William Clarke, Australia]	Taken into acount in the new formulation of the paragraph.
18884	5	6	11	6	13	[Executive summary] This sentence reads with difficulty, the meaning seems unclear to me. E.g. what do authors mean by "adaptation". Could this last paragrah be rewritten in such a way that it is understandable by a broader audience? [Sophie Rabouille, France]	Taken into acount in the new formulation of the paragraph.
13712	5	6	12	6	13	Should be augmented' sounds policy prescriptive. [Debra Roberts and Durban Team, South Africa]	Taken into acount in the new formulation of the paragraph.
1362	5	6	13	6	14	agree with focus on institutional capacity as a key driver for policy responses [Marcus Haward, Australia]	The text was altered as suggested by the reviewer.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
23002	5	6	20	6	20	Executive Summary should contain another paragraph on the "governance at all scales" section, essentially stating that the oceans are not cosidered well in the climate policy process, but that there are potential avenues and mechanisms for addressing it. This specific report should be used a starting ground for this conversation on how the oceans will be considered in the mitigation and adaptation process, within the UNFCCC, Law of the Sea, etc. [Yassir Eddebbar, USA]	Taken into acount in the new formulation of the paragraph.
9240	5	7	1	28	5	This part of chapter 5 updates and presents the ongoing and projected impact of anthropogenic climate change on physical and biogeochemical properties of the ocean, and their impact on marine productivity. Changes in temperature, salinity, oxygen, carbon and nutrients are presented, and the underlying dynamical processes mediating these changes are described in sufficient details. Most parts are well written, present a logical progression of ideas within each paragraph, and the language is well tuned for intended audience. There are however some general comments that I would like to make. 1. The reference to figures and their captions are not correct at multiple instances. Hence a lot of effort and time was spent to find out which figure is the text describing. See specific comments below. 2. Where ever new results are provided, I got a feeling that they are not placed in the context of our understanding from AR5 report. 3. Throughout this part of Chapter 5, there is a tendency to not describe figures in the order of their numbering, which obstructs the flow. Figure quality can also be improved. [APECS Group Review, Germany]	These suggestions are taken into account in the preparation for SOD. We have ensured accurate referenes to figures and sections in SOD. We have now also put substantial effort in highlighting the point of departure from AR5 in our assessment. Figure quality is also improved.
1620	5	7	3	7	10	In this introduction, particularly the first sentence, please consider to explicity mention the oceans important role in shaping the earths climate and weather patterns. [Aurora Stenmark, Norway]	Taken in consideration in preparation of SOD
9242	5	7	3	7	10	The first paragraphs lists various important roles of the ocean, however, there is a missing connection to the subsequent paragraph. A last sentence can be added which clarifies the progression of ideas. [APECS Group Review, Germany]	Taken in consideration in preparation of SOD

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
9248	5	7	3	7	35	This introduction could be better substantiated with the material presented from the summary of the WG I & II more explicitly integrated. I felt that the WG I & II results (e.g. quoted text containing the confidence language of the previous results) could be substantially shortened and woven into the introductory paragraph lines 3-10 for a more effective introductory section. For example, lines 3-4 the sentence starting with “It stores…” could be broken down and combined with the relevant information concluded from the IPCC AR5 report (e.g. on lines 12-19). The following is a suggestion for one possible way to re-combine these paragraphs using the above example: “The ocean stores heat trapped in the atmosphere by rising greenhouse gases, dominating the increased energy storage of the climate system that is extremely likely to be dominated by human influences (AR5 WG1, Rhein et al., 2013). This heat drawdown masks and slows the surface warming of earth. The ocean also draws down atmospheric carbon dioxide, having absorbed around 30% of anthropogenic carbon emitted (Rhein et al., 2013). Increased ocean acidification is a result of this draw down of increased atmospheric carbon dioxide. These and other ongoing physical and chemical changes to the ocean are highlighted in the IPCC AR5 report, where chapters 3 (Bindoff et al., 2013), 10 (Collins et al., 2013), and 12 (Adger et al., 2014) detail observed changes in oceans, their attributions to human influences and future projections of the physical system, respectively.” [APECS Group Review, Germany]	Taken in consideration in preparation of SOD
9250	5	7	3	7	35	I feel that if the previous reports' main findings were better integrated this would substantially improve the clarity of the section 5.1 and ensure that there are no gaps in the state of the knowledge left by the previous assessments. This is vital given the that the current report is an update to the previous reports as stated on pg 5-8 lines 30-33, and an integrative assessment of ‘the coupled human-natural marine system’. [APECS Group Review, Germany]	Taken in consideration in preparation of SOD. Point-of-departure from AR5 is provided specifically in each sections.
14388	5	7	3			The ocean is not an element of the earth, it is a component of the Earth System [Jennifer Fehrenbacher, USA]	The text was altered as suggested by the reviewer.
17456	5	7	3	7	3	Change "The ocean is a key element of the earth" to "The ocean is a key component of the earth system", since this is an incorrect use of the word "element" in a scientific context. [Sonya Legg, USA]	The text was altered as suggested by the reviewer.
18638	5	7	3	7	10	This paragraph requires some citations [Roland Seferian, France]	Taken in consideration in preparation of SOD
18886	5	7	3	7	3	suggestion to replace "by" (rising greenhouse) with "consequent to" [Sophie Rabouille, France]	The text was altered as suggested by the reviewer.
21962	5	7	3	7	3	Capitalise Earth because your using ita as a noun [Bryony Caswell, UK]	The text was altered as suggested by the reviewer.
21964	5	7	4	7	4	again Earth [Bryony Caswell, UK]	The text was altered as suggested by the reviewer.
5022	5	7	5			It not true that '2,260,000 described eukariotic speces' are already known. There is a statistical estimate of the existence of more that 2 million marine species ,91% of which still await description (Mora et al., 2011). Mora, C., Tittensor, D. P., Adl, S., Simpson, A. G., & Worm, B., 2011: How many species are there on Earth and in the ocean?. PLoS biology, 9(8), e1001127. [Alessandro Crise, Italy]	The text was altered as suggested by the reviewer.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
13714	5	7	5			Over 2m described spp in ocean? That is that correct? It sounds more like global total spp described, or estimated ocean spp not described. Check and state source. [Debra Roberts and Durban Team, South Africa]	Taken in consideration in preparation of SOD
18888	5	7	5	7	6	Could the equivalent number be cited regarding prokaryotic species? Prokaryotes are responsible for a subtantial part of primary production, and for so, would deserve not to be omitted here. [Sophie Rabouille, France]	No longer relevant in SOD
21966	5	7	6	7	7	Important ecosystem services missing here such as providing oxygen, coastal protection and protection agains tflooding, waste treatment [Bryony Caswell, UK]	The text was altered as suggested by the reviewer.
5024	5	7	7			I'm not sure that biota have something to do with 'human security'. My proposal is to change it in 'human health' [Alessandro Crise, Italy]	The text was altered as suggested by the reviewer.
5026	5	7	7			Add: Marine algae and plants are also responsible for producing an estimated 80% of the world's oxygen fluxes entering the atmosphere. [Alessandro Crise, Italy]	More detailed introduction on this aspect of the ocean is given in specific sections of the assessment
22672	5	7	7	7	9	This is a very curious choice of words and selection of "services" that the ocean "provides". First of all, the sentence is grammatically incorrect (it should be "humans" - plural), and unclear because the ocean itself doesn't provide services as such, it may provide opportunities for, or may enable services. Also, the ocean may be an important part of (what actually should be termed) "Indigenous knowledge" and "local knowledge", but it doesn't provide or sustains the knowledge itself - the Indigenous Peoples and local residents who observe and interact with the ocean aquire, provide and sustain this knowledge). [Eva Kruemmel, Canada]	The text was altered as suggested by the reviewer.
3244	5	7	8			human' should be humanity [Martin Edwards, UK]	The text was altered as suggested by the reviewer.
6008	5	7	8	7	8	humans [Jens Zinke, Germany]	The text was altered as suggested by the reviewer.
14034	5	7	8	7	8	Add "transportation" to the list of key services that the ocean provides to humans. [Elizabeth Jewett, USA]	These are just examples instead of an exhaustive list, we have clarified this now.
16644	5	7	8	7	8	I would consider that oxygen production and nutrient procesing are possibly more significant ecosystem services provided by the ocean than those listed here [Cliff Law, New Zealand]	These are just examples instead of an exhaustive list, we have clarified this now.
20262	5	7	8	7	8	"human" should probably rather be "humankind" or "people", or at least "humans" [Michelle A. North, South Africa]	The text was altered as suggested by the reviewer.
24408	5	7	9			please conider the number of figures in this section and which are the most essential [Hans-Otto Poertner and WGII TSU, Germany]	Taken in consideration in preparation of SOD
21968	5	7	10	7	10	change 'land' to 'land-based ecosystems' or similar [Bryony Caswell, UK]	The text was altered as suggested by the reviewer.
9244	5	7	12	7	35	This reads like a table of contents of the AR5 report. Is the goal to highlight which parts of AR5 report presented what results or to extract the key findings from that report? If it is the latter, then beginning each sentence with the reference takes focus away from the important points being made. Instead of quoting sentences, rephrasing them to fit the present narrative might help. [APECS Group Review, Germany]	Taken in consideration in preparation of SOD. Point-of-departure from AR5 is provided specifically in each sections.
18640	5	7	12	7	35	Although interesting this enumeration of AR5 findings is too long. One thing to highlights is that AR5 provides different report from WGI and WGII whereas this reports aims at gathering knowledge from these two WGs as well as providing updates since AR5 [Roland Seferian, France]	Taken in consideration in preparation of SOD
9246	5	7	13	7	17	The sentence is too long and addresses multiple things.. It would help to break it into three sentences. [APECS Group Review, Germany]	Taken in consideration in preparation of SOD

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
13716	5	7	13	7	13	Add page number for the direct quotation. [Debra Roberts and Durban Team, South Africa]	This will be added
3978	5	7	18	7	35	Check that references are correct-WG1 ones on lines 18-19 look wrong and Rhein reference on line 35 is WG1 not WG2 [Helene Hewitt, UK]	An error occurred when chapter 5 references were compiled in Endnote by the TSU resulting in a displacement of all the references by one position. This resulted in a great number of misplaced references which we have since then fixed.
16204	5	7	18	7	19	Bindoff is the wrong author. Chapter 3 is Rhein! At end of line Collins is the wrong author. Chapter 10 is Bindoff! In line 19, Adger is the wrong author. Chapter 14 is Collins! This leaves us with a problem of who Adger et al. (2014) is. The year is not the IPCC WG1 report. [Lynne Talley, USA]	An error occurred when chapter 5 references were compiled in Endnote by the TSU resulting in a displacement of all the references by one position. This resulted in a great number of misplaced references which we have since then fixed.
13718	5	7	29	7	35	Complete in-text reference information for the direct quotation should be provided. [Debra Roberts and Durban Team, South Africa]	The text was altered as suggested by the reviewer.
24404	5	7	31	7	31	Do you mean chapter 30 not chapter 10? [Hans-Otto Poertner and WGII TSU, Germany]	The text was altered as suggested by the reviewer.
20544	5	7	33			implciations should be changed in 'implications' [Chiara Lombardi, Italy]	The text was altered as suggested by the reviewer.
20546	5	7	35			Other than well known coral reefs, I would mention other other vulnerable biconstructional taxa such as coralline algae,sponges, mollucs, bryozoans, etc. that provide ecosystem services [Chiara Lombardi, Italy]	That is a direct qutation from previous assessment.
24672	5	7	35			reference is not for the cited WGII findings. [Hans-Otto Poertner and WGII TSU, Germany]	An error occurred when chapter 5 references were compiled in Endnote by the TSU resulting in a displacement of all the references by one position. This resulted in a great number of misplaced references which we have since then fixed.
13720	5	7	40	7	40	Insert 'and' before 'biological' [Debra Roberts and Durban Team, South Africa]	The text was altered as suggested by the reviewer.
1156	5	7	41			It is heartening that this report undertakes to "specifically assess methods and approaches that have been taken to reduce risk and the governance options that might mitigate the risks of anthropogenic climate change" as the above approaches are also suitable for local and regional application and mitigation. They need have no transnational effects beyond accepted technologies such as cloud seeding, ice road making or fish farming. [William Clarke, Australia]	Considered in detail in 5.5 of SOD
18642	5	7	43	7	44	It might be relevant to push this information about SRM in the ES and to consider to discuss this topics as a knowledge gap in thie chapter. I don't know if the other chapter does discuss SRM. In a situation where they don't. It might be helpfull to push this information somewhere in Chap 1. [Roland Seferian, France]	Considered in detail in 5.5 of SOD
17458	5	7	47	7	54	The "suite of guiding questions" should have question marks "?" at the end of every sentence. [Sonya Legg, USA]	The text was altered as suggested by the reviewer.
9252	5	7	50	7	50	Please define “blue carbon” here for non-experts. [APECS Group Review, Germany]	Defined in 5.5 of SOD
13722	5	7	50	7	51	For consistency, suggest converting this into a question. [Debra Roberts and Durban Team, South Africa]	The text was altered as suggested by the reviewer.
22972	5	8	0			section 5.2.1.2.3: this section discussses results from sparse in situ sampling and models, but synoptic scale satellite observations have confirmed a higher rate of warming in recent years that is not well captured in other sets of observations and model results - this should be added: Hausfather et al, 2017 http://advances.sciencemag.org/content/3/1/e1601207 [Jamie Shutler, UK]	This is considered in preparation for SOD

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
5028	5	8	1	8	2	This chapter subdivides the ocean into coastal, pelagic and deep-floor ecosystem' Is this sentence referred to Chapter 5.2.2 only? If yes, I don't see the relation with the remaining text in the present form. It should be amended. [Alessandro Crise, Italy]	This is considered in preparation for SOD
5086	5	8	1	15	1	Suggest to assess more literatures about the progress in ocean heat content estimation after AR5. Five OHC time series provided in AR5 are with large difference: the minimal trend over the 1971-2010 period is about the half of the maximum trend. After AR5, some progress has been made to understand the uncertainty in OHC estimate and improve it. Now we know better about the errors in instrumental error (XBT). And it was identified that many of the traditional time series underestimate the long-term OHC change (due to gap-filling method) and some new/updated time series are available and showing more consistency and larger long-term warming rate. A number of references for example: Boyer, T., et al., 2016: Sensitivity of Global Ocean Heat Content Estimates to Mapping Methods, XBT Bias Corrections, and Baseline Climatology Journal of Climate, 29, 4817–4842, doi:10.1175/JCLI-D-15-0801.1. Cowley, R., et al., 2013: Biases in Expendable Bathythermograph Data: A New View Based on Historical Side-by-Side Comparisons. Journal of Atmospheric and Oceanic Technology, 30 (6), 1195-1225, doi:10.1175/jtech-d-12-00127.1. Cheng, L., et al., 2016: XBT Science: assessment of instrumental biases and errors. Bulletin of the American Meteorological Societ, doi:Doi: 10.1175/BAMS-D-15-00031.1. Cheng, L., et al., 2017: Improved estimates of ocean heat content from 1960-2015. Sci. Adv., 3, doi:10.1126/sciadv.1601545. [Lijing Cheng, China]	The text has been extensively revised in a way that addresses the reviewer's concerns.
5088	5	8	1	15	1	Durack, P., P. J. Gleckler, F. Landerer and K. E. Taylor, 2014: Quantifying underestimates of long-term upper-ocean warming. Nature Climate Change, 4, 999–1005. Ishii, M., et al., 2017: Accuracy of Global Upper Ocean Heat Content Estimation Expected from Present Observational Data Sets. SOLA, 13, 163-167, doi:10.2151/sola.2017-030. Levitus, S., et al., 2012: World ocean heat content and thermosteric sea level change (0-2000 m), 1955-2010. Geophysical Research Letters, 39 (10). Cheng, L., et al., 2018: Taking the pulse of the planet. Eos, 98, doi:10.1029/2017EO081839. Cheng, L. and J. Zhu, 2014: Artifacts in variations of ocean heat content induced by the observation system changes. Geophysical Research Letters, 20, 7276-7283. Cheng, L., Zhu, J., Cowley, R., Boyer, T. & Wijffels, S. 2014: Time, Probe Type and Temperature Variable Bias Corrections to Historical Expendable Bathythermograph Observations. Journal of Atmospheric and Oceanic Technology 31, 1793–1825. Trenberth, K., J. Fasullo, K. von Schuckmann and L. Cheng, 2016: Insights into Earth's Energy Imbalance from Multiple Sources. Journal of Climate, 29 (20), 7495-7505. There are more literatures besides of these, should be assessed comprehensively. [Lijing Cheng, China]	The text has been extensively revised in a way that addresses the reviewer's concerns.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
5090	5	8	1	15	1	Recommend to focus on long-term change rather than only 9-years trend in Argo-period (i.e. Fig 5.1). Firstly, this is consistent with other variables (salinity, oxygen, PH et al. shown in this chapter). It makes no sense that all other variables are shown for long-term trend, but temperature/OHC is shown for only 9-years trend (note that temperature is most observable variable in the ocean); Secondly, in a short-period, internal variability (i.e. PDO, ENSO) dominates (i.e. England et al. 2014), so the spatial pattern of short-term ocean temperature or OHC change is very different from the long-term change. Finally, only long-term trend pattern is compatible with CMIP5 simulations (anthropogenic greenhouse gasses forced pattern): if you look at the spatial pattern of observed within 1960-2016 and CMIP5 simulated OHC change (historical run), great consistency between model and observation can be found (one could easily prepares such observational based plots based several ocean analysis: IAP/CAS, EN, Ishii). References: Yan, X.-H., et al., 2016: The global warming hiatus: Slowdown or redistribution? Earth's Future, 4 (11), 472-482, doi:10.1002/2016EF000417. Meehl, G. A., et al., 2011: Model-based evidence of deep-ocean heat uptake during surface-temperature hiatus periods. Nature Climate Change, 1 (360-364). England, H. M., et al., 2014: Recent intensification of wind-driven circulation in the Pacific and the ongoing warming hiatus. Nature Climate Change, doi:doi:10.1038/nclimate2106. [Lijing Cheng, China]	The text and figures have been extensively revised in a way that addresses the reviewer's concerns.
5092	5	8	1	15	1	CMIP5 models overestimate global OHC changes in AR5, however, now model simulations are reconciled with updated/new observed OHC (see references below). And The current obs/model comparison in figure 5.1 of FOD is not clear (where are the two observed time series come from? How reliable they are? Are they carefully evaluated?). This figure gives an impression that observed OHC is not reliable and mismatch with models, but it is not (see references below). Cheng, L., Trenberth, K. E., Palmer, M. D., Zhu, J. & Abraham, J. P. Observed and simulated full-depth ocean heat-content changes for 1970–2005. Ocean Sci. 12, 925-935, doi:10.5194/os-12-925-2016 (2016). Gleckler, P. J., et al., 2016: Industrial-era global ocean heat uptake doubles in recent decades. Nature Clim. Change, 6 (4), 394-398, doi:10.1038/nclimate2915. [Lijing Cheng, China]	The text and figures have been extensively revised in a way that addresses the reviewer's concerns.
5094	5	8	1	15	1	Suggest to given more assessment on the OHC change within 700-2000m. AR5 mainly assessed OHC change at upper 700m, but now more analyses on 700-2000m changes are available (showing substantial warming with a clear spatial pattern), so one can draw a complete picture on OHC changes at upper 2000m now (than AR5). This report may consider to shift from 0-700m in AR5 to 0-2000m?? And, studies confirm that the heat is penetrated into the deep ocean below 700m. This is another major conceptual advance after AR5 (some of these stuff are discussed in the “hiatus” context). And also, ocean warming is accelerating which has important implication for the global warming (e.g. no hiatus in global ocean warming). Several references: Roemmich et al. Cheng, L., et al., 2017: Improved estimates of ocean heat content from 1960-2015. Sci. Adv., 3, doi:10.1126/sciadv.1601545. Balmaseda, M. A., Trenberth, K. E. & Källén, E. , 2013: Distinctive climate signals in reanalysis of global ocean heat content. Geophys. Res. Lett., 40. [Lijing Cheng, China]	The text and figures have been extensively revised in a way that addresses the reviewer's concerns.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
5096	5	8	1	15	1	Ocean reanalyses are not mentioned. There is an international ocean reanalysis inter-comparison project (ORA-IP). The capability of ocean reanalysis in representing ocean temperature/salinity changes have been carefully evaluated, there are >10 papers published in Climate Dynamics to compare reanalysis for different variables, which should be assessed. Here is a website collecting a lot of references: https://icdc.cen.uni-hamburg.de/daten/reanalysis-ocean/oraip.html [Lijing Cheng, China]	Text has been added that considers recent reanalysis-based temperature change estimates, and the figures showing observationally-based estimates of temperature and salinity changes are in fact reanalysis products.
5098	5	8	1	15	1	Should consider substaintially shorten the texts about abyssal changes. The discussion on the abyssal changes takes 800 words (the total words in temperature change is ~2200, so ⅓, imbalanced with 0-2000m, with more data and more advanced understanding). Actually there is little progress made since AR5 for abyssal change because still lack of data (Argo is at upper 2000m). Figure 5.2 is nearly identical to AR5 (seems no new message). [Lijing Cheng, China]	The text and figures related to this point have been extensively revised in a way that addresses the reviewer's concerns. The former Figure 5.2 has been eliminated.
5100	5	8	1	15	1	Plots need to be updated. For example, Fig.5.4 is 1950-2000, should end to 2016/2017. And Fig.5.4 starts from 1950, Fig.5.3 from 1965, 5.2 from 1981, 5.1 from 2007. Recommend to start from 1960, where the reliable estimates are available for observational OHC at upper 2000m (i.e. refer to Cheng et al. 2017). [Lijing Cheng, China]	The text and figures related to this point have been extensively revised in a way that addresses the reviewer's concerns.
5102	5	8	1	15	1	Should also state something like this: "OHC record is impacted much less by natural variability compared with surface temperature, thus has been suggested as one of the primary climate indicators (Cheng, et al., 2018a, b)" .Cheng, L., et al., 2018: Taking the pulse of the planet. Eos, 98, doi:10.1029/2017EO081839. Cheng, L. and J. Zhu, 2018: 2017 was the warmest year on record for the global ocean. Advances in Atmospheric sciences, 35 (3), 261-263, doi:10.1007/s00376-018-8011-z. [Lijing Cheng, China]	This is considered in preparation for SOD
13724	5	8	1	8	2	There should be consistency in the subdivision. Compare the subdivision here with chapter 1 page 6 lines 5-10. [Debra Roberts and Durban Team, South Africa]	This is considered in preparation for SOD
17394	5	8	1	8	3	I found the layout of this chapter confusing at the start. Suggest the order in this paragraph is changed to match the order they appear later i.e. "pelagic, coastal and deep sea floor ecosystems" (standardise for this wording for each of the subheadings later too). About 5.2.1: most is about open ocean e.g. where would someone find information on temperature, salinity and stratification changes in estuaries for instance?; expand the coastal content in this first subsection; could you use the same headings of pelagic, coastal and deep sea floor ecosystems there? [Helen Kettles, New Zealand]	This is considered in preparation for SOD
13726	5	8	4	8	4	Footnotes 1 and 3 should be integrated into a single footnote. [Debra Roberts and Durban Team, South Africa]	The text was altered as suggested by the reviewer.
2502	5	8	14	8	14	There are better references for oxygen loss, e.g., Schmidtko, S., Stramma, L., & Visbeck, M. (2017). Decline in global oceanic oxygen content during the past five decades. Nature, 542(7641), 335-339. [Xiujun Wang, China]	An error occurred when chapter 5 references were compiled in Endnote by the TSU resulting in a displacement of all the references by one position. This resulted in a great number of misplaced references which we have since then fixed.
9258	5	8	14	8	14	The timeline and what this is a comparison to should be added for clarity. [APECS Group Review, Germany]	The text was altered as suggested by the reviewer.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
16206	5	8	14	8	17	Same problem. Bindoff shoulld be Rhein. Collins should be Bindoff. [Lynne Talley, USA]	An error occurred when chapter 5 references were compiled in Endnote by the TSU resulting in a displacement of all the references by one position. This resulted in a great number of misplaced references which we have subsequently fixed.
20548	5	8	14			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]	This introduction is attempting to describe large-scale trends in the simplest possible language. The committee does not feel that there is an issue here with the chosen language.
9254	5	8	16	8	17	With what confidence/uncertainty? [APECS Group Review, Germany]	This is considered in preparation for SOD
18644	5	8	17	8	17	gasses [Roland Seferian, France]	The text was altered as suggested by the reviewer.
24108	5	8	17	8	17	"gasses" or "gases"? Please check which plural form is used in other chapters and be consistent [Hans-Otto Poertner and WGII TSU, Germany]	The text was altered as suggested by the reviewer. "Gases" will be used in this chapter like the others.
24674	5	8	17		18	Here and later in text balancing with 1.5 report chapter 1 and SPM needed. [Hans-Otto Poertner and WGII TSU, Germany]	This is considered in preparation for SOD
1884	5	8	20	8	28	This paragraph needs referencing [Jens Rassmann, Belgium]	The text was altered as suggested by the reviewer.
3246	5	8	20		21	Sentence needs reconstructing to make sense [Martin Edwards, UK]	The text was altered as suggested by the reviewer.
5030	5	8	20	8	21	'local manifestation of global-mean change' does not sound fully correct since a global-mean is by definition global. A more coherent alternative is 'The impacts on ocean ecosystems and human societies are primarily driven by regional trends and by the local response to the global change.' [Alessandro Crise, Italy]	The text was altered as suggested by the reviewer.
6496	5	8	20	8	22	It has been shown uniquivocally that ocean carbonate chemistry varies at the regional and local scale, affecting the ability of populations to endure long term changes, both resulting from ocean acidification and climate change. See e.g. Vargas et al. 2017 Nat Ecol Evol 1: DOI: 10.1038/s41559-017-0084; Queiros et al. 2015 Glob Change Biol 21: DOI: 10.1111/gcb.12675 ; Nagelkerken and Connell 2015 PNAS 112: DOI 10.1073/pnas.1510856112. Changes in carbonate chemistry resulting from increased CO2 emmissions, although not directly resulting from climate change, are ubiquitous and pervasive enough, sufficiently affecting the ability of populations to endure climate related stressors, that could warrant mention alongside the key climate-driven pressures mentioned. [Ana Queiros, UK]	This is considered in preparation for SOD
2504	5	8	21	8	22	Need rewording, it is hard to understand. [Xiujun Wang, China]	The text was altered as suggested by the reviewer.
5032	5	8	21	8	22	the temperature, salinity, nutrient and oxygen fields… are expected to exhibit well-understood basin and local-scale changes. It is unclear why these changes should be well understood. A better wording is recommended. Better to use 'properties ' instead of fields (to keep up with the title style) [Alessandro Crise, Italy]	The text was altered to address the reviewer comment
20550	5	8	22			oxygen fields' is not of very clear for a non-scientific reader, so I would suggest to replace the term with a more understandable one (i.e. easy to understand for a broad audience/readers) [Chiara Lombardi, Italy]	The text was altered as suggested by the reviewer.
18646	5	8	23	8	23	please define natural variability. Chap 1 distinguishes forced and unforced. It might be good to refer to it. [Roland Seferian, France]	Clarifying text has been added.
5034	5	8	27	8	28	The most severe impacts of a changing climate will typically be experienced when conditions are driven outside of the range of previous experience' I'm not sure that the material in Box 5.1 supports this statement. [Alessandro Crise, Italy]	The reference to the emergence CCB has been moved earlier in this paragraph, and an additional clause about rates of change versus adaptation added to this particular sentence.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
9260	5	8	27	8	28	I am not sure how the sentence starting on line 27 relates to the box on Time of Emergence. The concept in the box to my understanding is about when the signal of change emerges from the large interannual and heterogenous nature of ocean physical and chemical properties. What is the sentence referencing to with the statement “the most severe impacts of a changing climate”? [APECS Group Review, Germany]	The reference to the emergence CCB has been moved earlier in this paragraph, and an additional clause about rates of change versus adaptation added to this particular sentence.
12006	5	8	33	8	34	The following proposition needs rephrasing: Our emerging understanding of the processes driving ocean mixing and its rich geography and temporal variability…… The understanding of those processes cannot be emerging now. Large-scale ocean circulation (conveyor belt) and mixing that distribute heat across waters and atmosphere and related consequences have been widely researched, and documented. The contributors may wish to consider the following and other references or works on speed of near-surface or ocean current/circulation. Visbeack M, Power of pull, Nature 447 (2007); Roemmich D, Super spin in the southern seas, Nature (2007); Quadfasel D, The Atlantic heat conveyor slows, Nature (2005). Additional references can be found in journals of cosmology and others. The contributors should have at least described the global and regional changes in ocean circulations induced by global warming and related impacts on climate change and growth in the mainstream and ocean economies. [Louis Mitondo Lubango, Ethiopia]	The "Global Conveyor Belt" cartoon may have been an easy-to-understand analogy for popular consumption, but it never accurately captured the effects of either diapycal mixing or the global-scale circulation of watermasses; outside of the North Atlantic, it is simply wrong. There has in fact been extensive study in recent years of the geography and dyanmics of ocean mixing, which is pertinent to projections of climate change, and which this sub-section intends to describe. The committee stands by this proposition as currently worded.
17460	5	8	33	8	36	Clarify whether you are referring to changes in mixing, or mixing-related changes in ocean circulation and/or stratification. [Sonya Legg, USA]	The text has been altered to clarify that both are a possibility.
9256	5	8	35	8	35	By “climate related changes” do the authors mean “changes due to natural variability”? If it is so then it should be said explicitly. [APECS Group Review, Germany]	The text has been clarified that this refers to additional changes in the ocean driven by anthropogenic climate change that are not yet incorporated into our projections.
18890	5	8	35	8	35	"there to be" : meaning unclear. Could you please rephrase this sentence? [Sophie Rabouille, France]	The text has been revised to clarify this point.
18648	5	8	38	8	38	After reading this section, I think it would merits to condense temperature, salinity and density as a subsection on hydrodynamics and another subsection with large-scale circulation. A subsection combining temperature, salinity and density could improve the flow of this section. [Roland Seferian, France]	The text was dramatically revised to braodly along the lines suggested by the reviewer.
240	5	8	40	18	3	Variation of salinity, temperature and circulation pattern due to climate change and SLR: global warming can change salinity, temperature and circulation patterns in water body in particular shallow water such as Persian gulf. Therefore, anticyclone`s circulation of Persian gulf maybe Strengthen and change other phenomena such as sedimentation process. [Abbas Einali, Iran]	This is a valuable comment, but the strict space limitations on the chapter preclude going into detail regarding changes in particular marginal seas such as the Persian Gulf.
16484	5	8	40	15	6	It would be good to clearly distinguish between historical observations and future projections. So, split this sub-section, which is already quite long, into two subsections on historical observations and future projections. [Patrick Gonzalez, USA]	The text has been restructured significantly and now clearly distinguishes between projected and historically observed changes.
24110	5	8	40	15	6	Section 5.2.1.2.1 Temperature changes- observed and projected: please coordinate with Chapter 3 to avoid duplication regarding Polar seas [Hans-Otto Poertner and WGII TSU, Germany]	This is considered in preparation for SOD

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5106	5	8	41	9	23	In AR5, five OHC estimates of the upper 700m are provided, showing a warming rate ranging from 78 TW to 136 TW during the 1971-2010 period (Rhein, et al., 2013b): huge spread. That's why people always said OHC records are not reliable. This report should assess whether the community is able to refine the uncertainty. This is extremely important. This is related to my previous comments, and also you can use the information from annual BAMS state of climate report (for the 1991~up to now period). Johnson et al. from 2012 to 2017. [Lijing Cheng, China]	This section has been extensively revised and now includes an extensive discussion drawing on multiple estimates of ocean heat uptake, as suggested by the reveiwer.
23004	5	8	41	8	47	This entire section and especially the starting paragraph needs to present updated estimates of global whole ocean warming since the AR5 WGI report on oceans, not just one estimate (i.e. 0.4 W/m2). While regionality, mechanisms, and upper vs deeper ocean warming are detailed, there is no consideration of other estimates of OHC from other groups, products. There should be detailed estimates from other efforts. Ideally, this could be an updated figure of the OHC estimates from WGI AR5 Ocean chapter, showing different timeseries. A good start is looking at recent OHC reviews such as Johnson et al 2017; and others listed below: Johnson, G. C. et al. Ocean Heat Content [in “State of the Climate in 2016”]. Am. Meteorol. Soc. Bull. 98, S66–S68 (2017). Riser, S. C. et al. Fifteen years of ocean observations with the global Argo array. Nat. Clim. Change 6, 145–153 (2016). Boyer, T. et al. Sensitivity of Global Upper-Ocean Heat Content Estimates to Mapping Methods, XBT Bias Corrections, and Baseline Climatologies. J. Clim. 29, 4817–4842 (2016). Cheng, L. et al. XBT Science: Assessment of Instrumental Biases and Errors. Bull. Am. Meteorol. Soc. 97, 924–933 (2016). Ishii, M. et al. Accuracy of Global Upper Ocean Heat Content Estimation Expected from	This section has been extensively revised and now includes an extensive discussion drawing on multiple estimates of ocean heat uptake, as suggested by the reveiwer.
9262	5	8	44	8	44	The statement “over multiple decades” is vague. Does this mean that this uptake has taken multiple decades or that this process has been happening over multiple decades or both? [APECS Group Review, Germany]	This is considered in preparation for SOD
22970	5	8	44			consistency issue. 93% quoted here, it was stated as 90% in chapter 1 [Jamie Shutler, UK]	"About 93%" is "more than 90%". The two statements are consistent.
16208	5	8	46	8	46	surface' [Lynne Talley, USA]	The text was altered as suggested by the reviewer.
20264	5	8	46	8	46	"surface" is misspelled [Michelle A. North, South Africa]	The text was altered as suggested by the reviewer.
14390	5	8	47			Missing space between comma [Jennifer Fehrenbacher, USA]	The text was altered as suggested by the reviewer.
16652	5	9	1	10	9	Numerous grammatical errors & poorly constructed sentences [Cliff Law, New Zealand]	This subsection has been extensively revised.
20266	5	9	2			I love this phrasing "...at a rate that depends upon which radiative forcing scenario we collectively choose to follow...", thank you for emphasizing our collective choice in this matter, rather than allowing us the luxury of making it an inevitable, 'someone else's fault' [Michelle A. North, South Africa]	Thank you for this complement.
13728	5	9	3	9	3	Delete close parenthesis after '1.8.2.3' [Debra Roberts and Durban Team, South Africa]	The text was altered as suggested by the reviewer.
16210	5	9	3	9	3	extra ")" [Lynne Talley, USA]	The text was altered as suggested by the reviewer.
18650	5	9	3	9	3	typos : remove the braket after 1.8.2.3 [Roland Seferian, France]	The text was altered as suggested by the reviewer.
17462	5	9	6	9	6	Change "much more heat than" to "much additional heat as" [Sonya Legg, USA]	The text was altered as suggested by the reviewer.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
20268	5	9	6	9	6	"twice as much more heat than" is redundant, modify to "twice as much heat as" or "about double the heat than" [Michelle A. North, South Africa]	The text was altered as suggested by the reviewer.
21212	5	9	6	9	6	twice as much heat as RCP2.6 [Momme Butenschön, Italy]	The text was altered as suggested by the reviewer.
5504	5	9	7	9	9	This part refers to a surface warming with respect to pre-industrial conditions, but continues with oceanic temperatures afterwards. I suggest to refer to surface air temperature, to distuinguish it from sea surface temperature [Roderik Van De Wal, Netherlands]	The text was altered as suggested by the reviewer.
9270	5	9	7	9	7	What is meant by “surface”, Surface of the earth or sea surface or surface ocean? [APECS Group Review, Germany]	The text was clarified.
11622	5	9	7	9	8	"surface temperature", "surface air temperature" [Akihiko Murata, Japan]	The text was altered as suggested by the reviewer.
16212	5	9	7	9	7	"even for a" [Lynne Talley, USA]	The text was altered as suggested by the reviewer.
21214	5	9	7	9	7	Even at a …. [Momme Butenschön, Italy]	The text was altered as suggested by the reviewer.
16214	5	9	9	9	9	"Collins et al., 2013" [Lynne Talley, USA]	An error occurred when chapter 5 references were compiled in Endnote by the TSU resulting in a displacement of all the references by one position. This resulted in a great number of misplaced references which we have subsequently fixed.
16646	5	9	11	9	16	"Historically…" these first two sentences are not required in this update. Indeed I wonder if thids parahraph is required; although interesting no pther parameter/section contains background informatrion on the measurement techniques (also with more references than other sections) [Cliff Law, New Zealand]	The text has been extensively revised in a way that addresses the reviewer's concerns.
21216	5	9	12	9	14	missing verb [Momme Butenschön, Italy]	The text was altered as suggested by the reviewer.
16216	5	9	14	9	14	At this point I'm wondering why no one proofread this carefully before releasing! One small typo or missing word or wrong verb after another. "started in the 1970s" [Lynne Talley, USA]	The text was altered as suggested by the reviewer. The authors apologize for the embarrassingly poor gramatical quality of this passage.
1502	5	9	16	9	23	May it be worth mentioning here some information about the impact of these data in numerical models through assimilation? What about their use in combination with satellite data? [Davide Bonaldo, Italy]	We have extensively revised the section on the observationally inferred ocean heat updake, including estimates of oceanic changes from assimilative model systems.
16218	5	9	18	9	19	Zilbermann is about deep Argo. New reference for BGC-Argo, and also seasonal ice cover: Riser, S., D. Swift, and R. Drucker (2018). Profiling floats in SOCCOM: Technical capabilities for studing the Southern Ocean. J. Geophys. Res. Oceans. Doi10:1002/2017/JC013419 [Lynne Talley, USA]	An error occurred when chapter 5 references were compiled in Endnote by the TSU resulting in a displacement of all the references by one position. This resulted in a great number of misplaced references which we have subsequently fixed. Also, thank you for the suggested reference.
21218	5	9	20	9	20	revolutionized [Momme Butenschön, Italy]	The text was altered as suggested by the reviewer.
5104	5	9	22	9	23	Not sure about this. Argo data are also used and highlighted in AR5. Although the data accumulates for several years since AR5, but still too short to resolve long-term spatial pattern. [Lijing Cheng, China]	The text has been extensively revised in a way that addresses the reviewer's concerns.
9264	5	9	22	9	22	The reference “Desbruyeres et al 2016a” should be “Desbruyeres et al 2017”. [APECS Group Review, Germany]	An error occurred when chapter 5 references were compiled in Endnote by the TSU resulting in a displacement of all the references by one position. This resulted in a great number of misplaced references which we have subsequently fixed. Also, thank you for the suggested reference.
5036	5	9	23			Change ' observatory systems' with the more appropriate ' state-of-art platforms ' [Alessandro Crise, Italy]	The text was altered.
13730	5	9	23	9	23	Delete 'assessment report' after 'AR5' [Debra Roberts and Durban Team, South Africa]	The text was altered as suggested by the reviewer.

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16220	5	9	23	9	23	since the AR5' [Lynne Talley, USA]	The text was altered as suggested by the reviewer.
16650	5	9	25	9	25	"southern side of the Southern Ocean" requires further clarification [Cliff Law, New Zealand]	This is a clear description of the region in question.
17464	5	9	25	9	27	I did not understand this sentence. Do you mean that the detailed patterns are possible because of the improved observational network? Or that the data is consistent (i.e. coherent in time)? In particular the words "consistently shown" were confusing to me. [Sonya Legg, USA]	This comment is no longer relevant due to revisions to the text.
16222	5	9	26	9	26	are consistently shown owing to the..." phrase doesn't make sense. Rewrite. [Lynne Talley, USA]	This comment is no longer relevant due to revisions to the text.
14392	5	9	27			"since the last decades" is poorly written. Should be more specific: since the YYYY or over the last two decades [Jennifer Fehrenbacher, USA]	The text was altered as suggested by the reviewer.
5108	5	9	28	9	29	The references are incorrect. [Lijing Cheng, China]	An error occurred when chapter 5 references were compiled in Endnote by the TSU resulting in a displacement of all the references by one position. This resulted in a great number of misplaced references which we have subsequently fixed.
6010	5	9	28	9	29	How about the strong tropical Indian Ocean warming that many studies have highlighted as one of the strongest in recent years? Papers by Roxy and Lee et al., 2015 [Jens Zinke, Germany]	This is considered in preparation for SOD
5038	5	9	32			Please add after the dot: 'The Mediterranean Sea exhibits a prominent acceleration in heat content both in the surface , intermediate and deep layer after 1990's (Iona et al., 2018). More that half of this warming in Mediterranean waters could be attributed a long-term variability strongly correlated with the Atlantic Multidecadal Oscillation (Macias et al., 2013)' Iona, A., Theodorou, A., Sofianos, S., Watelet, S., Troupin, C., & Beckers, J. M. Mediterranean Sea climatic indices: monitoring long term variability and climate changes. Macias D, Garcia-Gorriz E, Stips A (2013) Understanding the Causes of Recent Warming of Mediterranean Waters. How Much Could Be Attributed to Climate Change? PLoS ONE 8(11): e81591. doi:10.1371/journal.pone.0081591 [Alessandro Crise, Italy]	This is considered in preparation for SOD
3342	5	9	33	9	34	Should it be 40ºN? [Castor Muñoz Sobrino, Spain]	No, this passage refers to the signal in the Southern Ocean, which is centered around 40ºS.
16224	5	9	33	9	34	in the tropical North Indian Ocean north" has one too many 'norths' in it [Lynne Talley, USA]	The text was altered as suggested by the reviewer.
6004	5	9	34	9	34	"...in the tropical North Indian Ocean north...", the word north needs to be deleted [Jens Zinke, Germany]	The text was altered as suggested by the reviewer.
9272	5	9	34	9	34	Define “extra-tropical” to non-experts. [APECS Group Review, Germany]	The text was altered as suggested by the reviewer.
21220	5	9	34	9	35	"Warming of the extra-tropical Southern Ocean ..." I suppose Southern should be dropped here. [Momme Butenschön, Italy]	The Southern Ocean is the name of the ocean basin in question.
16132	5	9	36	9	36	Do marine heatwaves need to be mentioned as a separate phenomenon from temperature changes? There are significant examples off Australia and off New Zealand in recent times. [Mary Livingston, New Zealand]	This is discussed in later section.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
2152	5	9	37			"The upper 700 m cooling dominates in the North Atlantic around 40o S-60o S." IT should be 40ºN [Fiz Fernandez Perez, Spain]	The text was altered as suggested by the reviewer.
3248	5	9	37		42	Needs to be written in past sense: ' ...temperature conditions have persisted since 2014.... And together have caused a cooling pattern.... [Martin Edwards, UK]	The text was altered as suggested by the reviewer.
3344	5	9	37	9	37	Should it be 40ºN-60 ºN? [Castor Muñoz Sobrino, Spain]	The text was altered as suggested by the reviewer.
5110	5	9	37	9	50	The trend pattern after 2004 is different from long-term trend (or long-term ocean heat uptake). It confuses the audience whether those signals reveal internal variability or GHG forced change (which should be the focus of IPCC). The authors may consider to discuss short-term change in the context of long-term change, rather showing short-term change only. And this is also related to the question of how long the OHC signals emerges beyond the natural variability. [Lijing Cheng, China]	This text has been revised.
5506	5	9	37	9	37	It refers to the North Atlantic between 40° S - 60° S, should this not be 40° N - 60° N? [Roderik Van De Wal, Netherlands]	The text was altered as suggested by the reviewer.
9266	5	9	37	9	37	Change this to 40N-60N. [APECS Group Review, Germany]	The text was altered as suggested by the reviewer.
16226	5	9	37	9	37	error: North Atlantic does not have southern latitudes. Somebody needs to fix this sentence. Probably the latitudes are "N" [Lynne Talley, USA]	The text was altered as suggested by the reviewer.
16648	5	9	37	9	44	Poorly written [Cliff Law, New Zealand]	This text has been revised.
18652	5	9	37	9	37	"North Atlantic" AND "around 40°S-60°S" are a bit confusing. [Roland Seferian, France]	The text was altered as suggested by the reviewer.
18892	5	9	37	9	37	"in the North Atlantic around 40o S-60o S." Inconsistent sentence. Either South Atlantic, or degrees N ? [Sophie Rabouille, France]	The text was altered as suggested by the reviewer.
18924	5	9	37	9	37	I think 40°S-60°S should be 40°N-60°N [Jonathan Tinker, UK]	Considered and edited
20532	5	9	37	9	37	"40N-60N" instead of "40S-60S"? [Shin-Ichi Ito, Japan]	The text was altered as suggested by the reviewer.
16228	5	9	38	9	38	have persisted' [Lynne Talley, USA]	The text was altered as suggested by the reviewer.
16230	5	9	40	9	40	of the North [Lynne Talley, USA]	The text was altered as suggested by the reviewer.
18654	5	9	40	9	41	This sentence is not clear [Roland Seferian, France]	The text was clarified.
16232	5	9	41	9	41	that is linked' [Lynne Talley, USA]	The text was altered as suggested by the reviewer.
18656	5	9	41	9	42	If there is a robust changes we may want to know what support this robustness: does it colmes from observations, models or other lines of evidence. In either case, it would merit a conficende statement [Roland Seferian, France]	This is considered in preparation for SOD
5040	5	9	42			Please change' reduction in the strength of ocean circulation and heat transport that linked' with 'the persistent reduced intensity and heat transport of the North Atlantic Current (Smeeds et al., 2018) that very likely contributes' Smeed, D. A., Josey, S. A., Beaulieu, C., Johns, W. E., Moat, B. I., Frajka-Williams, E., et al. (2018). The North Atlantic Ocean is in a state of reduced overturning.Geophysical Research Letters, 45,1527–1533. https://doi.org/10.1002/2017GL076350 [Alessandro Crise, Italy]	This is considered in preparation for SOD

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
3606	5	9	43	9	44	See Haine (2016, Nat. Geosci., cited above) for an alternate argument about the significance of subpolar North Atlantic cooling and freshening in recent years, which has led to increased, not decreased, Labrador Sea Water formation (as documented by Yashaev & Loder, 2017, Further intensification of deep convection in the Labrador Sea in 2016, Geophys. Res. Lett., 44, doi:10.1002/2016GL071668). Also the Gao et al. (2018) reference is about subantarctic mode water, not the Labrador Sea. [Thomas Haine, USA]	An error occurred when chapter 5 references were compiled in Endnote by the TSU resulting in a displacement of all the references by one position. This resulted in a great number of misplaced references which we have since then fixed.
16234	5	9	43	9	43	and the role [Lynne Talley, USA]	The text was altered as suggested by the reviewer.
2	5	9	46	9	47	when mentioned the cooling trends of the ocean surface temperature in the tropical eastern Pacific, may indicate that "cooling trends in the eastern tropical Pacific Ocean combined with the warming trends in the western tropical Pacific enlarged the zonal gradient across the Pacific basin and linked with strengthening of Walker circulation (L'Heureux et al. 2013)." L'Heureux, M., D. Collins, and Z.-Z. Hu, 2013: Linear trends in sea surface temperature of the tropical Pacific Ocean and implications for the El Niño-Southern Oscillation. Clim. Dyn., 40 (5-6), 1223-1236. DOI: 10.1007/s00382-012-1331-2. [Zeng-Zhen Hu, USA]	The text was altered as suggested by the reviewer.
6006	5	9	46	9	46	please indicate latitude where in the southwestern Indian Ocean cooling has been observed [Jens Zinke, Germany]	Edited
14394	5	9	46	9	56	This page is discussing warming trends with an abrupt change in the writing to discuss cooling., while the concept of ocean cooling has not been explained or discussed. This transition is awkward and seems out of place. There should be a transitional sentence describing that there has also been some substantive cooling in the oceans. After these two paragraphs, the discussion returns to warming trends, then on the first line of the next pages, cooling is discussed again. Maybe paragraph betinning on line 52 should be moved? [Jennifer Fehrenbacher, USA]	The text has been extensively revised in a way that addresses the reviewer's concerns.
13732	5	9	49	9	49	Suggest removing 'been' from the sentence. [Debra Roberts and Durban Team, South Africa]	The text was altered as suggested by the reviewer.
17466	5	9	52	9	56	Delete these sentences, since they repeat material from the next page, but are more poorly written and lack references. [Sonya Legg, USA]	The text has been extensively revised in a way that addresses the reviewer's concerns.
18658	5	9	54	9	54	If there is a quite robust changes we may want to know what support this robustness: does it colmes from observations, models or other lines of evidence. In either case, it would merit a conficende statement [Roland Seferian, France]	The text in question has been revised.
9268	5	9	55	9	56	Emergence of climate change signal is quicker in deep ocean than in surface, a non-trivial point; should be backed with references. [APECS Group Review, Germany]	A reference to review in the 2017 State of the Climate report has been added.
16236	5	9	55	9	56	run-on sentence, awkward grammar, please fix [Lynne Talley, USA]	The text has been revised.
18660	5	9	55	9	55	please provide references with "previous literature" [Roland Seferian, France]	This text has been revised.
21222	5	9	55	9	55	literatures -> literature [Momme Butenschön, Italy]	The text was altered as suggested by the reviewer.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
5112	5	10	1	10	10	AR5 assessed the time period after 1970, which is choozn based on the time when XBT data are boosted (there are more data after 1970 than before), but not by the quantified accuracy of the OHC records (i.e. there is no evidence that time series in 1960s are less accurate than that in 1970s, isn't it?). So, please consider if this choose is still valid, or in another word, if it is ready to extend back to 1960 or late 1950s, when MBT data are available? [Lijing Cheng, China]	In this assesment, the committee has deliberately chosen to emphasize the changes in the better observed period since the start of the Argo era, in about 2004, both because various observationally-based assessments now agree, and because this newer near-global ocean data is a substantial advance over what was available to be assessed in AR5.
5508	5	10	1	10	2	The start of this section refers to "these patches of cooler water", in the previous paragraphs no clear indication has been made of patches of cold water. It is unclear to what this refers. [Roderik Van De Wal, Netherlands]	This text has been significantly revised.
16238	5	10	1	10	1	"In spite". "cooler water, every". "has experienced" [Lynne Talley, USA]	The text was altered as suggested by the reviewer.
20270	5	10	1	10	1	"Inspite of..." should be "Despite..." or "In spite of..." [Michelle A. North, South Africa]	The text was altered as suggested by the reviewer.
21224	5	10	1	10	1	...each of the world's ocean basins has experienced... [Momme Butenschön, Italy]	The text was altered as suggested by the reviewer.
9274	5	10	2	10	2	There are no figure captions E or F in figure 5.1 [APECS Group Review, Germany]	The correct figure references have been added.
9280	5	10	2	10	4	Lines 2-4 overlaps with page 9 lines 27-30. [APECS Group Review, Germany]	The text in question has been extensively revised to avoid duplicated material and to make the point of each paragraph clearer.
21226	5	10	3	10	3	southern ocenans or Southern Ocean? If "southern oceans" please use "southern parts of the major ocean basins" [Momme Butenschön, Italy]	Thie has been clarified as the Southern Ocean.
20272	5	10	4	10	6	Please rewrite the following sentence to make sense: "Indeed the Southern Hemisphere is 67-98% of the total heat increase and for this period of 2005 to 2015 the warming of the ocean in the instrumental record since 1970 has continued unabated" [Michelle A. North, South Africa]	The text was altered as suggested by the reviewer.
16240	5	10	5	10	5	"Hemisphere accounts for 67-98%..." [Lynne Talley, USA]	The text was altered as suggested by the reviewer.
21228	5	10	5	10	5	...Hemisphere is subjected to ..., this period of -> the period of [Momme Butenschön, Italy]	The text was altered as suggested by the reviewer.
2126	5	10	7	10	7	The word "recent" is duplicated. Either one of them should be removed. [Michio Kawamiya, Japan]	The text was altered as suggested by the reviewer.
2124	5	10	8	10	8	Warming rate should have a dimension of K/year or something. The word "warm" should be replaced with something like "take up heat". The same applies to the title of panels in Figure 5.1. [Michio Kawamiya, Japan]	The text was altered as suggested by the reviewer.
3346	5	10	8	10	8	Should it be i.e.? [Castor Muñoz Sobrino, Spain]	The text was altered as suggested by the reviewer.
20274	5	10	8	10	8	Change "(ie very likely range)" to "(very likely)" [Michelle A. North, South Africa]	The text was altered as suggested by the reviewer.
20276	5	10	8	10	9	Change to read: "...and thus in the same range as reported by the IPCC AR5 WGI ()." [Michelle A. North, South Africa]	The text was altered as suggested by the reviewer.
5114	5	10	11	10	29	Suggest to start from the global time series comparing CMIP5 models with obs. What is the status in AR5 and what is the progress after AR5. [Lijing Cheng, China]	The text has been extensively revised in a way that addresses the reviewer's concerns.

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16242	5	10	11	10	29	This paragraph has zero references in it. Almost every sentence needs a reference, similar to preceding and following paragraphs. The incraesed warming in the CMIP5 models in the northern North Atlantic is also due in part to reduction in aerosol forcing in the CMIP5 model forcings. new paper, which we will submit to the chapter authors: Shi, J.-R., S.-P. Xie, and L. D. Talley, 2018. Evolving relative importance of the Southern Ocean and North Atlantic in anthropogenic ocean heat uptake. J. Climate, accepted. [Lynne Talley, USA]	References were added.
20552	5	10	11		29	References should be added to this paragraph [Chiara Lombardi, Italy]	References were added.
24112	5	10	11	10	29	Please provide references [Hans-Otto Poertner and WGII TSU, Germany]	References were added.
18662	5	10	13	10	13	please provide references if it is well understood (for example Walin 1982, Iudicone et al. 2009, Downes et al. 2009, 2010, 2011 ...) [Roland Seferian, France]	References were added.
20278	5	10	16	10	16	Change to read: "...subducted over decades..." [Michelle A. North, South Africa]	The text was altered as suggested by the reviewer.
20280	5	10	17	10	17	What do you mean by "penetrates further into the interior than other gyres", the interior of what? Do you mean closer to the equator, the centre of the gyre or deeper into the ocean? [Michelle A. North, South Africa]	The text was altered as suggested by the reviewer.
9282	5	10	28	10	28	Is “high confidence” here meant in the confidence language? If so, please split into agreement and evidence levels. [APECS Group Review, Germany]	This is considered in preparation for SOD
18664	5	10	28	10	28	confidence statement should be mention in italic [Roland Seferian, France]	The text was altered as suggested by the reviewer.

SROCC First Order Draft Expert Review Comments - Chapter 5							
Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
18928	5	10	30	10	30	Shelf and coastal seas are quasi-isolated from the open ocean by land (e.g. the Mediterranean and Baltic Seas) or ocean currents (e.g. the North West European Shelf Seas). They are often economically, environmentally and culturally important as they are typically where most human-ocean interaction occur. They account for 30% of the global oceanic production (Walsh et al. 1988; Walsh et al. 1991; Longhurst et al. 1995) and XX% of the global fisheries value despite only accounting for 8% of the global ocean area (Holt et al. 2009). They are often dominated by different processes than the open ocean, and so important aspects of coastal and shelf seas are typically poorly represented in GCMs. Their observed and projected response to climate change can be very different to the adjacent ocean. For example, in Europe, the North Sea is projected to warm more than the global average (3.00°C ±2s=0.72°C 2069-2098 relative to 1960-1989, based on SRES A1B, (Tinker et al. 2016)), whereas the adjacent wider North Atlantic is projected to warm less than the global mean. (Menary and Wood 2018). Care must be taken when interpreting the oceanic scale changes into the local shelf and coastal sea. Holt, J., Harle, J., Proctor, R., Michel, S., Ashworth, M., Batstone, C., Allen, I., Holmes, R., Smyth, T., Haines, K., Bretherton, D. and Smith, G. (2009). "Modelling the global coastal ocean." Philosophical Transactions of the Royal Society a-Mathematical Physical and Engineering Sciences 367(1890): 939-951 10.1098/rsta.2008.0210. Longhurst, A., Sathyendranath, S., Platt, T. and Caverhill, C. (1995). "An estimate of global primary production in the ocean from satellite radiometer data." Journal of Plankton Research 17(1245-1271) doi:10.1093/plankt/17.6.1245. Menary, M. B. and Wood, R. (2018). "An anatomy of the projected North Atlantic warming hole in CMIP5 models." Climate Dynamics 50(7-8): 3063-3080 https://doi.org/10.1007/s00382-017-3793-8. Tinker, J., Lowe, J., Pardaens, A., Holt, J. and Barciela, R. (2016). "Uncertainty in climate projections for the 21st century northwest European shelf seas." Progress In Oceanography 10.1016/j.pocean.2016.09.003. Walsh, J. J., Biscaye, P. E. and Csanady, G. T. (1988). "The 1983–1984 shelf edge exchange processes (SEEP)-I experiment: hypotheses and highlights." Continental Shelf Research 8: 435-456 doi:10.1016/0278-4343(88)90063-5. Walsh, J. J., Biscaye, P. E. and Csanady, G. T. (1991). "Importance of continental margins in the marine biogeochemical cycling of carbon and nitrogen." Nature 359: 53-59 doi:10.1038/350053a0. [Jonathan Tinker, UK]	This is considered in preparation for SOD
9276	5	10	31	10	31	The figure caption mentions 1981-2018 so here it should be 1980s and 2010s instead of 1990s and 2010s [APECS Group Review, Germany]	The text was altered as suggested by the reviewer.
11300	5	10	32	10	32	Citation for Purkey includes authors first name [Croot Peter, Ireland]	The text was altered as suggested by the reviewer.
16244	5	10	32	10	32	remove 'Sarah' in reference [Lynne Talley, USA]	The text was altered as suggested by the reviewer.
17862	5	10	32	10	32	Ref 'Purkey Sarah et al., 2014' is cited incorrectly by including a first name here and in the reference list. [Roberta Hansman, France]	The text was altered as suggested by the reviewer.
24114	5	10	32	10	32	The reference should be “Purkey et al”("Sarah" is the first authors first name) [Hans-Otto Poertner and WGII TSU, Germany]	The text was altered as suggested by the reviewer.
9278	5	10	37	10	39	Why does the impact of changes in AABW extend far north in the Pacific and not Atlantic? Why is it relevant here? A sentence can be added here. [APECS Group Review, Germany]	This is considered in preparation for SOD
24118	5	10	37	10	39	There are no panels a & b in Figure 5.2. Please revise [Hans-Otto Poertner and WGII TSU, Germany]	The figure citation has been corrected.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
5510	5	10	39	10	41	"The total deep… from thermal expansion". This section refers to the total deep ocean warming below 2000m, but the text fails to distuinguish between the deep (2000 - 4000m) and abyssal (4000 - 6000m). This seems to imply the warming of the fluid column below 2000m, which is according to the cited study (Desbruyères et al., 2016b) larger than the reported value. If only the deep ocean warming is considered, please specify the column depth. [Roderik Van De Wal, Netherlands]	This is considered in preparation for SOD
1504	5	10	43	10	50	What about expected trends in these oscillations? [Davide Bonaldo, Italy]	These oscillations do not generally have enough predictability on decadal to centennial timescales to warrant a brief discussion here, especially when it is our understanding that the upcoming AR6 is supposed to have an entire chapter that deals with these questions of predictable climate oscillations.
18666	5	10	43	10	50	If these changes are not robust or assessed as significant, it might be better a caveat this paragraph. Or at least to mention to the understanding our these changes are limited in regards of the current knowledge on the deep ocean dynamics [Roland Seferian, France]	This is considered in preparation for SOD
5042	5	10	46			Thornalley et al. paper does not explicitely support the idea that deep Atlantic cooling is related to NAO. PLease drop the Thornalley quotation here. Add: ' Conversely, in last 150year changes in the AMOC have not always been synchronous with temperature changes but the persistence of a weak AMOC during the twentieth century suggests that other climate forcings—such as greenhouse gas warming—were dominant during this period (Thornalley et al., 2018)' [Alessandro Crise, Italy]	An error occurred when chapter 5 references were compiled in Endnote by the TSU resulting in a displacement of all the references by one position. This resulted in a great number of misplaced references which we have since then fixed. The original text would have properly described the message of the Thornally et al. paper had this error not occured.
16246	5	10	48	10	48	Weddell Sea [Lynne Talley, USA]	The text was altered as suggested by the reviewer.
24116	5	10	48	10	48	Weddell Sea [Hans-Otto Poertner and WGII TSU, Germany]	The text was altered as suggested by the reviewer.
17864	5	10	49	10	49	Should this be Ross and Adelie Seas rather than Coast? I could not clarify this in the references that are cited in this paragraph as they only refer to the warming trends not AABW formation. [Roberta Hansman, France]	An error occurred when chapter 5 references were compiled in Endnote by the TSU resulting in a displacement of all the references by one position. This resulted in a great number of misplaced references which we have since then fixed. The text was clarified.
9284	5	10	52	11	26	The discussion of uncertainty in deep ocean heat content and the improvements possible with ARGO floats would make more sense after the discussion what is currently known about deep ocean heat content starting on pg 11 line 7. [APECS Group Review, Germany]	The text has been dramatically revised, including the suggested reordering of the material.
16248	5	10	53	10	53	for summary of shipb-based transects that provide this data, use the GO-SHIP summary paper: Talley et al. (2016). (in the reference list) [Lynne Talley, USA]	The text was altered as suggested by the reviewer.
11624	5	10	55	11	5	I agree to that Deep Argo is one of promising techniques in observing deep ocean. But usefullness is not examined sufficiently, and papers appearred in peer-review journals are limited..Thus it should be not covered here. [Akihiko Murata, Japan]	The extent of the discussion of Deep Argo and bio-Argo are appopriate and appropriately referenced.
3250	5	10	57			infant' should be infancy [Martin Edwards, UK]	The text was altered as suggested by the reviewer.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
13734	5	11	0	15		Fig 5.1 -5.5 These are potentially very helpful figures to help understand the text. Only please be very explicit in the figure legend and explain everything very clearly, with a non-specialist in mind. What does "heat flux in W m–2" mean exactly? How is "heat uptake" different from "rate of warming"? Letters missing in 2 figures. What is P-E (or E-P)? Whenever the figure shows a prediction, please add the word 'projected' or 'historical modelled' to make it very clear what is observed and what is model based. What does "Observed salinity changes" mean? 2015 minus 1965? Lots more clarity please. Legends should be stand-alone pieces of text that do not require the body of the text to be understood. Explain what the reader is looking at. Like in 5.5 what does red mean? That the water is getting denser? Meaning what? [Debra Roberts and Durban Team, South Africa]	The figures and figure captions have been extensively revised with these comments in mind.
16654	5	11	1	11	1	Only A& B are labelled in Fig 5.1 [Cliff Law, New Zealand]	Panel labels were addded.
16250	5	11	4	11	4	remove extra comma after parenthesis [Lynne Talley, USA]	An additional comma was added instead.
1506	5	11	7	11	12	Could it be relevant/feasible mentioning some regional-scale implications of these processes, such as for topographic waves in marginal seas? [Davide Bonaldo, Italy]	This is considered in preparation for SOD
9288	5	11	7	11	7	Please define "abyssal" for the non-experts. [APECS Group Review, Germany]	The text was altered as suggested by the reviewer.
23494	5	11	7	11	12	Fast communication with surface ocean and deep ocean if small scale processes are represented (Capet et al. 2016) or parametrized, read also [Soeren Thomsen, France]	This is considered in preparation for SOD
21108	5	11	10	11	24	The comments regarding heat content varying by topographic and planetary waves, or - in the Weddell Sea context - just "waves," are confusing. Except for small mixing effects not considered here, heat content varies by advective processes. If linear waves are invoked here, then the advective processes that are represented in linear approximation should be explained, or the text risks misleading the reader by suggesting an independent, non-advective mechanism for the variability of deep ocean heat content. [Roger Samelson, USA]	This is considered in preparation for SOD
24120	5	11	17	11	26	Refer to Chapter 3 Box 3.2 Polynyas and remove duplicate information here [Hans-Otto Poertner and WGII TSU, Germany]	A cross reference to Box 3.2 has been added, and we have checked that the material here, which discusses the deep ocean signals that might be linked to the Weddell polynya are not duplicattive of the material in Chapter 3.
24406	5	11	17	11	19	Link to chapter 3 where Weddell Polyna is also discused [Hans-Otto Poertner and WGII TSU, Germany]	The text was altered as suggested by the reviewer.
16252	5	11	21	11	21	Weddell polynya will have citations. There is a section in the new BAMS State of the Climate report, authors. Swart et al., that discuses it. There is a manuscript in progress by PhD students at UW: Campbell, E., Wilson, E. with advisor S. Riser, that should be submitted before the Oct. 15 cutoff for submitted papers. I do not know the mechanism for providing manuscripts that are not yet submitted, but would like to learn more about it. Note also that Chapter 3 has Box 3.2 with a section on Weddell polynya. [Lynne Talley, USA]	This is considered in preparation for SOD
11304	5	11	22	11	22	...increased the volume of the coldest waters... [Croot Peter, Ireland]	The text was altered as suggested by the reviewer.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
5044	5	11	26			Please add after the dot. 'In Mediterranean Sea the mean temperature of the 600m-bottom layer exhibited a monotonic increase of T in the period 1950-2000 with a sharp increase of about 0.1 °C during the last 15 years (Rixen et al., 2015) likely due to climate change at least for the Western Mediterranean Deep Water' Rixen, M., et al. (2005), The Western Mediterranean Deep Water: A proxy for climate change, Geophys. Res. Lett., 32, L12608, doi:10.1029/2005GL022702. [Alessandro Crise, Italy]	This is considered in preparation for SOD
1622	5	11	28	12	10	The figure's caption refers to panel A-G, but the letters are missing in the panel. [Aurora Stenmark, Norway]	The text was altered as suggested by the reviewer.
4604	5	11	28	12	10	Figure 5.1: not clear. Please identify correctly with a letter the Figure 5.1.a, Figure 5.1.b, Figure 5.1.c, Figure 5.1.d, Figure 5.1.e, Figure 5.1.f, Figure 5.1.g (only Figure 5.1.a and Figure 5.1.b are identified at page 11 [Alessandro Pezzoli, Italy]	This figure and caption have been extensively revised, and this comment has been addressed or is no longer pertinent.
6012	5	11	28	11	29	Figure panel has no caption and should panel in B read 2006-2014 like in A or 2007-2014 as in caption for Fig. 5.1 which is the caption referring to this pnale A and B? [Jens Zinke, Germany]	This figure and caption have been extensively revised, and this comment is no longer pertinent.
9286	5	11	28	11	28	The time period in the figure caption B of figure 5.1 should be 2006-2014 instead of 2016-2014. [APECS Group Review, Germany]	This figure and caption have been extensively revised, and this comment is no longer pertinent.
9290	5	11	28	11	28	The quality of the map that is part of the figure should be enhanced [APECS Group Review, Germany]	This figure and caption have been extensively revised, and this comment has been addressed or is no longer pertinent.
14036	5	11	28	11	28	Please clarify whether these first graphs are part of Figure 5.1 as the second set of graphics in the set don't have any letters associated with them. Looks like you just need to add letters to each graph and it will make more sense. [Elizabeth Jewett, USA]	This figure and caption have been extensively revised, and this comment has been addressed or is no longer pertinent.
16130	5	11	28	11	28	Figure 5.1 Panels A and B there appears to be an inconsistency between the year spans indicated and the Figure Title. [Mary Livingston, New Zealand]	This figure and caption have been extensively revised, and this comment is no longer pertinent.
17468	5	11	28	12	1	Figure 5.1: Panels C,D,E,F,G,H need letter labels. [Sonya Legg, USA]	The text was altered as suggested by the reviewer.
21110	5	11	28	11	28	The trend in rate of change of "Global 0-2000 m Heat Content" shown in the upper right hand panel of the portion of Figure 5.1 that appears on page 5-11 would seem to depend heavily on whether the starting point is taken as 1982 or during the period 1983-1992. The change over the entire time series presented in the figure is nearly zero. Either way, the figure does not seem persuasively to support the claim of systematic recent deep ocean warming. [Roger Samelson, USA]	This figure and caption have been extensively revised, and this comment has been addressed or is no longer pertinent.
2210	5	12	0			Font size to be bigger in Figure 5.1 [Chandani Appadoo, Mauritius]	The text was altered as suggested by the reviewer.
1792	5	12	1	12	2	Fig. 5.1: Since the atmosphere interacts with the top 50-150m layer, it is worth showing how the heat content of the top layers are changing. [Meer Ali, India]	This is a good suggestion, but could not be accomodated due to constraints on avaialble space.
3348	5	12	1	12	1	Insert C, D, E and F on the Figures, please. [Castor Muñoz Sobrino, Spain]	The text was altered as suggested by the reviewer.
5046	5	12	1	12	10	Plates references are missing and/or wrong. Please number the plates according the caption. [Alessandro Crise, Italy]	Panel labels were addded.
6014	5	12	1	12	1	Figure 5.1 has no panel descriptions from A to D as in captions [Jens Zinke, Germany]	Panel labels were addded.
13160	5	12	1	12	10	Fig. A and B are very poor quality. Panels C-F are listed in the caption but the panels lack the letters. Can the units be placed over the color bars? [Baerbel Hoenisch, USA]	The figures have been revised and panel labels and units added.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
13736	5	12	1	12	10	It is quite difficult to read the text in the figures. Also not sure which sections of the panels were referred to as A-G since no labelling is evident. [Debra Roberts and Durban Team, South Africa]	Panel labels were addded and the font sizes increased.
16656	5	12	1	12	1	What are the small symbols in Fig 5.1 F & H? Also, description of H is missing from the figure legend [Cliff Law, New Zealand]	This figure and caption have been extensively revised, and this comment has been addressed or is no longer pertinent.
18894	5	12	1	12	10	Figure 5.1 If rates are shown on the figure, then a time unit is missing. There are aso a few typos in the figures : letters C, D, E, F G (and H?) are missing; in the titles: space missing (bottom two panels) and "mm" instead of "m" on both panels on the right [Sophie Rabouille, France]	This figure and caption have been extensively revised, and this comment has been addressed or is no longer pertinent.
20282	5	12	1	12	10	Figure 5.1. Of the 6 sub-figures, only A and B are labelled, and the font is too small to read. Also, the "global 0-2000m heat content graphs don't appear to be located in the right place since they appear to be number E and F in the legend; the final four maps are also labelled incorrectly (F and G), when they should be G, H, I and J [Michelle A. North, South Africa]	This figure and caption have been extensively revised, and this comment has been addressed or is no longer pertinent.
20554	5	12	1		10	Images in figure A and B are poor, I would increase the resolution. Letters C, D, E and F are missing. Figures E and F separated by a line, as figures C and D are. Font size and property (bold/regular) should be homogenous in all figures. [Chiara Lombardi, Italy]	This figure and caption have been extensively revised, and this comment has been addressed or is no longer pertinent.
17470	5	12	8	12	9	Figure 5.1, caption. (F) is referred to twice (one should be G). Reference to panel H is missing (current G should be H). [Sonya Legg, USA]	This figure and caption have been extensively revised, and this comment has been addressed or is no longer pertinent.
5512	5	12	9	12	10	In the caption it refers to subfigure (F), and subfigure (G), these should be (G) and (H) respectively [Roderik Van De Wal, Netherlands]	This figure and caption have been extensively revised, and this comment has been addressed or is no longer pertinent.
21112	5	12	12	12	13	The stippling in the right-hand panel is barely visible. It may be better not to show any shading in the regions where changes are below 90% significance, a criterion that is already rather weak. [Roger Samelson, USA]	The stipling indicates changes that are not significant at the 95% confidence level; The changes with lower significance are shown for comparison with the observed changes, which are also of limited regional signficance.
9292	5	12	13	12	19	Hard to see stippling. No figure caption a or b but are mentioned in the text. Stippling pattern should ideally be consistent throughout the chapter. [APECS Group Review, Germany]	The size of the stipling has been increased in Figures 1 and 2, and panel labels have been added.
13162	5	12	13	12	13	it would be nice to add arrows to panel A, incication warming (right arrow) and cooling (left arrow). In panel B, it would be more clear to place the color bar and units outside of the map projection. The caoption is difficult to decipher - which part addresses which panel? Lettering the panels might clarify this, as would using different sentences for each panel. [Baerbel Hoenisch, USA]	This figure and caption have been extensively revised, and this comment has been addressed or is no longer pertinent.
11306	5	12	14	12	17	Include the source of the data used in Figure 5.2 [Croot Peter, Ireland]	This figure has been removed due to space constraints.
16254	5	12	14	12	17	Indicate that this is an updated version of Figure 3.3 in Rhein et al. (2013). The original reference is required: Purkey and Johnson (2010) [Lynne Talley, USA]	This figure has been removed due to space constraints.
17472	5	12	14	12	17	Figure 5.2: caption needs to include reference (is this from Purkey et al?) [Sonya Legg, USA]	This figure has been removed due to space constraints.
20284	5	12	14	12	14	The font on the map on the right panel needs to be larger [Michelle A. North, South Africa]	This figure has been removed due to space constraints.
5514	5	12	15	12	17	"and (right panel) ... no significant changes". It is unclear if this refers to spatial and/or temporal average. [Roderik Van De Wal, Netherlands]	This figure has been removed due to space constraints.
3350	5	13	1	13	1	Insert E and F on the Figures, please. [Castor Muñoz Sobrino, Spain]	This figure has been removed due to space constraints.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
5048	5	13	1	13	7	Plates references E and F are missing. Please add (capital) letters to the plates according the caption. [Alessandro Crise, Italy]	This figure has been removed due to space constraints.
6016	5	13	1	13	1	Fig.5.3 has small letters for panels a-d, while caption uses capital letters, e and f missing [Jens Zinke, Germany]	This figure has been removed due to space constraints.
9294	5	13	1	13	9	In figure captions: (a) Mean over which time period? (c) change with respect to mean? (d) what is shown here, salinity anomaly? With respect to what? [APECS Group Review, Germany]	This figure has been removed due to space constraints.
20286	5	13	1	13	7	The last two maps in Figure 5.3. aren't labelled (e and f), and the legend and figure labels don't match (capital vs small letters, respectively). Also, please describe what P-E means [Michelle A. North, South Africa]	This figure has been removed due to space constraints.
4606	5	13	2	13	7	Figure 5.3: not clear. Please identify correctly the Figure 5.3.e and Figure 5.3.f [Alessandro Pezzoli, Italy]	This figure has been removed due to space constraints.
13738	5	13	2	13	8	Again, difficult to read some texts. Label panels [Debra Roberts and Durban Team, South Africa]	This figure has been removed due to space constraints.
16256	5	13	2	13	7	Indicate that this is an updated version of Figure 3.4 in Rhein et al. (2013) [Lynne Talley, USA]	This figure has been removed due to space constraints.
17474	5	13	2	13	2	Figure 5.3, caption: Indicate that (A) and (B) show observed values. [Sonya Legg, USA]	This figure has been removed due to space constraints.
18896	5	13	2	13	7	Figure legend for B reads Mean P-E while figure indicates E-P. E and P are not defined. Please replace "Observed salinity" with "Observed sea surface salinity (SSS)" [Sophie Rabouille, France]	This figure has been removed due to space constraints.
20556	5	13	2		7	Figure 5.3. Letters are missing in the last two images. Property of the font should be the same both in the figure and in the legend: if bold in the legend they should be bold in the figures. The text in the last two images (ensamble size and lobal Avg) in unredeable, so please increse the size or put it in the legend. [Chiara Lombardi, Italy]	This figure has been removed due to space constraints.
2154	5	13	3	13	5	In the figure do not apperar "F" and "E" [Fiz Fernandez Perez, Spain]	This figure has been removed due to space constraints.
20558	5	13	7			"] " should be replaced with " . " [Chiara Lombardi, Italy]	This figure has been removed due to space constraints.
14038	5	14	0	14		not clear how these graphics are showing trends as the years don't show up on the graphs anywhere, [Elizabeth Jewett, USA]	This figure has been removed due to space constraints.
6018	5	14	1	14	1	Fig. 5.4 has letters assigned to each panel which do not appear in caption. I suggets to remove letter A to L [Jens Zinke, Germany]	This figure and caption have been extensively revised, and this comment has been addressed or is no longer pertinent.
9296	5	14	1	14	5	Figure 5.4 The labels on this figure make it a bit complex to follow. Perhaps the Salinity, Density, and Temperature labels could go on the top of each corresponding column of graphics. [APECS Group Review, Germany]	This figure and caption have been extensively revised, and this comment has been addressed or is no longer pertinent.
17476	5	14	1	15	6	Figure 5.4 and 5.5: These two figures need to use the same color scale and contour style so that they can be better compared. [Sonya Legg, USA]	These figures have been extensively revised, as suggested.
2212	5	14	3			Font size to be bigger in Figure 5.4 [Chandani Appadoo, Mauritius]	The figure font sizes have been increased.
11308	5	14	3	14	5	Include the source of the data used in Figure 5.4 [Croot Peter, Ireland]	A reference to the reanalysis product used and a description of the CMIP5 models used are now in the text.
13740	5	14	3	14	3	Some of the panesl in Figure 5.4 seem cropped. Please check. [Debra Roberts and Durban Team, South Africa]	This figure and caption have been extensively revised, and this comment has been addressed or is no longer pertinent.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
16258	5	14	3	14	3	Indicate that this is reproduced from Figure 3.9 in Rhein et al. (2013). This figure caption is MISSING the reference that is clearly stated in the Rhein (2013) caption: "Salinity results are republished from Durack and Wijffels (2010) with the unpublisehd temperature and density results from that study also presented." [Lynne Talley, USA]	This figure and caption have been extensively revised, and this comment has been addressed or is no longer pertinent.
18898	5	14	3	14	5	The order of the left to right panels indicated in the legend is not the same as that indicated on the figure [Sophie Rabouille, France]	This figure and caption have been extensively revised, and this comment has been addressed or is no longer pertinent.
20560	5	14	5			Figure 5.4 "] " should be replaced with " . " [Chiara Lombardi, Italy]	This figure and caption have been extensively revised, and this comment has been addressed or is no longer pertinent.
9298	5	14	7	15	6	Figure 5.5 The axes are hard to read on this version of the figure; I would recommend these be larger in the final version for clarity. [APECS Group Review, Germany]	The figure font sizes have been increased.
20562	5	14	8			Figure 5.6. In Temperture Change graph "(°C/50 years) " should be placed in a second line below, according to the other titles. A space is needed between "/" and "50". [Chiara Lombardi, Italy]	The text was altered as suggested by the reviewer.
11066	5	14	38	14	38	Suggest to add human pollution and activities such as waste pollution(rubbish, chemical used for marine agriculture , congestion attributed to coastal areas beside climate change. It would be relevant to include the social science perspective in describing the effects on coastal communities , simply both science and social science are critical in this context to provide more practical and holistic perspective. [Kim Lian Chan, Malaysia]	This comment does not appear to pertaiin to the lines that are referred to.
24676	5	15	0			Figure 5.5. starting point of degree change per 50 years unclear. [Hans-Otto Poertner and WGII TSU, Germany]	This has been clarified in the figure caption.
4126	5	15	1	15	6	Subtitle in each of the six diagrams of the figure 5.5 is too small for proper reading. [Jinsoon Park, Republic of Korea]	The font sizes and proper labels have been added to the figure.
5116	5	15	1	16	50	The salinity section mainly discussed long-term change by Durack et al. (similar to AR5). May Worthy to discuss that in a short time period (inter-annual or decadal), ocean dynamics plays a role (assess studies by Lisan Yu). And during the Argo period, differnet salinity change pattern are involved compared with long-term change. And global salinity change even shows an increase in the upper 2000m (either due to insufficient Argo data coverage, or internal variability, or both). Yu, L. (2011), A global relationship between the ocean water cycle and near-surface salinity, J. Geophys. Res., 116, C10025, doi: 10.1029/2010JC006937. Wang, G.; Cheng, L.; Boyer, T.; Li, C. Halosteric Sea Level Changes during the Argo Era. Water 2017, 9, 484. [Lijing Cheng, China]	This is considered in preparation for SOD
13742	5	15	9			Section: is it possible please to summarise something in plain English? If salinity is an important issue, can the authors make a few statements that are predominantly scientific jargon? Perhaps a schematic diagram could be included - as in Ch 3 and 2. These are really helpful for non-specialists. [Debra Roberts and Durban Team, South Africa]	This portion of the text has been extensively revised, shortened and folded into an earlier section, so this comment is no longer pertinent.
3252	5	15	10			as key element' should read 'as it is a key element' [Martin Edwards, UK]	This portion of the text has been extensively revised and shortened, so this comment is no longer pertinent.
14396	5	15	10			Opening sentence on line 10 is poorly written. [Jennifer Fehrenbacher, USA]	This portion of the text has been extensively revised and shortened, so this comment is no longer pertinent.
16260	5	15	10	15	11	Sentence is awkwardly written, needs editing. [Lynne Talley, USA]	This portion of the text has been extensively revised and shortened, so this comment is no longer pertinent.

SROCC First Order Draft Expert Review Comments - Chapter 5							
Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
24410	5	15	10	15	10	This is the first time (and I think only time) EOV are introduced [Hans-Otto Poertner and WGII TSU, Germany]	This portion of the text has been extensively revised and shortened, so this comment is no longer pertinent.
5050	5	15	11			Please add after the dot ' and a major driver of the thermohalince circulation' [Alessandro Crise, Italy]	This portion of the text has been extensively revised and shortened, so this comment is no longer pertinent.
5052	5	15	13	15	14	The phrase starting with ' The spatial structure…' and ending with '…fluxes' is redundant since the concept is much better explained later. My suggstion is to drop it, since it also does not sound correct as it is (e.g. ocean circulation is also wind-driven) . Change also 'At this interface' with 'In the upper layer of the ocean' [Alessandro Crise, Italy]	This portion of the text has been extensively revised and shortened, so this comment is no longer pertinent.
12008	5	15	13	15	14	In the description the special structure of the global ocean surface and subsurface salinity field is maintained by ocean circulation and mixing, which are driven by ocean density gradient and air-sea fluxes, wind and tides, which constitute the strongest sources of mechanical energy for the interior mixing, have totally been forgotten. This description should be updated accordingly. The contributors may wish to consider the following and other references. Munk W & Wunsch C, Deep-Sea Research (1998). [Louis Mitondo Lubango, Ethiopia]	This portion of the text has been extensively revised and shortened, so this comment is no longer pertinent. Also, some of the key points about mixing are already discussed later in the section on changing ocean mixing.
5516	5	15	15	15	15	SSS also responds to melting of ice [Roderik Van De Wal, Netherlands]	This is considered in preparation for SOD
6020	5	15	15	15	15	"and river runoffs patterns", change to runoff? [Jens Zinke, Germany]	The text was altered as suggested by the reviewer.
22122	5	15	15	15	17	The correlations of two data sets should be carefully reported once it is evaluated whether (1) the number of realizations is enough and (2) the reported correlations are just seasonal variability in two data sets. [Sung Yong Kim, Republic of Korea]	This portion of the text has been extensively revised and shortened, so this comment is no longer pertinent.
6022	5	15	16	15	16	"Evaporation–Precipitation-River runoffs", change to runoff [Jens Zinke, Germany]	The text was altered as suggested by the reviewer.
3352	5	15	17	15	17	The same reference just showed at the end of the paragraph. Delete it, please. [Castor Muñoz Sobrino, Spain]	This portion of the text has been extensively revised and shortened, so this comment is no longer pertinent.
16262	5	15	17	15	17	Yes, it has long been noted. So why cite Durack (2015) twice in 3 lines? Why not a more textbookish reference? Here are 2 suggestions: Talley et al. (2011) (Descriptive Physical Oceanography 6th edition), or my 2008 freshwater paper in Progress in Oceanography, or Schanze et al. (2010) [Lynne Talley, USA]	This portion of the text has been extensively revised and shortened, so this comment is no longer pertinent.
18712	5	15	21	15	36	The discussion here does not consider recent developments in the relationship via surface freshwater fluxes between changing ocean salinity and potential strengthening of the global hydrological cycle. A significant literature (e.g. papers led by Skliris, Vinogradova, Zika) has developed on this topic since AR5 and needs to be assessed including claims that intensification of surface freshwater flux has now been robustly identified in the sub-tropical gyres. [Simon Josey, UK]	This portion of the text has been extensively revised and shortened, so this comment is no longer pertinent. A more complete discussion of changes in the hydrologic cycle is beyond the scope of this report and should be addressed in the upcoming AR6 report.
24122	5	15	22	15	23	please provide explanation for terms such as "Clausius-Clapeyron relationship" [Hans-Otto Poertner and WGII TSU, Germany]	This portion of the text has been extensively revised and shortened, so this comment is no longer pertinent.
14398	5	15	24			The text "roughly 7% more moisture for every degree of warming" should have a citation. A few years ago this number was 4% (or varied between 4 and 7%), so citing this value is important. Even better, perhaps it is wise to give a range? [Jennifer Fehrenbacher, USA]	This portion of the text has been extensively revised and shortened, so this comment is no longer pertinent.
21114	5	15	25	15	27	Relative humidity is a measure of saturation, so the comment regarding different behavior of relative humidity and saturation (under-saturation) does not make sense. [Roger Samelson, USA]	This portion of the text has been extensively revised and shortened, so this comment is no longer pertinent.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
15196	5	15	26	15	26	layer does not react much to changes in temperature, [Christophe Deissenberg, Luxembourg]	The text was altered as suggested by the reviewer.
5058	5	15	31			Wrong reference. Durack et al. 2016 advocate for a multiplatform global salinity observation network. Please find an appropriate one. [Alessandro Crise, Italy]	An error occurred when chapter 5 references were compiled in Endnote by the TSU resulting in a displacement of all the references by one position. This resulted in a great number of misplaced references which we have since then fixed.
16264	5	15	31	15	36	This was first pointed out as far as I know in the AR4 Ocean Obs chapter (Bindoff et al., 2007), based on Boyer et al. changes in ocean salinity, then amplified in Durack and Wijffels (2010) using Argo data, with additional synthesis in Rhein et al. (2013), and evaluation of this statement about the hydrologic cycle. We debated it extensively in the AR5 committee and wrote an FAQ about it. [Lynne Talley, USA]	This portion of the text has been extensively revised and shortened, so this comment is no longer pertinent. A more complete discussion of changes in the hydrologic cycle is beyond the scope of this report and should be addressed in the upcoming AR6 report.
5054	5	15	33			Change ' tend to become more salty' with 'will very likely become saltier' [Alessandro Crise, Italy]	This portion of the text has been extensively revised and shortened, so this comment is no longer pertinent.
5056	5	15	36			Change 'hydrologic' in 'hydrological' [Alessandro Crise, Italy]	Webster's dictionary lists hydrological as a second variant of hydrologic.
1508	5	15	38	15	38	oean --> ocean? [Davide Bonaldo, Italy]	The text was altered as suggested by the reviewer.
16266	5	15	38	16	14	2 paragraphs that need citations to back up statements. [Lynne Talley, USA]	Numerous citations have been added for key points.
18668	5	15	38	15	38	oean [Roland Seferian, France]	The text was altered as suggested by the reviewer.
20564	5	15	38			" oean" should be "ocean' [Chiara Lombardi, Italy]	The text was altered as suggested by the reviewer.
23512	5	15	38		43	Perhaps the work of Friedman et al. (2017) regarding N. Atlantic SSS should also be referenced (https://doi.org/10.1002/2017GL072582) [Laura Lorenzoni, USA]	This is considered in preparation for SOD
3604	5	15	41	15	43	It says "The freshening of the high latitudes in the North Atlantic and Arctic basin is consistent with the widely expected weakening of the Atlantic Meridional Overturning Circulation (discussed in Chapter 6) and a decline in the volume of sea ice (discussed in Chapter 3)." Yet the observed freshening in the North Atlantic is not apparently linked to anthropogenic AMOC decline (see: Tesdal et al., 2018, Salinity Trends within the Upper Layers of the Subpolar North Atlantic. J. Climate, 31, 2675–2698, https://doi.org/10.1175/JCLI-D-17-0532.1). Haine (2016; Vagaries of Atlantic overturning, Nat. Geosci., https://rdcu.be/0m9T) summarizes the evidence that the freshening and AMOC weakening are not anthropogenic. For the Arctic, Haine et al. (2015; 10.1016/j.gloplacha.2014.11.013) show that loss of summer Arctic sea ice is not the main reason for recent decadal Arctic Ocean freshening: instead the increased meteoric freshwater sources are mainly responsible. [Thomas Haine, USA]	This is considered in preparation for SOD
9300	5	15	41	15	41	"…across the suite of climate models." Since only CMIP5 mean is shown in Fig 5.2f, is it implied here that averaging across models does not cancel the signal and hence a robust result? A reference on CMIP5 model projections is warranted instead. [APECS Group Review, Germany]	This is considered in preparation for SOD
24124	5	15	41	15	41	Figure 5.2f does not exist. Please check and revise [Hans-Otto Poertner and WGII TSU, Germany]	The figure reference has been corrected.
9302	5	15	42	15	42	It's not just a projected decrease, but also an observation made by Caesar et al. and Thornalley et al. 2018 as you correctly state on page 10. [APECS Group Review, Germany]	This is considered in preparation for SOD

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
17478	5	15	48	16	3	This section on the biases of numerical models is useful, but I'm not sure if this is the right place for it. Rather I think the biases in numerical models should be referenced when discussing a quantity where such bias has an impact. So discuss the model bias in the thermocline heat uptake when referencing the changes in ocean stratification, for example. Also, explain more about the impacts of the model formulation on relevant aspects of ocean circulation, e.g. how do they affect overflows, etc. [Sonya Legg, USA]	This is considered in preparation for SOD
23214	5	15	48	17	46	The progress of climate changes in atmospheric circulation and its poleward movement to induce the intensification of western boundary currents could be included in this chaper . [Dongxiao Wang, China]	Unfortuately we were working with a very extensive set of topics to be discussed. As such we do not have space available to discuss changes in the atmospheric circulation, which we expect to be assessed in the upcoming AR6.
9308	5	16	2	16	14	I found the connectivity between the text and figures here difficult to follow. Perhaps the water masses could be labeled on one of the figures referenced? The shifts in the water mass dynamics discussed throughout this portion of the text may be hard for a non-expert to trace back within the figures. [APECS Group Review, Germany]	The figures have been extensively revised, and the the schematic figure in the Southern Ocean cross-chapter box explicitly labels many of the watermasses that are being discussed.
9310	5	16	2	16	14	This discussion is a bit unclear for which changes in water masses have already been observed (ie. info in Figure 5.4) vs what is projected (i.e. Figure 5.5). I think this could be very easily fixed by including the time frames from within the figures into the text discussion. For example, the sentence starting on line 5: “Changes in the interior…” could include a statement on the integrated timeframe the “changes” are referring to. [APECS Group Review, Germany]	The figures in question have been extensively revised, including placeing the obsered and projected changed next to each other with identical color scales for greater east of comparison.
18670	5	16	6	16	7	this sentence could be improved [Roland Seferian, France]	The text was altered as suggested by the reviewer.
24126	5	16	6	16	8	Coordinate with/refer to Chapter 3 [Hans-Otto Poertner and WGII TSU, Germany]	Done
5060	5	16	11			After the dot add ' In this basin the salinity positive trend have been identified with high degree of confidence and it is likely that it will continue (Jordà et al., 2017).' Jordà, G., Von Schuckmann, K., Josey, S. A., Caniaux, G., García-Lafuente, J., Sammartino, S., ... & Adloff, F. (2017). The Mediterranean Sea heat and mass budgets: estimates, uncertainties and perspectives. Progress in Oceanography, 156, 174-208. [Alessandro Crise, Italy]	An error occurred when chapter 5 references were compiled in Endnote by the TSU resulting in a displacement of all the references by one position. This resulted in a great number of misplaced references which we have since then fixed.
9304	5	16	12	16	13	“…in many models.” A reference to support this statement should be included [APECS Group Review, Germany]	This is considered in preparation for SOD
21522	5	16	18	16	22	Consider changing "The combination of surface intensified warming and near-surface freshening at high latitudes leading to a projection of more intense near-surface stratification across all ocean basins (Figure 5.5) is a robust result with a high level of agreement across successive generations of coupled climate models (Bopp et al., 2013; Johnson et al., 2014)." to "The combination of surface intensified warming and near-surface freshening at high latitudes leading to a projection of intensified near-surface stratification across all ocean basins (Figure 5.5) is a robust result that is associated with a high level of agreement across successive generations of coupled climate models (Bopp et al., 2013; 22 Johnson et al., 2014)." [Tseng Rose, USA]	The text was altered to correct the awkward phrasing noted by the reviewer.

SROCC First Order Draft Expert Review Comments - Chapter 5							
Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
5518	5	16	20	16	21	"a robust result … coupled climate models". It only state a high level of agreement, but makes no statement in confidence. Should a confidence statement be made? [Roderik Van De Wal, Netherlands]	The confidence statement describing this result is at the end of this paragraph.
24128	5	16	20	16	21	"robust result with a high level of agreement": is this supposed to be a confidence statement? Please revise [Hans-Otto Poertner and WGII TSU, Germany]	The confidence statement describing this result is at the end of this paragraph.
18672	5	16	21	16	21	high agreement fits better [Roland Seferian, France]	The text was altered as suggested by the reviewer.
18674	5	16	21	16	21	Bopp et al. 2013 do not compare different generation of models. It doesn't support this statement [Roland Seferian, France]	An error occurred when chapter 5 references were compiled in Endnote by the TSU resulting in a displacement of all the references by one position. This resulted in a great number of misplaced references which we have since then fixed. The two refererncs cited here highlight similar findings regarding the stratification from successive generations of CMIP models.
18676	5	16	24	16	24	I might be useful to refer to other studies since Gill 1982. [Roland Seferian, France]	Gill is a well-written classic textbook that illustrates these points very well.
9306	5	16	27	16	27	remove “but” [APECS Group Review, Germany]	The text was altered as suggested by the reviewer.
5520	5	16	30	16	46	Though a nice thought experiment, on the effects of stratification, this section does not assess anything and seems redundant with respect to the rest of the chapter. I would suggest to leave this part out. [Roderik Van De Wal, Netherlands]	Without descrbing the projections and consequences of stratificaiton changes, many of the other projected changes described in this chapter, such as to open-ocean ecosystems or tides, can not be supported.
9312	5	16	30	16	46	I think clarity surrounding this discussion could be increased with rearrangement of existing text. For example, line 42-46 starting with “Increasing interior..” could be moved after the confidence language on line 31. This would put the motivation for why stratification is important to understand at the forefront of the discussion. I find that the included example within the rest of this paragraph makes this discussion hard to follow, particularly as the choice of 21% seems arbitrary to me. If the example is included in the revised text, could the authors clarify why this particular scenario was discussed? [APECS Group Review, Germany]	The previous text had been a failed attempt to describe the various power-law dependences between quantities. This paragraph has been simplified to avoid any specific percentage changes.
21116	5	16	30	16	46	The specified percentage changes in various quantities depend on certain assumptions regarding the structure of the stratification changes and on the linearity of the dynamics, and don't serve any clear purpose. If they are to be retained, they should be qualified and interpreted to elucidate meaning. [Roger Samelson, USA]	The previous text had been a failed attempt to describe the various power-law dependences between quantities. This paragraph has been simplified to avoid any specific percentage changes.
24130	5	16	30	16	46	This entire paragraph is impossible to undertand for somebody without expertise in this field. Please revise carefully [Hans-Otto Poertner and WGII TSU, Germany]	The previous text had been a failed attempt to describe the various power-law dependences between quantities. This paragraph has been simplified to avoid any specific percentage changes.
20288	5	16	33	16	46	I'm not sure that this degree of textbook explanation/example is required here [Michelle A. North, South Africa]	Without descrbing the projections and consequences of stratificaiton changes, many of the other projected changes described in this chapter, such as to open-ocean ecosystems or tides, can not be supported.
1510	5	16	34	16	46	This point is very interesting, but is it possible to say something about the implications of wave propagation modifications for mixing? Is there any feedback? Maybe this could be linked to what is described at page 19 (lines 23-36 and 52-54) [Davide Bonaldo, Italy]	The prevous text has been substantially revised ot make the conseqences of changing stratification easier to understand.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
5062	5	16	34			What is stratification ? The square of Brunt-Vaisala frequency? Please define. [Alessandro Crise, Italy]	A definitiion of stratification and its relationship to the buoyancy frequency have been added.
16268	5	16	34	16	42	A bizarre paragraph with very specific numbers. Where did 1.1 come from that starts it all off? Completely out of the blue. Needs a citation. [Lynne Talley, USA]	The previous text had been a failed attempt to describe the various power-law dependences between quantities. This paragraph has been simplified to avoid any specific percentage changes.
16658	5	16	34	16	35	"consider the impacts of increasing stratification by 21% (chosen because the square root of 1.21 is 1.1)". The logic here requires further explanation. Ideally the projected rate of stratification would be better given at a certain timpoint rather than for an arbitrary value [Cliff Law, New Zealand]	The previous text had been a failed attempt to describe the various power-law dependences between quantities. This paragraph has been simplified to avoid any specific percentage changes.
2128	5	16	44	16	44	"increase" -> "increased" [Michio Kawamiya, Japan]	The text was altered as suggested by the reviewer.
1660	5	16	48	18	4	Please consider to include assessment of the following litterature in 5.2.1.2.3: * Eldevik, T., et al., A brief history of climate – the northern seas from the Last Glacial Maximum to global warming, Quaternary Science Reviews, 106, 225-246, https://doi.org/10.1016/j.quascirev.2014.06.028, 2014. * Iversen, T. et al., The Norwegian Earth System Model, NorESM1-M – Part 2: Climate response and scenario projections, Geoscientific Model Development, 6, 389-415, doi:10.5194/gmd-6-389-2013, 2013. * Langehaug, H. and E. Falck, Changes in the properties and distribution of the intermediate and deep waters in the Fram Strait, Progress in Oceanography, 96 (1), 57-76, https://doi.org/10.1016/j.pocean.2011.10.002, 2012. * Østerhus, S. and T. Gammelsrød, The Abyss of the Nordic Seas is warming, J of Climate, 12 ()11, 3297-3304, 1999. [Aurora Stenmark, Norway]	This is considered in preparation for SOD
12244	5	16	48	18	41	Based on analogy of present-day observation of surf zone migration in relation to tidal oscillation, SLR, using tidal elevation as a surrogate, will cause a coastward shift in boundaries of major marine hydrodynamic bands (wind-induced ocean circulation, offshore tidal currents and wave-generated longshore currents) postulated and validated by author off the Nigerian coast in the course of Mobil Producing Nigeria 1998 Idoho oil spill. Such cross-shore hydrodynamic bands likely exist off many other coasts, but the significance of their knowledge is in contigency planning to mitigate marine ecosystem degradation from influx of natural and anthropogenic pollutants. [Effiom Edem Antia (Prof), Nigeria]	This comment introduces a number of interesting ideas that unfortunately are beyond the scope of this chapter.
22124	5	16	48	18	3	The material in this section is dominantly based on Southern Ocean including ACC, in particular, open ocean. If the coastal processes and other regional studies can be included, it will be less biased reviews on the literatures. [Sung Yong Kim, Republic of Korea]	The material on the Southern Ocean has been moved into a new cross-chapter box, and additional references to large-scale circulation changes have been added. Coastal changes are discussed later in this chapter.
23212	5	16	48	17	12	This statement needs more evidences and references for the interannual and decadal warming of the mean state may attribute to the global warming. [Dongxiao Wang, China]	Several reference, either to relevant review papers or to other chapters in this report have been added.
23236	5	16	48	17	57	more emphasise should be placed on the change of circulation as it helps to redistribute the heat, salt and other biogeochemcial properties in the ocean. [Dongxiao Wang, China]	Additional references and discussion of the changes in the ocean circulation have been added.
22974	5	16	49			thise sentence needs to say '..heat and carbon', rather than just heat. [Jamie Shutler, UK]	This is considered in preparation for SOD

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
24132	5	16	49	17	2	Provide references [Hans-Otto Poertner and WGII TSU, Germany]	Several reference, either to relevant review papers or to other chapters in this report have been added.
21118	5	16	50	16	52	The importance of the AMOC to northern European climate is less well understood than is implied here. Some analyses suggest that large-scale atmospheric structure induced by the Rocky Mountains plays a role that is at least equal to that of heat transport by the Gulf Stream and North Atlantic Current, and the AMOC is the source of only part of that ocean heat transport. [Roger Samelson, USA]	This sentence has been revised to reflect what is known (in agreement with the reviewer's comment), rath than what has long been considered.
6024	5	16	51	16	51	"clement climate", what is that meaning? [Jens Zinke, Germany]	Webster's dictionary gives "mild" as a synonym of clement. The word choice is appropriate.
16270	5	16	51	16	51	"identified as the source" [Lynne Talley, USA]	The text was altered as suggested by the reviewer.
16272	5	16	52	16	52	Add reference here to the heat transport mechanisms. Can use a Bryden reference, or Talley (JPO 2003). [Lynne Talley, USA]	A reference to the Buckley and Marshall review paper was added here.
9314	5	17	4	17	46	Why are eddies in other ocean basins excluded in this discussion? [APECS Group Review, Germany]	Eddies are important in all ocean basins, and this point has been made in previous A.R.s. However, there is neither the convincing observational evidence nor a robust theoretical understanding for how the eddies can be expected to change in a changing climate for the other basins the way there is for the Southern Ocean eddy field.
16274	5	17	4	17	4	Sentence should be definitive. We know the S.O. is important. Reword "The Southern Ocean is important for the uptake ...." [Lynne Talley, USA]	The text was alltered as suggested by the reviewer
24134	5	17	4	17	46	Coordinate with/refer to chapter 3 [Hans-Otto Poertner and WGII TSU, Germany]	The Southern Ocean material has been combined with that from Chapter 3 into a new cross-chapter box.
21120	5	17	10	17	10	Numerical studies and theory [(see, e.g., textbooks by Vallis (2017) and Samelson (2016)] show that the ACC is not driven directly by the wind or dense water formation, but rather should be understood first as a geostrophic current in balance with existing ocean density structure that is strongly controlled by topographic constraints, given only the qualitative structure of large-scale surface forcing patterns. Surface wind stress and heat and freshwater fluxes (including not just dense water formation but also warming of the equatorward surface Ekman transport across the ACC) are necessary for its existence, but to first order that density structure depends on the combination of the qualitative characteristics of the surface forcing and the basin topography and geometry, not on a direct balance that would depend at first order in a quasi-equilibrium manner on the amplitude of the forcing. This is relevant also to the discussion in the succeeding paragraphy, lines 12-20 on page 17. [Roger Samelson, USA]	The Southern Ocean material has been combined with that from Chapter 3 into a new cross-chapter box. The discussion of the dyanmics of the ACC in that box is expanded from what was there before, and this expanded discussion should address the reviewers concerns.
16278	5	17	12	18	3	Although not labeled as such, this set of paragraphs is focused on the Southern Ocean. There is a new paper on metrics for Southern Ocean climate modeling that describes many of these signals, might be useful here: Russell, J., et al., 2018. Metrics for the Evaluation of the Southern Ocean in Coupled Climate Models and Earth System Models. J. Geophys. Res., 123, 3120-3143. doi: 10.1002/2017JC013461 [Lynne Talley, USA]	This paper is referenced in the new Southern Ocean Cross-Chapter Box.
1512	5	17	16	17	16	I would suggest considering to add a few words recalling the concept of "eddy saturation". [Davide Bonaldo, Italy]	The description of this comment has been expanded as requested. It is now in the Southern Ocean Cross-Chapter Box.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
23496	5	17	22	17	37	The whole part on the potential role of submesoscale is very general (and weak in terms of literature) and not up to date. Some suggestions for improvements are listed below. [Soeren Thomsen, France]	An error occurred when chapter 5 references were compiled in Endnote by the TSU resulting in a displacement of all the references by one position. This resulted in a great number of misplaced references which we have since then fixed.
23498	5	17	28	17	28	Bachman et al. (2017) is not really a review paper. Well established review Papers on Submesoscale processes are: Thomas et al. 2008, Levy et al.2012 (https://agupubs.onlinelibrary.wiley.com/doi/abs/10.1029/2012GL052756) and McWilliams 2017 (http://rspa.royalsocietypublishing.org/content/472/2189/20160117) [Soeren Thomsen, France]	An error occurred when chapter 5 references were compiled in Endnote by the TSU resulting in a displacement of all the references by one position. This resulted in a great number of misplaced references which we have since then fixed.
22120	5	17	31	17	33	It has known that submesoscale processes lead the secondary vertical circulations and may enhance the vertical mixing. The given summary of the paper describes in an opposite way of vertical mixing associated with submesoscale processes. Please clarify this. [Sung Yong Kim, Republic of Korea]	This is considered in preparation for SOD
23502	5	17	33	17	33	Not sure Bachmann 2017 is the right paper to cite here. [Soeren Thomsen, France]	An error occurred when chapter 5 references were compiled in Endnote by the TSU resulting in a displacement of all the references by one position. This resulted in a great number of misplaced references which we have since then fixed.
5064	5	17	35			Primarily the supply of iron (and possibly light) seem to control onset and duration of the blooms in Southern Ocean (Hoppe et al., 2017) This fact should be linked with the productivity (macronutrient are not expected to control primary production in S.O.) so the traditional mesoscale mechanism should be refined including Iron and light. Hoppe, C. J. M., Klaas, C., Ossebaar, S., Soppa, M. A., Cheah, W., Laglera, L. M., ... & Hoppema, M. (2017). Controls of primary production in two phytoplankton blooms in the Antarctic Circumpolar Current. Deep Sea Research Part II: Topical Studies in Oceanography, 138, 63-73. [Alessandro Crise, Italy]	This is considered in preparation for SOD
12010	5	17	35	17	37	The description Intensifying Southern Ocean eddy fields will likely have a significant impact on biological productivity, ecosystem, and carbon uptake…is too vague. The readers, particularly those interested in ocean economy or policy, should be expecting at least some estimates on the effects the eddy fields on regional distribution of primary production. [Louis Mitondo Lubango, Ethiopia]	This is considered in preparation for SOD
23500	5	17	35	17	35	Beside Brannigan et al., (2017) also Zhong et al. (2017) Observed and simulated submesoscale vertical pump of an anticyclonic eddy in the South China Sea, Nature, Scientific Reports https://www.nature.com/articles/srep44011, might be cited instead. [Soeren Thomsen, France]	This is considered in preparation for SOD
23504	5	17	37	17	37	A recent study on the role of Submesoscale vertical fluxes for the global ocean heat uptake has to be mentioned here. https://www.nature.com/articles/s41467-018-02983-w; https://doi.org/10.1038/s41467-018-02983-w, there should be more literature inside that paper about quantification of Submesoscale vertical heat fluxes [Soeren Thomsen, France]	This is considered in preparation for SOD
2682	5	17	48	17	57	Before starting this section, there should be a brief description of how to use numerical models [Mohammad Javad Zareian, Iran]	There is now a passage on the use of numerical coupeld climate models earlier in this section.

SROCC First Order Draft Expert Review Comments - Chapter 5							
Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
18678	5	17	48	18	3	While interesting this paragraph should be either push in a knowledge gaps section or move in Chap 1 "1.7.1 Ways of knowing". It applies to all models and all geophysical fields. [Roland Seferian, France]	This is considered in preparation for SOD
3980	5	17	51	17	51	Include also reference to Megann, 2017 discussing the numerical mixing [Helene Hewitt, UK]	Thank you for the suggested reference; the text has been modified as suggested by the reviewer.
5522	5	18	1	18	3	"In the case... order 20%". The cited study, Arbic et al., 2009, is on tidal resonance on coastal shelfs. But the paragraph concerns itself with model bias due to the thermocline, and ascribes it partially to heat uptake and the steric sea level rise. These aspects however are not considered in the cited study. Is the wrong study cited, or from what study can these conclusions be drawn? [Roderik Van De Wal, Netherlands]	An error occurred when chapter 5 references were compiled in Endnote by the TSU resulting in a displacement of all the references by one position. This resulted in a great number of misplaced references which we have subsequently fixed.
18680	5	18	1	18	1	where these numbers comes from ? Are they scenario dependant ? [Roland Seferian, France]	An error occurred when chapter 5 references were compiled in Endnote by the TSU resulting in a displacement of all the references by one position. This resulted in a great number of misplaced references which we have subsequently fixed. The cited reference shows this fractional sensitvity to be largely independent of scenario.
3982	5	18	3	18	3	Is Arbic et al. 2009 the correct referene here? [Helene Hewitt, UK]	An error occurred when chapter 5 references were compiled in Endnote by the TSU resulting in a displacement of all the references by one position. This resulted in a great number of misplaced references which we have since then fixed.
14400	5	18	7			The text "force-damped-resonance system" should be explained. It would only take a sentence or two to explain what this means. [Jennifer Fehrenbacher, USA]	After several tries, we found that full explanationation of resonance that would be better than a reference was much longer than could fit here. Moreover, resonance is a standard topic in many undergraduate-level mechanics courses. As such, the committeee has decided not to add the requested explanded explanation.
20534	5	18	9	18	29	It seems curious why the authors don't mention about the 18.6-year nodal tide modulation. The amplitude cannot be ignored, if the authors want to mention about 100 years time scale tidal change. Reference: Yasuda, I. (2009) The 18.6-year period moon-tidal cycle in Pacific Decadal Oscillation reconstructed from tree-rings in western North America. Geophys. Res. Lett., 36, doi:10.1029/2008GL036880. McKinnell, S. M., and W. R. Crawford (2007) The 18.6-year lunar nodal cycle and surface temperature variability in the Northeast Pacific. J. Geophys. Res., 112, 1-15, doi:10.1029/2006JC003671 [Shin-Ichi Ito, Japan]	We have already devoted as much space to the discussion of the climate-change induced changes changes in the tides as we could afford. While the long-cycle tides are an interesting natural forcing of the climate system, this point goes beyond the agreed upon scope of this chapter.
17482	5	18	11	18	12	As a consequence of changes in tides, the tidally-driven mixing will also change. I suggest mentioning this, either here or in the mixing section. An useful reference for the changes of tidal mixing in the glacial maximum is Schmittner, A., Green, J. A. M., and Wilmes, S.-B. (2015) Glacial Ocean Overturning Intensified by Tidal Mixing in a Global Circulation Model Geophysical Research Letters, 42(10), 4014-4022, doi: 10.1002/2015GL063561. [Sonya Legg, USA]	This is considered in preparation for SOD

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
24136	5	18	13	18	16	Consider briefly explaining “principal lunar semidiurnal tide M2” [Hans-Otto Poertner and WGII TSU, Germany]	A parenthetic description with two classic references has been added. Note also that one of these reference is not in English, helping address an overall criticism of the report.
13744	5	18	14			What is M2 tide phase? What are tracers? [Debra Roberts and Durban Team, South Africa]	Parenthetic definitions of both have been added to the text.
17484	5	18	24	18	25	After "modifies the rate of energy conversion from the barotropic tides to the internal tides" reference Jayne and St Laurent, 2001. https://doi.org/10.1029/2000GL012044 [Sonya Legg, USA]	The text was altered as suggested by the reviewer.
14040	5	18	29	18	29	add some citations for this finding. [Elizabeth Jewett, USA]	This entire paragraph, and the numerous citations therein, are the justification for this finding.
4116	5	18	38	18	39	Actually the alteration of tidal regime, due to the changes in the coastal lines, is not restricted to the Bohai Sea only. Rather it is present in the entire basin of the Yellow Sea. Please refer to the following study. "Hwang JH, Van SP, Choi B-J, Chang YS, Kim YH. 2014. The physical processes in the Yellow Sea. Ocean & Coastal Management 102: 449-457 [Jinsoon Park, Republic of Korea]	The text was altered as suggested by the reviewer.
17480	5	18	39	18	39	The MacKinnon et al 2017 is not the correct reference for a statement on flood defenses. [Sonya Legg, USA]	An error occurred when chapter 5 references were compiled in Endnote by the TSU resulting in a displacement of all the references by one position. This resulted in a great number of misplaced references which we have since then fixed.
16282	5	18	43	20	3	This section could be much more useful for an IPCC report if it dealt with observed changes in turbulence, with a major reduction in the tutorial aspect. Even if there isn't much to include at this point in terms of interannual variability of turbulence, it would be a basis for an ongoing section that would grow with the. years as the database is extended. As it is,it's too speculative. The figure would also be more applicable if it also included a panel showing the abyssal mixing referred to in the text. [Lynne Talley, USA]	This is considered in preparation for SOD
22126	5	18	43	20	4	This section contains an general overview on the turbulent mixing and relatively weak literature reviews on recent papers. [Sung Yong Kim, Republic of Korea]	An error occurred when chapter 5 references were compiled in Endnote by the TSU resulting in a displacement of all the references by one position. This resulted in a great number of misplaced references which we have subsequently fixed.
23054	5	18	43	19	11	This is scientifically a very interesting issue, but this section is too speculative to warrant nearly two pages. This could easily be shortened by 50% or more. [Nicolas Gruber, Switzerland]	This is considered in preparation for SOD
13746	5	18	57	18	57	Change 'colmn' to 'column'. [Debra Roberts and Durban Team, South Africa]	The text was altered as suggested by the reviewer.
21122	5	19	2	19	5	Cite here also recent studies by Kunze (JPO, 2017 or 2018). [Roger Samelson, USA]	This citation has been added.
680	5	19	7	19	7	insert "to" after "according" [Kathiresan Kandasamy, India]	The text was altered as suggested by the reviewer.
13748	5	19	7	19	7	Insert 'to' before 'local conditions' [Debra Roberts and Durban Team, South Africa]	The text was altered as suggested by the reviewer.
16280	5	19	8	19	11	These are definitely not figures from Rodenbeck, which is about carbon, not diffusivity. These are maps produced by Caitlin Whalen. Last sentence: "All panels are using data updated from Whalen et al. (2012)." [Lynne Talley, USA]	An error occurred when chapter 5 references were compiled in Endnote by the TSU resulting in a displacement of all the references by one position. This resulted in a great number of misplaced references which we have subsequently fixed.

SROCC First Order Draft Expert Review Comments - Chapter 5							
Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
14402	5	19	23	20	3	The paragraphs here go back and forth between discussing the arctic and the southern ocean, would be better if the content were orgamized by location instead of going back and forth between the two regions, which makes the text harder to follow. [Jennifer Fehrenbacher, USA]	The text was altered as suggested by the reviewer.
20536	5	19	23	19	36	Normal wind is not effective for ocean mixing. Strong disturbance like typhoon is important for PSI (parametric subharmonic instability). Increase of super typhoon influence on mixing processes. Reference: Hibiya, T., M. Nagasawa and Y. Niwa (2006), Global mapping of diapycnal diffusivity in the deep ocean based on the results of expendable current profiler (XCP) surveys, Geophys. Res. Lett., 33, L03611, doi:10.1029/2005GL025218. [Shin-Ichi Ito, Japan]	An error occurred when chapter 5 references were compiled in Endnote by the TSU resulting in a displacement of all the references by one position. This resulted in a great number of misplaced references which we have subsequently fixed.
5524	5	19	27	19	27	It is the Southern Annular Mode, not Southern Annual mode. [Roderik Van De Wal, Netherlands]	The text was altered as suggested by the reviewer.
13750	5	19	35	19	35	Insert 'of' before 'ocean turbulence' [Debra Roberts and Durban Team, South Africa]	The text was altered as suggested by the reviewer.
16660	5	19	39	19	40	Remove " our expected changes in" [Cliff Law, New Zealand]	The text was altered as suggested by the reviewer.
24138	5	19	40	19	48	Refer to the relevant section(s) in chapter 3 [Hans-Otto Poertner and WGII TSU, Germany]	This is considered in preparation for SOD
9316	5	19	41	19	41	Could the specific section be referenced for the statement “discussed previously”? [APECS Group Review, Germany]	A reference to the Southern Ocean cross chapter box has been added.
16662	5	19	45	19	45	increasing the GRADIENT in oxygen concentrations [Cliff Law, New Zealand]	The text was altered as suggested by the reviewer.
17486	5	19	50	20	3	This Arctic process should also have been mentioned in the Polar chapter. [Sonya Legg, USA]	The text was altered as suggested by the reviewer.
15198	5	19	53	19	53	warmer, saltier water, [Christophe Deissenberg, Luxembourg]	The text was altered as suggested by the reviewer.
16664	5	19	56	19	56	What are "social structures"? [Cliff Law, New Zealand]	The text was altered to societies.
5264	5	20	0	22		Only about inorganic carbon, this should be made clear [Emma Cavan, Australia]	This is considered in preparation for SOD
13752	5	20	0			Figure 5.6 Please explain "diapycnal diffusivity" . Why is there such a neat belt across the equator? Is this a model artefact? What do the scales mean? Please explain in plain English. [Debra Roberts and Durban Team, South Africa]	A plain English explanation of diapycnal diffusivity has been added to the caption for Fig. 5.6. The enhanced equatorial miixng is real - this is based on observational data, not a model. We will work toward a try better description for the color scale.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
22978	5	20	0			section 5.2.1.3: this whole section seems very incomplete and over reliant on a limited references and authors. As a result It reads as if the ocean carbon sink function and variability is fully understood, which it is not, There are large holes in our understanding and large holes in our abiliy to monitor the complete global oceans; hence it is a very active area of research. I feel that this section needs re-writing to fully capture current knowledge and capability. e.g. the magnitude of the oceanic uptake of CO2 is controlled by biological and physical pumps and processes and varies on inter-annual and potentially decadal timescales (Watson et al., 2009, Wanninkhof et al., 2013, Landschützer et al., 2015) but the exact controls, how they combine and may change in the future are not well understood. Unlike the land sink, the ocean sink is measureable and so this measurement, along with atmospheric sink measurements provide the two main constraints on the global carbon budget. Therefore not measuring the ocean sink would mean that we would not be able to balance the global carbon budget. references: http://science.sciencemag.org/content/326/5958/1391 ; Wanninkhof R., et al. (2013), Global ocean carbon uptake: magnitude, variability and trends, Biogeosciences, 10, 1983-2000, doi:10.514/bg.10.1983.2013. The Landschutzer reference is already in the text. [Jamie Shutler, UK]	An error occurred when chapter 5 references were compiled in Endnote by the TSU resulting in a displacement of all the references by one position. This resulted in a great number of misplaced references which we have since then fixed.
22980	5	20	0			The information about the southern ocean is incomplete and overly brief. This aspect of the southern ocean is covered in more detail and more thouroughly in section 3.3.1.2.4 of chapter 3. suggest that you cross check this with chapter 3 and/or remove the text from here. [Jamie Shutler, UK]	The information about the Southern Ocean in chapters 3 and 5 were combined into a cross-chapter box, per the reviewer's suggestion.
16666	5	20	6	20	8	Is Figure 5.6 required? [Cliff Law, New Zealand]	Yes, this figure illustrates the rich geography and dynamism of ocean mixing, something that is not well accounted for in most climate change projections. This figure absolutely does belong in this chapter.
2506	5	20	8	20	8	he bands along the equator look strange. [Xiujun Wang, China]	This enhanced mixing at depth was not fully anticipated prior to Argo, but this is what the Argo finescale data shows. Given the importance of rotation elsewhere, it is not surprising that the the equatorial turbulence, like the large-scale dynamics, are different than in mid-latitude. Note that shear-driving mixing along the Equator has a long history in descriptions of equatorial dynamics, but available space does not permit a full discourse on this fascinating topic in this report.
3354	5	20	8	20	8	Should it be (a, c)? [Castor Muñoz Sobrino, Spain]	In the interests of brevity, the figure in question has been reduced to a single panel.
9318	5	20	11	20	11	Figure 5.6 The referenced paper is about pCO2 with no clear reference to diapycnal diffusivity or turbulent energy dissipation rates in the publication. If this is not an error, the connection between the referenced publication and presented data should be more transparent for traceability. [APECS Group Review, Germany]	An error occurred when chapter 5 references were compiled in Endnote by the TSU resulting in a displacement of all the references by one position. This resulted in a great number of misplaced references which we have since then fixed.
1514	5	20	14	22	12	In this paragraph I would suggest, if possible, to add some links to the depth distribution of the described phenomena in relation with the changes described in the previous sections [Davide Bonaldo, Italy]	We have rewritten the entire subsection dealing with ocean carbon to provide an expansion of the assessment. All comments have been taken on board during this rewrite

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
2130	5	20	14	20	14	Contrary to the sentence "...with consequences for the uptake of anthropogenic carbon (section 5.2.1.3)..." (page15, line 44-46), there is no mentioning to the effect of intensified stratification in section 5.2.1.3. The effect of stratification to reduce carbon uptake is discussed by Friedlingstein et al. (2006, J. Clim., vol.19, pp.3337–3353) and Miyama and Kawamiya (2009, GRL, vol.36, doi:10.1029/2009GL039678), for example. Those efforts should be cited somewhere in section 5.2.1.3. [Michio Kawamiya, Japan]	We have rewritten the entire subsection dealing with ocean carbon to provide an expansion of the assessment. All comments have been taken on board during this rewrite
2508	5	20	14	22	12	Overall, this section is not well organized. There is too much about pH, and not enough on ocean carbon. I would expect to include changes in DIC, DOC, POC (in addition to carbon uptake) over various spatial and temporal scales. [Xiujun Wang, China]	We have rewritten the entire subsection dealing with ocean carbon to provide an expansion of the assessment. All comments have been taken on board during this rewrite
16284	5	20	14	22	12	again too much tutorial. Focus on CHANGE that might be attributable to anthropogenic forcing. [Lynne Talley, USA]	We have rewritten the entire subsection dealing with ocean carbon to provide an expansion of the assessment. All comments have been taken on board during this rewrite
16486	5	20	14	20	14	To be accurate, this section should be labeled "Changes in Ocean Acidity" (not carbon) [Patrick Gonzalez, USA]	We have rewritten the entire subsection dealing with ocean carbon to provide an expansion of the assessment. All comments have been taken on board during this rewrite
22192	5	20	14	22	12	This section is quite incomplete, patchy, and incorrect in large bits. It seems to randomly select references and does not include the type of comprehensive assessment of post-AR5 literature I would expect from an IPCC report. Most of the section is on pH rather than on ocean carbon, which occupies 2 tiny paragraphs and do not mention carbon-climate feedbacks. This is a major omission of this report. I suggest splitting ocean carbon from pH, and spending a solid 2-pages with at least one figure on ocean carbon. In particular, I have been longing for a re-assessment of the mean global ocean CO2 sink over the recent decade since the 2.2+/00.4PgC/y provided by AR4, and I hope/expect SROCC will do the community the immense favour to provide one. [Corinne Le Quere, UK]	We have rewritten the entire subsection dealing with ocean carbon to provide an expansion of the assessment. All comments have been taken on board during this rewrite
22210	5	20	14	22	12	This section needs to provide an update of what we know on the impact of climate change on the ocean carbon sink mediated by changes in ocean acidification. Does the decrease in primary production cited in the executive summary influence the uptake of CO2 by the ocean? I would expect it does. Can you assess its size? In AR5, we said at the end of Section 6.3.2.5.6 when referring to ocean biological and coastal processes: "the fit of ocean model results to the integrated CO2 sink and decadal trends discussed above suggest that, up to now, the missing processes have not had a dominant effect on ocean CO2 beyond the limits of the uncertainty of the data." . Do you agree still with this assessment or are new studies suggesting larger influence for ecosystem change? If you agree, please make sure that the statements made about blue carbon are consistent with this. If you don't agree, please provide your own assessment. [Corinne Le Quere, UK]	We have rewritten the entire subsection dealing with ocean carbon to provide an expansion of the assessment. All comments have been taken on board during this rewrite

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
23056	5	20	14	20	32	The ocean carbon uptake section needs to be substantially expanded and much more thoroughly discussed. There has been much progress on different fronts that need to be discussed here in much more depth. Of course, I am not completely unbiased here, but given the fact that the ocean uptake of carbon is one of the most important ecosystem services of the ocean, it behooves IPCC well to assess the latest insights on this issue - from global to the regional scale. [Nicolas Gruber, Switzerland]	We have rewritten the entire subsection dealing with ocean carbon to provide an expansion of the assessment. All comments have been taken on board during this rewrite
2510	5	20	16	20	17	The statement is not correct. The temporal variability in ocean carbon uptake (i.e., increase since 2000) does not agree with atmospheric CO2 growth rate. [Xiujun Wang, China]	We have rewritten the entire subsection dealing with ocean carbon to provide an expansion of the assessment. All comments have been taken on board during this rewrite
3552	5	20	16	20	18	The latest analyses of community datasets and ocean models demonstrate that ocean carbon uptake has increased since 2000, commensurate with the increase in the atmospheric carbon dioxide growth rate (high confidence; (Figure 5.8a) (Landsch□tzer et al., 2016). [Richard Feely, USA]	We have rewritten the entire subsection dealing with ocean carbon to provide an expansion of the assessment. All comments have been taken on board during this rewrite
14404	5	20	16			Should this state that the RATE of ocean carbon uptake has increased since 2000, in broad agreement with carbon dioxide RATE? [Jennifer Fehrenbacher, USA]	We have rewritten the entire subsection dealing with ocean carbon to provide an expansion of the assessment. All comments have been taken on board during this rewrite
23058	5	20	16	20	23	Here and elsewhere. There are important errors in the cited references. E.g. line 23 - Sabine et al. (2004) did not discuss any model results. [Nicolas Gruber, Switzerland]	An error occurred when chapter 5 references were compiled in Endnote by the TSU resulting in a displacement of all the references by one position. This resulted in a great number of misplaced references which we have since then fixed.
2512	5	20	18	20	18	Should "Figure 5.8" be Figure 5.7? [Xiujun Wang, China]	The text was altered as suggested by the reviewer.
18682	5	20	18	20	18	Please refer to Le Quéré et al. 2018 (global carbon budget) and maybe to Séférian et al. GRL 2014 (detection and attribution of rising ocean c sink) [Roland Seferian, France]	We have rewritten the entire subsection dealing with ocean carbon to provide an expansion of the assessment. All comments have been taken on board during this rewrite
22194	5	20	18	20	19	Substantial degree compared to what? numbers please. My own assessment is that there is not a substantial interannual variability and this has not changed snce AR5, but that there is far more decadal and semi-decadal variability than previously thought. This assessment should give an idea of scale. For example the variability in the pCO2-based flux products of Landschutzer and of Roedenbeck suggests variability that is of the order of 0.3 to up to perhaps 1 PgC/y, which is more than the models produce, but much less than the variability in the atmospheric growth rate. Also nothing is said about the impact of climate change on the trend in CO2 uptake. [Corinne Le Quere, UK]	We have rewritten the entire subsection dealing with ocean carbon to provide an expansion of the assessment. All comments have been taken on board during this rewrite
22202	5	20	18	20	22	There is so much said in this sentence that needs to be broken down and detailed, particularly regarding the Southern Ocean CO2 trends. [Corinne Le Quere, UK]	We have rewritten the entire subsection dealing with ocean carbon to provide an expansion of the assessment. All comments have been taken on board during this rewrite
22200	5	20	19	20	19	This is not actually true. Model do reproduce variability associated with ENSO (or at least many of them). It is the one region where model variability is actually reasonable. [Corinne Le Quere, UK]	We have rewritten the entire subsection dealing with ocean carbon to provide an expansion of the assessment. All comments have been taken on board during this rewrite
22976	5	20	20			Please see and add in this paper by Rodenbeck et al., 2015 which performed a global study and intercomparison using multiple observation based datasets https://www.biogeosciences.net/12/7251/2015/ (whereas the existing reference in this sentence focusses on one method) [Jamie Shutler, UK]	We have rewritten the entire subsection dealing with ocean carbon to provide an expansion of the assessment. All comments have been taken on board during this rewrite

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
24140	5	20	20	20	20	Please spell out the acronym ENSO the first time [Hans-Otto Poertner and WGII TSU, Germany]	The text was altered as suggested by the reviewer.
2514	5	20	21	20	22	The statement is confusing. [Xiujun Wang, China]	We have rewritten the entire subsection dealing with ocean carbon to provide an expansion of the assessment. All comments have been taken on board during this rewrite
3226	5	20	21	20	23	I didn't read a consensus in the attribution to westerly winds only in the publications concerning the 1990s and 2000s Southern Ocean decadal variability. The westerly winds strenthening might explain the weakening Southern Ocean carbon uptake, but cannot be the only explanation for the increasing Southern Ocean Carbon uptake trend in the 2000s. There is the inverse modelling study from DeVries, 2017 which demonstrates the strengthening (90s) and weakening (2000s) of the Southern Hemisphere Overturning as a driving factor. Lovenduski 2016 is not about the Southern Ocean winds, but rather Lovenduski 2015 [Aaron Spring, Germany]	We have rewritten the entire subsection dealing with ocean carbon to provide an expansion of the assessment. All comments have been taken on board during this rewrite
18684	5	20	21	20	21	Neither the future response of the Southern ocean C sink to changing westerlies (coarse and eddy resolving model do not show the same feature or response) nor the current mechanisms of the Southern Ocean decadal fluctuations (current generation of models do not capture such large decadal fluctuations) are well understood or attributed. This statement is misleading. [Roland Seferian, France]	We have rewritten the entire subsection dealing with ocean carbon to provide an expansion of the assessment. All comments have been taken on board during this rewrite
11310	5	20	22	20	22	…to changes in wind patterns… [Croot Peter, Ireland]	We have rewritten the entire subsection dealing with ocean carbon to provide an expansion of the assessment. All comments have been taken on board during this rewrite
22198	5	20	22	20	23	Several issues here. Sabine et al 2004 is rather old; it does not actually talk about models; we need your own assessment here. [Corinne Le Quere, UK]	We have rewritten the entire subsection dealing with ocean carbon to provide an expansion of the assessment. All comments have been taken on board during this rewrite
2516	5	20	23	20	23	The statement and reference do not match well. [Xiujun Wang, China]	An error occurred when chapter 5 references were compiled in Endnote by the TSU resulting in a displacement of all the references by one position. This resulted in a great number of misplaced references which we have since then fixed.
3230	5	20	23	20	23	Sabine 2004 is about the first data estimate of pCO2,ocean. Covers modelled variability: Resplandy, L., R. Séférian, and L. Bopp. "Natural Variability of CO2 and O2 Fluxes: What Can We Learn from Centuries-Long Climate Models Simulations?" Journal of Geophysical Research: Oceans 120, no. 1 (January 2015): 384–404. https://doi.org/10/f63c3h. [Aaron Spring, Germany]	We have rewritten the entire subsection dealing with ocean carbon to provide an expansion of the assessment. All comments have been taken on board during this rewrite
23522	5	20	23			Sabine et al. 2004 is an old reference and doesn't say much about interannual variability. There has been a lot done on this topic in the past 14 year. A more comprehensive reference is the review of McKinley et al. 2017 : McKinley, G. A., Fay, A. R., Lovenduski, N. S. & Pilcher, D. J. Natural Variability and Anthropogenic Trends in the Ocean Carbon Sink. Annu. Rev. Marine. Sci. 9, 125–150 (2017). [Galen Galen Mckinley, USA]	We have rewritten the entire subsection dealing with ocean carbon to provide an expansion of the assessment. All comments have been taken on board during this rewrite
16668	5	20	25	20	29	It would be useful to include some scaling, or reference to how these estimates of ocean carbon uptake compare with anthropogenic CO2 emissions over the same period [Cliff Law, New Zealand]	We have rewritten the entire subsection dealing with ocean carbon to provide an expansion of the assessment. All comments have been taken on board during this rewrite

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
22204	5	20	25	20	25	Most of the studies cited here are actually based on very simple models calibrated by data. To present them as primarily 'based on data' is not quite a fair representation of what the information actually brings. I think the language in this paragraph needs to make this clear. If it help, in the global carbon budget we have introduced the terminology of flux products following a suggestion from Ralph Keeling, for example Landschutzer and Roedenbeck are producing 'pCO2-based flux products'. It's a bit heavy and I'd be happy if you can suggest something lighter, but it's a least spelling out what they are. [Corinne Le Quere, UK]	We have rewritten the entire subsection dealing with ocean carbon to provide an expansion of the assessment. All comments have been taken on board during this rewrite
22206	5	20	27	20	27	Please can we have an assessment that includes cumulative carbon uptake to 2018? The global carbon budget xlsx spreadsheet provide values to 2016 based on the average of two flux products by Khatiwala and De-Vries (see worksheet 'Historical Budget' in file https://data.icos-cp.eu/licence_accept?ids=%5B%22mtuoxtXq4VhQaZmS4hPJuoQZ%22%5D and its justifiable to assume that the ocean sink will persist for 2017 & 2018 at a similar level as 2016. [Corinne Le Quere, UK]	We have rewritten the entire subsection dealing with ocean carbon to provide an expansion of the assessment. All comments have been taken on board during this rewrite
9320	5	20	29	20	29	Is “high confidence” here meant in the confidence language? If so, please split into agreement and evidence levels. [APECS Group Review, Germany]	We have rewritten the entire subsection dealing with ocean carbon to provide an expansion of the assessment. All comments have been taken on board during this rewrite
22208	5	20	30	20	30	I don't think it is demonstrated that regional and global variability is driven by changes in ocean physics, though it is probably to a first order, this sentence sounds more definite than possibly the evidence warrants. I think the language and references need a bit of clarify. The Landschutzer product differs quite a lot from that of Roedenbeck, which suggests that the explanation provided might have some issues. I think this sentence needs a lot more attention and detail. [Corinne Le Quere, UK]	We have rewritten the entire subsection dealing with ocean carbon to provide an expansion of the assessment. All comments have been taken on board during this rewrite
13164	5	20	31	20	31	I would suggest to remove the citation of Zeebe & Wolf-Gladrow 2001here, as it does not talk about local and regional differences in ocean carbon uptake. Also, please check spelling of Landschützer throughout, the umlaut is often missing [Baerbel Hoenisch, USA]	We have rewritten the entire subsection dealing with ocean carbon to provide an expansion of the assessment. All comments have been taken on board during this rewrite
3228	5	20	32	20	32	You might want to cite Landschutzer 2016 which is about all regions of the ocean carbon sink. Landschutzer 2015 is only about the Southern Ocean [Aaron Spring, Germany]	We have rewritten the entire subsection dealing with ocean carbon to provide an expansion of the assessment. All comments have been taken on board during this rewrite
1886	5	20	37	20	41	These sentences need a little bit of restructuration. I suggest the following wording: The three forms of DIC are aqueous carbon dioxide (CO2(aq)), bicarbonate (HCO3-) and carbonate (CO32-) that are coupled via a set of reversible reactions known as the 'pH-buffer system' and their relative abundance is strongly controlled by ocean pH. At the typical pH of seawater of around 8.1, the ratio bicarbonate:carbonate:CO2(aq) approximates 100:10:1. If the ocean pH lowers (or acidity increases), CO2(aq) becomes more abundant… [Jens Rassmann, Belgium]	We have tried to improve the phrasing
3554	5	20	40	20	40	the ratio of DIC/TA [Richard Feely, USA]	The text was altered as suggested by the reviewer.

SROCC First Order Draft Expert Review Comments - Chapter 5							
Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
3556	5	21	5	21	12	Ecosystems are sensitive to specific aspects associated with carbon speciation in response to ocean acidification. As reviewed in IPCC AR5 and elsewhere (Roleda et al., 2012; Aze et al., 2014), photosynthesising organisms may respond favourably to the increasing availability of dissolved CO2(aq). Calcifying organisms are generally negatively affected by changes in pH and aragonite and calcite saturation states, although increasing bicarbonate could, in theory, promote calcification (Orr et al., 2005). Reduced carbonate levels affect the saturation state of calcite and aragonite minerals (?CAL and ?ARAG), causing dissolution of unprotected calcium carbonate structures, e.g., coral exoskeletons, in undersaturated water (Feely et al., 2004; 2009; Bates et al., 2014; Takahashi et al., 2014). Habitat and taxon-specific impacts of ocean acidification are considered in greater detail in 5.2.2 and 5.2.3 below. [Richard Feely, USA]	This text has been removed in revision
9324	5	21	5	21	13	Could confidence language be included here to guide how much agreement and evidence there are for these statements? [APECS Group Review, Germany]	We have improved the assessment phrasings throughout the section
16670	5	21	8	21	8	There are published metanalysis such as by Krocker et al (2010) that should be cited to confirm that calcifying organisms are negatively affected by acidification. Kroeker KJ, Kordas RL, Crim RN, Singh GG. Meta-analysis reveals negative yet variable effects of ocean acidification on marine organisms. Ecology letters. 2010 Nov 1;13(11):1419-34. [Cliff Law, New Zealand]	included
9322	5	21	9	21	9	Line 1 on this page suggests that "....bicarbonate is not very sensitive..." but here it is not clear in which case would one expect bicarbonate to increase. [APECS Group Review, Germany]	This text has been removed in revision
12100	5	21	9	21	9	Enough studies have been conducted by now that a qualifier like "In theory" shouldn't be needed. Either more carbonate facilitates calcification or it doesn't. Provide evidence or cut this statement out. [Sarah Cooley, USA]	This text has been removed in revision
12098	5	21	11	21	11	I'd suggest offering different examples instead of coral exoskeletons: pteropod shells, biogenic calcium carbonate sediments. There's a lot of evidence that OA is currently eroding the latter two and in patterns directly related to geochemical changes. Coral skeletons have to be exposed to be damaged by low saturation state, and full undersaturation isn't as typical a problem in warm tropical waters as it is in higher latitudes/deeper waters. [Sarah Cooley, USA]	This text has been removed in revision
16672	5	21	12	21	12	Do the cited references (Bates et al., 2014; Takahashi et al., 2014) actually demonstrate dissolution of unprotected carbonate structures? [Cliff Law, New Zealand]	This text has been removed in revision

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
3558	5	21	15	15	20	Analyses of direct pH trends from ocean time-series and derived pH changes from shipboard studies show consistent decreases in pH and the saturation state of aragonite and calcite have occurred over the past few decades (high confidence). The largest changes are observed from time-series in the Irminger Sea (0.0026 yr-1) and the Cariaco Basin (0.0025 yr-1), with the longest available time series in Bermuda and Hawaii (spanning >30 and >25 years, respectively) showing similar trends of 0.0016/7 yr-1 (Rhein et al., 2013; Lauvset et al., 2015). It would be useful to show the trends in pH and pCO2 at all of the available time series station in order to show the regional trends in rate changes, i.e., is there a latitudinal trend in rate of acidification or pCO2 increase? What does 0.0016/7 mean? [Richard Feely, USA]	The text was altered as suggested by the reviewer.
11312	5	21	15	21	21	Include the pH scale being used in this section, on line 22 the seawater scale is mentioned but not before. [Croot Peter, Ireland]	amended
23060	5	21	15	21	30	There are a lot of rather confident statements here without a lot of supporting evidence. The literature needs to be more thoroughly screened and assessed [Nicolas Gruber, Switzerland]	We have improved the assessment phrasings throughout the section
1888	5	21	17	21	18	A pH decrease of -0,028+/-0,0003 /yr has been registered in the bay of Villefranche sur Mer (Kapsenberg, L., Alliouane, S., Gazeau, F., Moussean, L., Gattuso, J.-P.: Coastal ocean acidification and increasing total alkalinity in the northwestern Mediterranean Sea (2017), Ocean Science, vol., 13, issue 3, pages 411-426, doi: 10.5194/os-13-411-2017 [Jens Rassmann, Belgium]	Here we have focussed on open ocean trends rather than enclosed seas
13754	5	21	17			Suggest a different unit that doesn't give you small decimals like this. [Debra Roberts and Durban Team, South Africa]	The text was altered as suggested by the reviewer.
16488	5	21	17	21	17	Add here an important analysis of Pacific Ocean acidity, something like "Anthropogenic CO2 has increased acidity in Pacific Ocean waters by as much as 40% (-0.15 pH) from ca.1750 to 2014 (Carter et al. 2017)." Carter, B.R., R.A. Feely, S. Mecking, J.N. Cross, A.M. Macdonald, S.A. Siedlecki, L.D. Talley, C.L. Sabine, F.J. Millero, J.H. Swift, A.G. Dickson, and K.B. Rodgers. 2017. Two decades of Pacific anthropogenic carbon storage and ocean acidification along Global Ocean Ship-based Hydrographic Investigations Program sections P16 and P02. Global Biogeochemical Cycles 31: 306-327. [Patrick Gonzalez, USA]	We have rewritten the entire subsection dealing with ocean carbon to provide an expansion of the assessment. All comments have been taken on board during this rewrite
11314	5	21	19	21	19	typographic? -0.0016/7 what does the / mean here? [Croot Peter, Ireland]	The text was altered as suggested by the reviewer.
12102	5	21	20	21	20	Change "require" to "requires" [Sarah Cooley, USA]	The text was altered as suggested by the reviewer.
16674	5	21	26	21	26	should "large trends" be "increases"? [Cliff Law, New Zealand]	The text was altered as suggested by the reviewer.
3560	5	21	29	21	30	There is observational and theoretical evidence (medium confidence) that seasonal variability in pH and pCO2 has increased, and will continue to do so with increasing atmospheric CO2 (Lauvset et al., 2015; Fassbender et al., 2017; Feely et al., 2018). [Richard Feely, USA]	The text was altered as suggested by the reviewer.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
16134	5	21	32	21	40	There are not many time series available from the Southern Hemisphere. The longest time series is off New Zealand, the "Munida" Time Series from ship board water samples. Kim Currie at Otago University is the key scientist and author of papers on this time series and should be mentioned here somewhere Currie, K.I., Reid, M.R., and Hunter, K.A. (2011). Interannual variability of carbon dioxide drawdown by subantarctic surface water near New Zealand. Biogeochemistry, 104(1-3): 23-34. Cliff S. Law, James J. Bell, Helen C. Bostock, Chris E. Cornwall, Vonda J.Cummings, Kim Currie, Simon K. Davy, Malindi Gammon, Christopher D. Hepburn, Catriona L.Hurd, Miles Lamare, Sara E. Mikaloff-Fletcher, Wendy A. Nelson, Darren M. Parsons, Norman L.C. Ragg, Mary A. Sewell, Abigail M. Smith & Dianne M. Tracey (2017): Ocean acidification in NewZealand waters: trends and impacts, New Zealand Journal of Marine and Freshwater Research http://dx.doi.org/10.1080/00288330.2017.1374983 [Mary Livingston, New Zealand]	The text was altered as suggested by the reviewer.
2136	5	21	34	21	35	The sentence gives an impression that lwerd pH waters are transferred into the ocean interior only in the Atlantic, which is not true. Watanabe and Kawamiya (2017, Journal of Oceanography, vol.73, pp. 771–784), for example, showed that low pH water in the North Pacific is transported into ocean interior by intermediate water formation. A sentence like "In other oceans such as the North Pacific, low pH waters are also transferred into ocean interior, albeit to shallower depths, by intermediate water formation (Watanabe and Kawamiya, 2017)" should be added after "...and south Atlantic (Rios et al., 2015)." (page.21, line 35). [Michio Kawamiya, Japan]	The text was altered as suggested by the reviewer.
14042	5	21	37	21	38	suggested change in wording: "the variability over a seasonal cycle of the carbonate parameters represents (the difference between the high and low values) a change greater than 10 years of the predicated long term trend for open ocean sites" [Elizabeth Jewett, USA]	This text has been removed in revision
20990	5	21	37	21	38	This statement should clarify that the seasonal cycle is equivalent to around 10 years of the long-term trend at some "open ocean" sites. Sutton et al. 2016 Figure 5, for example, shows a coastal site where the seasonal cycle is equivalent to a century-scale long-term change. [Adrienne Sutton, USA]	This text has been removed in revision
2144	5	21	42	21	56	Strong penetration of decreasin of pH in the subpolar gyre. Please consider the letter in nature (doi:10.1038/nature25493) "Meridional overturning circulation conveys fast acidification to the deep Atlantic Ocean" [Fiz Fernandez Perez, Spain]	The text was altered as suggested by the reviewer.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
3562	5	21	42	21	49	Over the next century, pH is projected to decline by 0.07-0.31 pH units for RCP2.6 and 8.5 scenarios, respectively (Orr et al., 2009; Bopp et al., 2013; Gattuso et al., 2015), with good agreement across the range of CMIP5 models (high confidence) (Figure 5.7a). Projected changes in pH show relatively weak spatial variations, but they are greatest in the Arctic Ocean and the high latitudes of the Atlantic and Pacific Oceans due to their decreasing buffering capacity and are lowest in contemporary upwelling systems (Figure 5.7b). Other ocean regions show changes similar to the global average. Similar declines in the concentration of CO32- ions is predicted by the CMIP5 models (Orr et al., 2005; Gattuso et al., 2015), with high latitude and Arctic Ocean regions first to be undersaturated due to their systemic vulnerability (Steinacher et al., 2009; Gehlen et al., 2014a). [Richard Feely, USA]	The text was altered as suggested by the reviewer.
14044	5	21	42	21	42	suggested change in wording: "pH is projected to decline by 0.07 +/- .31 in open ocean system". We don't yet have any global models which can predict the change in coastal systems which are chemically much more complex. [Elizabeth Jewett, USA]	The text was altered as suggested by the reviewer.
16676	5	21	42	21	42	Should this read "by the END OF THE CURRENT Century "? This cited range is also incorrect - see Fig 5.7a, in which the decrease in pH is greater than 0.24 over much of the ocean & extends to 0.4 in places, by 2100 [Cliff Law, New Zealand]	The text was altered as suggested by the reviewer.
18686	5	21	42	21	42	RCP8.5 [Roland Seferian, France]	The text was altered as suggested by the reviewer.
16678	5	21	43	21	43	Orr et al (2005) was a seminal pape, but the projections have now been superceded by many models (indeed, the CMIP5 models were not created in 2005) [Cliff Law, New Zealand]	An error occurred when chapter 5 references were compiled in Endnote by the TSU resulting in a displacement of all the references by one position. This resulted in a great number of misplaced references which we have since then fixed.
11634	5	21	49	21	49	See also Steinacher et al., Biogeosciences 2009 who first predicted imminent Arctic Ocean Undersaturation [Fortunat Joos, Switzerland]	The text was altered as suggested by the reviewer.
2146	5	21	51			0.02 pH units is twice the vertical gradient surface-bottom in the supolar gyre. [Fiz Fernandez Perez, Spain]	We acknowledge the information
13166	5	21	53	21	53	(>3 km deep) [Baerbel Hoenisch, USA]	The text was altered as suggested by the reviewer.
18688	5	21	53	21	53	abyssal ocean deep [Roland Seferian, France]	The text was altered as suggested by the reviewer.
14046	5	21	54	21	54	Add: according to global models. (given the direct observations of this aren't yet possible) [Elizabeth Jewett, USA]	The text was altered as suggested by the reviewer.
18690	5	21	55	21	55	please consider acknowledging Gehlen et al BG 2014 [Roland Seferian, France]	The text was altered as suggested by the reviewer.
20992	5	21	55			Clarify that model skill is generally good for "trends of" carbon speciation variables. Models in general tend to underestimate ocean carbon variability. [Adrienne Sutton, USA]	The text was altered as suggested by the reviewer.
18692	5	21	56	21	56	Keller et al. 2014 and Frolicher et al. 2016 do not discuss about the model skill [Roland Seferian, France]	An error occurred when chapter 5 references were compiled in Endnote by the TSU resulting in a displacement of all the references by one position. This resulted in a great number of misplaced references which we have since then fixed.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
20994	5	22	1	22	12	This paragraph needs a clear statement that these results are relevant to open ocean systems. Earth system models are not able to capture time of emergence for coastal regions, where most policy makers are most concerned about ocean acidification impacts. Sutton et al. 2016 (cited earlier in Chapter 5) used direct observations in open ocean and coastal systems to compare present day natural variability in pH and aragonite saturation state to the pre-industrial bounds of natural variability. They found, as the models do, that open ocean conditions have emerged from pre-industrial variability throughout the year; however, in coastal locations, present day conditions still overlap with pre-industrial variability and pH has not emerged from this variability envelope. [Adrienne Sutton, USA]	The text was altered as suggested by the reviewer.
11316	5	22	3	22	6	rephrase as sentence repetitious (emerge and emergence), suggest using phrase 'resolving of a pH trend' or similar [Croot Peter, Ireland]	The text was altered as suggested by the reviewer.
13168	5	22	3	22	4	not sure what this sentence wants to say: "As the trends in pH can be observed to emerge with a median of 15 years of data is needed for the emergence of a pH trend". Please rephrase. [Baerbel Hoenisch, USA]	The text was altered as suggested by the reviewer.
18694	5	22	3	22	3	please consider acknowledging Henson et al. NatComm 2017 [Roland Seferian, France]	The text was altered as suggested by the reviewer.
2132	5	22	4	22	4	"is needed for the emergence of a pH trend" should be deleted. [Michio Kawamiya, Japan]	The text was altered as suggested by the reviewer.
9326	5	22	4	22	4	Is “high confidence” here meant in the confidence language? If so, please split into agreement and evidence levels. [APECS Group Review, Germany]	We have improved the assessment phrasings throughout the section
20566	5	22	4			high confidence, in italics? [Chiara Lombardi, Italy]	We have improved the assessment phrasings throughout the section
14048	5	22	5	22	5	Add" surface OPEN ocean to this sentence. The time of emergence is being calculated to be more like 30 years for coastal waters. [Elizabeth Jewett, USA]	The text was altered as suggested by the reviewer.
24144	5	22	6	22	9	Sentence is a bit long and wordy, consider revising [Hans-Otto Poertner and WGII TSU, Germany]	The text was altered as suggested by the reviewer.
13170	5	22	7	22	8	please correct spelling of Frölicher [Baerbel Hoenisch, USA]	The text was altered as suggested by the reviewer.
242	5	22	14	23	29	Sea water oxygen losing in Oman sea by global warming: Global warming makes thermocline layer deeper and mixing process weaker. So oxygen flux reduces between ocean and atmosphere. This phenomena affect fisheries activities. Oman sea in northern of Indian ocean has the lowest level of oxygen in the world. [Abbas Einali, Iran]	This section is dealing with open ocean changes
1892	5	22	14	23	29	What about increasing hypoxic areas due to euthrophisation and enhanced stratification? [Jens Rassmann, Belgium]	This section is dealing with open ocean changes
2856	5	22	14			Changing oxygen levels in the ocean. We do not cover this in Ch 3 so great that it's done here also for Polar regions! [Geir Ottersen, Norway]	Many thanks
9328	5	22	14	22	14	A nice review came out in January on this topic and might be useful to incorporate: Breitburg, D., Levin, L. A., Oschlies, A., Grégoire, M., Chavez, F. P., Conley, D. J., ... & Jacinto, G. S. (2018). Declining oxygen in the global ocean and coastal waters. Science, 359(6371), eaam7240. http://dx.doi. org/10.1126/ science.aam7240 [APECS Group Review, Germany]	Many thanks

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
11640	5	22	14	23	29	It would be nice to learn in the section that changes in O2 affect also N2O production and emissions (e.g. Martinez Rey, Biogeosciences, 2015; Battaglia and Joos, Global Biogeochemical Cycles, 2018). This also leads to a biogeochemical N2O- climate feedback (currently projected to be small) [Fortunat Joos, Switzerland]	The text was altered as suggested by the reviewer.
16286	5	22	14	23	29	The southern hemisphere subtropical gyres have increased in oxygen, due to increased ventilation due to stronger winds. Should include this in this section. [Lynne Talley, USA]	This was mentioned
18900	5	22	14	23	29	Similarly as for the section 5.2.1.5 on nutrients, the present section would raise further awareness if the consequences of changes in oxygen concentration on the marine biota were discussed. As oxygen becomes more available (resp. less available), the environment becomes more oxidant (resp. more reductant). This will be of consequence for the chemical reactions governing the biogeochemical cycles, (and in particular in OMZs). I wonder to what extent denitrification rates, for instance, could be affected? or will there be geographical or depth shifts in the areas whether this process was so fas observed? Also, nitrogenfixation is particularly sensitive to oxygen. I also wonder whether diazotrophs will cope if facing increased O2 concentrations. [Sophie Rabouille, France]	We refer to impacts on marine biota, which are covered in a subsequent section
21230	5	22	14	23	29	Missing mentioning of ventilation effect of tropical storms and potential (even if highly uncertain to my understanding) impact on oxygen (and nutrient) fields [Momme Butenschön, Italy]	The text was altered as suggested by the reviewer.
23006	5	22	14	23	30	The section on ocean oxygen needs a figures that shows spatial patterns of O2 change. An example could be Figure 1 from Schmidtko et al 2017 or Ito et al. 2017 showing longterm trends over the recent five decades. This wil make the oceanic O2 loss more visible to readers who often do not read text but scan through figures. If there is a limit on number of figures, then nutirents related figures should be limited to one instead of two, so that carbon, O2, and nutrients are represented failry. [Yassir Eddebbar, USA]	The text was altered as suggested by the reviewer.
23012	5	22	14	23	30	This section also needs to address the extent of natural variabilty associated with ENSO (Ito and Deutsch 2013; Eddebbar et al 2017), PDO (Deutsch et al. 2011; 2014, Duteil et al., 2014; 2018), which act to amplify or attenuate observed trends expected from anthropogenic forcing. This section also need to mention the biases in models in representing large scale spatial distribution of mean O2, failure of models to simulate observed spatial patterns of O2 loss, and weaker magnitude of loss in longterm trends(Oschlies et al., 2018) and interannual-to-decadal variabilty (Long et al. 2016; Eddebbar et al 2017). [Yassir Eddebbar, USA]	The text was altered as suggested by the reviewer.
1890	5	22	16	22	18	Oxygen is also consumed by the reoxidation of reduced species like HS-, NH4+, Fe2+, Mn2+. This plays a rôle at oxic/anoxic interfaces (e.g. Black Sea, Baltic Sea) [Jens Rassmann, Belgium]	This section deals more with open ocean
2518	5	22	16	23	29	There is a need to improve the presentation. I would like to see some well cited references in the first paragraph, and a figure or two from Schmidtko et al. (2017) for the past, followed by model projections for the future. The following reference should be included: [Xiujun Wang, China]	The text was altered as suggested by the reviewer.
5266	5	22	16		25	no citations in first paragraph on oxygen. [Emma Cavan, Australia]	The text was altered as suggested by the reviewer.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
18594	5	22	16	23	29	There is a significant literature about paleo hypoxia that might be relevant to the discussion of mechanisms of hypoxia beyond thermal solubility. Although there is still some debate, it is now pretty clear that hypoxia associated with deglacial and early holocene warming is not associated with increases watermass residence time (based on radiocarbon) but instead at least partially reflects biological productivity and remineralization of organic matter. For example, see Praetorius, S.K., Mix, A.C., Walczak, M.H., Wolhowe, M.D., Addison, J.A., & Prahl, F.G. (2015). North Pacific deglacial hypoxic events linked to abrupt ocean warming. Nature, 527(7578), 362-366. and references therein. [Alan Mix, USA]	The text was altered as suggested by the reviewer.
21972	5	22	18	22	18	add 'being' after 'atmosphere' [Bryony Caswell, UK]	The text was altered as suggested by the reviewer.
21974	5	22	20	22	20	start of line 20 delete 'atmospheric' [Bryony Caswell, UK]	The text was altered as suggested by the reviewer.
21976	5	22	22	22	22	change 'cannot carry in' to 'does not supply' [Bryony Caswell, UK]	The text was altered as suggested by the reviewer.
21978	5	22	23	22	23	change 'in' to 'on' after 'zones' [Bryony Caswell, UK]	The text was altered as suggested by the reviewer.
13756	5	22	24			What are "time-mean advective pathways" [Debra Roberts and Durban Team, South Africa]	The text was altered as suggested by the reviewer.
13758	5	22	27	22	27	Insert 'to' before 'the 1960s' [Debra Roberts and Durban Team, South Africa]	The text was altered as suggested by the reviewer.
18598	5	22	27	22	39	cite Deutsch et al., 2014, Science 345, 665-668 that showed contraction of OMZ in the Pacific in response to winds [Alan Mix, USA]	The text was altered as suggested by the reviewer.
21980	5	22	27	22	27	word missing - 'to' after 'back' [Bryony Caswell, UK]	The text was altered as suggested by the reviewer.
21988	5	22	27	22	39	This paragraph and the next cite quite a very narrow range of literature (e.g. mostly Shmidtko et al. 2017 and Helm et al. 2011). There is a more which supports these changes. [Bryony Caswell, UK]	The text was altered as suggested by the reviewer.
23008	5	22	27	22	39	This section needs to address estimates also from Ito et al. 2017, which focuses on the upper 1000m, e.g. showing section on ocean oxygen needs figures: Example could be Figure 1b from Schmidtko et al 2017 showing longterm trends over the recent five decades. [Yassir Eddebbar, USA]	The text was altered as suggested by the reviewer.
23062	5	22	27	22	39	I very much like the Schmidtko et al. study, but there are substantial methodological concerns associated with this work. I thus think that this paragraph needs to be formulated much more carefully. Most importantly, it seems to me that these trends need to be put into context of shorter-term fluctuations. [Nicolas Gruber, Switzerland]	The text was altered as suggested by the reviewer.
5526	5	22	28	22	31	Something is odd here: the global average oxygen decrease is 961 Tmol/decade, and the strongest regional is 210 Tmol/decade. [Roderik Van De Wal, Netherlands]	Text has been clarified
14050	5	22	28	22	29	Convert this change into % change. It is tough to know what this means otherwise. [Elizabeth Jewett, USA]	2% already given
16680	5	22	30	22	31	Why the distinction between the Arctic (as a hotspot), and the other regions in this sentence? [Cliff Law, New Zealand]	Text has been clarified
16682	5	22	30	22	31	Luyten et al., 1983 is not appropriate reference for this sentence, Citation is required to support the 3.5% decline in all areas projected by CMIP5 models, all of which are not in Luyten et al., 1983 [Cliff Law, New Zealand]	An error occurred when chapter 5 references were compiled in Endnote by the TSU resulting in a displacement of all the references by one position. This resulted in a great number of misplaced references which we have since then fixed.
21982	5	22	30	22	30	add 'the' before 'North' [Bryony Caswell, UK]	The text was altered as suggested by the reviewer.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
9330	5	22	31	22	31	Is the arctic a regional hotspot of oxygenated or low oxygen conditions? [APECS Group Review, Germany]	Text has been clarified
12104	5	22	31	22	31	"hotspot" means different things to different people and isn't always easily understood by non-native English speakers. Suggest replacing with a a more straightforward term or developing a uniform/consisten definition to be used everywhere and in the glossary. [Sarah Cooley, USA]	Text has been clarified
20290	5	22	31	22	31	What do you mean by "the Arctic Ocean emerges as a regional hotspot" - does it have the most or least oxygen, or the highest or lowest trends? [Michelle A. North, South Africa]	Text has been clarified
2520	5	22	33	22	33	20% over which period? [Xiujun Wang, China]	Text has been clarified
21984	5	22	34	22	35	What does this mean 'contributed to the global decline'? There was a 25 drop in the southern ocean which contirbuted a large proportion of the global mean? Could be worded better [Bryony Caswell, UK]	The text was altered as suggested by the reviewer.
14052	5	22	35	22	35	What is a Tmol? Providing some context would be helpful. [Elizabeth Jewett, USA]	The text was altered as suggested by the reviewer.
21986	5	22	36	22	37	This is very technical and so inaccessible. 'Repeat occupations'? Is this somehow related to the measurement. Can you explain more clearly what you mean? [Bryony Caswell, UK]	The text was altered as suggested by the reviewer.
24142	5	22	36	22	36	Explain “CLIVAR” programme [Hans-Otto Poertner and WGII TSU, Germany]	The text was altered as suggested by the reviewer.
23064	5	22	38	22	39	"attributed to climate change": This is not what Schmidtko et al. Write. They attribute the loss of oxygen to warming. Not all of this warming is due to anthropogenic climate change. Some of it is also reflecting other types of variations. [Nicolas Gruber, Switzerland]	The text was altered as suggested by the reviewer.
2522	5	22	41	22	42	This statement is confusing. [Xiujun Wang, China]	Rephrased
21990	5	22	41	22	41	After 'loss of oxygen' add 'to the atmsophere' [Bryony Caswell, UK]	The text was altered as suggested by the reviewer.
21992	5	22	42	22	42	add 'and is' before 'similar' [Bryony Caswell, UK]	The text was altered as suggested by the reviewer.
9332	5	22	45	22	45	Is “likely” here meant in the confidence language? [APECS Group Review, Germany]	The text was altered as suggested by the reviewer.
21994	5	22	45	22	45	before 'stratification' add 'changes to patterns of' [Bryony Caswell, UK]	The text was altered as suggested by the reviewer.
2134	5	22	46	22	46	Maybe "stratification" should be replaced with "saturation"? [Michio Kawamiya, Japan]	The text was altered as suggested by the reviewer.
21996	5	22	46	22	46	change 'quantifiable' to 'attributable to' because youre not referring to amounts you referring to causality I think. Othersiwe try 'cannot be quantitatively linked to...' [Bryony Caswell, UK]	The text was altered as suggested by the reviewer.
21998	5	22	48	22	48	change to 'have been attributed to changes in ocean physics' [Bryony Caswell, UK]	The text was altered as suggested by the reviewer.
10974	5	22	54	22	56	This 3,5%, decrease is for the high emission scenarios. Luyten et al., 1983 is not dealing with oxygen neither with future scenarios to the best of my knowledge. [Marilaure Gregoire, Belgium]	An error occurred when chapter 5 references were compiled in Endnote by the TSU resulting in a displacement of all the references by one position. This resulted in a great number of misplaced references which we have since then fixed.
11636	5	22	54	23	18	In long-term projections, deoxygenation peaks about a thousand years after stabilization of radiative forcing and new steady-state conditions are established only many millennia after forcing stabilisation (Battaglia and Joos, ESD, 2018 and references therin) . This finding is important to judge reversibity and the long-term hazards associated with global warming [Fortunat Joos, Switzerland]	The text was altered as suggested by the reviewer.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
11638	5	22	54	23	18	The link between the magnitude of global warming, e.g. 1.5 K vs 2 K vs 10 K, and changes in O2 and related metabolic indices (Deutsch et al., 2015) should be discussed - see e.g. Battaglia and Joos, Earth System Dynamics, 2018 . This information is directly policy relevant in the context of the Paris Agreement. [Fortunat Joos, Switzerland]	The text was altered as suggested by the reviewer.
23066	5	22	54	23	18	There are multiple problems with the references here. For example, the extended simulations that show an increase in tropical O2 come from Fu et al. (2018) etc. [Nicolas Gruber, Switzerland]	An error occurred when chapter 5 references were compiled in Endnote by the TSU resulting in a displacement of all the references by one position. This resulted in a great number of misplaced references which we have since then fixed.
23068	5	22	54	23	18	I think the authors need to make a much stronger distinction between the O2 changes in the high latitudes and that at low latitudes, particularly the OMZ. The models uniformly show a decrease in high lat. O2, but the situation is much less clear in the low latitudes. [Nicolas Gruber, Switzerland]	The text was altered as suggested by the reviewer.
18696	5	22	56	22	56	I don't think that Luyten et al. 1983 is based on CMIP5 outputs. This is maybe a suitable reference for the stratification process [Roland Seferian, France]	An error occurred when chapter 5 references were compiled in Endnote by the TSU resulting in a displacement of all the references by one position. This resulted in a great number of misplaced references which we have since then fixed.
21124	5	22	56	22	56	Nice to see reference to fundamental theory here (Luyten et al., 1983), but the cited article did not directly address climate change, so the connection or interpretation needs to be explained here. [Roger Samelson, USA]	An error occurred when chapter 5 references were compiled in Endnote by the TSU resulting in a displacement of all the references by one position. This resulted in a great number of misplaced references which we have since then fixed.
18698	5	22	57	22	57	please consider acknowledging Cocco et al BG 2013 [Roland Seferian, France]	The text was altered as suggested by the reviewer.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
3564	5	23	1	23	11	Anthropogenic trends in carbon speciation variables (pH, ?CAL and ?ARAG) emerge from the background variability by 2010 or 2020 for the tropical ocean or regions of low and high latitude upwelling, respectively (Cooley et al., 2012; Rodgers et al., 2015; Henson et al., 2016). As the trends in pH can be observed to emerge with a median of 15 years of data is needed for the emergence of a pH trend (Rodgers et al., 2015), there is high confidence that the surface ocean has already transitioned to a new state, where pH levels are consistently lower than the standard deviation of the previous state. For omega saturtion state (ARAG), the anthropogenic signal has already emerged from the background over much of the ocean (Frolicher et al., 2016). By the end of century, the anthropogenic pH signal is projected to have emerged over the entire ocean (Frolicher et al., 2016). While internal variability and model uncertainty are most important for the next few decades, the largest source of uncertainty in the projection for end-of-century pH change (Figure 5.7c) at both global and local scale is the emissions scenario (Schmidtko et al., 2017), with large changes in the trajectory and magnitude of pH changes between the RCP8.5 and RCP2.6 scenarios (Figure 5.7a and c). Time of Emergency is longer in coastal regions with higher variability of the carbonate species (see Sutton et al., submitted; Sutton, A.J., R.A. Feely, S. Maenner-Jones, S. Musielewicz, J. Osborne, C. Dietrich, R. Bott, N. Monacci, J. Cross, and A. Kozyr (2018): Autonomous seawater pCO2 and pH time series from 40 surface buoys and the emergence of anthropogenic trends. Earth Syst. Sci. Data. [Richard Feely, USA]	The text was altered as suggested by the reviewer.
9334	5	23	2	23	2	correct the figure number [APECS Group Review, Germany]	The text was altered as suggested by the reviewer.
16096	5	23	3	23	3	Shigemitsu et al. (2017, GBC) also investigated the future changes in the thickness of the water column with oxygen concentrations less than 30 µmol L-1 and the uncertainty, which is different from the aspect the cited papers addressed. The papers cited here have investigated the future changes in oxygen concentration at intermediate depths. Thus, the paper might also be cited here. [Masahito Shigemitsu, Japan]	The text was altered as suggested by the reviewer.
16098	5	23	5	23	9	Ito and Deutsch (2013) does not investigate the future changes in saturated oxygen, apparent oxygen utilization, and export production. They examined only the changes during 1960-2000. Thus, citing the paper here is not valid. The most valid paper should be Cabre et al. (2015, BG). [Masahito Shigemitsu, Japan]	An error occurred when chapter 5 references were compiled in Endnote by the TSU resulting in a displacement of all the references by one position. This resulted in a great number of misplaced references which we have since then fixed.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
16100	5	23	5	23	9	The future changes in saturated oxygen and apparent oxygen utilization (AOU) in the models are valuable proxies for diagnosing the mechanisms behind the changes. However, both are affected by undersaturated oxygen concentration of water mass at zones where subduction occurs, and oxygen saturation state in the interior ocean affected by diapycnal mixing. In addition, AOU is also influenced by biological and physical processes. Thus, it is highly desirable that all oxygen transport tendency terms and their future changes in the model are investigated. As far as I know, only the paper which addressed those is Shigemitsu et al. (2017), to date, and the paper might be cited here. They revealed that the uncertain future changes in oxygen concentration in the Eastern Tropical Pacific were mainly due to the future changes in ventilation there. [Masahito Shigemitsu, Japan]	The text was altered as suggested by the reviewer.
20292	5	23	5	23	8	Try to rewrite and shorten this sentence [Michelle A. North, South Africa]	The text was altered as suggested by the reviewer.
12106	5	23	6	23	9	Very confusing sentence. Rewrite to eliminate 3x repetition of "due to" [Sarah Cooley, USA]	The text was altered as suggested by the reviewer.
13760	5	23	11	23	11	Check and confirm that 'bathyala' shouldn't start with a capital letter. [Debra Roberts and Durban Team, South Africa]	The text was altered as suggested by the reviewer.
22000	5	23	14	23	15	I think its important here to be clear that you refer to a reversal ONLY in the tropics not elsewhere. The fossil record certainly does not suggest that globally the trend does not reverse within a few hundred years [Bryony Caswell, UK]	The text was altered as suggested by the reviewer.
11318	5	23	18	23	18	Include reference to Oschlies et al. (2018) Nature Geoscience paper on oxygen modelling [Croot Peter, Ireland]	The text was altered as suggested by the reviewer.
18700	5	23	18	23	18	If usefull please refer to Séférian et al. GMD 2017 which document why difference in modelling protocol (in particular spin-up) can affect trends in oxygen fields. [Roland Seferian, France]	The text was altered as suggested by the reviewer.
23010	5	23	20	23	29	This section should also address the time of emergence and observation detection periods results of Long et al 2016, which show several large regions of delayed emergence, with different years than described here. [Yassir Eddebbar, USA]	The text was altered as suggested by the reviewer.
2524	5	23	28	23	28	The reference (Falkowski et al. 1998) may be too old or not relevant. [Xiujun Wang, China]	An error occurred when chapter 5 references were compiled in Endnote by the TSU resulting in a displacement of all the references by one position. This resulted in a great number of misplaced references which we have since then fixed.
22002	5	23	29	23	29	I am curious at the lack of referencve to the coastal oceans which have the added problems of anthropogenic nutrient enrichment. This section has an open ocean focus - but surely changes near the coast are also important. And although anthropogenic changes in nutrient delivery aren't simply due to climate change it is relevant - and should be included in projections/discussion or at least cross referenced? In fact it doesnt get much mention elsehwere either. [Bryony Caswell, UK]	This section has an open ocean focus
1894	5	23	31	26	7	What about changing import of land derived nutrients by riverine input and erosion? [Jens Rassmann, Belgium]	The text was altered as suggested by the reviewer.
2526	5	23	31	23	31	It is better to move this to front (before ocean carbon). [Xiujun Wang, China]	We preferred to leave this where it was

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
2528	5	23	31	26	7	The writing in this section does not read well. Please consider rearrange. One way is to separate into two sections, i.e., nutrients (only), and primary production (maybe with ecosystem dynamics). Please check figure order. [Xiujun Wang, China]	We have tried to streamline the text
12160	5	23	31			Section 5.2.1.5 General comment. The section would gain in clarity, if the authors indicate more clearly whether the evidence provided and results described are based on model outputs, in-situ or satellite observations. [Marie-Fanny Racault, UK]	The text was altered as suggested by the reviewer.
12164	5	23	31			The title seems restrictive and not reflecting about the range of variables discussed in the section, which include organic matter production (line 43, page 23), phytoplankton chlorophyll concentration (line 31, page 24), phenology (line 47, page 24), export production (line 54, page 25), etc. Please consider changing the title to be more inclusive, such as: “Changing ocean conditions and associated response of primary producers”. [Marie-Fanny Racault, UK]	The text was altered as suggested by the reviewer.
12166	5	23	33	23	41	The description provided in this paragraph is missing the variable light as a major driver of phytoplankton production. Please indicate in line 33, that both “Light and nutrient support the base of marine food webs”; please also include a description of the mechanisms driving phytoplankton productivity: at low- and mid-latitudes, productivity is driven by nutrient availability modulated by turbulent mixing and upwelling of nutrient-rich deep waters, and at high-latitudes, including polar regions, productivity is primarily driven by light availability modulated by water-column stratification (e.g., Racault et al., 2017a, please see their Figure 3). Racault, M.-F., Sathyendranath, S., Brewin, R.J.W., Raitsos, D.E., Jackson, T., Platt, T. (2017a) Impact of El Niño Variability on Oceanic Phytoplankton. Frontiers in Marine Science, doi:10.3389/fmars.2017.00133. [Marie-Fanny Racault, UK]	The text was altered as suggested by the reviewer.
14406	5	23	34			Change "interplay of external supply" to "interplay between external supply" [Jennifer Fehrenbacher, USA]	The text was altered as suggested by the reviewer.
16684	5	23	34	23	34	thermohaline circulation, advection & upwelling have greater influence on the level of nutrients in different regions than external sources such as rivers & dust [Cliff Law, New Zealand]	The text was altered as suggested by the reviewer.
2530	5	23	37	23	41	Need rewording, it is hard to understand. [Xiujun Wang, China]	The text was altered as suggested by the reviewer.
2532	5	23	43	23	45	There is a problem. Please rewrite. [Xiujun Wang, China]	The text was altered as suggested by the reviewer.
12168	5	23	43	23	45	In addition, to nutrient supply, please include light availability and temperature as dominant drivers of phytoplankton production. Note that the influence of temperature is described later on in the paragraph (Lines 49-50 “strongly sensitive to warming”), hence it would be useful to introduce it with all dominant drivers at the beginning of the paragraph. [Marie-Fanny Racault, UK]	The text was altered as suggested by the reviewer.
12170	5	23	45	23	47	The sentence could be misleading. Please specify that it is “at low-latitudes and in coastal and upwelling regions” that rates of phytoplankton productivity may increase with nutrient supply. Please remove the word “largest”, and please use the word “productivity” instead of “activity”. In line 46, please also note that upwards mixing is not the same as upwelling and both processes influence primary production. Horizontal supply can also be important especially in coastal environment. [Marie-Fanny Racault, UK]	The text was altered as suggested by the reviewer.
12158	5	23	48			Please remove "the" in 'the their requirements" [Marie-Fanny Racault, UK]	The text was altered as suggested by the reviewer.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
14054	5	23	48			extra word at the end of the sentence. [Elizabeth Jewett, USA]	The text was altered as suggested by the reviewer.
16686	5	23	48	23	48	"the relative supply of different resources" - unclear what this means [Cliff Law, New Zealand]	The text was altered as suggested by the reviewer.
16688	5	23	52	23	52	and ocean acidification (Hutchins et al, 2013; Hutchins, David A., Fei-Xue Fu, Eric A. Webb, Nathan Walworth, and Alessandro Tagliabue. "Taxon-specific response of marine nitrogen fixers to elevated carbon dioxide concentrations." Nature Geoscience 6, no. 9 (2013): 790) [Cliff Law, New Zealand]	The text was altered as suggested by the reviewer.
9336	5	23	54	23	55	Lines 54-55 overlaps with lines 33-35. [APECS Group Review, Germany]	The text was altered as suggested by the reviewer.
12172	5	23	54	24	3	It would be useful to specify that the largest rates of phytoplankton productivity per unit area (gC.m-2.y-1) occur in high-latitude regions, which are primarily controlled by light availability, and in coastal and upwelling regions, which are driven by nutrient supply from upwelling and river discharge (Longhurst et al., 1995). In low-latitude regions, rates of phytoplankton productivity per unit area are low and primarily limited by nutrient availability. 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. https://doi.org/10.1093/plankt/17.6.1245. [Marie-Fanny Racault, UK]	In the high laittudes, once out of the polar night, iron is the main limiting resource, similar to upwelling regions, while in gyre systems nitrogen and phosphorus are more common as limiting nutrients
2534	5	23	55	23	56	This may not apply globally. For example, there is a decreasing trend in the Yellow River's runoff over the past decade. [Xiujun Wang, China]	Section modified to focus on open oceans
3356	5	23	56	23	56	Not always. In some areas coastal upwelling may be a more important source of nutrients than river supplies, e.g. García-Moreiras et al (2018). Palaeogeography, Palaeoclimatology, Palaeoecology, 504: 201-218 [Castor Muñoz Sobrino, Spain]	Section modified to focus on open oceans
2536	5	24	1	24	1	Increasing stratification ver which period? The tropical Pacific experienced stronger physical processes post late 1998. [Xiujun Wang, China]	We make here a generic point and refer to earlier section for details
3254	5	24	2			retard' could be changed to 'limit'? [Martin Edwards, UK]	The text was altered as suggested by the reviewer.
22006	5	24	4	24	5	And runoff from fertilisers applied to farmland and animal slurry [Bryony Caswell, UK]	Section modified to focus on open oceans
18914	5	24	7	24	13	"Microbial turnover", that usually means whole process of biological DOM production and its prompt decomposition within euphotic zone, enhance gross (not net) primary production but makes no change in nutrient concentration in surface water. As this paragrap argues not about gross primary production but about nutrient level in surface water, counterfunction of microvial turnover against reduced vertical nutrient supply proposed in this sentenses is inappropriate. The author should rather mention about "microvial consumption of already-exsisted DOM," i.e, net decrease of surface DOM concentration, if you want discuss about the possoble biological counteraction against vertical nutrient supply reduction. [Tsuneo Ono, Japan]	The text was altered as suggested by the reviewer.
11320	5	24	11	24	11	Banse 1968 citation does not refer to DON or DOP it is a hydrography paper, was it meant to be Banse (1974)? [Croot Peter, Ireland]	Citation removed
2538	5	24	15	24	27	There is a need to revise this paragraph. The statement "ignored the role of…" is not appropriate. [Xiujun Wang, China]	Text removed

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
11322	5	24	15	24	18	An appropriate citation here would be Saito et al. (2008) https://doi.org/10.4319/lo.2008.53.1.0276 as this explains the types of co-limitation in more detail and has precedence. This section also omits any mention of the work over the last 20+ years on iron limitation until the following sentence when it phrases it as recent. [Croot Peter, Ireland]	Text modified
11324	5	24	20	24	22	Strongly suggest rephrasing this sentence as the final part of the sentence links iron limitation with high productivity - which is the opposite of what a limiting nutrient would do. While understanding the need for brevity, the concept of High Nutrient Low Chlorophyll (HNLC) regions could be invoked here and used to explain that iron limits these regions and can thus limit offshore upwelling regions (Eq Pacific) and the Southern Ocean [Croot Peter, Ireland]	The text was altered as suggested by the reviewer.
9338	5	24	22	24	22	It is figure 5.9 and not 5.8 [APECS Group Review, Germany]	The text was altered as suggested by the reviewer.
9340	5	24	23	24	23	“Moreover, more extensive…” Remove “more” [APECS Group Review, Germany]	The text was altered as suggested by the reviewer.
13762	5	24	23	24	23	Delete 'in' after 'colimitation' [Debra Roberts and Durban Team, South Africa]	The text was altered as suggested by the reviewer.
22004	5	24	23	24	25	And there is evidence from the fossil record that limitations of other trace lemenst e.g molybdenate (https://doi.org/10.1130/G34819.1) and selenium (https://doi.org/10.1016/j.gr.2015.10.001) may have been important in limiting primary productivity in past oceans during comparable periods of change [Bryony Caswell, UK]	Colimiting text has been removed/rephrased
11326	5	24	24	24	24	incorrect figure reference - this is Figure 5.9 as supplied in the pdf [Croot Peter, Ireland]	The text was altered as suggested by the reviewer.
23314	5	24	27	24	27	Boyce et al. (2014) is the incorrect citation for this work. Perhaps it is something by Saito or by Boyd that was meant to be cited? [Ryan Rykaczewski, USA]	The text was altered as suggested by the reviewer.
23070	5	24	29	24	45	As written above, I don't think that there is a community consensus on this issue here. The discussion is intense, and in my opinion, the jury is really out. [Nicolas Gruber, Switzerland]	The text was altered as suggested by the reviewer.
12174	5	24	30	24	33	The statement that a global decline in organic matter production is reported in all studies is not correct. Please consider amending the sentence such as “a range of studies have reported overall declines […]”. Please also note that according to the cited review of Boyce and Worm 2015, most of the trends established over time spans of 50 years or longer show predominantly increasing trends or no trends in phytoplankton. Moreover, these trends do not appear to support the text of Chapter 5, page 4, lines 12-13. [Marie-Fanny Racault, UK]	This part has been removed as the paper blends satellite and ther datsets whereas primarly this part of the pragraphy is about remote sensing
12012	5	24	33	24	47	The description on the effects of changing ocean nutrients on primary production (L33-L47). The discussion is too generic. Some precisions on how induced changes in the ratio N/P affect primary production (regionally) would have been more appealing and convincing. How do changes in the known N/P=16 ratio affect bioavailability of iron and primary production? Same comments apply on L15-L36 (p24). [Louis Mitondo Lubango, Ethiopia]	Rejected - out of scope.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
12176	5	24	34			After the end sentence stating that “no information on how biomass consumption (e.g., zooplankton) may have changed”, please consider adding a sentence to report about the most recent global chlorophyll trend analysis based on the longest continuous climate-quality controlled satellite record, which show increase in high latitudes and moderate decrease in chlorophyll concentration in tropical areas over the past 20 years (Mélin et al., 2017; Sathyendranath and Pardo, 2018 in press). 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.” Remote Sensing of Environment, Earth Observation of Essential Climate Variables, 203 (December 15, 2017): 139–51. https://doi.org/10.1016/j.rse.2017.03.039. Sathyendranath, S., Pardo, S., Ocean Colour, Chapter 1.8, in The Copernicus Marine Environment Monitoring Service Ocean State Report – issue #2, p 45-50, eds. K. von Schuckmann and P.-Y. Le Traon (2018), Journal of Oceanography, doi:10.1080/1755876X.2018.1489208, In press. https://doi.org/10.1080/1755876X.2018.1489208. [Marie-Fanny Racault, UK]	The text was altered as suggested by the reviewer.
12178	5	24	34			Please consider adding a sentence to explain that significant trends in bulk properties of the ecosystem (such as chlorophyll concentration) may be apparent within a time-scale of 10-20 years (as shown in the satellite trend analyses of phytoplankton chlorophyll). However, the trend in total chlorophyll may not reflect changes in the components of phytoplankton population (Brewin et al., 2012; Racault et al., 2014), or in particles other than phytoplankton (Vantrepotte and Mélin, 2011). Including this information would give a more comprehensive view on trends and take into account the different rate of change of different attributes of the marine ecosystem. Brewin, R. J. W., Hirata, T., Hardman-Mountford, N. J., Lavender, S. J., Sathyendranatha, S., and Barlow, R. (2012). The influence of the Indian Ocean Dipole on interannual variations in phytoplankton size structure as revealed by Earth Observation. Deep Sea Res. II 77–80, 117–127. doi: 10.1016/j.dsr2.2012.04.009. Racault, M.-F., Platt, T., Sathyendranath, S., Ağirbaş, E., Martinez Vicente, V., Brewin, R.W.J., (2014). Plankton indicators and ocean observing systems: support to the marine ecosystem state assessment. Journal of Plankton Research, 36: 621-629. Vantrepotte, V., H. Loisel, F. Mélin, D. Desailly, and L. Duforêt-Gaurier. “Global Particulate Matter Pool Temporal Variability over the SeaWiFS Period (1997–2007).” Geophysical Research Letters 38, no. 2. Accessed June 27, 2018. https://doi.org/10.1029/2010GL046167. [Marie-Fanny Racault, UK]	Accepted in part - here we wish to keep a focus on estimates of changes to phytoplankton

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
12180	5	24	34	24	36	It is apparent from climate-quality controlled satellite observations based on multiple sensors and including error characterisation and bias correction that regional trends are larger than the global trend in chlorophyll concentration (Mélin et al., 2017; Sathyendranath and Pardo, 2018 in press). 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. Based on these robust evidences, please considering changing the statement line 36 from “low confidence” to “medium confidence”, with supporting references Mélin et al., 2017 and Sathyendranath and Pardo, 2018 in press. 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.” Remote Sensing of Environment, Earth Observation of Essential Climate Variables, 203 (December 15, 2017): 139–51. https://doi.org/10.1016/j.rse.2017.03.039. Sathyendranath, S., Pardo, S., Ocean Colour, Chapter 1.8, in The Copernicus Marine Environment Monitoring Service Ocean State Report – issue #2, p 45-50, eds. K. von Schuckmann and P.-Y. Le Traon (2018), Journal of Oceanography, doi:10.1080/1755876X.2018.1489208, In press. https://doi.org/10.1080/1755876X.2018.1489208. [Marie-Fanny Racault, UK]	The text was altered as suggested by the reviewer. But due to the lack of corroboration with in situ time series and the likely complex and poorly understood underlying processes we retain low confidence
13764	5	24	35	24	35	Think the sentence is meaningful without 'For regional scales' [Debra Roberts and Durban Team, South Africa]	The text was altered as suggested by the reviewer.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
12182	5	24	36	24	37	Most recent and comprehensive analyses of regional trends based on longest climate-quality controlled satellite data records show regional trends up to ±5% (not ±2% as presently stated). Please update the sentence with the figure ±5% and supporting references Collela et al., 2016; Mélin et al., 2017; Sathyendranath and Pardo, 2018 in press. Please also cite the latter three references in line 37 along with Beaulieu et al., 2013 presently cited. Colella, Simone, Federico Falcini, Eleonora Rinaldi, Michela Sammartino, and Rosalia Santoleri. “Mediterranean Ocean Colour Chlorophyll Trends.” PLOS ONE 11, no. 6 (June 3, 2016): e0155756. https://doi.org/10.1371/journal.pone.0155756. 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.” Remote Sensing of Environment, Earth Observation of Essential Climate Variables, 203 (December 15, 2017): 139–51. https://doi.org/10.1016/j.rse.2017.03.039. Sathyendranath, S., Pardo, S., Ocean Colour, Chapter 1.8, in The Copernicus Marine Environment Monitoring Service Ocean State Report – issue #2, p 45-50, eds. K. von Schuckmann and P.-Y. Le Traon (2018), Journal of Oceanography, doi:10.1080/1755876X.2018.1489208, In press. https://doi.org/10.1080/1755876X.2018.1489208. [Marie-Fanny Racault, UK]	The text was altered as suggested by the reviewer.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
12186	5	24	37	24	38	To support the statement “The length of the time series plays an important role in the magnitude of the phytoplankton trend derived”, please report on 1) the most recent comprehensive analyses of phytoplankton chlorophyll trends, which shows comparative analyses of satellite chlorophyll trends over the periods 1998-2007 and 2002-2011 (their Figures 8a and 9a respectively); and 2) the significant and regionally-different influences of climatic modes of variability on primary producers at global and regional scales (e.g., Racault et al., 2017a, observing regional changes in primary production ranging between ±7 to 14% associated with different types of El Niño events; and Brewin et al., 2012 and Currie et al., 2013 showing significant impacts of El Niño Southern Oscillation and Indian Ocean Dipole on chlorophyll anomalies in the Indian Ocean). Racault, M.-F., Sathyendranath, S., Brewin, R.J.W., Raitsos, D.E., Jackson, T., Platt, T. (2017a) Impact of El Niño Variability on Oceanic Phytoplankton. Frontiers in Marine Science, doi:10.3389/fmars.2017.00133. Brewin, R. J. W., Hirata, T., Hardman-Mountford, N. J., Lavender, S. J., Sathyendranatha, S., and Barlow, R. (2012). The influence of the Indian Ocean Dipole on interannual variations in phytoplankton size structure as revealed by Earth Observation. Deep Sea Res. II 77–80, 117–127. doi: 10.1016/j.dsr2.2012.04.009. Currie, J. C., Lengaigne, M., Vialard, J., Kaplan, D. M., Aumont, O., Naqvi, S. W. A., et al. (2013). Indian Ocean dipole and El Niño/southern oscillation impacts on regional chlorophyll anomalies in the Indian Ocean. Biogeosciences 10, 6677–6698. [Marie-Fanny Racault, UK]	The text was altered as suggested by the reviewer.
12184	5	24	38			Please change “trends shorter than the typical…” to “time spans shorter than the typical…”. The expression “trends shorter” is not meaningful. [Marie-Fanny Racault, UK]	The text was altered as suggested by the reviewer.
9342	5	24	42	24	45	I was a bit confused about the meaning of this sentence as it seems there are two main messages: 1. At low latitudes organic matter production occurs away from the surface so cannot be observed by satellite measurements 2. Satellite measurements in general have not been recording ocean color long enough to isolate trends from natural variations. Could the authors perhaps split these two messages? The combination of them in a single sentence adds ambiguity to the main message here. [APECS Group Review, Germany]	The text was altered as suggested by the reviewer.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
12188	5	24	42	24	45	Please remove misleading statement “as the maxima in organic matter production occurs away from the surface layer observed by satellite records”. Please consider that primary production rates estimated from satellite observations take into account the vertical profile of chlorophyll concentration, including deep chlorophyll maxima observed at low latitudes (e.g., Sathyendranath and Platt, 1993; Longhurst et al., 1995; Morel and Berthon 1989; Antoine and Morel 1996; Antoine et al., 1996; Uitz et al., 2010; Brewin et al., 2010; Brewin et al., 2017). Sathyendranath, S., and Platt, T. (1993). Remote sensing of water-column primary production. In: Measurement of Primary Production from the Molecular to the Global Scale, W. K. W. Li and S. Y. Maestrini (eds.), ICES Marine Science Symposia, Vol. 197, Copenhagen, 236-243. 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, https://doi.org/10.1093/plankt/17.6.1245. Morel, André, and Jean-François Berthon. “Surface Pigments, Algal Biomass Profiles, and Potential Production of the Euphotic Layer: Relationships Reinvestigated in View of Remote-Sensing Applications.” Limnology and Oceanography 34, no. 8 (n.d.): 1545–62, https://doi.org/10.4319/lo.1989.34.8.1545. Antoine, David, and André Morel. “Oceanic Primary Production: 1. Adaptation of a Spectral Light-Photosynthesis Model in View of Application to Satellite Chlorophyll Observations.” Global Biogeochemical Cycles 10, no. 1 (n.d.): 43–55. https://doi.org/10.1029/95GB02831. Antoine, David, Jean-Michel André, and André Morel. “Oceanic Primary Production: 2. Estimation at Global Scale from Satellite (Coastal Zone Color Scanner) Chlorophyll.” Global Biogeochemical Cycles 10, no. 1 (n.d.): 57–69. https://doi.org/10.1029/95GB02832. Uitz, Julia, Hervé Claustre, Bernard Gentili, and Dariusz Stramski. “Phytoplankton Class-Specific Primary Production in the World’s Oceans: Seasonal and Interannual Variability from Satellite Observations.” Global Biogeochemical Cycles 24, no. 3. Accessed June 27, 2018. https://doi.org/10.1029/2009GB003680. Brewin, Robert J. W., Samantha J. Lavender, and Nick J. Hardmanmountford. “Mapping Size-Specific Phytoplankton Primary Production on a Global Scale.” Journal of Maps 6, no. sup1 (January 2010): 12–25. https://doi.org/10.1080/jom.2010.9711034. Brewin, Robert J. W., Gavin H. Tilstone, Thomas Jackson, Terry Cain, Peter I. Miller, Priscila K. Lange, Ankita Misra, and Ruth L. Airs. “Modelling Size-Fractionated Primary	Text removed

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
12190	5	24	42	24	45	The reference Poloczanka et al., 2016 cited at the end of the sentence does not seem appropriate to support the statement about the length of the satellite record. The reference focuses on in-situ time series and does not appear to mention satellite observations. Please include information about on-going efforts to produce long-term climate-quality controlled ocean-colour time series from multiple satellite sensors with supporting reference Mélin et al., 2017. Please consider modifying the statement to “climate-quality global-scale ocean-colour products are now available for ~20 years (Sathyendranath et al., 2017), and allow us to detect influence of climate variability on phytoplankton chlorophyll, primary production and phenology (Racault et al., 2017a, 2017b). It is important to maintain and extend such time-series data for multiple decades to be able to extract a climate-change signal unambiguously.” 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.” Remote Sensing of Environment, Earth Observation of Essential Climate Variables, 203 (December 15, 2017): 139–51. https://doi.org/10.1016/j.rse.2017.03.039. Sathyendranath, S., Robert J. W. Brewin, Thomas Jackson, Frédéric Mélin, and Trevor Platt. “Ocean-Colour Products for Climate-Change Studies: What Are Their Ideal Characteristics?” Remote Sensing of Environment, Earth Observation of Essential Climate Variables, 203 (December 15, 2017): 125–38. https://doi.org/10.1016/j.rse.2017.04.017. Racault, M.-F., Sathyendranath, S., Brewin, R.J.W., Raitsos, D.E., Jackson, T., Platt, T. (2017a) Impact of El Niño Variability on Oceanic Phytoplankton. Frontiers in Marine Science, doi:10.3389/fmars.2017.00133. Racault, M.-F., Sathyendranath, S., Menon, N., Platt. T. (2017b) Phenological responses to ENSO in the global oceans. Surveys in Geophysics, 38: 277. doi:10.1007/s10712-016-9391-1. [Marie-Fanny Racault, UK]	An error occurred when chapter 5 references were compiled in Endnote by the TSU resulting in a displacement of all the references by one position. This resulted in a great number of misplaced references which we have since then fixed.
16690	5	24	42	24	45	split into two sentences [Cliff Law, New Zealand]	The text was altered as suggested by the reviewer.
2860	5	24	47	24	49	Please specify which direction the 5-10 days per decade trends are [Geir Ottersen, Norway]	Text removed from this section
10954	5	24	47	27	47	The authors say "Upper trophic levels also respond to changes in the timing of phytoplankton bloom, known as the phenology, with historical datasets demonstrating trends of around 5-10 days per decade (Henson et al., 2017)" I was not able to find any clear evidence in the text above of changes in the phytoplankton phenology. This is in fact the first time that "phenology" is mentioned (except in the executive summary), so please give robst evidences on global changes in phytoplankton phenology (e.g. based on the analysis of long term statellite data) that would lead to the mentioned changes in upper trophic levels. Generally, changes in phenology is mentionned at several places in Chapter 5 but no clear global evidence is given (except some particular examples derived from specific time series). [Marilaure Gregoire, Belgium]	Text removed from this section

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12192	5	24	47	24	49	The reference Henson et al. 2017 is not supporting the statement of this sentence. The reference does not mention phenology. Please consider citing reference Henson et al. 2018 GBC, which reports specifically about changes in phytoplankton phenology of 5-10 days per decade. Please consider changing the term “historical” to “modelled”. In the paper of Henson et al. 2018, the trend in phenology is estimated based on model output over the period 2006-2100. Henson, Stephanie A., Harriet S. Cole, Jason Hopkins, Adrian P. Martin, and Andrew Yool. “Detection of Climate Change-Driven Trends in Phytoplankton Phenology.” Global Change Biology 24, no. 1 (2018): e101–11. https://doi.org/10.1111/gcb.13886. [Marie-Fanny Racault, UK]	Text removed from this section
22008	5	24	47	24	47	In turn effects their phenology or time of reproduction [Bryony Caswell, UK]	Text removed from this section
24146	5	24	47	24	47	It sounds like the timing of phytoplankton is called phenology (but it's rather only the timing which is called so. E.g. there is also the phenology of other organisms) I suggest rewording [Hans-Otto Poertner and WGII TSU, Germany]	Text removed from this section
12194	5	24	49	24	51	Please consider specifying “Attributing climate-change signal to […] changes in phenology” (rather than “climate signal”). The influence of climate variability on phytoplankton phenology has been demonstrated globally and for different biogeochemical provinces (Racault et al., 2017b, please see their Figure 5). Please consider adding a sentence to provide information about detection and attribution of climate-variability influence on phytoplankton phenology. Based on decade-long satellite time series, significant influence of large-scale patterns of climate variability, such as El Niño Southern Oscillation, has been demonstrated on the timing of phytoplankton bloom with regional changes in phenology up to ±30 days (Racault et al. 2017b). Racault, M.-F., Sathyendranath, S., Menon, N., Platt. T. (2017b) Phenological responses to ENSO in the global oceans. Surveys in Geophysics, 38: 277. doi:10.1007/s10712-016-9391-1. [Marie-Fanny Racault, UK]	Text removed from this section
16420	5	24	53	25	36	This narrative is very good at showing a) changed in primary production are unclear and variable and b) generally low and reflecting nutrient changes. However, the narrative fits poorly with the main message ((p. 4 l. 12-13) that primary production is changing. [Coswig Kalikoski Daniela, Italy]	Thank you
9344	5	24	54	24	54	Can the confidence level be split into agreement and evidence for this statement? It seems that based on the evidence in the above paragraphs that many of the factors contributing to the response of productivity and organic matter production with changing ocean variables is at a low confidence level. E.g. lines 32, 35-36, etc. How is the conclusion of medium confidence derived here? [APECS Group Review, Germany]	We have improved the assessment phrasings throughout the section

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
10958	5	25	1	25	18	Please clearly define what is meant by "primary production", "organic matter production", and "particulate organic matter production". This is confusing. I would also recommend to synthetise what is the message about the trend on primary production. The paragraph lists different findings but does not decide at the end whether "a decrease in primary production"is likeley/unlikly, with medium/low confidences It is laso mentioned that in some models an enhancement of prmary production is simulated due to increased temperature. In the litertaure (e.g. Schmittner et al., 2008; Taucher and Oschlies, 2011) some authors find an increase in NPP at the end of the 21st century. So please, attribute a degree of confidence. In the executive summary we are told that there is unequivocal evidences for a decrease in primary production. Reading that paragraph, I am not convinced that the evidences are unequivocal. [Marilaure Gregoire, Belgium]	The text was altered as suggested by the reviewer.
9346	5	25	4	25	8	What are the assumptions in this emergent constraint approach? Do majority of CMIP5 models reproduce observed links between variability in productivity and temperature anomalies? Is it true for open ocean and marginal seas? Do the models take into account how these links might change in future? Few sentences can be added on these aspects. [APECS Group Review, Germany]	The text was altered as suggested by the reviewer.
21232	5	25	4	25	5	Kwiatkowski et al. 2017 report a decrease in the tropical ocean of primary production by 11+-6% and not a decrease of particulate production by 11+-24%. [Momme Butenschön, Italy]	An error occurred when chapter 5 references were compiled in Endnote by the TSU resulting in a displacement of all the references by one position. This resulted in a great number of misplaced references which we have since then fixed.
14408	5	25	9			Figure 5.7, last column of plots (internal variability, model and scenario uncertainty) is confusing. [Jennifer Fehrenbacher, USA]	The text was altered as suggested by the reviewer.
18596	5	25	13	25	18	callout to Fig. 5.10 cites Southern Ocean nutrient trapping as a fact. It should be assessed with a confidence designation. I suspect convidence is low, given the difficulty of simulating southern ocean circulatoin in most models. [Alan Mix, USA]	The text was altered as suggested by the reviewer.
22010	5	25	14	25	18	These protracted timescales for 'recovery' also seem to be reinforced by evidence from the fossil record [Bryony Caswell, UK]	Thanks
3722	5	25	17	25	18	I think its clearer to speak of a „negative trend“. A declining trend could be a positive trend that is getting weaker over time. [Dirk Notz, Germany]	The text was altered as suggested by the reviewer.
11328	5	25	17	25	18	Figure indicates 2300, text refers to 2100. Is this the correct figure then? Should it be Figure 5.8? [Croot Peter, Ireland]	The text was altered as suggested by the reviewer.
16692	5	25	17	25	17	The trapping of nutrients in the interior is due to the effect of "changes to winds, sea ice and ongoing warming" on stratification & thermohaline circulation [Cliff Law, New Zealand]	The text was altered as suggested by the reviewer.
9350	5	25	18	25	18	It seems important to mention the biological pump here when discussing changing organic matter fluxes and export as well as the uncertainties around the response of the biological pump to climatic shifts, perhaps reference later sections of the text. Eg. Table 5.1 and Section 5.2.2.2.1 pg 37 lines 6-17. [APECS Group Review, Germany]	The text was altered as suggested by the reviewer.
5268	5	25	20			what are the changes in c:n:p? [Emma Cavan, Australia]	The text was altered as suggested by the reviewer.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
5528	5	25	20	25	22	This refers to the food quality availability in the upper trophic levels. Quality seems a subjective term, as it has not been defined beforehand. Would it be conducive to define the term "quality"? [Roderik Van De Wal, Netherlands]	The text was altered as suggested by the reviewer.
9352	5	25	20	25	36	Should this section also consider the creation and role of dissolved organic matter, as it is a very large pool of organic material in the ocean and an important component of marine biogenic carbon export to the deep ocean? The phase of exported OM may have implications for the overall fate of that carbon (e.g. Section 5.4.1.2.1). Additionally, there has been some experimental work that suggest the production of dissolved vs particulate organic carbon from primary production may be changing with warming. Reference: Wohlers, Julia, Anja Engel, Eckart Zöllner, Petra Breithaupt, Klaus Jürgens, Hans-Georg Hoppe, Ulrich Sommer, Ulf Riebesell. Changes in biogenic carbon flow in response to sea surface warming. Proceedings of the National Academy of Sciences Apr 2009, 106 (17) 7067-7072; DOI:10.1073/pnas.0812743106 [APECS Group Review, Germany]	Rejected - here we are not covering mitigations scenarios (see Sec 5.5), DOM is mentioned as a potential nutrient source
10960	5	25	20	25	22	"In the surface ocean, the progressive decline in upper ocean major nutrients (nitrogen and phosphorus) with increasing stratification will affect the food quality available upper trophic levels via its impact on the C:N:P ratio of organic matter "A list of references is needed to support this statement. Beisdes, I was not able to find in Bopp et al (2013) any evidence of a decrease of the food quality in terms of its N:P composition in the Arctic Ocean. By the way all the models (except Pelagos and Topaz) used in Bopp et al assume Redfield NP ratios and can not simulate a variation in the NP composition of phytoplankton due to change in inorganic nutrients ratios. Please clarify. [Marilaure Gregoire, Belgium]	An error occurred when chapter 5 references were compiled in Endnote by the TSU resulting in a displacement of all the references by one position. This resulted in a great number of misplaced references which we have since then fixed.
20538	5	25	20	25	20	"the progressive decline in upper ocean major nutrient" (nitrogen) is high confidence? In North Pacific, the nitrate trend is not significant. Reference: Yasunaka, S., Nojiri, Y., Hashioka, T. et al. J Oceanogr (2018) 74: 1. https://doi.org/10.1007/s10872-017-0433-1 [Shin-Ichi Ito, Japan]	The text was altered as suggested by the reviewer.
13766	5	25	21	25	21	First usage and last usage of 'C:N:P'. Please spell out in full. [Debra Roberts and Durban Team, South Africa]	The text was altered as suggested by the reviewer.
5270	5	25	24		28	highlight impact on global carbon cycle, remineralisation depth effects atmospheric CO2, Kwon 2009, Nat Geo [Emma Cavan, Australia]	The text was altered as suggested by the reviewer.
10962	5	25	26	25	36	I would suggest that you also give estimations of the changes in export production in other RCP conditions (not only RCP8,5) [Marilaure Gregoire, Belgium]	The text was altered as suggested by the reviewer.
10964	5	25	38	25	52	The authors point righlty to the limitation of models in simulating net and export production. Therefore I would suggest not being so sure in the executive summary about the unequivocal evidence of changes in primary and export production (very high level confidence). [Marilaure Gregoire, Belgium]	The text was altered as suggested by the reviewer.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
12196	5	25	38	25	39	The sentence seems restrictive and does not reflect adequately the need to consider not only chemical variables but also biological variables when assessing skills of ecosystem or biogeochemical models. Please consider changing the sentence such as: “the model skill in reproducing distributions of biogeochemical variables” (rather than “limiting nutrients”). Please also consider citing supporting reference Kwiatkowski et al., 2015 reporting on inter-comparison of ocean biogeochemistry models using biogeochemical variables to evaluate the skills of the different models. Kwiatkowski, L., Yool, A., Allen, J.I., Anderson, T.R., Barciela, R., Buitenhuis, E.T., Butenschön, M., Enright, C., Halloran, P.R., Le Quéré, C., de Mora, L., Racault, M.-F., Sinha, B., Totterdell, I.J., Cox, P.M. (2015) iMarNet: an ocean biogeochemistry model intercomparison project, Biogeosciences, doi:10.5194/bg-11-7291-2014. [Marie-Fanny Racault, UK]	The text was altered as suggested by the reviewer.
12198	5	25	38	25	39	Please note that the Figure 5.8 does not seem to support the sentence statement about limiting nutrients. Figure 5.8 is related to the ocean carbon sink. Please consider referring to Figure 5.9, which shows a global map of limiting nutrients. [Marie-Fanny Racault, UK]	The text was altered as suggested by the reviewer.
21234	5	25	38	25	52	Should also mention the poor representation of the contribution of coastal production in current ESMs due to coarse resolution and other factors... [Momme Butenschön, Italy]	Rejected - not relevant for this section
9348	5	25	39	25	39	Figure 5.8 does not show what the text describes. [APECS Group Review, Germany]	The text was altered as suggested by the reviewer.
11330	5	25	42	25	42	incorrect figure reference - this is Figure 5.9 as supplied in the pdf, Figure 5.8 is a time dependent carbon sink [Croot Peter, Ireland]	The text was altered as suggested by the reviewer.
5272	5	26	1			many time series cites in gyres or regions that could represent large areas of the oceans...For example PAP, BATS, SOTS, HOTS. What is the recommendation then...more time series? More autonomous vehicles? This would be helpful to get future funding. [Emma Cavan, Australia]	Rejected - the scope of this report is to assess the literature and recommendtiotations are not present in this section
23072	5	26	1	27	19	wrong references [Nicolas Gruber, Switzerland]	An error occurred when chapter 5 references were compiled in Endnote by the TSU resulting in a displacement of all the references by one position. This resulted in a great number of misplaced references which we have since then fixed.
1624	5	26	9	26	18	It would be interesting to see the simulated global changes for the RCP1.9 scenario (corresponding to the 1.5 temperature level in the Paris agreement). It is important that the findings in this report are consistent (where possible) to the SR15 and relevant in the context of the Paris agreement. Discrepansies with the SR15 should be pointed out. [Aurora Stenmark, Norway]	Rejected - these simulations are not discussed in the literature we are assessing
9354	5	26	9	26	18	Could the global maps for panels b, e, h, k be labeled on the panels not just in the figure caption? This figure contains a lot of information and would be easier to follow with this addition. [APECS Group Review, Germany]	The text was altered as suggested by the reviewer.
1646	5	26	10	26	18	Please make clear the time period, reference period, and emission scenario of the middle panels. Please be precise in the caption. [Aurora Stenmark, Norway]	The text was altered as suggested by the reviewer.
14056	5	26	10	26	18	what do the colors represent in the far right panel? [Elizabeth Jewett, USA]	The text was altered as suggested by the reviewer.
2540	5	26	11	26	18	Please check which row is oxygen. Units are missing in the middle panel. In general, people use red color for increases. It is not a good idea to have all these plots in the ocean carbon section. [Xiujun Wang, China]	The text was altered as suggested by the reviewer.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
13172	5	26	17	26	17	"over top 100 m" reads a little confusing. Maybe change this to "over the upper 100 m"? It would also be nice to make the properties and units on the left hand side of the figure larger, as it is at first a little unclear what the middle and right hand panels reflect [Baerbel Hoenisch, USA]	The text was altered as suggested by the reviewer.
3220	5	26	18	26	18	Figure 5.7 isnt adapted from Landschutzer 2016 [Aaron Spring, Germany]	The text was altered as suggested by the reviewer.
3566	5	27	1	27	1	Figure 5.7 b is missing the x and y axis labels. The figure is wrong.as it is presently displayed. [Richard Feely, USA]	The text was altered as suggested by the reviewer.
5530	5	27	1	27	6	Time-axis label missing [Roderik Van De Wal, Netherlands]	The text was altered as suggested by the reviewer.
13174	5	27	1	27	1	the figure is of poor quality and cut off on the left hand side. Please also specify the white and black line, and the grey shaded area. [Baerbel Hoenisch, USA]	The text was altered as suggested by the reviewer.
20568	5	27	1			Scale lable is not visible (on Y axis) [Chiara Lombardi, Italy]	The text was altered as suggested by the reviewer.
24148	5	27	1	27	1	Fig 5.8: y axis caption is cut in half [Hans-Otto Poertner and WGII TSU, Germany]	Figure removed
1896	5	27	3	27	4	The X-axis has no title (time or years) and the title of the Y-axis is cut (Pg C yr-1) [Jens Rassmann, Belgium]	Figure removed
16288	5	27	3	27	4	This figure is incomprehensible. No information about twhat the contours are, colors, data sets, vertical axis label is cut off, some random label 'uncertainty'. [Lynne Talley, USA]	Figure removed
23520	5	27	3			Figure 5.8 is from Landschutzer et al 2016 (GBC) ,not Moore et al. 2013. It is also very important that this be called a "data-based estimate", and not just "observations". The observations are very sparse and there is a lot of extrapolation that goes into these estimates. Their uncertainty is poorly quantified and there are other competing estimates with substantial differences (Rodenbeck et al. 2015 Biogeoscience, Landschutzer et al. 2015 Science). Thus, there is a strong potential for significant revisions of these estimates in the coming years. [Galen Galen Mckinley, USA]	Figure removed
3224	5	27	4	27	4	Figure 5.8 isnt from Moore 2013 but Landschutzer 2016 [Aaron Spring, Germany]	The text was altered as suggested by the reviewer.
1794	5	27	8	27	8	The insert of Fig. 9 is blocking other area. [Meer Ali, India]	The text was altered as suggested by the reviewer.
2542	5	27	8	27	18	Please indicate over which period. [Xiujun Wang, China]	The text was altered as suggested by the reviewer.
4608	5	27	8	27	18	There is no quote of the Figure 5.9 in the manuscript. Please add... [Alessandro Pezzoli, Italy]	The text was altered as suggested by the reviewer.
5274	5	27	8			Great figure...but has any work been done on resource limitation under future warming? Can we predict what might happen? [Emma Cavan, Australia]	Reject - beyond the scope
12108	5	27	8	27	8	Run the final version of this figure through a red/green colorblindness checking program. I don't think the colors will be distinguishable by people with low color vision. [Sarah Cooley, USA]	The text was altered as suggested by the reviewer.
16290	5	27	8	27	18	Map is pretty. Figure caption does not describe what it is. First sentence should lead off with content that any reader could understand. [Lynne Talley, USA]	The text was altered as suggested by the reviewer.
16694	5	27	8	27	8	Although Fig. 5.9 is interesting I'm not sure it is required. The point can be made that limiting nutrient varies regionally without a (complex) figure [Cliff Law, New Zealand]	Reject - the figure supports a strong change in understanding since AR5
11332	5	27	10	27	10	include the source of the primary producitvity data used in this figure. [Croot Peter, Ireland]	The text was altered as suggested by the reviewer.
13768	5	28	0			Fig 5.10 What is the hatching? This schematic looks very interesting and deserves a detailed explanation in the legend. [Debra Roberts and Durban Team, South Africa]	figure removed

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
1516	5	28	1	28	5	This figure is very informative, but I would suggest to include in the caption some quick statement on how this relates to the expected variations in hydrodynamics-related vertical and off-shelf fluxes introduced before [Davide Bonaldo, Italy]	Figure removed
2858	5	28	1			Fig. 5.10. Nice graphics. Coordinate with Ch. 3 [Geir Ottersen, Norway]	Figure removed
16292	5	28	2	28	5	Wasn't there a recent high profile paper by Moore et al. (Science, March 9, 2018) on this topic? [Lynne Talley, USA]	The text was altered as suggested by the reviewer.
3222	5	28	5	28	5	Figure 5.10 isnt from Hawkins and Sutton [Aaron Spring, Germany]	An error occurred when chapter 5 references were compiled in Endnote by the TSU resulting in a displacement of all the references by one position. This resulted in a great number of misplaced references which we have since then fixed.
3984	5	28	5	28	5	Is Hawkins and Sutton (2012) the correct reference here? [Helene Hewitt, UK]	An error occurred when chapter 5 references were compiled in Endnote by the TSU resulting in a displacement of all the references by one position. This resulted in a great number of misplaced references which we have since then fixed.
16294	5	28	5	28	5	This figure is definitely NOT from Hawkins and Sutton (2012). In fact it's from the Science magazine issue that published Moore et al. I just spent 10 minutes looking for it since it looked familiar. The reference is Laufkotter and Gruber (2018) which you have on the reference list. [Lynne Talley, USA]	The text was altered as suggested by the reviewer.
23074	5	28	5	28	5	wrong reference [Nicolas Gruber, Switzerland]	The text was altered as suggested by the reviewer.

SROCC First Order Draft Expert Review Comments - Chapter 5							
Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
4066	5	28	10	34	15	Time of emergence and especially time of response is essential for understanding consequences and adaptive ability/capacity of species and ecosystems, and it therefore is very satisfying that these topics are discussed in the report. At the same time adaptive capacity of individuals and populations are far more complicated than just generation time, thus especially the table is a bit misleading because it gives the impression that generation time is the sole determinant of adaptation. Although generation time is highly important for adaptation through evolution by natural selection, it is not the only factor affecting evolution and adaptive capacity and it is not the only adaptation pathway for biodiversity. Adaptation may occur without evolution through e.g. phenotypic plasticity, epigenetics, or tracking suitable climates and habitats (i.e. moving). In addition evolutionary adaptation is not only affected by generation time, but possibly equally important are population size and genetic variation in the population, which sets the stage for what adaptation is actually possible. Genetic variation, in turn, is strongly coupled to mode and strength of selection on the population (for all selective forces that act on the population), as well as stochastic events. For example, populations undergoing directional or stabilising selection will over time likely reduce their genetic variation, while populations undergoing stabilising selection is more likely to maintain genetic variation, and strong selection will result in faster response on genetic variation. Stochasticity will be particularly important for small populations, and may even cause local extinction. Thus, time of response and adaptive ability/capacity would merit a chapter or a report of its own, but not in this special report. However, please consider including a few short sentences that explains the different adaptive possibilities that exist for individuals and populations, as well as other factors that affects adaptation through evolution by natural selection. [Aurora Stenmark, Norway]	This text has been revised significantly following the review comments
23076	5	28	10	34	15	ToE is an interesting concept, but also should not be oversold. One could also draw completely wrong conclusions from it, i.e., as long as the system has not yet reached the ToE, everything is fine, and thereafter, everything is bad. I thus ask the authors to put this particular metric better into context and also discuss more the uncertainties. The current estimates are primarily model-based, and since most models underestimate variability, there is also a tendency of the models to estimate a too early ToE. [Nicolas Gruber, Switzerland]	The text was altered as suggested by the reviewer.
24150	5	28	10	34	13	The box is a bit lengthy. Try to reduce the content [Hans-Otto Poertner and WGII TSU, Germany]	This text has been revised significantly following the review comments
9366	5	29	2	29	2	Some climate extremes sounds a bit too colloquial [APECS Group Review, Germany]	This text has been revised significantly following the review comments
9358	5	29	4	29	4	is there a probablity description for averaged ocean heat content, as it is the only one in the list without one? [APECS Group Review, Germany]	This text has been revised significantly following the review comments
9356	5	29	5	29	5	the "and" before ocean salinity should be removed as the list continues and includes Arctic sea ice [APECS Group Review, Germany]	This text has been revised significantly following the review comments
9360	5	29	6	29	6	"have provided the critical evidence" the word the should be removed [APECS Group Review, Germany]	The text was altered as suggested by the reviewer.

SROCC First Order Draft Expert Review Comments - Chapter 5							
Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
3256	5	29	9			ToE (Time of Emergence) and its acronym needs to be described here as it is the first time it is mentoned in chapter 5 [Martin Edwards, UK]	The text was altered as suggested by the reviewer.
4610	5	29	9	29	9	Sentence "The concept of ToE is defined" better "The concept of Time of Emergence (ToE) is defined" [Alessandro Pezzoli, Italy]	The text was altered as suggested by the reviewer.
9368	5	29	9	29	9	Despite having Time of Emergence in the headline, I think you spell it in full once before using ToE [APECS Group Review, Germany]	The text was altered as suggested by the reviewer.
13176	5	29	9	29	9	please spell out ToE = time of emergence? [Baerbel Hoenisch, USA]	The text was altered as suggested by the reviewer.
13770	5	29	9	29	9	First usage of 'ToE'. Please spell out in full. [Debra Roberts and Durban Team, South Africa]	The text was altered as suggested by the reviewer.
16296	5	29	9	29	9	Define ToE acronym. [Lynne Talley, USA]	The text was altered as suggested by the reviewer.
16696	5	29	9	29	9	Define ToE [Cliff Law, New Zealand]	The text was altered as suggested by the reviewer.
20294	5	29	9	29	9	Please write out Time of Emergence at first mention of the acronym ToE [Michelle A. North, South Africa]	The text was altered as suggested by the reviewer.
12110	5	29	16	29	19	Note that Cooley et al., 2012 (Nutrition and income from molluscs today imply vulnerability to ocean acidification tomorrow. 2011. Cooley, Lucey, Kite-Powell, and Doney, Fish and Fisheries, https://doi.org/10.1111/j.1467-2979.2011.00424.x) was the first paper to discuss a ToE concept for ocean acidification, although it wasn't called that at the time. [Sarah Cooley, USA]	This text has been revised significantly following the review comments
17888	5	29	16	29	37	the description of the indicators proposed in this section varies and is therefore confusing. For example, they are referred to as essential, key ecosystem, and key ocean circulation variables. Might be useful to harmonize the description and give some rationale for their selection: e.g. that they are measureable. And would these be better refered to as indicators or variables? [Haroon Kheshgi, USA]	This text has been revised significantly following the review comments
23524	5	29	28			ToE for CO2 flux shouldn't be left out of this discussion or the subsequent table. There is much more structure in the emergence pattern that what is shown in the figure include here. This has important implications for monitoring the evolving ocean carbon sink . Reference: McKinley, G. A. et al. Timescales for detection of trends in the oceancarbon sink. Nature 530, 469–472 (2016). [Galen Galen Mckinley, USA]	This text has been revised significantly following the review comments
23526	5	29	28			There is excessive dependence on the reference of Froelicher et al. 2016. Should include Rodgers et al 2015 Biogeoscience, McKinley et al. 2016 Nature [Galen Galen Mckinley, USA]	This text has been revised significantly following the review comments
11642	5	29	32			Please distinguish internal and natural variability as some studies e.g. Keller et al., BG, 2015, used interannual variability from 17 ESM 20 century simuations which typically include solar and volcanic forcing. [Fortunat Joos, Switzerland]	This text has been revised significantly following the review comments
18702	5	29	33	29	33	Please refer to Hawkins and Sutton BAMS 2009 who published this ToE framework first. The given list of reference account only for followers and could be completed (e.g., Keller et al. BG 2014 is missing for instance) [Roland Seferian, France]	An error occurred when chapter 5 references were compiled in Endnote by the TSU resulting in a displacement of all the references by one position. This resulted in a great number of misplaced references which we have since then fixed.

SROCC First Order Draft Expert Review Comments - Chapter 5							
Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
18704	5	29	34	29	34	Weatherhead et al. 1998 developped a framework to detect how long does it take for a given trends to emerge from a noise. They provide a mathematical formulation under the assumption that the noise follows an AR1 processes. This framework is limited compared to ToE when the statistical characteristics of the background noise exhibits low frequency variations (Arn n>2). [Roland Seferian, France]	This text has been revised significantly following the review comments
9362	5	29	38	29	38	the sentence beginning "Calculated" shouldn't be a new sentence, it should continue from the previous one so a comma would be more appropriate here [APECS Group Review, Germany]	This text has been revised significantly following the review comments
11644	5	29	38			Keller et al., BG, 2015 shows results for pH, pCO2, DIC, and SST from 17 ESM simulations considering natural variability. pH emerges also early in these simulations. [Fortunat Joos, Switzerland]	This text has been revised significantly following the review comments
14058	5	29	39	29	39	If by Time of Emergence, you mean that the system is completely outside of preindustrial bounds, then pH has NOT emerged everywhere. We see some emergence, some of the year, but most of the coastal zones are still within the range of natural variability at least part of the year. [Elizabeth Jewett, USA]	This text has been revised significantly following the review comments
14060	5	29	45	29	45	30 years is also needed for detection of pH trend in the coastal zone. [Elizabeth Jewett, USA]	This text has been revised significantly following the review comments
11646	5	29	46			Mention here also emergence for DIC and pCO2, (pCO2 is also important for marine life as part of the respiratory chain. DIC is important for detection of anthropogenic carbon) [Fortunat Joos, Switzerland]	This text has been revised significantly following the review comments
9364	5	29	47	29	47	The 30 years or greater was also shown in the paper by Henson, S. Et al., Rapid emergence of climate change in environmental drivers of marine ecosystems, 2017. Nature Communications, 10.1038/ncomms14682, 8 [APECS Group Review, Germany]	This text has been revised significantly following the review comments
13772	5	30	0			Box Figure 2 Don't understand the graphs. What do they show? The temperature graph of area vs time of emergence goes up and then down. What does that mean? [Debra Roberts and Durban Team, South Africa]	This text has been revised significantly following the review comments
13178	5	30	1	30	1	this is a great figure! [Baerbel Hoenisch, USA]	Thank you for the complement.
20996	5	30	3	30	6	There should be another clarifying statement related to this figure that these predictions apply to open ocean conditions, and not necessarily coastal systems. As mentioned in previous comments, observations in coastal regions show that present day mean change in pH has not yet exceeded historical variability (Sutton et al. 2016). [Adrienne Sutton, USA]	This text has been revised significantly following the review comments
14410	5	30	8			Box 5.1, Figure 2: This figure is also confusing. It is not described well and so I don't understand it's significance. [Jennifer Fehrenbacher, USA]	This text has been revised significantly following the review comments
9372	5	30	9	30	9	The labels in Box 5.1 Fig 2 D-F are too small [APECS Group Review, Germany]	This text has been revised significantly following the review comments
9374	5	30	9	30	9	To me it looks like you included some shallower shelf areas in Box 5.1 Fig. 2 C [APECS Group Review, Germany]	This text has been revised significantly following the review comments
13180	5	30	9	30	9	I don't quite understand this figure. Do panels A-C represent the status quo or is there any projection included? What do panels D-F present? Shouldn't the lines stay high after patterns emerged or increase as time progresses? [Baerbel Hoenisch, USA]	This text has been revised significantly following the review comments
9370	5	30	10	30	15	It is not made clear what "biodiversity" is composed of, is this all biological organisms? Only phytoplankton, or metazoans? I think it should be made clear what the authors are referring to [APECS Group Review, Germany]	This text has been revised significantly following the review comments

SROCC First Order Draft Expert Review Comments - Chapter 5							
Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
10952	5	30	10	30	15	Legend of Figure 2: what do you mean by "each taxonomic group has been recorded? Those that are in the OBIS, GBIF and IUCN data base? Deoxygenation has occurred in a lot of coastal areas This is difficult to define a unique ToE for all the coastal area, what is its significance and how has it been estimated? (global ocean models can not resolve the coastal zone with the necessary resolution for deriving such a robust diagnostic). Looking at the current graph, we have the feeling that deoxygenation will only emerge after 2040 although,we know that more than 500 sites are currently affected by hypoxia (the signal is outside the natural variability). I am wondering if this ToE is pertinent for the whole coatsal zone as its interpretation from figure 2 is misleading. [Marilaure Gregoire, Belgium]	This text has been revised significantly following the review comments
24152	5	30	10	30	11	"each taxonomic group"? Please specify and/or provide examples [Hans-Otto Poertner and WGII TSU, Germany]	This text has been revised significantly following the review comments
24154	5	30	14	30	15	Figure 5.11 in Mora et al? Figure 5.11 in this chapter is on mangrove distribution. Please clarify [Hans-Otto Poertner and WGII TSU, Germany]	This text has been revised significantly following the review comments
3568	5	30	16	30	18	Recent studies consider essential variables such as pH, carbonate ion concentrations, aragonite and calcite saturation states, nutrient levels and marine primary productivity (Box 5.1, Figure 1) (Ilyina et al., 2009; Cooley et al., 2012; Friedrich et al., 2012; Keller et al., 2014; Lovenduski et al., 2015; Rodgers et al., 2015),around a decade are sufficient to detect a trend in pH or SST in the open-ocean, whereas datasets spanning 30 years or longer are typically needed for detection of emergence at local scales for oxygen, nitrate and primary productivity (Froelicher et al., 2016). Longer times are required to detect the trends in pH or SST in coastal regions were local variability is much higher. [Richard Feely, USA]	This text has been revised significantly following the review comments
18902	5	U	18	31	7	The question of species adaptability is critical as it will determine the extent of the climate change impact. This response is complex as it encompasses both concepts: the magnitude of the environmental change and the time scale of these fluctuations. Phytoplankton for instance may adapt to a large variation in temperature if the rate of change in T is slow enough for the organism to adapt, while a lower T change but occurring on a shorter time scale could lead to cell mortality. So the adaptation time scale is key to apprehend the potential impact of climate change on phytoplankton diversity (Demory et al, 2018, ISMEJ). In this regard, the extreme events that accompany the general increasing trend in warming, which happen over shorter periods, may be as detrimental as the overall increase in T over a longer periods. Last, another level of uncertainty is added in the present model simulation scenarios, as adaptation may not be accounted for in the models. [Sophie Rabouille, France]	This text has been revised significantly following the review comments
10948	5	30	19	30	20	The definition of the time of organismal response is not clear. Is it the generation time? [Marilaure Gregoire, Belgium]	This text has been revised significantly following the review comments
9376	5	30	20	30	21	Something is missing in this sentence. [APECS Group Review, Germany]	This text has been revised significantly following the review comments

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
16698	5	30	20	30	20	Box 5.1, Figure 2 only shows ToE, not ToOR [Cliff Law, New Zealand]	This text has been revised significantly following the review comments
20296	5	30	20	30	22	The sentences: "As organisms have evolved to be adaptable to natural variations in the environmental conditions of their habitats. Thus, changes to their habitat conditions larger than that typically experienced may become hazardous" can be joined into one, omitting the "thus" [Michelle A. North, South Africa]	This text has been revised significantly following the review comments
20570	5	30	20		21	I would replace ". " with " , " between "...habitat. Thus..." (line 21) [Chiara Lombardi, Italy]	This text has been revised significantly following the review comments
9378	5	30	23	30	23	I'm not a biologist but may evolve more quickly to...sounds somewhat off. Maybe use may adapt more quickly to? [APECS Group Review, Germany]	This text has been revised significantly following the review comments
12150	5	31	0			Box 5.1, Table 1. Vibrio bacteria: the reference #4 is about Rhamnaceae sclerophyllous (flowering plant) not Vibrio bacteria. Relevant reference to Virbio seems to be #5 Wendling &Wegner (2015) (shown at the end of Table 1 in page 33) [Marie-Fanny Racault, UK]	This text has been revised significantly following the review comments
12152	5	31	0			Box 5.1, Table 1. Vibrio bacteria: the sentence "Average time of emergence of ocean condition variables within its range: 2030 years" is not clear, and the figure provided "2030 years" does not seem to be coherent with the rest of the ToE provided in Table 1 [Marie-Fanny Racault, UK]	This text has been revised significantly following the review comments
14062	5	31	0			Again, not for pH in the coastal zone. Be careful here. [Elizabeth Jewett, USA]	This text has been revised significantly following the review comments
14064	5	31	0			I think it would be a good idea to add citations to this table. Also, provide a rationale for why these species or functional groups were included in the table. Also, might be a good idea to include Harmful Algal Blooms since they are frequently an indicator of ocean health? [Elizabeth Jewett, USA]	This text has been revised significantly following the review comments
24602	5	31	0			Climate change velocity and observations of displacement / movement provide information on adaptation success and should probably be considered here? [Hans-Otto Poertner and WGII TSU, Germany]	This text has been revised significantly following the review comments
16700	5	31	1	31	9	citations required to support some of these statements [Cliff Law, New Zealand]	This text has been revised significantly following the review comments
3574	5	31	3	31	6	Plot B is inadequate as show here. Coastal regions have ToE that are as much as 30 to 40 years for parameters like pH and aragonite saturate saturation state. [Richard Feely, USA]	This text has been revised significantly following the review comments
4618	5	31	5	31	7	Compariong pteropod life history with microbes is incorrect. With 2-3 year life cycle, pteropods do not belong to the species with rapid reproductive cycles. In fact, the changes in the environment with respect to OA are happening faster then generation cycle modifications that would allow for rapid adaptation within ToOR context. This comparison should be omitted, especiially since none of the studies so far have demonstrated any evidence of rapid adaptation processes in pteropods. [Nina Bednarsek, USA]	This text has been revised significantly following the review comments
9382	5	31	5	31	5	Yes, calcifying plankton might reproduce fast, but it is also severly threatened by ocean acidification. [APECS Group Review, Germany]	This text has been revised significantly following the review comments
10946	5	31	5	31	5	"Pelagic microbes, such as phytoplankton or calcifying plankton,..." As far as I know, phytoplankton is not a microbe. Please clarify. [Marilaure Gregoire, Belgium]	This text has been revised significantly following the review comments

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
20298	5	31	5	31	9	These sentences essentially repeat what is said in the sentence p30 line 22 to p31 line 2. I think the greater detail covered in these sentences is beneficial, but try to arrange this paragraph so that it doesn't simply feel redundant. It may be best to move "However, evidence on evolutionary adaptation to expected climate change is limited, thus while shorter generation time may facilitate adaptation to environmental change, it does not necessarily result in successful adaptation of organisms (5.2.4, 5.4.3, low confidence)." to the end of the paragraph. [Michelle A. North, South Africa]	This text has been revised significantly following the review comments
5276	5	U	9			what are the implications on societal issues of different ToOR? Eg fisheries, nutrient cycles, biodiversity.. [Emma Cavan, Australia]	This text has been revised significantly following the review comments
10950	5	31	12	34	4	This table needs to be revised. First the content is not clear. Column 1 mixes information on the time scale of emergence of changes beyond natural variability; generation time scales, climate stressors for the considered species, and also "average time of emergence of ocean variables within its range" This last quantity has not been defined and its link with the above mentioned time scales is not clearly made. Please detail how it is estimated. Column 2 also mixes a lot of information: spatial pattern of occurrence of the ToE, spatial patterns of the selected species, tolerance of the species to environmental stress (vague because not quantitative specification, neither precision on the environmental factors considered) and possible adaptation. Then column 3 mentions the degree of confidence in the information. This is not clear to which information it is related (ToE, spatial pattern, tolerance, all of them. Please clarify. Besides, it is mentioned at the beginning (footnote page 3) that an information with a high degree of confidence results from a high level of evidences and high levels of agreement. Checking the references listed in column 4, it appears that some rows considered as high confidence results from one reference which is not a review. So, please clarify to which facts the degree of confidence is related and how it is estimated. It also appears that the referencing is wrong. For instance, reference 3 from Turner et al., 2011 is absolutely not related to pH, nutrients, temperature but rather on bacteria (it is probably related to the next variable, bacteria Vibrio vulnificus?) while Onstein Renske et al. (2016) is not related at all to bacteria neither to any variables mentioned in this Table. Please check all the reference, there is a big mess. Considering that the numbering of the references is not correct, I have checked Wendling and Wegner (2015) as a reference for Pacific oyster. Surprisingly this paper investigates the resistance of Pacific Oysters to a bacteria and was not (clearly) related to the tolerance and adaptation of oyster to acidification, warming and deoxygenation but rather its resistance to bacteria which gives them an advantage for being invasive. Please clarify. [Marilaure Gregoire, Belgium]	This text has been revised significantly following the review comments
11648	5	31	12			Suggest to add also DIC and pCO2 in this table and to reference additional relevant studies on ToE [Fortunat Joos, Switzerland]	This text has been revised significantly following the review comments

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
16136	5	31	12	33	57	some key references missing from Table 1 in Box 5.1. Also why key out the references numerically instead of simply putting authors names? Cummings V, Hewitt J, Van Rooyen A, Currie K, Beard S, Thrush S, Norkko J, Barr N, Heath P, Halliday J, et al. 2011. Ocean acidification at high latitudes: potential effects on functioning of the Antarctic bivalve Laternula elliptica. PLoS One. 6(1):e16069.; Pinkerton, MH. Forthcoming 2017. Impacts of climate change on New Zealand fisheries and aquaculture. In: Phillips BF, Pérez-Ramírez M, editors. The impacts of climate change on fisheries and aquaculture in New Zealand. Wiley/Blackwell. [Mary Livingston, New Zealand]	This text has been revised significantly following the review comments
16702	5	31	12	31	12	Box 5.1, Table 1 requires editing. ToE & ToOR are not mentioned in the column headers and there are missing values [Cliff Law, New Zealand]	This text has been revised significantly following the review comments
20998	5	31	12	33	4	In Box 5.1, Table 1. Here, the table is relating open ocean predictions of time of emergence (ToE) to potential impact of some coastal species. This caveat needs to be transparent: there is significant uncertainty in applying open ocean predictions to coastal carbon conditions. Related to the examples provided in Table 1 for the Pacific oyster and oyster farming, pH observations show noise > signal in waters nearby oyster hatcheries in the northwest U.S. coast (Sutton et al. 2016 Figure 5). [Adrienne Sutton, USA]	This text has been revised significantly following the review comments
9380	5	31	16	33	57	Confidence is defined as very low, low, medium, high, and very high, and therefore, I assume that “moderate” should be replaced by “medium”, or be defined previously as a confidence level. [APECS Group Review, Germany]	This text has been revised significantly following the review comments
24156	5	31	16	33	4	Box 5.1 Table 1: in the table it should say "medium" confidence (instead of "moderate") [Hans-Otto Poertner and WGII TSU, Germany]	This text has been revised significantly following the review comments
3576	5	32	1	32	1	Across the open- ocean; Longer for coastal oceans [Richard Feely, USA]	This text has been revised significantly following the review comments
9384	5	33	0	33		In table 1, box 5.1, in the oyster farming section, the number of years has yet to filled in (currently xx) [APECS Group Review, Germany]	This text has been revised significantly following the review comments
16422	5	33	0	33		Table - Governance - International- Not ALL countries require consensuated responses. Many of the international agreements require regional implementation, where the number of countries is lower. [Coswig Kalikoski Daniela, Italy]	This text has been revised significantly following the review comments
20572	5	33	0			Table: Oyster farming (Mariculture). Temperature, Oxygen and pH: " X " schoud be replaced with numbers. [Chiara Lombardi, Italy]	This text has been revised significantly following the review comments
13182	5	33	1	33	1	the ToE and uncertainty values need to be added to the oyster farming entries (all currently listed as xx+/- 0.x [Baerbel Hoenisch, USA]	This text has been revised significantly following the review comments
16144	5	33	1	33	1	Table Oyster Farming: Missing numbers in Temperature - average time of emergence where the farms operate: [xx ± x.0] years from 2000; [Adi Nugraha, USA]	This text has been revised significantly following the review comments
16146	5	33	1	33	1	Table Oyster Farming: Missing numbers in Oxygen - average time of emergence where the farms operate: [xx ± x.0] years from 2000; [Adi Nugraha, USA]	This text has been revised significantly following the review comments
16148	5	33	1	33	1	Table Oyster Farming: Missing numbers in pH - average time of emergence where the farms operate: [xx ± x.0] years from 2000; [Adi Nugraha, USA]	This text has been revised significantly following the review comments
9388	5	34	6	34	6	a comma should be placed after "(next few decades)" and "acidification" [APECS Group Review, Germany]	This text has been revised significantly following the review comments

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
9390	5	34	12	34	12	time frame should be time frames [APECS Group Review, Germany]	This text has been revised significantly following the review comments
11650	5	34	14			This section should also include a discussion on multi-century to millennial scale change as projected in a range of recent studies, some including different warming targets and considering variables such as oxygen in the thermocline and the deep, temperature, metabolic indices, productivity, nutrient availability, N2O, - see for example Shaffer et al., Nat Geosci, 2009, Battaglia and Joos, ESD, 2018 and Battagla and Joos, GBC, 2018, Niemeyer et al., ESD, 2017, Randerson et al., GBC, 2015) [Fortunat Joos, Switzerland]	This text has been revised significantly following the review comments
9386	5	34	18	52	14	Among the multiple climate drivers affecting key ecosystem vulnerabilities, I miss some clarification of others that will significantly impact these ecosystems, such as ultraviolet radiation or pollution, which were barely explored. [APECS Group Review, Germany]	The structure of the chapter has been substantially modified and this introduction is not longer in the chapter. The drivers affecting key ecosystems vulneabilities are further considered in different sections: for pelagic and deep sea ecosystems the drivers are discussed inside the 5.2. open ocean section, and for coastal ecosystems, in the coastal seas section (5.3).
23078	5	34	18	63	29	section 5.2.2. This section is too long and reads much more like a textbook than an assessment. Furthermore, it does not really address the key question at hand very well, i.e., "multiple climate drivers". [Nicolas Gruber, Switzerland]	The structure of the chapter has been substantially modified, assessing pelagic and deep sea ecosystems in the open ocean section (5.2), and coastal ecosystems into the coastal seas section (5.3). In addition, a subsection (5.3.4) of risk assessment for coastal ecosystem has been included.
24160	5	34	18			Section 5.2.2: The generel structure should be identical/similar across the subsections 5.2.2.2 (pelagic), 5.2.2.3 (coastal) and 5.2.2.4 (deep sea). e.g., one of these includes a summary subsection, another one sections on gaps and overviews, and the third one none of these. Would be nice to have a more consistent structure, here. [Hans-Otto Poertner and WGII TSU, Germany]	The structure of the chapter has been substantially modified, assessing pelagic and deep sea ecosystems in the open ocean section (5.2), and coastal ecosystems into the coastal seas section (5.3). The subsections have been furher modified for consistency.
24162	5	34	18	63	29	Section 5.2.2 is a nice & very comprehensive review, but not really an assessment; the entire section could be condensed and need to become an assessment. Please be concise and focus on whats new since AR5. [Hans-Otto Poertner and WGII TSU, Germany]	The structure of the chapter has been substantially modified, assessing pelagic and deep sea ecosystems in the open ocean section (5.2), and coastal ecosystems into the coastal seas section (5.3). Furthermore, a subsection (5.3.4) of risk assessment for coastal ecosystem has been included.
12200	5	34	31	34	35	The reference Henson et al. 2017 does not seem to provide appropriate support to the statement about “short-term fluctuations, ranging from the seasons to climate oscillations like El Niño”. This reference does not include information about climate oscillations or El Niño. Please consider citing supporting references Racault et al. 2017a, and Racault et al. 2017b discussing detection and attribution of climate variability and change, and demonstrating regionally-different responses of the marine ecosystem to El Niño climate oscillations. Racault, M.-F., Sathyendranath, S., Brewin, R.J.W., Raitsos, D.E., Jackson, T., Platt, T. (2017a) Impact of El Niño Variability on Oceanic Phytoplankton. Frontiers in Marine Science, doi:10.3389/fmars.2017.00133. Racault, M.-F., Sathyendranath, S., Menon, N., Platt. T. (2017b) Phenological responses to ENSO in the global oceans. Surveys in Geophysics, 38: 277. doi:10.1007/s10712-016-9391-1. [Marie-Fanny Racault, UK]	An error occurred when chapter 5 references were compiled in Endnote by the TSU resulting in a displacement of all the references by one position. This resulted in a great number of misplaced references which we have since then fixed.

SROCC First Order Draft Expert Review Comments - Chapter 5							
Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
2544	5	34	32	34	34	It is a bit confusing because of "...cliame trends.....natural ....climate oscillation.." [Xiujun Wang, China]	The structure of the chapter has been substantially modified and this introduction is not longer in the chapter. The suggestion has been taken under consideration.
6498	5	34	39	34	44	This sentence provides an artificial contrast with regard to the key pressures mentioned, especially those related to the coastal ocean. Though I understand that the chapter considers a specific partitioning of the ocean, the coastal ocean and its high biodiversity are crucially affected by pressures such as seasonal extremes and long term trends not captured by those listed here. Erosion and sea level rise will affect primarily fringe habitats such as wetlands and the wider intertidal zone. This listing excluds the effects of more frequent and extreme heat-wave events, accentuated seasonal deoxygenation, and increasedlong term warming and acidification experienced by the coastal ocean, more widely, motivated by climate change and increased CO2 emmissions. This comment is in line with section 5.2.2.3. It may be useful to harmonise the two sections. [Ana Queiros, UK]	The structure of the chapter has been substantially modified to accomplish the reviewers comments. The pelagic and deep sea ecosystemsare now assessed in the open ocean section (5.2), and coastal ecosystems into the coastal seas section (5.3), as different levels of oceanographic and climate drivers affect the coastal areas and the open ocean. In addition, a subsection 5.3.2 Oceanographic drivers has been included to assess the key pressures in the coastal ocean covering seasonal variability, increased extreme weather events and long-term trends, as well as human drivers such as eutrophication and pollution.
2546	5	34	40	34	40	Need rewording. [Xiujun Wang, China]	The structure of the chapter has been substantially modified and this introduction is not longer in the chapter.
2862	5	34	41	34	42	"pelagic systems face intensified thermal stratification and nutrient depletion in the upper layers". This statement about nutrient depletion should be modiifed as it now is too general. It's precisely stated in 5.2.1.5 too apply to major (trophical) regions, while in others nutrient enrichment is expected. [Geir Ottersen, Norway]	The structure of the chapter has been substantially modified and this introduction is not longer in the chapter.
9392	5	34	41	34	44	Any references and/or confidence for the statements made in this sentence? [APECS Group Review, Germany]	The structure of the chapter has been substantially modified and this introduction is not longer in the chapter.
2548	5	34	43	34	44	There is a problem. Please check. [Xiujun Wang, China]	The structure of the chapter has been substantially modified and this introduction is not longer in the chapter.
13774	5	34	46	34	49	Sounds too policy prescriptive. Consider rephrasing the sentence [Debra Roberts and Durban Team, South Africa]	The structure of the chapter has been substantially modified and this introduction is not longer in the chapter.
24158	5	34	46	34	49	Not fully clear what this sentence aims to say, needs rewording; are you talking about adaptive management? Then please say so. [Hans-Otto Poertner and WGII TSU, Germany]	The structure of the chapter has been substantially modified and this introduction is not longer in the chapter.
6500	5	34	51	34	53	This sentence limits the impacts of climate to the individual, whcih is repeated in page 65, L29-33. We understand well that these effects are reflected at higher levels, including: community structuring through changes in species interactions (Nagelkerken and Connell 2015 PNAS 112: DOI 10.1073/pnas.1510856112; Queiros et al. 2015 Glob Change Biol 21: DOI: 10.1111/gcb.12675; Harley 2011 Science 334: DOI:10.1126/science.1210199); as well as meta-population dynamics (Coleman et al 2017 Glob Change Biol 23: DOI: 10.1111/gcb.13634; Jonsson et al. 2018 Diversity and Distributions DOI: 10.1111/ddi.12733). [Ana Queiros, UK]	The structure of the chapter has been substantially modified and this introduction is not longer in the chapter. The suggestion has been taken under consideration.
24164	5	35	2	35	4	Provide reference(s) for this statement [Hans-Otto Poertner and WGII TSU, Germany]	The structure of the chapter has been substantially modified and this introduction is not longer in the chapter.
17368	5	35	9	35	14	Before commenting on projected changes in the ACC in the CMIP5 models, I think there should be a comment about the mean state of the ACC in the ensemble and therefore how much confidence we have in these projections. [Helene Hewitt, UK]	This is considered in preparation for SOD

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
3262	5	35	16	37	17	In general more evidence and references should be presented for this summary (very little evidence is presented). For example, there have multi-decadal studies on changing size-structure of the pelagic community and carbon drawdown. Long-term studies on epipelagic biodiversity. Long-term projections of global epipelagic biodiversity changes under various warming scenarios. Long-term studies on range shifts and phenology. Quantification of natural cliimate variability and global warming on pelagic populations. Invasive species and trans-Arctic migrations. Regime shifts. Plankton trends and carbon sequestration. All these changes have been related to climate warming and variability and some should be cited as evidence in this section. Some of these findings are discussed on page 68 [Martin Edwards, UK]	We have changed the structure of the chapter and added more evidence of all the topics raised by the reviewers
4068	5	35	16	37	17	Table 5.1: Please consider rephrasing the text connected to this table such that it is clear that the list in the table is not exhaustive and that it synthesises existing studies on individual components of the biological pump that are reported both to influence the performance of the pump and are sensitive to changing ocean conditions. As phrased now, it can easily be misinterpreted as it exists a complete knowledge of all these components and how they affect and are affected. In many cases only one study is listed. [Aurora Stenmark, Norway]	We have modified the text according to the suggestion
10968	5	35	16	37	17	This section needs to be imporved. In its present state, this lacks of integration preventing the delivering of clear messages on what we know about the pelagic ocean in terms of current and possible future change. It appears like a succession of findings without clear connection between them and usually very specific. For instance, the authors mention that during the last 50 years the stocks of coccolithophores has increased by 20% thanks to the increase of CO2 and this conclusion is based on a paper by Irwin et al., 2015. However, looking at the paper, it appears that this conclusion is derived from the analysis of one time series and hence is not representative for a global increase of coccolithophorids during the last decades (note that at page 36, lines 6-7, we are told that in the coastal area Emiliana huxleyi, a coccolithophorid species, is decreasing idue to acidification. this appears as a contradiction with is mentioned above) Anoter example with lines 4-10, page 36, the authors first start to mention that mesocosm have shed the light on the effects of acidification on pelagic community structure from microbes to zooplankton but there is no details on these evidecnes. Just after, we move to the coastal area where data show a decrease of Emiliana (no information on the global significance of this decrease) and then we switch to model simulations for the future with at the end no clear message. [Marilaure Gregoire, Belgium]	We have changed the structure of the chapter and added more evidence of all the topics raised by the reviewers
14412	5	35	16	36	17	This section insufficiently addresses stressors to the epipelagic ocean. Discussion focuses on coccolithophores, but no mention of pteropods, krill, foramifera, etc. I know that this section cannot be all inclusive, but discussion on stressors and effect on these organisms would be worth adding, at least in brief. [Jennifer Fehrenbacher, USA]	We have changed the structure of the chapter and added more evidence of all the topics raised by the reviewers

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
16704	5	35	16	35	16	"Epipelagic" is not a commonly-used term; "Surface ocean" would be clearer. In addition, this section is relatively short & disappointing, bearing in mind that the productivity in the surface ocean supports the majority of marine foodwebs & also that there has been more climate-related research in this area than many of the areas subsequently discussed. [Cliff Law, New Zealand]	We kept surface, epipelagic ocean and defined the depth boundaries at the start of the secion
16710	5	35	16	36	10	All citations in this section seem to be offset forwards by one relative to the information attributed to them. For example Riebesell et al (2016) did not analyse 6 decades of CPR data. This entire section needs to be checked. [Cliff Law, New Zealand]	An error occurred when chapter 5 references were compiled in Endnote by the TSU resulting in a displacement of all the references by one position. This resulted in a great number of misplaced references which we have since then fixed.
16714	5	35	16	35	16	Section 5.2.2.2.1 is missing important information on the range shift towards the poles which is larger for phytoplankton & zooplankton than other groups [Cliff Law, New Zealand]	We have modified the text accordingly
10966	5	35	22	35	24	These lines are not specific to Pelagic systems. [Marilaure Gregoire, Belgium]	An error occurred when chapter 5 references were compiled in Endnote by the TSU resulting in a displacement of all the references by one position. This resulted in a great number of misplaced references which we have since then fixed.
9394	5	35	28	35	34	The paper which identified the 20% increase in CPR data was Rivero-Calle et al., 2015 (cited in line 24), not the Irwin et al., 2015 paper. [APECS Group Review, Germany]	An error occurred when chapter 5 references were compiled in Endnote by the TSU resulting in a displacement of all the references by one position. This resulted in a great number of misplaced references which we have since then fixed.
14066	5	35	28	35	29	add citation for the CPR findings? [Elizabeth Jewett, USA]	added
16706	5	35	28	35	45	Much of this paragraph has the wrong references ; Rivero-Calle et al (2015) report a 20% increase in Coccolithophores (not Irwin et al, 2015); Irwin et al (2015) analysed the shifts in phytoplankton over 15 years at the CARIACO site (not Brun et al); Brun et al (2015) questoon Bartons interpretation. [Cliff Law, New Zealand]	An error occurred when chapter 5 references were compiled in Endnote by the TSU resulting in a displacement of all the references by one position. This resulted in a great number of misplaced references which we have since then fixed.
3260	5	35	29		35	This should be included in the augument: In another study using the same biological dataset the authors concluded that the main patterns in calcareous orgainsims including coccolithophores was primarlity driven by temperature and climate variability. Reference: Beaugrand, G., McQuatters-Gollop, A., Edwards, M. and Goberville, E., 2012. Long-term changes in North Atlantic calcifying plankton and climate. Nature Climate Change Letters, 3: 263–267. [Martin Edwards, UK]	An error occurred when chapter 5 references were compiled in Endnote by the TSU resulting in a displacement of all the references by one position. This resulted in a great number of misplaced references which we have since then fixed.
24166	5	35	31	35	31	it is called Mauna Loa Archive [Hans-Otto Poertner and WGII TSU, Germany]	The text was altered as suggested by the reviewer.
16708	5	35	41	35	45	If waters were warming in the PETM were coccolithophores moving towarsd higher latitudes to maintain their ambient temperatures, and actually moving into cooler waters as this sentence suggests? I suspect the former as warming is unlikely to lower the thermal minimum of phytoplankton [Cliff Law, New Zealand]	The text was modified
682	5	35	42	35	42	use "to" instead of "than" [Kathiresan Kandasamy, India]	N/A
9396	5	35	42	35	42	"equally important role than..." the than should be changed to "as" [APECS Group Review, Germany]	This text has been removed in revision
11334	5	35	42	35	43	mismatch in use of equally and than, suggest rephrasing as: ...warming played an equally important role as ocean acidifcation in altering... [Croot Peter, Ireland]	This text has been removed in revision
20486	5	35	42	35	42	Please rewrite this sentence to reflect either "equally important to" or "more important than" when looking at the relative importance of the warming versus ocean acidification during the PETM [Michelle A. North, South Africa]	This text has been removed in revision

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
9398	5	35	44	35	44	should read "range shifts" not "range shift" [APECS Group Review, Germany]	This text has been removed in revision
5532	5	35	47	36	2	Both studies do not state the same about different migration speeds of species. Studies of Chivers et al (2017) does not name different migration speeds for diatoms and dinoflagellate. However and Riebesell et al (2016) does report different responses between species, Why is Riebesell conclusion used in line 1-2 of page 36 but the study by Chivers ignored? [Roderik Van De Wal, Netherlands]	An error occurred when chapter 5 references were compiled in Endnote by the TSU resulting in a displacement of all the references by one position. This resulted in a great number of misplaced references which we have since then fixed.
5534	5	35	47	36	2	Line 52 names drivers for diatoms and dinoflagellate stocks to change. Only temperature is briefely eleborated on. Why not include other factors as well (salinity, depth of mixed layer etc..)? Seems Rather Arbitrary [Roderik Van De Wal, Netherlands]	We have modified the text in the revision
9400	5	35	47	36	2	There are studies which have also found shifts in the distribution of coccolithophore populations (e.g. Neukermans et al, 2018. Increased intrusion of warming Atlantic waters leads to rapid expansion of temperate phytoplankton in the Arctic, Global Change Biology. Winter et al., 2013,. Poleward expansion of the coccolithophore Emiliania huxleyi. Journal of Plankton Res, 36, 2, 316-325.) [APECS Group Review, Germany]	We have modified the text in the revision
3258	5	35	53			The 'Riebesell et al 2016' reference is not correct. It should be 'Chivers et al 2017'. [Martin Edwards, UK]	An error occurred when chapter 5 references were compiled in Endnote by the TSU resulting in a displacement of all the references by one position. This resulted in a great number of misplaced references which we have since then fixed.
5280	5	36	0			Table 5.1. Different susceptibility, temperature - lots of work on temperature-dependance of autotrophs vs heterotrhops e.g. Lopez-Urrutia 2006/7 and yvon-duroche 2012 (Nature). Consider consulting literature and increasing confidence. [Emma Cavan, Australia]	The table has been updated and new references added
5282	5	36	0			Table 5.1. particle sinking rates increasing will increase export/flux [Emma Cavan, Australia]	The table has been updated and new references added
9410	5	36	1	36	1	This is a point I make in every second review. I strongly think you should use planktic instead of the commonly used planktonic. Please refer to Cesare Emiliani 1991 J. Paleontol 65(2), p. 329 [APECS Group Review, Germany]	We prefer to keep planktonic
5278	5	36	4		8	citations needed [Emma Cavan, Australia]	We have modified the text in the revision
16712	5	36	4	36	10	This refers to Riebesell et al (2016) mentioned in the paragraph above (line 52) [Cliff Law, New Zealand]	An error occurred when chapter 5 references were compiled in Endnote by the TSU resulting in a displacement of all the references by one position. This resulted in a great number of misplaced references which we have since then fixed.
16716	5	36	4	29	4	These are not climate change experiments; they are ocean acidification experiments as they include no warming component [Cliff Law, New Zealand]	We have modified the text in the revision
9406	5	36	5	36	5	"pelagics" I would change to "pelagic organisms" [APECS Group Review, Germany]	We have modified the text in the revision
9412	5	36	7	36	10	E. hux is very specific. Maybe you should add a sentence concerning the wider implications [APECS Group Review, Germany]	We have modified the text in the revision
5536	5	36	8	36	9	Emiliania huxleyi can not form a bloom under high CO2 conditions. Why not relate this finding to a RCP scenario? Will this be avoided e.g. for RCP 2.6? [Roderik Van De Wal, Netherlands]	We have modified the text in the revision

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
9408	5	36	8	36	10	Also include Schulz et al 2017 Phytoplankton Blooms at Increasing Levels of Atmospheric Carbon Dioxide: Experimental Evidence for Negative Effects on Prymnesiophytes and Positive on Small Picoeukaryotes. Frontiers in Marine Science, and also Riebesell et al., 2017 Competitive fitness of a predominant pelagic calcifier impaired by ocean acidification, Nature Geoscience, 10, 19-23 (this paper also makes reference to an impact on sinking velocities and thus the carbon pump. . It could also be mentioned that another mesocosm experiment has found that different changes to the environment can mitigate the impacts of high CO2, for instance dissolved iron (see Segovia et al 2017, Iron availability modulates the effects of future CO2 levels within the marine planktonic food web, Marine Ecology Progress Series, 565, 17-33. [APECS Group Review, Germany]	An error occurred when chapter 5 references were compiled in Endnote by the TSU resulting in a displacement of all the references by one position. This resulted in a great number of misplaced references which we have since then fixed.
5538	5	36	13	36	13	Table 5.1 contains some unknown acronyms or abbreviations. Additionally, the table is not very clear and contains more information than covered by the text. [Roderik Van De Wal, Netherlands]	The table has been updated and new references added
5540	5	36	13	36	13	Table: 3rd column title is "Projected change". Not clear on which period this change is calculated. [Roderik Van De Wal, Netherlands]	The text was altered as suggested by the reviewer.
10970	5	U	13	36	13	To my knowledge, Engel et al., (2002)l analyzed the results of mesocosm experiemnts (not modelling) and do not give any information on scenarios of change for the whoel ocean (since it is mesocosms experiment). It is mentionned with high confience although based on one paper. Please clarify. As important, it is mentionned that Engel et al 2002 find an increase at high latitude and a decrease at low latitude of similar importance (10-20%) this is in contradiction to what is mentionned in other parts of the text with a decrease of NPP. Please be sure to be coherent between sections in the conclusions. [Marilaure Gregoire, Belgium]	An error occurred when chapter 5 references were compiled in Endnote by the TSU resulting in a displacement of all the references by one position. This resulted in a great number of misplaced references which we have since then fixed.
11336	5	36	13	36	13	The role of the underwater light field is not considered here as an oceanic driver with the exception of vertical migrators,presumably it also has an impact in more stratified shallower mixed layers. Suggest include Huovinen (2016) https://doi.org/10.1371/journal.pone.0154887 under the net primary productivity component [Croot Peter, Ireland]	We have modified the text in the revision
13776	5	36	13			Biological pump deserves an explanation. [Debra Roberts and Durban Team, South Africa]	We have defined it
20300	5	36	13	36	13	Table 5.1. Please define POC, TEP, OA in the footnotes (DOC is already defined there) [Michelle A. North, South Africa]	We have defined it
24168	5	36	13	36	13	Faunistic shifts: Are the points under "ocean driver" and "projected change" accidentally swopped? [Hans-Otto Poertner and WGII TSU, Germany]	We have modified the text in the revision
24170	5	36	13	36	13	Vertical Migrators and Deoxygenation: What does (more export) mean and why is it in italics? [Hans-Otto Poertner and WGII TSU, Germany]	The table has been updated and new references added
24412	5	36	13			Please consider if this level of detailed table is better placed in supplementary material [Hans-Otto Poertner and WGII TSU, Germany]	We think should be included included here
16718	5	36	15	36	16	Table 5.1. Projected future changes for when? 2100? [Cliff Law, New Zealand]	The text was altered as suggested by the reviewer. Yes, by 2100

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
16720	5	U	15	36	16	Table 5.1 Bacterial hydrolytic effects - Burrell et al (2017) reports responses to acidification and warming, with 50% increase with elevated temperature; 70-170% increase under low pH. Burrell TJ, Maas EW, Hulston DA, Law CS, 2017. Variable response to warming and ocean acidification by bacterial processes in different plankton communities. Aquatic Microbial Ecology 79:49-62. https://doi.org/10.3354/ame01819 [Cliff Law, New Zealand]	The table has been updated and new references added
16722	5	36	15	36	16	Table 5.1 The papers cited for Bacterial hydrolytic enzyme activity are surface ocean, not deep ocean (>200m depth as efined in deep ocean section). Also there is mis-labelling of refrences; Bopp et al should be denoted M and not O; Engel et al (2002) is not M etc [Cliff Law, New Zealand]	The table has been updated and new references added
9402	5	36	25	36	25	TEP should be defined [APECS Group Review, Germany]	Defined
9404	5	36	30	36	40	Were Edwards et al. (2013) and Wohlers-Zôlner et al. (2011) results observational, experimental or modelled? [APECS Group Review, Germany]	Corrected
4132	5	36	43	6	43	Not only mudfalts but also mixed flats and sand flats well develop around the estuarine ecosystems. Thereafter I suggest the term "mudflats" is to be substituted by "tidal flats". [Jinsoon Park, Republic of Korea]	N/A
3358	5	37	1	37	3	Revise edition, please: models & denotes; only. ?; *denies [Castor Muñoz Sobrino, Spain]	revised
20302	5	37	1	37	2	Check this sentence and complete it please [Michelle A. North, South Africa]	revised
16728	5	37	6	37	17	Summarize paragraph in one sentence [Cliff Law, New Zealand]	We have modified the text in the revision
18904	5	37	6	37	17	To be possibly added: studies combining experimental approaches, data analysis and model simulations offer a mecanistic understanding of the adaptation abilities of species and the impact of warmng on plankton diversity and biogeography (Demory et al., 2018 ISMEJ). More studies are als needed to better appraise the combined effects of different stressors. A higher irradiance during heat stress for instance is particularly damaging for phytoplankton. Thus, sub-lethal or sub-critical factors, when combined, can lead to the non-resistance of the organism when they would have resisted to one or the other. Therefore, the overall, estimated growth responses may not reflect the actual response of the organism if the combined impacts are not clearly known. [Sophie Rabouille, France]	We have modified the text in the revision, but not included this text. We believe is too detailed to be added.
16724	5	37	9	36	9	Bopp et al (2013) is model, not synthesis of obserations [Cliff Law, New Zealand]	An error occurred when chapter 5 references were compiled in Endnote by the TSU resulting in a displacement of all the references by one position. This resulted in a great number of misplaced references which we have since then fixed.
16726	5	37	14	37	14	Again, citations are in the wrong order (Piontek et al report on bacterial enzyme activity, not particle sinking) [Cliff Law, New Zealand]	An error occurred when chapter 5 references were compiled in Endnote by the TSU resulting in a displacement of all the references by one position. This resulted in a great number of misplaced references which we have since then fixed.
5284	5	37	33			transfer efficiency controlled by much more...ballasting, phytoplankton compositon, so nutrients are very important. [Emma Cavan, Australia]	That's true, but we wanted to synthesize the effect of climate drivers (like temperature) over some of the main components of the BP, rather than making an exhaustive review of all the potential factos affecting the efficiency of the BP

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
9416	5	37	41	37	41	mesopelagial instead of mesopelagic [APECS Group Review, Germany]	Corrected
9414	5	37	46	37	48	What is the bibliography that supports the statement that mesopelagic zooplankton and fish communities living at DSL will increase their biomass by 2100? [APECS Group Review, Germany]	Proud et al 2016 (low confidence)
9418	5	37	46	37	48	Does the study cited only take climatic factors into account or is the exploitation of fish stocks considered as well? [APECS Group Review, Germany]	The study only considers climatic drivers influencing trophic efficiency. There is no consideration of mesopelagic flish exploitation
10976	5	U	49	37	49	The reduction of 3,5 % of oxygen inventory is in the high emission scenario. Besides, I do not agree that an increase in OMZ will lead to an increase in denitrifcation as it depnds on the lower values of oxygen reached. Recent investigations have shown that denitrifcation is inhibited by oxygen concentration of a few nM. So expansion of OMZ with oxygen values above ~1µM is not expected to lead to an increase in denitrification. Rather an expansion of AMZ will lead to enhanced denitrification. Please clarify. [Marilaure Gregoire, Belgium]	We have removed this text in the revision
3360	5	37	50	37	51	Ocurring in shallow marine sediments since the begining of the Holocene. E.g.: Martínez-Carreño, N. & García-Gil, S. 2013. Marine Geology 344, 82–100. [Castor Muñoz Sobrino, Spain]	N/A
9420	5	37	50	37	51	Please add the reference for the statement made in this line, concering the anaerobic processes and denitrification. [APECS Group Review, Germany]	We have removed this text in the revision
16730	5	37	50	37	51	"There is high confidence that OMZ expansion and shoaling would favour anaerobic microbial processes leading to denitrification" citations required for this statement [Cliff Law, New Zealand]	We have removed this text in the revision
684	5	38	2	38	2	"zooplankton is" be changed as "zooplankton are" [Kathiresan Kandasamy, India]	The text was altered as suggested by the reviewer.
5286	5	38	5			Wrong citation, this is the conclusion of the Cavan 2017 Nat.Comm paper just cited, not the Marsay 2015 paper, that just looked at temperature. [Emma Cavan, Australia]	An error occurred when chapter 5 references were compiled in Endnote by the TSU resulting in a displacement of all the references by one position. This resulted in a great number of misplaced references which we have since then fixed.
890	5	38	9	38	9	other remarks, is lack of cyclicity in the study of natural phenomena in this document for prediction (example the application of the model ARIMA in the study of lacyclicité), if not the output of the models used mention monotonous results (it is to always say up even if false or diminished) this vision gives a place to the term destiny and the god to manage his univer, with this perspective the human being will manage, share, push all natural risks to others continents and manage all the phenomena themselves. [Belkacem Balah, Algeria]	Not considered
6502	5	38	10	54	23	This section leaves out the habitats that compose the majority of the coastal ocean: soft sediment beds.This seems like a significant omission. [Ana Queiros, UK]	Soft sediments are addressed in other coastal ecosystems defined here, e.g. benthic fauna in intertidal mudflats are assessed in estuaries and saltmarshes.
20574	5	38	10		39	There are no references in the paragraph. [Chiara Lombardi, Italy]	The text was altered as suggested by the reviewer.
20578	5	38	10		39	According to other paraghps, I would suggest to insert a table, where CC drivers and habitat and fundation species are reported with their relative impacts. See table 5.2 [Chiara Lombardi, Italy]	The suggested table has been added in supplementary materials and used to build the figure of the new section (5.3.4) Risk Assessment for Coastal Ecosysems.
24414	5	38	10			This section is very generic review and how much of this is in AR5 Chapter 6 and 30? It may be worth considering if sections should be included on each of coastal blue carbon communities or assess these as a single section: (saltmarsh, seagrass, mangrove, macroalgae). [Hans-Otto Poertner and WGII TSU, Germany]	The text addresses the new findings since AR5 (Ch6 and 30) for each coastal ecosystem defined here, and a section of risk assessment for all coastal ecosystems has been added.

SROCC First Order Draft Expert Review Comments - Chapter 5							
Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
3362	5	38	15	38	15	Rias (partially submerged, non-glaciated valleys) might be also listed here. [Castor Muñoz Sobrino, Spain]	Rias are now considered inside estuaries section (5.3.3.1).
20576	5	38	16			Among fundation calcifying species, only coral reefs are mentioned. I would expand the concept to other biocenic reefs with which are thretened by CC. So, it could be changed in 'coral reefs and other biogenic reefs'. This concept has also a conservation meaning for decision makers. The need from scientific community is to expand conservation strategies to as broad range as possible of biconstructional species representing Vulnerable Marine Ecosystems but also providing ecosystem services. [Chiara Lombardi, Italy]	The text was altered as suggested by the reviewer. Also, this concept is now clarified in rocky reefs ecosystems (5.3.3.8)
3364	5	38	18	38	18	Again I missed lagoons here. [Castor Muñoz Sobrino, Spain]	Coastal lagoons are now considered inside estuaries section (5.3.3.1).
16732	5	38	18	38	21	"while some ecosystems…" there are some generalisations in this sentence that don't seem correct, but if they need to be backed up by citations. For example, coral reefs ae highly vulnerable to storm surges & sea level rise, [Cliff Law, New Zealand]	This introduction to coastal ecosystems attempts to be general, becuase all the specific references and drivers are in each coastal ecosystem subsection. Thus, the numbers of the subsections and general references have been included in this introduction. Furthermore, the suggested clarification concerning high vulnerability of biogenic reefs to storms has been inluded.
14068	5	38	34	38	39	remove this paragraph. Doesn't add anything to the section. [Elizabeth Jewett, USA]	We consider thisparagraph important to introduced how the assessments in the following subsections were made.
1518	5	38	42	38	52	May it be worth adding here a few words on the impact of the reduction of sediment supply from the rivers? [Davide Bonaldo, Italy]	Combined with other reviewer comment, this has been added later in the text of estuaries under the vulnerability of meso, macro and microtidal estuaries to sea level rise and river flow. The effect of reduction in sediment supply is also assessed in saltmarshes (5.3.3.2).
3366	5	38	42	38	52	Shallow marine ecosystems also contribute to C sequestration in CH4 form. E.g.: Martínez-Carreño, N. & García-Gil, S. 2013. Marine Geology 344, 82–100.; Muñoz Sobrino et al. 2014. Quaternary Science Reviews, 93: 11-33. [Castor Muñoz Sobrino, Spain]	Taken into account in SOD. Coastal ecosystems' contribution to carbon sequestration is considered in section 5.4 and 5.5 of SOD
10972	5	38	42	39	57	This section is a succession of findings with some of them in contradictions. For instance, "Increasing flooding during rainy periods over fertilized agriculture land will enhance estuarine eutrophication and stratification, and consequently will increase the likelihood of phytoplankton blooms (Thackeray et al., 2016) (high confidence) " but after we can read: " extreme river runoff increases the inflow of detritus and suspended sediments and reduces primary productivity by changing the optical properties of sea water. "The widespread observational evidence from shallow estuaries has already linked the increased levels of eutrophication and hypoxic conditions to warming (high confidence), and projections show that this processess will be more pronounced in estuaries from high latitudes (high confidence)".I guess that the increased eutrophication level is due to increased nutrients discharges and not to warming. At the end of the section, it is not straightforward to capture the main messages about what is known with high confidence on the situation of estuaries. [Marilaure Gregoire, Belgium]	The text has been modified for clarification according to the reviewer comment.

SROCC First Order Draft Expert Review Comments - Chapter 5							
Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
5542	5	38	45	38	46	Wetlands are said to be important areas of carbon burial. Nothing is mentioned about the emission of wetlands or net production. These might also change according to AR5 [Roderik Van De Wal, Netherlands]	Taken into account in SOD.
13778	5	38	47	38	47	Change 'on' to 'in' [Debra Roberts and Durban Team, South Africa]	The text was altered as suggested by the reviewer.
9422	5	38	57	39	1	Reference needed. [APECS Group Review, Germany]	The reference is Prandle and Lane (2015), indicated in the text.
686	5	39	4	39	4	"Meso- and macrotidal esturies 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" [Kathiresan Kandasamy, India]	The text was altered as suggested by the reviewer.
9424	5	39	15	39	15	PSS should be defined. [APECS Group Review, Germany]	The text was altered as suggested by the reviewer.
20304	5	39	15	39	15	Please provide an explanation for the salinity unit PSS [Michelle A. North, South Africa]	done
24172	5	39	15	39	15	What is “PSS”? please clarify [Hans-Otto Poertner and WGII TSU, Germany]	The text was altered as suggested by the reviewer.
17858	5	39	29	39	33	This section mentions harmful algal blooms (HABs) and refers to sections 5.2.2.3.2 and 5.2.2.3.4, but neither of these sections discuss HABs (though 5.2.2.3.5 does). In general, however, I think more discussion of HABs is warranted in the chapter, particularly with respect to human disease and/or food security (section 5.3.2). Increases in HABs due to changing climate conditions can/will impact human health through consumption of diseased seafood products (e.g., ciguatera fish poisoning). [Roberta Hansman, France]	HABs are discussed in sections 5.3.3.1 (estuaries) and 5.3.3.5 (sandy beaches). Moreover, HABs have been added in SOD as a Chapter Box (5.4 HABs and Climate Change) according to the reviewer suggestion.
16734	5	39	48	39	48	Is surface area to volume ratio is an issue that will influence warming of estuaries [Cliff Law, New Zealand]	Global literature has been assessed for this statement, including estuaries, coastal lagoons and shallow enclosed shelf seas.
16736	5	39	51	39	52	"AN INCREASE IN hypoxic conditions DUE TO algae blooms and microbIAL respiration" [Cliff Law, New Zealand]	The text was altered as suggested by the reviewer.
9426	5	39	52	39	52	"trough" should be "through" [APECS Group Review, Germany]	The text was altered as suggested by the reviewer.
20306	5	39	52			"through" is misspelled as "trough" [Michelle A. North, South Africa]	The text was altered as suggested by the reviewer.
20308	5	39	52			"microbial respiration" rather than "microbes respiration" [Michelle A. North, South Africa]	The text was altered as suggested by the reviewer.
4636	5	39	53	38	57	Coastal acidification is not only the concern in regards to hypoxia but also for the pelagic and benthic calcifiers due to OA effects related to shell dissoltuion and reduced calcification. [Nina Bednarsek, USA]	Taken into account in SOD.
24174	5	39	54	39	57	Provide reference(s) for this statement [Hans-Otto Poertner and WGII TSU, Germany]	References have been added to support this statement.

SROCC First Order Draft Expert Review Comments - Chapter 5							
Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
4	5	40	2	40	4	To avoid controversy and misleading, may add a sentence about the divergence and uncertainty of the projection and attribution of the changes of ENSO and NAO, and SAMOC. For example, it was noted that obserseved changes in the tropical Pacific as well as ENSO didn't all consist with the projections in global warming scenarios (Collines et al. 2010), that may partially due to the fact that many models used in the projections were unable to capture major features of the tropical Pacific climate, such as the spatial pattern and frequencies of ENSO.Collins, M., S.-I. An, W. Cai, A. Ganachaud, E. Guilyardi, F.-F. Jin, M. Jochum, M. Lengaigne, S. Power, A. Timmermann, G. Vecchi, and A. Wittenberg, 2010: The impact of global warming on the tropical Pacific Ocean and El Niño. Nature-Geoscience, 3(6), 391-397. DOI: 10.1038/ngeo868. Jha, B., Z.-Z. Hu, and A. Kumar, 2014: SST and ENSO variability and change simulated in historical experiments of CMIP5 models. Clim. Dyn., 42 (7-8), 2113-2124. DOI: 10.1007/s00382-013-1803-z. [Zeng-Zhen Hu, USA]	Taken into account in SOD.
6	5	40	2	40	4	To avoid controversy and misleading, may add a sentence about the divergence and uncertainty of the projection and attribution of the changes of ENSO and NAO, and SAMOC. For example, "it was noted that obserseved changes in the tropical Pacific as well as ENSO didn't all consist with the projections in global warming scenarios (Collines et al. 2010), that may partially due to the fact that many models used in the projections were unable to capture some major features of the tropical Pacific climate, such as the spatial pattern and frequencies of ENSO." Collins, M., S.-I. An, W. Cai, A. Ganachaud, E. Guilyardi, F.-F. Jin, M. Jochum, M. Lengaigne, S. Power, A. Timmermann, G. Vecchi, and A. Wittenberg, 2010: The impact of global warming on the tropical Pacific Ocean and El Niño. Nature-Geoscience, 3(6), 391-397. DOI: 10.1038/ngeo868. Jha, B., Z.-Z. Hu, and A. Kumar, 2014: SST and ENSO variability and change simulated in historical experiments of CMIP5 models. Clim. Dyn., 42 (7-8), 2113-2124. DOI: 10.1007/s00382-013-1803-z. [Zeng-Zhen Hu, USA]	Duplicate comment.
16738	5	40	2	40	24	This is a good paragraph as it gives clear examples of observations to support the issues of concern; unlike other sections [Cliff Law, New Zealand]	OK
3368	5	40	4	40	4	Similar evidence was found in the eastern Atlantic in relation to changes in dinoflagellate composition. E.g.: García-Moreiras et al (2018). Palaeogeography, Palaeoclimatology, Palaeoecology, 504: 201-218 [Castor Muñoz Sobrino, Spain]	This citation has been added.
11338	5	40	7	40	23	references out of order in this section - see individual citations flagged below [Croot Peter, Ireland]	An error occurred when chapter 5 references were compiled in Endnote by the TSU resulting in a displacement of all the references by one position. This resulted in a great number of misplaced references which we have since then fixed.
11340	5	40	8	40	8	Citation mismatch as cited work is for the South Atlantic, text refers to North Atlantic [Croot Peter, Ireland]	An error occurred when chapter 5 references were compiled in Endnote by the TSU resulting in a displacement of all the references by one position. This resulted in a great number of misplaced references which we have since then fixed.

SROCC First Order Draft Expert Review Comments - Chapter 5							
Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
3578	5	40	11	40	23	This paragraph needs to add some information on ocean acidification effects on coastal ecosystems (see papers by Bednarsek et al., 2014, 2016, 2017). [Richard Feely, USA]	Taken under consideration in SOD, reference included.
11342	5	40	14	40	14	Citation mismatch compared to text - cited work does not refer to Bahia Blanca [Croot Peter, Ireland]	An error occurred when chapter 5 references were compiled in Endnote by the TSU resulting in a displacement of all the references by one position. This resulted in a great number of misplaced references which we have since then fixed.
11344	5	40	16	40	16	Citation mismatch compared to text - should be Pascaul et al. (2015)? [Croot Peter, Ireland]	An error occurred when chapter 5 references were compiled in Endnote by the TSU resulting in a displacement of all the references by one position. This resulted in a great number of misplaced references which we have since then fixed.
11346	5	40	18	40	18	Citation mismatch compared to text - should be Macreadie et al (2015)? [Croot Peter, Ireland]	An error occurred when chapter 5 references were compiled in Endnote by the TSU resulting in a displacement of all the references by one position. This resulted in a great number of misplaced references which we have since then fixed.
9428	5	40	23	40	23	I am not sure about the suitability of using Scott et al. (2014) book to state the likely intensification of ENSO events for 2100. [APECS Group Review, Germany]	An error occurred when chapter 5 references were compiled in Endnote by the TSU resulting in a displacement of all the references by one position. This resulted in a great number of misplaced references which we have since then fixed.
16740	5	40	33	41	17	No comments on salt marshes,mangroves, seagrasses, sandy beaches as no expertise [Cliff Law, New Zealand]	OK
20310	5	40	34			Shouldn't it be "upper intertidal zone"? [Michelle A. North, South Africa]	The text was altered as suggested by the reviewer.
3370	5	40	48	40	48	In my experience, mud sediment from shallow marine ecosystems may be also included here (e.g. Martínez-Carreño, N. & García-Gil, S. 2013. Marine Geology 344, 82–100.; Muñoz Sobrino et al. 2014. Quaternary Science Reviews, 93: 11-33.) [Castor Muñoz Sobrino, Spain]	Taken into account in SOD. Coastal ecosystems' contribution to carbon sequestration is considered in section 5.4 and 5.5 of SOD
20312	5	41	22			"is exacerbated in cases…" rather than "exacerbates in cases…" [Michelle A. North, South Africa]	The text was altered as suggested by the reviewer.
688	5	41	24	41	24	"lost" be changed as "loss" [Kathiresan Kandasamy, India]	The text was altered as suggested by the reviewer.
20314	5	41	24			"loss" not "lost" [Michelle A. North, South Africa]	The text was altered as suggested by the reviewer.
690	5	41	25	41	25	"donot" be changed as "does not" [Kathiresan Kandasamy, India]	The text was altered as suggested by the reviewer.
20316	5	41	25			"does not seem" not "do not seem" [Michelle A. North, South Africa]	The text was altered as suggested by the reviewer.
20318	5	41	27			Rather use "e.g., compaction" instead of "i.e., compaction", since the latter implies that compaction is the only subsurface process you are interested in [Michelle A. North, South Africa]	The text was altered as suggested by the reviewer.
24176	5	41	42	41	43	Avoid being policy presciptive [Hans-Otto Poertner and WGII TSU, Germany]	The text was altered as suggested by the reviewer.
9430	5	41	43	41	43	Correct to eutrophication [APECS Group Review, Germany]	The text was altered as suggested by the reviewer.
3580	5	41	54	41	57	The widespread observational evidence from shallow estuaries has already linked the increased levels of eutrophication and hypoxic conditions to warming (high confidence), and projections show that this processess will be more pronounced in estuaries from high latitudes (high confidence). [Richard Feely, USA]	The text was altered as suggested by the reviewer.

SROCC First Order Draft Expert Review Comments - Chapter 5							
Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
9432	5	42	8	42	10	The reference Zhang et al. (2016) does not belong to this statement (Line 8). In lines 8-10, authors probably wanted to cite Zhang et al., 2017?) [APECS Group Review, Germany]	An error occurred when chapter 5 references were compiled in Endnote by the TSU resulting in a displacement of all the references by one position. This resulted in a great number of misplaced references which we have since then fixed.
1520	5	42	24	42	32	In my opinion it could be worth dedicating more attention here to the description of the constructive and destructive mechanisms for salt marshes and how they are affected by climate change, maybe referring to Table 5.2 [Davide Bonaldo, Italy]	A table of risk assessments and vulnerability for all coastal ecosystems has been added.
20320	5	42	27			I think "extirpated" would be better than "extinguished" in this sentence [Michelle A. North, South Africa]	The text was altered as suggested by the reviewer.
20322	5	42	27			Replace "loose" with "loss" [Michelle A. North, South Africa]	The text was altered as suggested by the reviewer.
692	5	42	28	42	28	"positive feedbacks" or "negative feedbacks"? [Kathiresan Kandasamy, India]	The text is correct, please see figure
9434	5	42	34	43	10	Reference needed. [APECS Group Review, Germany]	References have been included.
23080	5	42	34	47	44	There is way too much text for these ecosystems compared to their relevance vis-a-vis the other ecosystems. This needs to be re-balanced [Nicolas Gruber, Switzerland]	The structure of the ecosystem section has been substantially modified in SOD. All the ecosystems i.e. pelagic, deep sea floor and coastal, have been reorganised for consistency.
24416	5	42	42	42	45	This content is repeated in Figure 5.16, is this figure necessary? [Hans-Otto Poertner and WGII TSU, Germany]	The figure has been removed.
16742	5	42	45	42	45	Is Figure 5.11 required? [Cliff Law, New Zealand]	The figure has been removed.

SROCC First Order Draft Expert Review Comments - Chapter 5							
Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
698	5	43	1	43	25	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 threasholds 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). [Kathiresan Kandasamy, India]	Taken into account in SOD. Mangroves vulnerability is considered in 5.3.3.3 section. Coastal ecosystems' contribution to carbon sequestration is considered in section 5.4 and 5.5 of SOD
2214	5	43	6			it is not clear what is meant by 'from the greenhouse' [Chandani Appadoo, Mauritius]	The text was altered as suggested by the reviewer.
20324	5	43	6			There is something wrong with "A rise in sea level from the greenhouse is predicted to increase flooding" - I think "from the greenhouse" should be deleted [Michelle A. North, South Africa]	The text was altered as suggested by the reviewer.
20326	5	43	6			Please fix the typo "drawn mangroves" - I suspect it should be "drown mangroves", rather [Michelle A. North, South Africa]	The text was altered as suggested by the reviewer.
24180	5	43	6	43	6	what is meant by greenhouse? Greenhouse gas? [Hans-Otto Poertner and WGII TSU, Germany]	The text was altered as suggested by the reviewer.
694	5	43	10	43	10	"in certain species" be deleted, as it is a general fact [Kathiresan Kandasamy, India]	The text was altered as suggested by the reviewer.
20328	5	43	10	43	12	Please rewrite "The expected increase in mangrove growth under high CO2 conditions has been experimentally observed, also an unexpected change in salinity optima, favouring more saline conditions (Reef et al., 2015)" [Michelle A. North, South Africa]	The text was altered as suggested by the reviewer.
9436	5	43	14	43	16	References needed. [APECS Group Review, Germany]	References have been added.
15418	5	43	14	43	16	This is generally accepted to be true but there was a new paper out that found that C4 plants did better over a long-term 20 year study and it suggested the C3 response is a short-term one. Might be worth adding this to the discussion since I think we don't yet know how different species and plant communities are going to respond. See the study here: http://science.sciencemag.org/content/360/6386/317.full [Ariana Sutton-Grier, USA]	This is considered in preparation for SOD

SROCC First Order Draft Expert Review Comments - Chapter 5							
Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
20330	5	43	14	43	16	Please provide citations for these statements [Michelle A. North, South Africa]	Edited
24178	5	43	14	43	16	provide reference(s) [Hans-Otto Poertner and WGII TSU, Germany]	An error occurred when chapter 5 references were compiled in Endnote by the TSU resulting in a displacement of all the references by one position. This resulted in a great number of misplaced references which we have since then fixed.
696	5	43	25	43	25	in the Table 5.2, under factor column "increased rainfall" be changed as "erratic rainfall" or "rainfall" [Kathiresan Kandasamy, India]	we would actually want to indicate direction of changes
24418	5	43	25			Please consider if this level of detailed table is better placed in supplementary material [Hans-Otto Poertner and WGII TSU, Germany]	This is considered in preparation for SOD
13780	5	44	3			Refer to the global map of seagrass here. [Debra Roberts and Durban Team, South Africa]	Referred
21564	5	44	4	44	7	Only Posidonia meadows provide "highly refractory carbon deposits." Other types of seagrasses only make small roots within a sediment-dominated matrix. Posidonia meadows only occur in the Mediterranean Sea and along the coast of Australia (Green and Short, 2003. World Atlas of Seagrasses, University of California Press.) [Robie Macdonald, Canada]	The text was altered as suggested by the reviewer.
9438	5	44	6	44	6	Correct to stored [APECS Group Review, Germany]	The text was altered as suggested by the reviewer.
13782	5	44	6	44	6	Change 'store' to 'stored' [Debra Roberts and Durban Team, South Africa]	The text was altered as suggested by the reviewer.
20332	5	44	11			"anthropogenic" - please correct the spelling typo [Michelle A. North, South Africa]	The text was altered as suggested by the reviewer.
20334	5	44	19			I think that "most vulnerable to loose seagrass area" may be intended to be "most vulnerable to loss of seagrass area", please check what is intended by this sentence [Michelle A. North, South Africa]	The text was altered as suggested by the reviewer.
700	5	44	25	44	25	"A. Antarctica" be changed as "A. antarctica" [Kathiresan Kandasamy, India]	The text was altered as suggested by the reviewer.
2216	5	44	25			A. Antarctica, the full name of the species should be written and the genus name should start with a capital letter and the species name should be lower case. [Chandani Appadoo, Mauritius]	The text was altered as suggested by the reviewer.
3372	5	44	25	44	25	Do you mean Amphibolis antartica? Specify, please. (antarctica should be in low case). [Castor Muñoz Sobrino, Spain]	The text was altered as suggested by the reviewer.
17868	5	44	25	44	25	The genus for A. Antarctica needs to be spelled out here. [Roberta Hansman, France]	The text was altered as suggested by the reviewer.
24182	5	44	25	44	25	in "UV-B-radiation" under "impacts": the only rating in this whole column. Nowhere else it is said whether there are mayor or minor impacts--> consider changing this cell [Hans-Otto Poertner and WGII TSU, Germany]	We keep the table as it is for SOD.
21566	5	44	26	44	27	The statement "… 9% of the C sequestration…" needs a reference. [Robie Macdonald, Canada]	The correct reference is Arias-Ortiz et al. (2018)
21568	5	44	36	44	37	"flowering of Posidonia has been advocated…" does not make sense. That will probably be caught in the copyedit, too. [Robie Macdonald, Canada]	The text was altered as suggested by the reviewer.
1662	5	44	46	44	48	Does this sentence miss a word in the end, after "community"? [Aurora Stenmark, Norway]	The text was altered as suggested by the reviewer.
21570	5	44	46	44	48	""… can result in their community…" This does not make sense because the sentence is incomplete. [Robie Macdonald, Canada]	The text was altered as suggested by the reviewer.

SROCC First Order Draft Expert Review Comments - Chapter 5							
Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
1626	5	44	48	44	50	If migration of tropical herbivores into temperate seagrass-dominated environments is also relevant for the polarmost parts of the temperate regions, please include litteratur related to this. [Aurora Stenmark, Norway]	The text has been modified according to the reviewer suggestion. We could not find literature on polarmost temperate regions so we have removed "globally" from the sentence.
9440	5	44	48	44	50	I find too speculative to state that the intensity of hervibory over seagrasses will increase globally due to the migration of tropical hervibores, based on just one experiment (Heck et al., 2015). [APECS Group Review, Germany]	New sutdies have been added in the paragraph of herbivory effects on seagrasses. An error occurred when chapter 5 references were compiled in Endnote by the TSU resulting in a displacement of all the references by one position.The statement that temperate seagrasses are more vulnerable to the introduction of tropical consumers is supported by Hyndes et al. 2016, which reviews global tropicalization of herbivorous and modification of seagrasses meadows.
9442	5	45	3	45	6	I find contradictory to state the role of the introduction of tropical species in higher latitudes, with the statement that tropical species have a low dispersal ability. [APECS Group Review, Germany]	We have modified the text for clarification. It is the introduction of tropical hervibores, and the low dispersal ability of seagrass species.
9446	5	45	9	47	44	What about the effects of extreme heat exposure on sandy beaches? Are there any evidences of these effects? [APECS Group Review, Germany]	We could not find any study of the particular effects of hetawaves on sandy beaches.
5544	5	45	20	45	21	Doesn't a rise in groundwater level attenuate the effects of erosion? [Roderik Van De Wal, Netherlands]	The text was altered for clarification.
20338	5	45	20			I think "exacerbate" would be a better word than "accentuate", here [Michelle A. North, South Africa]	The text was altered as suggested by the reviewer.
20340	5	45	23			The acronym "SAO" is unecessary as it is not used again. Also, I think it would be better to write out "sea surface temperature" here, rather than using the acronym SST [Michelle A. North, South Africa]	The text was altered as suggested by the reviewer.
13784	5	45	26	45	26	This was more than 10 years ago. Has there been no work since then adding to the understanding of the poleward shift? [Debra Roberts and Durban Team, South Africa]	An error occurred when chapter 5 references were compiled in Endnote by the TSU resulting in a displacement of all the references by one position. This resulted in a great number of misplaced references which we have since then fixed.
9444	5	45	38	45	38	SLR should be defined [APECS Group Review, Germany]	The text was altered as suggested by the reviewer.
13786	5	45	38			The single example of southerns California seems out of place here. Are there other examples from elsewhere? [Debra Roberts and Durban Team, South Africa]	The text was altered as suggested by the reviewer, and new references from other sandy beaches have been added.
20342	5	45	39			What are the "SLR scenarios"? Please write out the acronym or refer to the glossary or something similar. This acronym is introduced (written out in full) for the first time on p 135! [Michelle A. North, South Africa]	The text was altered as suggested by the reviewer.
20336	5	45	47			"and can result in their community" what? Please check that this sentence conveys what is intended [Michelle A. North, South Africa]	This comment does not match with the indicated page and lines.
9448	5	46	12	46	14	How references are shown in Table 5.3 should be homogenized as in Tables 5.1 or 5.2 (or vice versa) [APECS Group Review, Germany]	Table 5.1 is not longer in the SOD.
24184	5	46	12			Do superscript numbers in table 5.3 indicate the source reference? If yes, please clarify in legend to the table [Hans-Otto Poertner and WGII TSU, Germany]	The numbers have been explained in the legend.
24420	5	46	12			Please consider if this level of detailed table is better placed in supplementary material [Hans-Otto Poertner and WGII TSU, Germany]	We keep the table in SOD, it has been extended to sandy beaches of North and Sowth America and it is important for the ecosystem assessment.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
18730	5	47	5	47	15	Concerning the Sargassum bloom, satellite observations of the 2011 outbreak revealed that the algal rafts were not coming from the Sargasso Sea as originally thought but from the mouth of the Amazon along the northern coast of Brazil (likely due to eutrophication). Smetacek and Zingone, 2013; and Gower et al., 2011 found that the rafts did not follow the usual circulation and travelled to places where they have never been witnessed before like northwest Africa (Smetacek and Zingone, op. cit.; Gower, Young, and King, Satellite images suggest a new Sargassum source region in 2011, Remote Sensing Letters Volume 4, 2013 – Issue 8, p. 764-773). It would be interesting to mention the increasing spatial distribution alongside with intensity, periodicity… [Antoine Pebayle, France]	A Box (5.4) of Harmful algal blooms (HABS) assessment has been included in the SOD.
18732	5	47	5	47	15	Eutrophication is assumed to be the main factor explaining Sargassum harmful blooms. Impacts of climate change are generally assessed to contribute to this phenomenon but the attribution of correlation is not clear, neither consensual. Yet, the heating waters may cause an extension of the distribution area of Sargassum. Role of acidification and of a changing oceanic circulation are not well understood but still discussed (Louime, Fortune, and Gervais, Sargassum Invasion of Coastal Environments: A Growing Concern, American Journal of Environment Science, 13 (1): 58.64, p.58-63, 2017; Langin, Seaweed masses assault Caribbean islands, Science vol. 360, issue 6394, p.1157-1158, 15 June 2018). Cumulative stressors are difficult to elucidate, research is still needed to attribute Sargassum blooms to the effects of climate change. [Antoine Pebayle, France]	Taken under consideration in SOD. The suggested reference Louime et al. (2017) has been added.
18734	5	47	5	47	15	In the perspective of the coming UN Decade of ocean science for sustainable development (2021-2030) and of the SDG14 14.a target (Increase scientific knowledge, develop research capacity and transfer marine technology) this Special Report should call for more international cooperation around the issue of Sargassum and other HABs. As noted by Smetacek and Zingone (op. cit.), the establishment of an “international consortium” is needed. New surveying techniques, sampling and modelling can only benefit from an international interdisciplinary research program. [Antoine Pebayle, France]	A Box (5.4) of Harmful algal blooms (HABS) and Climate change has been included in the SOD.
20344	5	47	5	47	8	It is completely unnecessary to abbreviate 'harmful algal blooms' to HABs, please remove [Michelle A. North, South Africa]	The abbreviation remains in the text as it links the text with the new Chapter Box 5.3 of HABs
13788	5	47	7	47	7	Close bracket after 'medium confidence' [Debra Roberts and Durban Team, South Africa]	The text was altered as suggested by the reviewer.
20346	5	47	23	47	25	Write out sea level rise in full please [Michelle A. North, South Africa]	The text was altered as suggested by the reviewer.
9450	5	47	30	47	33	The reference of Revell et al. (2011) is incorrect, as their work was centered in a Californian beach rather than an Uruguyan beach. [APECS Group Review, Germany]	An error occurred when chapter 5 references were compiled in Endnote by the TSU resulting in a displacement of all the references by one position. This resulted in a great number of misplaced references which we have since then fixed.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
4064	5	47	46	49	10	Please consider clearly stating that only tropical coral reefs are to be addressed in this part, and that cold-water coral reefs (e.g. reefs built by Lophelia pertusa) at higher latitudes are included in 5.2.2.4.9. This distinction is important. [Aurora Stenmark, Norway+G1303:L1303F1303:L1303G1303:L1303H1303A1303:L1303]	Yes, only tropical reefs are considered here
4070	5	47	46	49	10	Reference should be made to IPCC AR5 WGII where tropical coral reefs were identified as ecosystems especially at risk both in near and long term future due to high vulnerability and low adaptive capacity. These risks are no longer scenarios or projections for the future - they are happening today! [Aurora Stenmark, Norway]	Accepted. IPCC AR5 WGII was inserted in the right sites.
24422	5	47	46			is this section only considering warm-water coral reefs - please specify in title [Hans-Otto Poertner and WGII TSU, Germany]	Done
16744	5	47	48	47	48	turbidity/sedimentation & storm surges should feature here [Cliff Law, New Zealand]	Added
16746	5	47	53	47	57	Too many citations! [Cliff Law, New Zealand]	There are 13 citations that reveal the wide range of information available in the literature
24186	5	47	54	48	9	split the references by topic; as it is now it is impossible to trace which informations comes from which source [Hans-Otto Poertner and WGII TSU, Germany]	Many of the references deal with more than a single driver, thus it is impossible to split the list into the individual climate change drivers.
1522	5	48	6	48	6	surpasses --> surpass? [Davide Bonaldo, Italy]	The text was altered as suggested by the reviewer.
20348	5	48	7	48	9	This sentence does not causally follow the previous one, thus I would recommend removing the word "consequently" and simply start with "Reefs are further exposed to indirect impacts…". [Michelle A. North, South Africa]	The text was altered as suggested by the reviewer.
6026	5	48	11	48	23	Several studies on corals taken from the field indicate resilience to ocean acidification duet to up-regulation of internal pH at the site of clacification. Those studies are not mentioned nor cited. McCullloch et alk. 2012 (Nature Climate Change) is a key reference to include. There are several papers that followed since 2012, McCulloch et al., 2017 and D'Olivo & McCulloch 2017 as examples. Tropical corals are primarily under threat from ocean warming and less so from current ocean acidification. That is a message that should come out very clear in this chapter. [Jens Zinke, Germany]	Accepted. A recent publication has been cited [Cornwall, C. E., Comeau, S., DeCarlo, T. M., Moore, B., D'Alexis, Q., & McCulloch, M. T. (2018). Resistance of corals and coralline algae to ocean acidification: physiological control of calcification under natural pH variability. Proc. R. Soc. B, 285(1884), 20181168.]
16748	5	48	13	48	15	Too many citations! [Cliff Law, New Zealand]	Citations provide the wide spectrum of outcomes and attest to the common literature knowledge.
12142	5	48	15			I suggest to include in this subsection invasive species as an additional stressor showing potential synergistic effects on corals (e.g. Kersting et al. 2015) Kersting DK, Cebrian E, Casado C, Teixidó N, Garrabou J, Linares C (2015) Experimental evidence of the synergistic effects of warming and invasive algae on a temperate reef-builder coral. Scientific Reports 5:18635 [Diego Kersting, Germany]	Invasive species threats are not directly resulted from global change impacts and are more related to anthropogenivc impacts.
9454	5	48	36	48	39	Even if corals possess the machinery to compensate the effects, is this also true on the very short timescale of the current climate change? [APECS Group Review, Germany]	The text has been revised

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
16750	5	48	36	48	43	Paragraph needs to be rewritten for clarity [Cliff Law, New Zealand]	The text was altered as suggested by the reviewer.
9452	5	48	37	48	38	... attest that corals, as other marine organisms, possess the... [APECS Group Review, Germany]	The text was altered as suggested by the reviewer.
20350	5	48	39	48	41	Please simplify this sentence, break it into two separate sentences if possible and remove all redundancies (e.g., "point to the conclusion for increased uncertainty") - it is incomprehensible as it is currently [Michelle A. North, South Africa]	The text was altered as suggested by the reviewer.
20352	5	48	49			What are "mesophotic reefs"? Please include this in the glossary or as a footnote or other explanation [Michelle A. North, South Africa]	The text was revised accordingly
9456	5	49	5	49	5	Despite being a commonly used term, please reference the geographical area of the Coral Triangle [APECS Group Review, Germany]	As a result of space limitation and further shortening the length of the text it is impossible to add information that should be easily obtained, if not known, such as the geographical contour of the 'coral triangle'.
16752	5	49	12	50	18	well-written section [Cliff Law, New Zealand]	Thanks
20580	5	49	12	50	18	This paragraph include all ecosystems living on rocky substrates, considering both calcifying and non-calcifying species. I so of course agree with rocky ecosistems but, as mentioned above, I would add a dedicated paragraph to other biogenic reef. This paragraph, as speciefied above, might include studies on other calcifying species (i.e. no corals) responsible in developing calcifying 'reef' such as coralline algae (i.e. maerl beds), mollusks, polychaetes, bryozoans, sponges. [Chiara Lombardi, Italy]	The discussion on other calcifying organisms is found in other sub chapters. In rocky reef ecosytems, biogenic reefs are mentioned in the description of ecosytem components as suggested by the reviewer.
12144	5	49	45			I propose to add following reference: Linares et al. (2015) as evidence of community shifts (calcifying organisms to fleshy algal dominated communities) in acidified waters. Linares C, Vidal M, Canals M, Kersting DK, Amblás D, Aspillaga E et al. (2015) Persistent natural acidification drives major distribution shifts in marine benthic ecosystems. Proceedings of the Royal Society B-Biological Sciences 282:20150587. [Diego Kersting, Germany]	The reference has been added in the text.
20354	5	49	55	49	56	Remove one of the two "however"s found in this sentence please [Michelle A. North, South Africa]	The text was altered as suggested by the reviewer.
15200	5	49	56	49	56	warmer temperature increase the strength of top-down control, which incReases predation [Christophe Deissenberg, Luxembourg]	The text was altered as suggested by the reviewer.
15202	5	49	57	49	57	and eliminates enhanced [Christophe Deissenberg, Luxembourg]	The text was altered as suggested by the reviewer.
20610	5	50	0	51		Nicely written. Figure 5.1 needs to be put more clearly as it seems the resoution of the image is not good. [Pushp Raj Tiwari, UK]	The comment does not match to the page indicated here.
24188	5	50	10	50	18	please clarify that this paragraph is just a summary of the above information [Hans-Otto Poertner and WGII TSU, Germany]	The text was altered as suggested by the reviewer.
3374	5	50	20	50	27	Significant C may be also buried in coastal shallow ecosystems (rias). E.g.: Martínez-Carreño, N. & García-Gil, S. 2013. [Castor Muñoz Sobrino, Spain]	Taken into account in SOD. Coastal ecosystems' contribution to carbon sequestration is considered in section 5.4 and 5.5 of SOD
13790	5	50	20			A Global map of kelp forest extent would be useful. [Debra Roberts and Durban Team, South Africa]	A map of some coastal ecosystems have been included in section 5.4

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
24424	5	50	20			Aren't kelp forests a subset of rocky reef systems (5.2.2.2.37)?? [Hans-Otto Poertner and WGII TSU, Germany]	There are some overlaps in the coastal ecosystems defined here, but there is enough evidence to assess each ecosytem separately, based on fundational species or geomorphological features. The number of the subsection rocky reefs (5.3.3.8) has been added in kelp forest text as suggested.
17850	5	50	22	50	22	The units here should be converted to PgC to be consistent with other sections of the chapter. [Roberta Hansman, France]	The text was altered as suggested by the reviewer.
24190	5	50	26	50	26	refer to 5.2.2.4 here [Hans-Otto Poertner and WGII TSU, Germany]	The text was altered as suggested by the reviewer.
16754	5	50	30	50	31	What is "a small instantaneous rate of change"? [Cliff Law, New Zealand]	Removed.
4054	5	50	31	50	31	Please check if the unit given for the rate of change (-0,018 yr-1) is correct [Aurora Stenmark, Norway]	Removed.
17852	5	50	31	50	31	What are the units for the change of -0.018 per year? Change of what? [Roberta Hansman, France]	Removed.
15204	5	50	37	50	38	attributed to climate change and not related to sea urchin overgrazing (which is a major driver of decline, Bolton et al., 2012) [Christophe Deissenberg, Luxembourg]	The text was altered as suggested by the reviewer.
12146	5	50	49	51	51	Worryngly range changes in the north coast of the Iberian Peninsula go beyond L. ochroleuca and S. polyschides. The retreat of other ecosystem engineers like Fucus serratus (Duarte et al. 2013) , Fucus vesiculosus (Nicastro et al. 2013), for example, are well documented. Duarte L, Viejo RM, Martínez B, de Castro M, Gómez-Gesteira M, Gallardo T (2013) Recent and historical range shifts of two canopy-forming seaweeds in North Spain and the link with trends in sea surface temperature. Acta Oecologica-International Journal of Ecology 51:1-10. Nicastro KR, Zardi GI, Teixeira S, Neiva J, Serrao EA, Pearson GA (2013) Shift happens: trailing edge contraction associated with recent warming trends threatens a distinct genetic lineage in the marine macroalga Fucus vesiculosus. Bmc Biology 11:6. [Diego Kersting, Germany]	The retreat of Fucus spp. has been assessed in rocky reef ecosystems (5.3.3.8), where the suggested references has been added as suggested by the reviewer.
20356	5	51	27			"what corroborates the predictions…" - shouldn't this be "which corroborates…"? [Michelle A. North, South Africa]	The text was altered as suggested by the reviewer.
20358	5	51	36			Check whether this should rather say "decreased by nearly 30% by 1998", rather than "in 1998". [Michelle A. North, South Africa]	The text was altered as suggested by the reviewer.
20360	5	51	51			Delete "known in the order Laminariales, " because it doesn't add anything to this sentence; and check whether this sentence doesn't repeat what has already been said in lines 39-42 (maybe try to combine) [Michelle A. North, South Africa]	The text was altered as suggested by the reviewer.
20362	5	51	55			"considerable", not "considerably" [Michelle A. North, South Africa]	The text was altered as suggested by the reviewer.
20364	5	52	1			Please explain "epibiontic community" or refer to glossary [Michelle A. North, South Africa]	The text refers now to the glossary.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
20366	5	52	12			"enhanced grazing by warming" doesn't make sense, 'warming' doesn't graze. I think this is missing who is doing the grazing (e.g., enhanced grazing by herbivores as a result of warming…) [Michelle A. North, South Africa]	The text was altered as suggested by the reviewer.
16756	5	52	19	52	19	The section on Kelp forests is interesting, but large relative to other sections; so is a further Box (5.2) justified? [Cliff Law, New Zealand]	The box of kelp forests has been replaced by a box of harmful algal blooms (HABs).
702	5	52	21	52	21	"have leaded" be changed as "have led" [Kathiresan Kandasamy, India]	The text was altered as suggested by the reviewer.
20368	5	52	21			"have lead" not "have leaded" [Michelle A. North, South Africa]	The text was altered as suggested by the reviewer.
20370	5	52	25			"have", not "has" [Michelle A. North, South Africa]	The text was altered as suggested by the reviewer.
20372	5	52	26	52	28	These two sentences could be joined together, e.g., "In early 2011, the most severe warming recorded in the last 140 years impacted this coastline, with seawater temperatures reaching unprecedented levels and 2°C–4°C warming anomalies present for more than 10 weeks (…)" or similar [Michelle A. North, South Africa]	The text was altered as suggested by the reviewer.
20374	5	52	36			"increased considerably" [Michelle A. North, South Africa]	The text was altered as suggested by the reviewer.
9458	5	52	42	52	42	2015 was four years after the heatwave so this sentence should say four years after instead of five. In the same sentence (upper line) 2013 is reffered as two years after the heatwave so 2015 should be four to keep consistency. [APECS Group Review, Germany]	The text was altered as suggested by the reviewer.
20376	5	53	1			What is meant by "thereby follows the diminution of the warm current"? Does the kelp decrease as the current decreases, or the reduction of kelp decreases as the current decreases, or the reduction follows the path of the current as it decreases? Please be more specific [Michelle A. North, South Africa]	The text was altered as suggested by the reviewer.
642	5	53	4	53	4	habitats of (not off) Tasmania has to be seen …. [Mostafa Jafari, Iran]	The text was altered as suggested by the reviewer.
644	5	53	5	53	5	only recently established (, 2005) - it is not recent with old reference [Mostafa Jafari, Iran]	The text was altered as suggested by the reviewer.
2218	5	53	6			to inlcude name of sea urchin species [Chandani Appadoo, Mauritius]	Kelp forest box moved to Ch.6
9460	5	53	27	53	30	Since this statement is based only on a single modelling projection it should include something like "there is limited evidence and the scale and geographical distribution of these impacts are unknown". Besides, there are some evidences that suggest that sometimes glacial melting effects might increase production of artic, antarctic and sub-antartic fjords, e.g. marine terminating glaciers in Greenland (Meire et al., 2017 within chapter 3 references). [APECS Group Review, Germany]	An error occurred when chapter 5 references were compiled in Endnote by the TSU resulting in a displacement of all the references by one position. This resulted in a great number of misplaced references which we have since then fixed.
20378	5	53	28			Omit the word "sediment" before "floods", it's the second time its used in the phrase [Michelle A. North, South Africa]	The text was altered as suggested by the reviewer.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
1658	5	53	30	53	42	There are some referencing errors. The Reibesell et al. 2016 paper is used as a reference for calcifying phytoplankton productivity in Chilean fjords (Line 30-33), but the paper is based on experiments from a Norwegian fjord system. This suggests that Riebesell should have been the reference for the sentence starting at line 33 (Similar evidence.…). Likewise, the Goldstein et al 2017 paper should be the correct reference for the sentence starting at line 36 (In the Baltic sea…) and since the Thomsen et al 2017 paper studied bivalves, this should be the correct reference for the sentence starting at line 40 (Fjord environments…) [Aurora Stenmark, Norway]	An error occurred when chapter 5 references were compiled in Endnote by the TSU resulting in a displacement of all the references by one position. This resulted in a great number of misplaced references which we have since then fixed.
16758	5	53	33	53	36	I believe there are more relevant factors to report here from the Norwegian fjord CO2 mesocosms experiments, such as changes in productivity, boimass, species compositoin of phytpolankton and impacts on foodwens & carbon cycling, than broader climate feedbacks such as DMS (& there is not even medium confidence in the link between DMS & climate!) [Cliff Law, New Zealand]	The text was altered as suggested by the reviewer.
9462	5	53	40	53	46	This entire paragraph lacks any term referring to the confidence of its statements or the amount of evidence provided to reach the conclusions or the existing agreement on them. It would be very helpful for readers to include them. [APECS Group Review, Germany]	Fjords moved to Ch. 3
20380	5	53	40			What is meant by "Fjord environments are in occasional naturally acidified habitats…"? Please rephrase [Michelle A. North, South Africa]	The text was altered as suggested by the reviewer.
11348	5	53	46	53	46	The cited reference is for ecosystems for the deep ocean and does not appear related to the subject of the sentence. Should this be the Mardones et al. 2016 work? [Croot Peter, Ireland]	An error occurred when chapter 5 references were compiled in Endnote by the TSU resulting in a displacement of all the references by one position. This resulted in a great number of misplaced references which we have since then fixed.
3376	5	53	48	53	57	Low confidence may result from models, but this can be confirmed by estudies in estuaries and rias (not glaciated fluvio-marine systems) which demonstrates that dinoflagellates communities changed during the Holocene as a result of clmate changes and the RSL rise. E.g.: Muñoz Sobrino et al. (2012) Boreas41: 578–601. [Castor Muñoz Sobrino, Spain]	Fjords moved to Ch. 3
9464	5	53	48	53	57	It is very difficult to evaluate the confidence level of these statements since there is not a single reference to the studies used to reach these conclusions. [APECS Group Review, Germany]	An error occurred when chapter 5 references were compiled in Endnote by the TSU resulting in a displacement of all the references by one position. This resulted in a great number of misplaced references which we have since then fixed.
24192	5	53	48	53	57	please clarify that this paragraph is just a summary of the above information [Hans-Otto Poertner and WGII TSU, Germany]	This is considered in preparation for SOD
2864	5	54	3	54	3	I think you should delete "all" as this now is a very strong statement. [Geir Ottersen, Norway]	Fjords moved to Ch. 3
704	5	54	8	54	8	"sandy beach and satmarshes morphology" be changed as 'morphology of sandy beach and saltmarshes" [Kathiresan Kandasamy, India]	The text was altered as suggested by the reviewer.
706	5	54	17	54	17	"Kelp forests and seagrass" be changed as "Kelp forests, mangroves and seagrass" [Kathiresan Kandasamy, India]	Fjords moved to Ch. 3
9466	5	54	17	54	19	Normally, organisms are more vulnerable to environmental disturbances (e.g storms), when they are colonizing a new location. Thus, extreme events might prevent organisms' poleward shift and istead promote a reduction of these habitat. [APECS Group Review, Germany]	Fjords moved to Ch. 3

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
20382	5	54	19			This is the third time I've seen the phrase "enhanced grazing by warming", and I still think it should be modified [Michelle A. North, South Africa]	The text was altered as suggested by the reviewer.
2866	5	54	21	54	22	Not all fjords are in high-latitude areas with snow and ice [Geir Ottersen, Norway]	Fjords moved to Ch. 3
20384	5	54	28			I think this should say ">200 m deep, deeper than…", or "…vast area of ocean deeper than 200 m…", or "vast area of ocean deeper than the continental shelves (>200 m)" or something [Michelle A. North, South Africa]	The text was altered as suggested by the reviewer.
2700	5	54	31	54	31	The citation (2014) does not make sense. At least one review paper should be cited here. [Kirk Sato, Japan]	This is corrected to cite the AR5 Ch30 (Hoegh-Guldberg et al. 2014).
9468	5	54	31	54	31	There is a reference missing inside the bracket (2014) [APECS Group Review, Germany]	This is corrected to cite the AR5 Ch30 (Hoegh-Guldberg et al. 2014).
13792	5	54	31	54	31	Author name missing. [Debra Roberts and Durban Team, South Africa]	This is corrected to cite the AR5 Ch30 (Hoegh-Guldberg et al. 2014).
13794	5	54	31	54	35	The definition here is confusing. Is the deep between 200 m and 1000 m? The definition by Gage falls outside of this range as it defined deep sea as area below 1000 m [Debra Roberts and Durban Team, South Africa]	The definition used here encompasses the 200-1000 m waters including those below. This is now clarified
17872	5	54	31	54	31	This reference (2014) is incomplete as it includes no author(s). [Roberta Hansman, France]	This is corrected to cite the AR5 Ch30 (Hoegh-Guldberg et al. 2014).
20386	5	54	31			Check this reference "(2014)" [Michelle A. North, South Africa]	This is corrected to cite the AR5 Ch30 (Hoegh-Guldberg et al. 2014).
2702	5	54	32	54	32	photosyntheticaly should be spelled photosynthetically [Kirk Sato, Japan]	The text was altered as suggested by the reviewer.
11350	5	54	32	54	32	While this is a reasonable definition it could be pointed out that it fails in the oligotrophic South Pacfic Gyre where the 1% light level for PAR can be below 200 m (Teddetti et al. 2007 doi:10.1029/2007GL029823). Whether you take the 1% light level as sufficient for growth is another thing but it does highlight that the 200 m definition does neglect deep chlorophyll maxima in the oligotrophic gyres. [Croot Peter, Ireland]	This section refers to the sea floor, but we have qualified the changes to recognize exceptions.
2704	5	54	40	54	42	As written, the sentence is difficult to understand. Also, there is a stray) after 6000 m. [Kirk Sato, Japan]	The text was altered as suggested by the reviewer.
13796	5	54	41	54	41	Delete close parenthesis after '> 6000 m' [Debra Roberts and Durban Team, South Africa]	The text was altered as suggested by the reviewer.
13798	5	55	0			Fig 5.12 A nice long informative legend that explains everything in the figure cleary would much improve the value of this beautiful figure. [Debra Roberts and Durban Team, South Africa]	A descriptive legend is now included
13184	5	55	1	55	1	Fig. 5.12 is pretty but it does not illustrate how the various climate drivers alter upwelling, circulation etc., as the caption promises. Either the figure needs to be augmented or the caption changed to say something along the lines of "illustrates the different terrestrial and marine components involved in upwelling, surface production, circulation, and fluid flows…" [Baerbel Hoenisch, USA]	The figure is modified to illustrate both the deep-sea ecosystems discussed and the processes linking climate change to deep-sea ecosystems.
20388	5	55	1			Lovely diagramme! Very complex but helps one orientate with all the things going on in the ocean (when it isn't your field) [Michelle A. North, South Africa]	Thank you.
16760	5	55	3	55	3	Fig. 5.12 is good. Perhaps add deep currents/thermohaline circulation, as this is an important climate-sensitive feature for the deep ocean [Cliff Law, New Zealand]	suggestion accepted
5546	5	55	11	55	11	Not entirely clear what is meant by "negative" exposure, temperature is rising for example. In the sense of undesirable? [Roderik Van De Wal, Netherlands]	The term negative exposure was replaced with cumulative exposures to higher temperature and declining oxygen, pH and POC flux

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
2706	5	55	15	55	21	The section refers to "an analysis", but it is unclear if this is Watling et al. 2013 or not. Please add who conducted this analysis at the end of the sentence. [Kirk Sato, Japan]	Now cited as Wei et al., in press.
16762	5	55	21	55	25	Remove RFMO information as not required [Cliff Law, New Zealand]	The text was altered as suggested by the reviewer.
9470	5	55	30	56	9	It would be very helpful for readers if the actual reports, articles, etc. containing the metrics and projections were included instead of repeating the acronyms of the RFMOs [APECS Group Review, Germany]	This report is being made available.
13186	5	56	14	56	14	correct spelling of Pörtner [Baerbel Hoenisch, USA]	The text was altered as suggested by the reviewer.
2708	5	56	23	55	23	KENNETT should be changed to Kennett [Kirk Sato, Japan]	The text was altered as suggested by the reviewer.
13188	5	56	23	56	23	no caps for Kennett [Baerbel Hoenisch, USA]	The text was altered as suggested by the reviewer.
20582	5	56	23			"KENNETT" should be changed to "Kennett", remove capitals [Chiara Lombardi, Italy]	The text was altered as suggested by the reviewer.
20390	5	56	24			"abrupt de glacial warming"? I think the "de" is a typo [Michelle A. North, South Africa]	The text was altered as suggested by the reviewer.
2710	5	56	41	56	41	insert "of" between range and physiological [Kirk Sato, Japan]	The text was altered as suggested by the reviewer.
13190	5	56	41	56	41	broad range of [Baerbel Hoenisch, USA]	The text was altered as suggested by the reviewer.
1158	5	56	46			Replace "cused" with "caused". [William Clarke, Australia]	The text was altered as suggested by the reviewer.
2712	5	56	46	56	46	the word "cused" should be changed to "caused" [Kirk Sato, Japan]	The text was altered as suggested by the reviewer.
3264	5	56	46			caused' [Martin Edwards, UK]	The text was altered as suggested by the reviewer.
20392	5	56	46			Typo: should be "caused", not "cused" [Michelle A. North, South Africa]	The text was altered as suggested by the reviewer.
16764	5	56	48	56	48	reduce the nutrient supply to the surface, REDUCING FOODWEB PRODUCTIVITY &FISHERIES IN UPWELLING REGIONS, AND SUBSEQUENTLY causing declines in export of primary production to the deep sea [Cliff Law, New Zealand]	This requested revisions belong in the discussion of upwelling, whereas the original statement applies over a broad range of oligotrophic abyssal environments as well. Thus the change was not made.
5548	5	56	53	57	5	Very condensed paragraphabout results from CMIP5. Not any background is given. Maybe some more background info would be usefull, now these statements seem isolated and somewhat misplaced in between the text. [Roderik Van De Wal, Netherlands]	More detail given in Section 5.2.1.5
13800	5	56	53	56	53	Delete 'in the IPCC Fifth Assessment Report' as AR5 has already been defined. [Debra Roberts and Durban Team, South Africa]	The text was altered as suggested by the reviewer.
20394	5	56	53			I think this is the first time in the whole report that I've actually seen CMIP5 written out ("Coupled Model Intercomparison Project (CMIP5)"), wow! Please could this be included in earlier chapters at first mention [Michelle A. North, South Africa]	This is now written out in Chapter 1. (see Section 1.8.2.3, and also IPCC 5th assessment report reference)
3582	5	57	2	57	20	This section needs a discussion of ocean acidfication in coastal waters. [Richard Feely, USA]	This is not appropriate for the deep-seafloor presentation but will be included in the coastal section.
5550	5	57	9	57	9	Efficiency is a biological term, might be very briefly introduced for readers with a non-biological background. [Roderik Van De Wal, Netherlands]	The term efficiency is now defined
14414	5	57	9	58	19	Planktic foraminifera may be less tolerant to changing climate drivers, such as OA, see Davis et al., 2017 experiments on G. bulloides that show decreased calcification under OA conditions. Although this is discussed again later in the chapber on page 67, citation for Roy et al., 2015, it is worth bringing up these effects here. [Jennifer Fehrenbacher, USA]	The results of Davis et al. 2017 are now addressed here as suggested.
708	5	57	23	57	23	"below 2000 km" be changed as 'below 2000 m" [Kathiresan Kandasamy, India]	The text was altered as suggested by the reviewer.
2714	5	57	23	57	23	2000 km should be changed to 2000 m (kilometers to meters) [Kirk Sato, Japan]	The text was altered as suggested by the reviewer.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
9472	5	58	2	58	4	If the loss of bioturbating fauna is "virtually certain"; how come the reduction of carbon burial presents only a low confidence? If I understood it correctly, it seems like there is a mismatch between the likelihood scale and the level of confidence. [APECS Group Review, Germany]	This clarifies the uncertainty by stating: A loss of deep bioturbating faunas at lowest oxygen levels is virtually certain, and but because they contribute to both carbon burial and remineralization (via oxygenation) there is less certainty about the net effect on carbon burial rates, although it is likely to be positive (Smith et al., 2000; Levin and Dayton, 2009).
11352	5	58	9	58	9	As protozoans include more species than just forams and indeed this document refers several times to nanoflagellate protozoans it would be mor approprate to just refer to forams here, as other protozoans that lack a CaCO3 shell may be even less susceptible to OA [Croot Peter, Ireland]	The text was altered as suggested by the reviewer.
24194	5	58	9	58	9	shouldn't it say Protozoans "such as" or "e.g. foraminifera"? [Hans-Otto Poertner and WGII TSU, Germany]	Text now refers exclusively to foraminiferans
2762	5	58	10	34	15	The Box 5.1 deals with important concept related to the emergence of change, which will be valuable information in adapting to climate change. It would be better to include this part as a sub-chapter of 5.2 [Suk Hui Lee, Republic of Korea]	Suggestion rejected. We prefer to keep this as a Box.
5552	5	58	10	58	10	OA is undefined here [Roderik Van De Wal, Netherlands]	Now defined as suggested by the reviewer.
20396	5	58	10			What is "OA"? [Michelle A. North, South Africa]	Now defined as suggested by the reviewer.
9476	5	58	18	58	18	You should explain once that forams = foraminifers or foraminifera. Also, you are jumping quite a bit between forams and foraminifera (also below). Maybe stick to one way of spelling. [APECS Group Review, Germany]	The text was altered as suggested by the reviewer.
9474	5	58	21	58	32	This entire paragraph lacks any term referring to the confidence of its statements or the amount of evidence provided to reach the conclusions or the existing agreement on them. It would be very helpful for readers to include them. [APECS Group Review, Germany]	This is considered in preparation for SOD
20398	5	58	21	58	25	"nematodes can respond rapidly to temperature change" - this statement implies that nematodes should be fine with changes in temperature, surviving by adapting; however, the next few lines seem to indicate that nematode abundance, biomass and diversity decreases with increasing temperatures… I would say that this statement needs to be rewritten to reflect their sensitivity to sudden changes (increase or decrease) in water and sediment temperature. I think that this whole sentence should be rewritten [Michelle A. North, South Africa]	The sentence has rewritten and split in two to illustrate nematode sensitivity to temperature; as they respond to both decline and increase in temperatures.
24426	5	58	34	58	36	This is lost placed among the ecosystem vulnerabilities, but is a potential climate feedback [Hans-Otto Poertner and WGII TSU, Germany]	This is considered in preparation for SOD

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
2716	5	58	38	58	40	As the lead author on this study, the phrase, "(deep-sea holothurians - Sato et al. (2017))" should be deleted because holothurians were not studied. Sato et al. (2017) studies echinoids. In addition, this sentence refers to Sato et al. (2017), but the content of this sentence is currently unpublished. It is IN REVIEW. As such, either change the citation to Sato et al. (2018), assuming it will be published before future IPCC deadlines. Or a new Sato et al. 2017b should be made to cite my PhD dissertation. Sato et al. 2017a = (Sato, K. N., L. A. Levin and K. Schiff, 2017…DSRII). [Kirk Sato, Japan]	An error occurred when chapter 5 references were compiled in Endnote by the TSU resulting in a displacement of all the references by one position. This resulted in a great number of misplaced references which we have since then fixed. Also Sato et al. 2018 is now cited.
2718	5	58	40	58	41	Taylor et al (2014) is the wrong citation. Sato et al. 2017 (as currently written in the reference list) is the correct study. Taylor et al. (2014) should change to Sato et al. (2017) [Sato, K. N., L. A. Levin and K. Schiff, 2017…DSRII] [Kirk Sato, Japan]	An error occurred when chapter 5 references were compiled in Endnote by the TSU resulting in a displacement of all the references by one position. This resulted in a great number of misplaced references which we have since then fixed.
3378	5	58	42	54	42	Strongylocentrotus fragilis? Specify which genera here, please. [Castor Muñoz Sobrino, Spain]	The text was altered as suggested by the reviewer.
3584	5	59	31	59	44	Include text on acidification in coastal species such as oysters, pteropods, etc. [Richard Feely, USA]	This will be included in the coastal ecosystem section.
9478	5	59	31	59	36	It is difficult to evaluate the confidence level of these statements since there no references. [APECS Group Review, Germany]	An error occurred when chapter 5 references were compiled in Endnote by the TSU resulting in a displacement of all the references by one position. This resulted in a great number of misplaced references which we have since then fixed.
24196	5	60	13	60	13	please specify where exactly climate effects on the ecosystems are discussed [Hans-Otto Poertner and WGII TSU, Germany]	We now specify the sections where climate effects on methane seeps and deep-water coral reefs are discussed.
1524	5	60	16	60	16	Is this meaning that all seamounts are underwater volcanoes? If so, is it true? [Davide Bonaldo, Italy]	Yes, we now point out that many volcanos are inactive.
17396	5	60	32	60	32	Deep sea corals also found in fiords in New Zealand i.e. under 5.2.2.3.9. See - http://www.cawthron.org.nz/coastal-freshwater/news/2015/New-Zealand-black-coral-another-indicator-climate-change/. Also see - https://fs.fish.govt.nz/Doc/23494/AEBR_117_2695_ZBD2010-41%20Obj1,%202%20and%203,%20MS3,%206%20and%209.pdf.ashx [Helen Kettles, New Zealand]	Fjords are no longer covered in this chapter. However, we mention the occurrence of black corals in NZ fjords to reflect their ability to tolerate low pH conditions.
13802	5	60	33	60	33	Change 'on' to 'of' [Debra Roberts and Durban Team, South Africa]	The text was altered as suggested by the reviewer.
2148	5	60	49	60	50	Rapid shoaling of ASH in subpolar gyre. Please sea letter in nature (doi:10.1038/nature25493) "Meridional overturning circulation conveys fast acidification to the deep Atlantic Ocean" [Fiz Fernandez Perez, Spain]	This is now cited.
20400	5	61	14			"CWC" has not been introduced previously, rather just write "cold water coral reefs" out in full [Michelle A. North, South Africa]	The text was altered as suggested by the reviewer.
3380	5	61	24	61	25	Confuse. Some other species? Perhaps do you mean some subspecies, forms (or others)? [Castor Muñoz Sobrino, Spain]	This was changed to some populations
9480	5	61	30	61	33	The reference of the single study is missing [APECS Group Review, Germany]	Now cited as Gori et al. 2016

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
9482	5	61	30	61	33	It is worth mentioning that Desmophyllum dianthus is able to live and thrive under natural low pH conditions in Northern Patagonia, which points out that this cold water coral is able to cope with ocean acidification somehow (Jantzen et al., 2013, Marine Biology; Fillinger and Richter, 2013, PeerJ). [APECS Group Review, Germany]	This example is now cited.
9484	5	61	46	61	48	The reference of the single study is missing [APECS Group Review, Germany]	Now cited as Gori et al. 2016
16766	5	62	5	62	9	The Fox et al reference for loss of habitat for corals around NZ & australia is incorrect. This should be Thresher et al (2015). It appears that the references are out of order in this section as well [Cliff Law, New Zealand]	An error occurred when chapter 5 references were compiled in Endnote by the TSU resulting in a displacement of all the references by one position. This resulted in a great number of misplaced references which we have since then fixed.
16768	5	62	19	62	19	"yielding medium confidence for the L. pertusa larval behavior model" - the medium confidence refers to the projected changes described in the preceding sentence, and not the behaviour model [Cliff Law, New Zealand]	The text was altered as suggested by the reviewer.
13804	5	62	20	62	20	Insert 'reported' before AR5 [Debra Roberts and Durban Team, South Africa]	The text was altered as suggested by the reviewer. (inserted after)
9486	5	62	33	62	36	What is the level of confidence or the likelihood of this statement? [APECS Group Review, Germany]	This is considered in preparation for SOD
20402	5	62	38			Please write out RFMOs [Michelle A. North, South Africa]	The text was altered as suggested by the reviewer.
13192	5	62	43	63	8	it might be nice to include some evidence from paleostudies herem which give a long-term perspective, but which typically integrate warming, acidification and deoxygenation. Hönisch et al. 2012 (Science) provided a review of the last 300 million years, highlighting the difficulty of identifying individual drivers from presence/absence of certian fossils in the absence of geochemical data, as well as the uncertainty of the short time scales (<10,000 years) to make past events comparable to the modern [Baerbel Hoenisch, USA]	This is now mentioned in the gaps section.
16770	5	62	43	62	43	"5.2.2.4.11 Gaps" & ".12 Overview"- why are there Gaps & Overview sections for rhe abyssal ocean but not the other sections? [Cliff Law, New Zealand]	This is being made uniform across sections
14416	5	63	1			Figure 13.5 A and B - font sizes are too small. Perhps this will be fixed during the next version of this [Jennifer Fehrenbacher, USA]	Font size is being enlarged
20404	5	63	1	63	2	Please add a comma after "deep sea" and remove the comma after "communities" [Michelle A. North, South Africa]	The text was altered as suggested by the reviewer.
24428	5	63	4	63	4	from Poloczanska et al 2016 not Howes et al [Hans-Otto Poertner and WGII TSU, Germany]	Could not find this citation.
13806	5	63	11	63	11	Delete 'the' before 'most' [Debra Roberts and Durban Team, South Africa]	The text was altered as suggested by the reviewer.
20406	5	63	11			Delete "the" before "most of the deep-sea floor" [Michelle A. North, South Africa]	The text was altered as suggested by the reviewer.
16772	5	63	13	63	13	"Vast areas of abyssal seafloor" this is too qualitative; the abyssal seafloor is vast so this descriptoin gives no context [Cliff Law, New Zealand]	The text was altered as suggested by the reviewer.
20408	5	63	15			What margins? I think there should be something saying what margins we are referring to here (deep sea margins, abyssal margins?) [Michelle A. North, South Africa]	Now clarified as upwelling margins
5554	5	63	25	63	25	Not entirely clear what is meant by "negative" exposure, temperature is rising for example. In the sense of undesirable? [Roderik Van De Wal, Netherlands]	changed to clarify this refers to cumulative exposures to warming, declining pH, oxygen and food supply,
20410	5	63	28	63	29	Modify to read: "…critical to the maintenance of biodiversity and ecosystem health ()" [Michelle A. North, South Africa]	The text was altered as suggested by the reviewer.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
24430	5	63	31			This section needs improved treatment of the mechanistic processes underpinning risks eg physiologcal insights, macroecological hypotheses [Hans-Otto Poertner and WGII TSU, Germany]	Accepted: we have expanded the treatment of mechanistic processes in both the main text and by including a modified figure to explain the evidence from physiological insights and macroecological hypothesis.
20412	5	63	39			"affects", not "affect" [Michelle A. North, South Africa]	The text was altered as suggested by the reviewer.
20414	5	63	40	63	42	Modify to read: "…with an optimal temperature range beyond which the biological functions of organisms decrease until they surpass their tolerance limits and can no longer survive…" or similar [Michelle A. North, South Africa]	The text was altered as suggested by the reviewer.
20416	5	63	44			Please modify to read: "biological sensitivity varies among species…" or "biological sensitivities vary among species" [Michelle A. North, South Africa]	The text was altered as suggested by the reviewer.
13810	5	64	0	64	1	Some of the texts in the left panel are to faint and difficult to read. [Debra Roberts and Durban Team, South Africa]	The text was altered as suggested by the reviewer.
4128	5	64	1	64	5	The font size of the text inside of the figures seems to be too small for proper reading. [Jinsoon Park, Republic of Korea]	The text was altered as suggested by the reviewer.
13194	5	64	1	64	1	the text in the figure on the left hand side is much too smal and should better be black than grey [Baerbel Hoenisch, USA]	The text was altered as suggested by the reviewer.
20418	5	64	1			Figure 5.13. Text needs to be larger in all three diagrammes; text in A and B needs to be black instead of dark grey and the axis labels' text need to be much larger [Michelle A. North, South Africa]	The text was altered as suggested by the reviewer.
20430	5	64	1			Figure 5.14: The heading "RCP8.5, 1990s to 20190s" could title all three maps at once (text a bit larger, at the top of the figure), while "mean % change", "standard deviation" and "model agreement" could serve as subheadings for each map, possibly even on the left of each map, orientated vertically… That way the mas themselves could be larger and the main focus of the figure [Michelle A. North, South Africa]	The text was altered as suggested by the reviewer.
24198	5	64	1	64	1	The axis and the caption of Fig 5.13 A and B is quite blurry [Hans-Otto Poertner and WGII TSU, Germany]	The text was altered as suggested by the reviewer.
2220	5	64	2			clarity of text needed in Figure 5.13. Fonts are small and blurred. [Chandani Appadoo, Mauritius]	The text was altered as suggested by the reviewer.
16774	5	64	2	64	2	Figure 5.13a) & b) what is the horizontal axis? Is it species within each group? [Cliff Law, New Zealand]	The text was altered as suggested by the reviewer.
16776	5	64	2	64	2	Figure 5.13 c) Might be more informative if the year was on the x-axis, & the risk level instead indicated by a symbol shape or 2nd colour [Cliff Law, New Zealand]	The text was altered as suggested by the reviewer.
13808	5	64	8	64	8	Two things: firstly, is it possible to quantify what proportion of the changes is attributed to these factors? Secondly, what other factors contribute to these changes besides those listed here. [Debra Roberts and Durban Team, South Africa]	This is considered in preparation for SOD
20420	5	64	8	64	9	Modify the sentence to read: "partly attributed to the affects of changes in temperature and primary production on recruitment, growth and survivorship…" and check whether it still retains the original meaning [Michelle A. North, South Africa]	The text was altered as suggested by the reviewer.
20422	5	64	10	64	14	Modify the sentence to read: "When comparing the total potential consumer biomass (mainly invertebrates and fish) in 2090–2099 with 1990–1999, and ensemble of marine ecosystem and fisheries models predict that it will decrease by 4.8% (RCP2.6) and 17.2% (RCP8.5), and by 4.5% by mid-21st century (all RCPs), without including the effect of fishing." [Michelle A. North, South Africa]	The text was altered as suggested by the reviewer.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
20424	5	64	14	64	16	Modify to read: "Including the effects of fishing to the models exacerbates the loss in biomass to -27.5%, with large-bodied animals (particularly sensitive to fishing) predicted to lose -54.4%..." [Michelle A. North, South Africa]	The text was altered as suggested by the reviewer.
20426	5	64	16	64	17	Modify to read: "Regionally, tropical and mid-latitude oceans are likely to experience decreases in total consumer biomass, wheras the Arctic ocean is predicted to experience increases in biomass ()." [Michelle A. North, South Africa]	The text was altered as suggested by the reviewer.
20428	5	64	17	64	19	Modify to read: "The high uncertainty in the Arctic is because the ways the model represents the effects of ocean variables (...) introduces uncertainties into its output.." or something similar [Michelle A. North, South Africa]	The text was altered as suggested by the reviewer.
13812	5	65	0			Fig 5.14 Eyeballing the maps, the StdDev tends to be highest in the areas where % mean change is also highest. Does this mean projected increases in fish biomass is very uncertain, but that reductions are more certain? Or that models disagree more? Please include a more informative legend. [Debra Roberts and Durban Team, South Africa]	Regional differences are now discussed
14418	5	65	1			Figure 5.14 should be explained better, the scales need an explanation as well. [Jennifer Fehrenbacher, USA]	The text was altered as suggested by the reviewer.
710	5	65	17	65	17	"phytoplanktons" be changed as "phytoplankton" [Kathiresan Kandasamy, India]	The text was altered as suggested by the reviewer.
6504	5	65	29	65	33	This sentence limits the impacts of climate to the individual, which is repeated in page 34, L51-53. We understand well that these effects are reflected at higher levels, including: community structuring through changes in species interactions (Nagelkerken and Connell 2015 PNAS 112: DOI 10.1073/pnas.1510856112; Queiros et al. 2015 Glob Change Biol 21: DOI: 10.1111/gcb.12675; Harley 2011 Science 334: DOI:10.1126/science.1210199); as well as meta-population dynamics (Coleman et al 2017 Glob Change Biol 23: DOI: 10.1111/gcb.13634; Jonsson et al. 2018 Diversity and Distributions DOI: 10.1111/ddi.12733). [Ana Queiros, UK]	This is now considered in preparing in SOD
20432	5	66	3	66	4	I think that the "(e.g., tropical coral reef)" belongs after "more stable environments", whereas there should be an explanation for what "stenothermal" means in parentheses after the word, similar to how eurythermal was explained [Michelle A. North, South Africa]	The text was altered as suggested by the reviewer.
20434	5	66	16	66	17	Please rewrite "marine organisms and ecosystems at specific ecosystems are assessed in (5.2.2)", I think that there should be a different term instead of the second "ecosystems" [Michelle A. North, South Africa]	The text was altered as suggested by the reviewer.
16778	5	66	18	66	18	"high conference" - high confidence [Cliff Law, New Zealand]	The text was altered as suggested by the reviewer.
17870	5	66	18	66	18	The phrase 'moderate to high conference' should be 'confidence' here. [Roberta Hansman, France]	The text was altered as suggested by the reviewer.
9492	5	66	20			This section as a whole could benefit from further discussion into the climate change effects on phytoplankton community composition and the effect that increased abundance of picophytoplankton (mentioned briefly) would have on the food web. [APECS Group Review, Germany]	The text has been modified and added to the Pelagic System section.
16792	5	66	20	67	30	This section is missing critical information. There are good reviews of climate impacts on phytoplankton that could be mentioned here, and there is currently no mention of climate impacts on competition between species; indirect cimate effects via nutrients, light and mixing, range & phenology shifts [Cliff Law, New Zealand]	The text has been modified and added to the Pelagic System section.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
17398	5	66	20	66	20	Should there be a heading 5.2.3.1 Introduction before this one (then change to 5.2.3.2 Microbes) to match 5.2.1.1, 5.2.2.1. Introductions. [Helen Kettles, New Zealand]	The text has been modified and added to the Pelagic System section.
17860	5	66	20	67	29	Section 5.2.3.1 Microbes should also include changes in the rates of heterotrophic production or respiration with increasing temperature (e.g., Yvon-Durocher et al., 2012 and Lønborg et al., 2016), which could have significant impacts on carbon cycling and nutrient remineralization. This could also be addressed in section 5.2.2.4.11 regarding gaps in deep sea ecosystems, or it also relates to carbon storage/sequestration in the deep sea via remineralization of flux from the biological carbon pump at depth. [Roberta Hansman, France]	The text has been modified and added to the Pelagic System section. (see also table 1)
16780	5	66	23	66	23	"and shifting patterns in the future ocean" - vague; shifting patterns in what? [Cliff Law, New Zealand]	removed.
5556	5	66	26	66	28	"Microbes will… thermodynamic constraints." Content partially repeats message of preceding sentence (fast adaption microbes). [Roderik Van De Wal, Netherlands]	The text has been modified
20436	5	66	30			Modify to read: "is complex, however, since it may involve…" [Michelle A. North, South Africa]	corrected
16782	5	66	32	66	33	too many references [Cliff Law, New Zealand]	reduced the number of references
9500	5	66	39	66	42	This sentence reads as if a poleward migration and phenological shift in microorganisms will only cause increasing bacterial infection outbreaks. Range shifts may also have effects on the food web through changes in species competition and possible harmful algal blooms. Some suggested references for further discussion on this topic are McLeod et. al, 2012 and Hallegraeff 2010. McLeod, D. J., Hallegraeff, G. M., Hosie, G. W. and Richardson, A. J.: Climate-driven range expansion of the red-tide dinoflagellate Noctiluca scintillans into the Southern Ocean, J. Plankton Res., 34(4), 332–337, doi:10.1093/plankt/fbr112, 2012. Hallegraeff, G. M.: Ocean climate change, phytoplankton community responses, and harmful algal blooms: A formidable predictive challenge, J. Phycol., 46(2), 220–235, doi:10.1111/j.1529-8817.2010.00815.x, 2010. [APECS Group Review, Germany]	we have modified the text in the new revised version
9494	5	66	41	66	41	The reference Bottjer. et al, 2014 is incorrect here and does not relate to the subject matter in this sentence. This reference is about CO2 effects on N2-fixing cyanobacteria, not infectious diseases. [APECS Group Review, Germany]	An error occurred when chapter 5 references were compiled in Endnote by the TSU resulting in a displacement of all the references by one position. This resulted in a great number of misplaced references which we have since then fixed.
9488	5	66	44	66	48	This sentence is long and confusing. Suggested rewrite: "Diazotrophic cyanobacteria have displayed a wide range of N2 fixation responses, from no change, to increases and decreases, under temperature and CO2 conditions similar to RCP 8.5 projections for the end of the 21st century (Eichner et al., 2014; Gradoville et al., 2014). These observed differences are possibly due to differences in the mechanisms of N2 fixation between strains and species (Hutchins and Boyd, 2016)." [APECS Group Review, Germany]	The text was altered as suggested by the reviewer.We have slightly modified the text in the Pelagic section

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
9496	5	66	48	66	48	The reference Hutchins and Boyd, 2016 is not relevant for this sentence. Hutchins et. al, 2007 is likely the reference intended here. Hutchins, D. A., Fu, F.-X., Zhang, Y., Warner, M. E., Feng, Y., Portune, K., Bernhardt, P. W. and Mulholland, M. R.: CO2 control of Trichodesmium N2 fixation, photosynthesis, growth rates, and elemental ratios: Implications for past, present, and future ocean biogeochemistry, Limnol. Oceanogr., 52(4), 1293–1304, doi:10.4319/lo.2007.52.4.1293, 2007. [APECS Group Review, Germany]	An error occurred when chapter 5 references were compiled in Endnote by the TSU resulting in a displacement of all the references by one position. This resulted in a great number of misplaced references which we have since then fixed.
9498	5	66	48	66	51	The reference Schulz et al, 2017 does not relate to the subject matter in this sentence. [APECS Group Review, Germany]	An error occurred when chapter 5 references were compiled in Endnote by the TSU resulting in a displacement of all the references by one position. This resulted in a great number of misplaced references which we have since then fixed.
712	5	66	49	66	49	"phosphorous" be changed as "phosphorus" [Kathiresan Kandasamy, India]	The text was altered as suggested by the reviewer.
9490	5	66	53	66	54	I suggest an additional reference, Schulz et al, 2017., who have provided a comprehensive review of ocean acidifcation effects on phytoplankton community structure, incorporating many recent large community mesocosm studies. Schulz, K. G., Bach, L. T., Bellerby, R. G. J., Bermúdez, R., Büdenbender, J., Boxhammer, T., Czerny, J., Engel, A., Ludwig, A., Meyerhöfer, M., Larsen, A., Paul, A. J., Sswat, M. and Riebesell, U.: Phytoplankton Blooms at Increasing Levels of Atmospheric Carbon Dioxide: Experimental Evidence for Negative Effects on Prymnesiophytes and Positive on Small Picoeukaryotes, Front. Mar. Sci., 4(64), 1–18, doi:10.3389/fmars.2017.00064, 2017. [APECS Group Review, Germany]	An error occurred when chapter 5 references were compiled in Endnote by the TSU resulting in a displacement of all the references by one position. This resulted in a great number of misplaced references which we have since then fixed.
14420	5	66	53	67	6	This paragraph is out of place in a section on microbes. Coccos and forams are not considered microbes, that term is more typically used with bacteria/viruses. [Jennifer Fehrenbacher, USA]	The text was modified in the new version (included in the Pelagic System)
714	5	66	57	66	57	"were" be changed as "are" [Kathiresan Kandasamy, India]	corrected
16794	5	67	0	67		Disappointed not to have been able to comment on the remainder of this chapter, but I have run out of time. More rigorous editing at the initial stage (english/formatting in the Summary & certain sections, correct reference numbers, and consisteny in style & content of the different sections) would have enabled more robust reviewing of the science/substance [Cliff Law, New Zealand]	The text has substantially be modified in the new version; and has been merged to the Pelagic section
9522	5	67	3	67	6	The reference Khanna et al, 2013 does not relate to the subject matter in this sentence. This study is about CO2 effects on foraminifer calcification. The reference Sett et. al, 2014 is the appropriate reference here. Sett, S., Bach, L. T., Schulz, K. G., Koch-Klavsen, S., Lebrato, M. and Riebesell, U.: Temperature Modulates Coccolithophorid Sensitivity of Growth, Photosynthesis and Calcification to Increasing Seawater pCO2, PLoS One, 9(2), e88308, doi:10.1371/journal.pone.0088308, 2014. [APECS Group Review, Germany]	An error occurred when chapter 5 references were compiled in Endnote by the TSU resulting in a displacement of all the references by one position. This resulted in a great number of misplaced references which we have since then fixed.
16784	5	67	3	67	3	Important to mention that coccollithophores have shown variation in both sign and magnitude in responses to low pH/high CO2 as detailed in Meyer & Riebesell (2015). Meyer J, Riebesell U. Reviews and Syntheses: Responses of coccolithophores to ocean acidification: a meta-analysis. Biogeosciences. 2015 Mar 15;12(6):1671. [Cliff Law, New Zealand]	included the reference in the modified version

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
9508	5	67	6	67	9	Foraminifera are discussed in more detail in the Zooplankton section (5.2.3.2.1, p.68 line 12-16) and the words in the Microbes section appear contradictory. I would not expect to see a discussion on foraminifera in the Microbes section so it would be more suitable to combine this sentence with the discussion in the Zooplankton section. [APECS Group Review, Germany]	The text was modified in the new version (included in the Pelagic System)
13196	5	67	6	67	9	the sentence on foraminifera should be moved into the following zooplankton section [Baerbel Hoenisch, USA]	The text was modified in the new version (included in the Pelagic System)
16786	5	67	6	67	6	"even reverse negative calcification" does this mean increase calcification or maintain calcification? [Cliff Law, New Zealand]	Corrected
9510	5	67	9	67	9	The reference Brussard. et al, 2013 is incorrect here and does not relate to the subject matter in this sentence. This study is about CO2 effects on phytoplankton community compositional change and viral lysis. [APECS Group Review, Germany]	An error occurred when chapter 5 references were compiled in Endnote by the TSU resulting in a displacement of all the references by one position. This resulted in a great number of misplaced references which we have since then fixed.
9502	5	67	11	67	16	Some references should be added to this paragraph so readers can check their accuracy and track where these findings came from. The predominant ideas in this paragraph appear to come from Engel et. al, 2014. Another useful reference for further discussion on nutrients and community composition would be Sala et. al, 2016. Engel, A., Piontek, J., Grossart, H.-P., Riebesell, U., Schulz, K. G. and Sperling, M.: Impact of CO2 enrichment on organic matter dynamics during nutrient induced coastal phytoplankton blooms, J. Plankton Res., 36(3), 641–657, doi:10.1093/plankt/fbt125, 2014. Sala, M. M., Aparicio, F. L., Balagué, V., Boras, J. A., Borrull, E., Cardelús, C., Cros, L., Gomes, A., López-Sanz, A., Malits, A., Martínez, R. A., Mestre, M., Movilla, J., Sarmento, H., Vázquez-Domínguez, E., Vaqué, D., Pinhassi, J., Calbet, A., Calvo, E., Gasol, J. M., Pelejero, C. and Marrasé, C.: Contrasting effects of ocean acidification on the microbial food web under different trophic conditions, ICES J. Mar. Sci., 73(3), 670–679, doi:10.1093/icesjms/fsv130, 2016." [APECS Group Review, Germany]	An error occurred when chapter 5 references were compiled in Endnote by the TSU resulting in a displacement of all the references by one position. This resulted in a great number of misplaced references which we have since then fixed.
9506	5	67	11	67	17	This paragraph could benefit from additional discussion about the effect of climate change on phytoplankton grazing. Currently, it only focuses on bacterial growth and grazing. One example is a possible effect of ocean acidification on fatty acid transfer from phytoplankton community compopsition changes by Bermudez et al, 2016; Bermúdez, J. R., Riebesell, U., Larsen, A. and Winder, M.: Ocean acidification reduces transfer of essential biomolecules in a natural plankton community, Sci. Rep., 6, 27749, doi:10.1038/srep27749, 2016. [APECS Group Review, Germany]	This has been modified in the new version (Pelagic Section)
16788	5	67	11	67	15	This paragraph sounds speculative & requires references [Cliff Law, New Zealand]	The text was modified in the new version (included in the Pelagic System)
9512	5	67	18	67	19	The reference Brucet et. al, 2008 is incorrect here and instead relates to copepod developmental stage feeding size. This study appears to be in reference to the sentence in p67 line 21-23 and should be moved. [APECS Group Review, Germany]	An error occurred when chapter 5 references were compiled in Endnote by the TSU resulting in a displacement of all the references by one position. This resulted in a great number of misplaced references which we have since then fixed.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
9520	5	67	18	67	25	This paragraph as a whole is not well constructed and needs more work. There isn't any introduction to this paragraph or any relation drawn between viral lysis and mesozooplankton grazing. [APECS Group Review, Germany]	The text was modified in the new version (included in the Pelagic System)
16790	5	67	18	67	25	This paragraph discusses zooplankton but is in the microbessection [Cliff Law, New Zealand]	The text was modified in the new version (included in the Pelagic System)
9518	5	67	19	67	21	This sentence appears to be from the study by Alvarez-Fernandez et. al, 2018. Papers by Taucher et al, 2017, Lischka et. al, 2017, and Caron & Hutchins, 2013 are worth reviewing for further discussion on the topic of micro- and mesozooplankton. Alvarez-Fernandez, S., Bach, L. T., Taucher, J., Riebesell, U., Sommer, U., Aberle, N., Brussaard, C. P. D. and Boersma, M.: Plankton responses to ocean acidification: The role of nutrient limitation, Prog. Oceanogr., 165(April), 11–18, doi:10.1016/j.pocean.2018.04.006, 2018. Taucher, J., Haunost, M., Boxhammer, T., Bach, L. T., Algueró-Muñiz, M. and Riebesell, U.: Influence of ocean acidification on plankton community structure during a winter-to-summer succession: An imaging approach indicates that copepods can benefit from elevated CO2 via indirect food web effects, PLoS One, 12(2), 1–23, doi:10.1371/journal.pone.0169737, 2017. Lischka, S., Bach, L. T., Schulz, K.-G. and Riebesell, U.: Ciliate and mesozooplankton community response to increasing CO2 levels in the Baltic Sea: insights from a large-scale mesocosm experiment, Biogeosciences, 14(2), 447–466, doi:10.5194/bg-14-447-2017, 2017. Caron, D. A. and Hutchins, D. A.: The effects of changing climate on microzooplankton grazing and community structure: Drivers, predictions and knowledge gaps, J. Plankton Res., 35(2), 235–252, doi:10.1093/plankt/fbs091, 2013. [APECS Group Review, Germany]	An error occurred when chapter 5 references were compiled in Endnote by the TSU resulting in a displacement of all the references by one position. This resulted in a great number of misplaced references which we have since then fixed.
11354	5	67	19	67	25	These sentences of the paragraph refers to mesozooplankton but the section heading is for microbes 5.2.3.1, suggest editing this into the followng section on Zooplankton 5.2.3.2.1 [Croot Peter, Ireland]	The text was modified in the new version (included in the Pelagic System)
21236	5	67	19	67	25	This should go into the next section I suppose... [Momme Butenschön, Italy]	The text was modified in the new version (included in the Pelagic System)
9514	5	67	21	67	23	The reference Sswat et. al, 2018 is incorrect here and instead relates to larval Atlantic herring. This study appears to be in reference to the sentence in p67 line 23-25, however I don't think the outcomes from this study are strong enough to state that increased CO2 enhanced larval survival as temperature was the dominant driver of larval response. There was also no indication that increased primary productivity from CO2 was responsible for any of these results. [APECS Group Review, Germany]	An error occurred when chapter 5 references were compiled in Endnote by the TSU resulting in a displacement of all the references by one position. This resulted in a great number of misplaced references which we have since then fixed.
9516	5	67	23	67	25	The reference Poloczanska. et al, 2013 is incorrect here and does not relate to the subject matter in this sentence. This reference relates to phenological shifts, which is incredibly important and should be considered further in this section. [APECS Group Review, Germany]	An error occurred when chapter 5 references were compiled in Endnote by the TSU resulting in a displacement of all the references by one position. This resulted in a great number of misplaced references which we have since then fixed.
21238	5	67	27	67	29	This statement is far too general at this point, the pelagic ecosstem is made of more than microbes, as discussed in the following section. [Momme Butenschön, Italy]	The text was modified in the new version (included in the Pelagic System)

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
24200	5	67	27	67	29	this subsection 5.2.3.1 is about microbes which are just one component of the pelagic system. Concluding that the entire pelagic ecosystem is highly resilient to ocean acidification based on results from microbes only seems a bit too much [Hans-Otto Poertner and WGII TSU, Germany]	The text was modified in the new version (included in the Pelagic System)
6506	5	67	31	70	5	This section leaves out invertebrates that have occupy the majority of the ocean seafloor, affecting ecosystem service delivery (ecosystem function mediation, food provision), supporting fundamental benthic-pelagic coupling processes that mediate global biogeochemistry (e.g. Snelgrove et al 2017 Trends Ecol Evol 33: 10.1016/j.tree.2017.11.004), as well as those on which most of the climate change experimental evidence has been gathered from (Gattuso and Riebsell 2014 Nat Climate Change 5: DOI: 10.1038/nclimate2456; Kroecker et al 2013 Glob Change Biol 19: DOI: 10.1111/gcb.12179): benthic invertebrates. This seems like a significant omission. [Ana Queiros, UK]	This is considered in preparation for SOD
20584	5	67	31			In section 5.2.3.2 Invertebrates, a dedicated paragraph should be added to 'Other Biogenic structures', analogously to paragraph 5.2.2.4.10 (Biogenic structure: sponges and other taxa for the deep sea). Several taxa should be mentioned, such as coralline algae, molluscs, bryozoans, sponges which are important biconstructional organisms, vulnerable and producing plastic responses to OA and GW (See Ragazzola et al papers, Lombardi et al. papers, Cocito et al. papers, Smith et al papers….). So, I would encourage to dedicate a separte paragraph to these other taxa responsible in forming 'biogenic reefs' (see Hiscock, 2014). See also my comments above. [Chiara Lombardi, Italy]	Section restructured. No longer relevant.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
21000	5	67	31			In this invertebrates section, I was surprised not to see shellfish included. There is a large amount of published research showing ocean acidification impacts to shellfish larvae, both experimental (to numerous to list) and observations in the field: Barton, A., Hales, B., Waldbusser, G. G., Langdon, C., and Feely, R. A.: The Pacific oyster, Crassostrea gigas, shows negative correlation to naturally elevated carbon dioxide levels: Implications for near-term ocean acidification effects, Limnol. Oceanogr., 57, 698–710, doi:10.4319/lo.2012.57.3.0698, 2012. Barton, A., Waldbusser, G. G., Feely, R. A., Weisberg, S. B., Newton, J. A., Hales, B., Cudd, S., Eudeline, B., Langdon, C. J., Jefferds, I., King, T., Suhrbier, A., and McLaughlin, K.: Impacts of coastal acidification on the Pacific Northwest shellfish industry and adaptation strategies implemented in response, Oceanography, 28, 146–159, doi:10.5670/oceanog.2015.38, 2015. Bednaršek, N., Tarling, G. A., Bakker, D. C. E., Fielding, S., and Feely, R. A.: Dissolution dominating calcification process in polar pteropods close to the point of aragonite undersaturation, PLoS ONE, 9, e109183, doi:10.1371/journal.pone.0109183, 2014. Bednaršek, N., Feely, R. A., Tolimieri, N., Hermann, A. J., Siedlecki, S. A., Waldbusser, G. G., McElhany, P., Alin, S. R., Klinger, T., Moore-Maley, B., and Pörtner, H. O.: Exposure history determines pteropod vulnerability to ocean acidification along the US West Coast, Sci. Rep., 7, 4526, doi:10.1038/s41598-017-03934-z, 2017a. [Adrienne Sutton, USA]	Section restructured. No longer relevant.
9504	5	67	40	67	41	Changes in zooplankton size vary geographically and depend on several factors not only temperature. It is perhaps worth mentioning that despite ocean warming there are areas where zooplankton increased their size so perhaps these responses are not so simple or straightforward. In the Bay of BIscay (temperate sea) zooplankton abundance/biomass increased from 1993 to 2010 especially large zooplankton (>1000 microns) causing a shift towards a larger zooplankton community (Gonzalez-Gil et al., 2015, Journal of Plankton Research). [APECS Group Review, Germany]	This is considered in preparation for SOD

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
4620	5	68	7	68	8	The evience that pteropods have been affected by OA exists from several different ocean basins where shell dissolution, calcification and survival has been demonstrated to be directly linked to OA. This needs to be brought into the context of individual level effects and distingushed from the population level effects. The references to support already existing evidence of OA on various impairmet process in pteropods in the natural environment are following: • Bednaršek, N., Feely, R.A., Reum, J.C.P., Peterson, B., Menkel, J., Alin, S.R. and Hales, B., 2014. Limacina helicina shell dissolution as an indicator of declining habitat suitability owing to ocean acidification in the California Current Ecosystem. Proc. R. Soc. B, 281(1785), p.20140123. • Bednaršek, N., Feely, R.A., Tolimieri, N., Hermann, A.J., Siedlecki, S.A., Waldbusser, G.G., McElhany, P., Alin, S.R., Klinger, T., Moore-Maley, B. and Pörtner, H.O., 2017. Exposure history determines pteropod vulnerability to ocean acidification along the US West Coast. Scientific reports, 7(1), p.4526. • Bednaršek, N., Tarling, G.A., Bakker, D.C.E., Fielding, S., Jones, E.M., Venables, H.J., Ward, P., Kuzirian, A., Lézé, B., Feely, R.A. and Murphy, E.J., 2012. Extensive dissolution of live pteropods in the Southern Ocean. Nature Geoscience, 5(12), p.881. [Nina Bednarsek, USA]	This is considered in preparation for SOD
4630	5	68	7	68	31	How come the coccolithophores were not mentioned in this regard? [Nina Bednarsek, USA]	This is considered in preparation for SOD
4634	5	68	7	68	16	This paragraph on no population decline in calcifying zooplankton is very skewed but most importantly, all the references provided are wrong and not remotely related to the topic, with the most particular that stand put being Oeman et al., 2007 and de Moel 2009. The rest of the reference are wrong in regards to the investigated regions (Mackas and Gailbraight, 2012). Here are corrected facts from multiple-ocean basins. The evidence of the multi-decadal studies are regional specific and need to be considered in this context. The greatest observed change in pteropod population decline were found in the North Atlantic (reference: Beaugrand et al., 2013; Beare et al., 2013) and Northeast Pacific (Mackas and Gailbraight, 2012). IN the other ocean basins, climate variability has more dominant effect on pteropod long term populations, such as described in the Western part of Antarctic peninsula (Loeb and Santora, 2013) and the southern California Current (Ohman and Lavaniegos, 2009), masking potential OA effects. The changes on the population level in pteropod population are already detected, but not in all ocean basins. [Nina Bednarsek, USA]	This is considered in preparation for SOD
9524	5	68	7	68	18	This entire paragraph lacks any term referring to the confidence of its statements or the amount of evidence provided to reach the conclusions or the existing agreement on them. It would be very helpful for readers to include them. [APECS Group Review, Germany]	This is considered in preparation for SOD
24202	5	68	7	68	18	provide full term (foraminiferans) for "forams" [Hans-Otto Poertner and WGII TSU, Germany]	The text was altered as suggested by the reviewer.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
4622	5	68	9	68	10	Oehman 2007 is completely wrong reference with no reletaiton to the topic at all! Need to be removed. [Nina Bednarsek, USA]	An error occurred when chapter 5 references were compiled in Endnote by the TSU resulting in a displacement of all the references by one position. This resulted in a great number of misplaced references which we have since then fixed.
14422	5	68	9			write out the word foraminifera (e.g. do not use 'forams') [Jennifer Fehrenbacher, USA]	The text was altered as suggested by the reviewer.
4624	5	68	10	68	11	Mackas and Gailbraight 2012 is a wrong reference for the NW Atlantic. This is the reference for NE Pacific. [Nina Bednarsek, USA]	An error occurred when chapter 5 references were compiled in Endnote by the TSU resulting in a displacement of all the references by one position. This resulted in a great number of misplaced references which we have since then fixed.
4626	5	68	11	68	12	de Moel et al 2009 is a completely wrong reference, it is not related to the topic whatsoever! Needs to be removed! [Nina Bednarsek, USA]	An error occurred when chapter 5 references were compiled in Endnote by the TSU resulting in a displacement of all the references by one position. This resulted in a great number of misplaced references which we have since then fixed.
716	5	68	14	68	14	"foram" be changed as "foramniferan" [Kathiresan Kandasamy, India]	The text was altered as suggested by the reviewer.
4628	5	68	14	68	14	Attril et al., 2007 is too old of the reference, newer reference show more suble changes in the foram community. [Nina Bednarsek, USA]	An error occurred when chapter 5 references were compiled in Endnote by the TSU resulting in a displacement of all the references by one position. This resulted in a great number of misplaced references which we have since then fixed.
4632	5	68	15	68	16	there is no evidence for this statement in any literature, in fact it is against all the refences that are showing the changes in zooplankton communities, especielly in regards to the pteropods. The changes in the pteropod trends are regionally specific, so global ocean-basin scale estimation is not approapriate in this context. The references that are missing in regards negative population trends in pteropod abundances linked to the changes of OA (and temp) are: • Beaugrand, G., McQuatters-Gollop, A., Edwards, M. and Goberville, E., 2013. Long-term responses of North Atlantic calcifying plankton to climate change. Nature Climate Change, 3(3), p.263. • Beare, D., McQuatters-Gollop, A., van der Hammen, T., Machiels, M., Teoh, S.J. and Hall-Spencer, J.M., 2013. Long-term trends in calcifying plankton and pH in the North Sea. PLoS One, 8(5), p.e61175. [Nina Bednarsek, USA]	This is now considered in preparing in SOD
718	5	68	17	68	17	delete "there was" [Kathiresan Kandasamy, India]	The text was altered as suggested by the reviewer.
9526	5	68	22	68	22	"High agreement" should be in italic if it refers to calibrated IPCC language used to treat uncertainties. [APECS Group Review, Germany]	The text was altered as suggested by the reviewer.
9528	5	68	34	69	4	These two paragraphs lack any term referring to the confidence of its statements or the amount of evidence provided to reach the conclusions or the existing agreement on them. It would be very helpful for readers to include them. [APECS Group Review, Germany]	This is now considered in preparing in SOD
24204	5	68	38	68	38	it's called scyphomedusa [Hans-Otto Poertner and WGII TSU, Germany]	The text was altered as suggested by the reviewer.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
13814	5	68	52			Abundance and body size equals biomass. One wants to see very clearly, somewhere (perhaps it is still coming) a discussion (ideally with diagram) of how changes in biomass of one trophic level affect other trophic levels. Phyto- and zooplankton impact on fishes and larger invertebrates. It would be useful to see time series data on recorded biomass of any trophic level or taxonomic group. Are there clear observed trends? This sort of information speaks loud and clear. also see pg70line44 Time series of recorded biodiversity would also be interesting. [Debra Roberts and Durban Team, South Africa]	Evidence is presented in figure 5.9 of SOD
20540	5	69	1	69	4	A major weakness common to coupling NPZ-type models with fish models is the coarse functional group representation of zooplankton and lack of calibration to zooplankton abundances. Reference: Ito S., K. A. Rose, B. Megrey, J. Schweigert, D. Hay, F. E. Werner, M. Noguchi Aita, 2015, Geographic variation in Pacific herring growth in response to regime shifts in the North Pacific Ocean, Prog. Oceanogr., 138, 331-347. doi:10.1016/j.pocean.2015.05.022. Ito S., K. A. Rose, A. J. Miller, K. Drinkwater, K. M. Brander, J. E. Overland, S. Sundby, E. Curchitser, J. W. Hurrell and Y. Yamanaka, 2010, Ocean ecosystem responses to future global change scenarios: A way forward, In: M. Barange, J.G. Field, R.H. Harris, E. Hofmann, R. I. Perry, F. Werner (Eds) Global Change and Marine Ecosystems. Oxford University Press., 287-322, pp440. DOI:10.1093/acprof:oso/9780199558025.001.0001. [Shin-Ichi Ito, Japan]	Such uncertainty is recognized in SOD
21240	5	69	3	69	3	project->projected [Momme Butenschön, Italy]	The text was altered as suggested by the reviewer.
3266	5	69	8			The sudy by Lewis et al 2013 does not refer to a 50 year time series. This may be the wrong reference. [Martin Edwards, UK]	An error occurred when chapter 5 references were compiled in Endnote by the TSU resulting in a displacement of all the references by one position. This resulted in a great number of misplaced references which we have since then fixed.
720	5	69	10	68	10	inser "and" before "more" [Kathiresan Kandasamy, India]	The text was altered as suggested by the reviewer.
18906	5	69	12	70	5	Another consideration, when discussing the ability of temperate and tropical corals to survive and adapt to climate change, is the adaptability and resistance of the zoxanthellae and of their diazotrophic symbionts, facing the same changing conditions… [Sophie Rabouille, France]	This discussion should be inserted in other parts
24206	5	69	12	70	5	what about other benthic invertebrates? Corals are not the only ones at risk! [Hans-Otto Poertner and WGII TSU, Germany]	The present section deals with coral reefs
12148	5	69	13	69	26	Additional example of multistressor synergies and impacts on corals in Kersting et al. (2015), taking into account widespread stressors (waming & invasive species) DK, Cebrian E, Casado C, Teixidó N, Garrabou J, Linares C (2015) Experimental evidence of the synergistic effects of warming and invasive algae on a temperate reef-builder coral. Scientific Reports 5:18635 [Diego Kersting, Germany]	As specified before, the topic of invasive species was not included as it is based on anthropogenic impacts and is not directly associated with global change impacts.
3268	5	70	10		12	Consider reconstructuring this sentence as it does not make sense [Martin Edwards, UK]	This is now considered in preparing in SOD
5558	5	70	10	70	10	"Changes in abundance…" Unclear what abundance is meant here. [Roderik Van De Wal, Netherlands]	This is now clarified

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
18926	5	70	21	70	21	Mention that some species are constrained by habitat type. in the Rutterford nature paper, they found that a number of comercially important European fish species were not able to move northwards or deeper (as had been suggested in previous bioclimatic envelope model based studies) - they had to adapt, or become locally extinct. Could say something like: "However, some species ability to move pole-ward or deeper is constrained by habitat availability, and so must adapt, or become locally extinct (Rutterford et al. 2015)." Rutterford, L. A., Simpson, S. D., Jennings, S., Johnson, M. P., Blanchard, J. L., Schön, P.-J., Sims, D. W., Tinker, J., and Genner, M. J.: Future fish distributions constrained by depth in warming seas, Nature Climate Change, 5, 569–573, 2015. [Jonathan Tinker, UK]	This is now considered in preparing in SOD
24208	5	70	35	70	36	It seems that calcification (only otoliths in fish) as well as crustaceans and mollusks does not really belong to this section [Hans-Otto Poertner and WGII TSU, Germany]	The sub-section has been restructured and merged with the pelaigc open ocean section
722	5	70	37	70	37	"sensitivitiy" be changed as 'sensitive" [Kathiresan Kandasamy, India]	The text was altered as suggested by the reviewer.
2868	5	70	37	70	38	"Also, ocean acidification and warming have shown to have synergistic effects with warming that exacerbate the risk of population decline. " Please rewrite by e.g. deleting "and warming" [Geir Ottersen, Norway]	The text was altered as suggested by the reviewer.
2870	5	70	44	70	46	This needs to be substantiated by references, especially since you claim "medium confidence" here, but "low confidence" in the statement before. Also, consider rewriting as to have both "historical responses" and "in the past" seems redundant. [Geir Ottersen, Norway]	This is now considered in preparing in SOD
10722	5	71	4	71	16	Please add, that marinr mummals and sea birds in Arctic can be limited not only by temperature changes, but also by sea ice spread. Sea ice can be used as habitats for migration, calving, keeping of cubes. Lack of thick ice is a large problem for the pacific walrus and some seals. High productivity of the zone near the sea ice edge in summer is very attractive for many sea birds. Size and location of large marine polynias in winter are also crusially important for marine mummals. [Oxana Lipka, Russian Federation]	Taken into account_ These issues are discussed a few lines later, see lines10-16. They item is not discussed again here as it will be repitition, will lengthen the document and damage the flow.
3586	5	71	7	71	18	This paragraph needs to be rewritten. There is specific evidence on the effects of ocean acidification on pteropod dissolution (Bednarsek et al., 2014, 2016; Feely et al., 2016). Also Mackas and Galbraith (2012) did show decreases in pteropod abundances in the northeast Pacific. [Richard Feely, USA]	Taken into account_The section is about vertebrates. The section talks about changes in their prey and we say that their prey are effected by pH and temp. Adding statements about pteropods is one specifc prey item. However, I do not know of any marine mammal or seabird that eats pteropods. Maybe some turtles do. This is a general statement that is supported. We were under severe word restrictions and adding specific examples becomes problematic. It's not clear how this section should be rewritten, so the suggestion to rewrite the paragraph is rejected. A sentence is added on pteropods with reference. I assume that pteropods are discussed elswehere in a more relevant section of this report and further information here would be redundant.

SROCC First Order Draft Expert Review Comments - Chapter 5							
Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
2872	5	71	10	71	14	Exchange between Pacific and Atlantic or expansion from these oceans into the Arctic? The latter is "virtually certain", not sure about the first. [Geir Ottersen, Norway]	Taken into account_gray whales are now being seen in the Atlantic and Mediterranean. They went extinct in the 1700s in the Atlantic. The only way for them to exist n the Atlantic and Mediterranean is to have come from the Pacific via the Arctic. Hooded seals have also been observed in the Pacific. Their range is limited to the Atlantic.
20438	5	71	10			Spelling error: should be "affecting", not "effecting" [Michelle A. North, South Africa]	Accepted - he text was altered as suggested by the reviewer.
20442	5	71	14	72	8	Rather include the latin names of the two whales in parentheses (e.g., "as killer whales (xxx), inhabit Arctic waters, narwhals (yyy) are avoiding...") [Michelle A. North, South Africa]	Accepted - the text was altered as suggested by the reviewer.
20440	5	71	15			"narwhals", not "narwhale's" [Michelle A. North, South Africa]	Accepted_the text was altered as suggested by the reviewer.
24432	5	71	38	71	41	Check consisteny with 3.3.3.2.4 [Hans-Otto Poertner and WGII TSU, Germany]	Taken into account_the section was compared andno inconsistencies found. For example, text on penguins was found to be consistent;
24210	5	71	44	71	44	populations of gentoo: this info is a repetition of P71 L36 [Hans-Otto Poertner and WGII TSU, Germany]	Accepted this section was rewritten.
20444	5	71	45	71	50	When listing several related species, rather list the common names together and then include their latin names, (e.g., "...Dolphin and Kelp gulls (Larus scoresbii and L. domnicanus)..." and "...aysan and Wandering albatrosses (xxx and yyy) have responded..."), because at the way it is currently, I thought the text was suddenly referring to dolphins and kelp (also relevant to this chapter), instead of the gull species [Michelle A. North, South Africa]	Accepted_the text was altered as suggested by the reviewer.
24212	5	71	46	71	46	it firstly sounds like you say that Larus scoresbii is a dolphin, and Larus dominicanus is a kelp--> I would restructure the sentence [Hans-Otto Poertner and WGII TSU, Germany]	Accepted_the text was altered as suggested by the reviewer.
24214	5	71	46	71	46	The phrase "some significantly" takes away the strength of your statement a little bit. Think about only listing significant changes [Hans-Otto Poertner and WGII TSU, Germany]	Accepted_deleted "some significantly"
24216	5	U	47	71	48	This statement fits well to the one about Adelies (P71 L38/39)--> think about combining them [Hans-Otto Poertner and WGII TSU, Germany]	Accepted_merged the sections into one paragraph
24218	5	71	49	71	49	either high confidence or very likely (highly likely isn't IPCC calibrated confidence language) [Hans-Otto Poertner and WGII TSU, Germany]	Accepted_changed to "very likely"
24220	5	71	51	71	53	several commas are missing, which makes it hard to grasp the meaning of the sentence [Hans-Otto Poertner and WGII TSU, Germany]	Accepted_the text was altered as suggested by the reviewer.
24222	5	72	6	72	8	This sentence is not really worded. Try to rephrase it. Also, what is a regional effect (this question arises with this formulation)? [Hans-Otto Poertner and WGII TSU, Germany]	Accepted_the text was rewritten and expanded to make the point clearer.
9530	5	72	11	72	11	Very high confidence should be in italics [APECS Group Review, Germany]	Accepted_the text was altered as suggested by the reviewer.
20446	5	72	11			Confidence language in italics [Michelle A. North, South Africa]	Accepted_the text was altered as suggested by the reviewer.
24224	5	72	11	72	11	Please put Galapagos in front of sea lion [Hans-Otto Poertner and WGII TSU, Germany]	Accepted_the text was altered as suggested by the reviewer.
9532	5	72	14	72	16	Including a term regarding the confidence or likelihood of the statement would be useful so readers have a better idea of the strength of the statement. [APECS Group Review, Germany]	Accepted_the text was altered as suggested by the reviewer.

SROCC First Order Draft Expert Review Comments - Chapter 5							
Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
10770	5	72	19	91	26	The title of the section Changing Marine Ecosystem Services and Human Wellbeing is misleading. The content focuses more in the changing marine ecosystem services and touches upon wellbeing in a very superficial way. This might require a substantial revision. [Coswig Kalikoski Daniela, Italy]	This section [5.4] consists of two large subsections: Changes in Key Ecosystem Services [5.4.1] and Climate Risk, Vulnerability and Expsoure of Human Communities and their Wellbeing [5.4.2]. The latter subsection particularly focuses on human wellbeing. We have further substantiated our assessment on human wellbeing in the Second Order Draft.
10600	5	72	21	72	24	Important ecosystem services and the habitats/ecosystems that supports them are missing here. Climate regulation is also supported by mangroves as a critical carbon sink (Pendleton et al., 2012). Coral reefs are critical for fisheries, coastal protection, and tourism. Reference : Pendleton et al. (2012). Estimating global “blue carbon” emissions from conversion and degradation of vegetated coastal ecosystems. PLoS ONE [Adrien Comte, France]	Assessment of climate change impacts on ecosystem services from coral reefs and mangroves are included.
15420	5	72	21	72	37	Another citation here about coastal ecosystem services and impacts of degradation to human health including disease but also human psychological well-being which is not discussed as much in this chapter and perhaps should be added: See the study here: https://onlinelibrary.wiley.com/doi/abs/10.1111/1477-8947.12047 [Ariana Sutton-Grier, USA]	Accepted: reference cited in the section.
18706	5	72	21	73	9	The definition of human wellbeing should not only include external context (social & cultural, economic, and environment) but also internal context or the how human think, feel about what they have, and can do which known as subjective wellbeing. [Listyati Palupi, Indonesia]	Accepted: subjective wellbeing is included in the assessment whenever literature is available to support such assessment.
2874	5	72	23	72	30	You have many references here (16 to one statement!). Consider reducing. [Geir Ottersen, Norway]	The text was altered as suggested by the reviewer.
22012	5	72	24	72	24	values plural [Bryony Caswell, UK]	The text was altered as suggested by the reviewer.
22014	5	72	24	72	24	tourism singular [Bryony Caswell, UK]	The text was altered as suggested by the reviewer.
22018	5	72	30	72	30	affects plural [Bryony Caswell, UK]	The text was altered as suggested by the reviewer.
22020	5	72	31	72	31	typo, ad should be 'and' [Bryony Caswell, UK]	The text was altered as suggested by the reviewer.
22022	5	72	31	72	31	change 'their' to 'the' [Bryony Caswell, UK]	The text was altered as suggested by the reviewer.
22414	5	73	0	73		Fig. 5.15: It has a lot of good information, but it's too small to see without having to significantly enlarge. Maybe instead of explaining B2, C2, etc., side by side, it can be done vertically? [Debora Ley, Guatemala]	Taken into account - combined with other comments in revising the figure
4118	5	73	1	73	9	Figure 5.15 may be too complex as the present form – too may information is packed into the limited space of the very page, and one would not be able to read and properly understand the infromation what the authors try to provide. [Jinsoon Park, Republic of Korea]	Accepted - the figure has been revised
9534	5	73	1	73	1	Figure 5.15 is very difficult to read. There is a lot of good information here and it appears to provide a roadmap for this section of Chapter 5 however the writing is so small that is impossible to read without zooming in on the pdf. It almost seems like there are as many as 3 figures combined here into 1 figure (which was probably done due to space concerns). However, the result is not as informative as it could be because everything is so small. Perhaps consider splitting this into at least 2 figures, with A and B1-E1 as one figure and a second figure of B2-E2. [APECS Group Review, Germany]	Accepted - the figure has been revised

SROCC First Order Draft Expert Review Comments - Chapter 5							
Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
9536	5	73	1	73	1	Figure 5.15 B2-E2. This section of Figure 5.15 includes a synthesis of confidence for climate change impacts for all of the ecosystem services described in the chapter except supporting services. In the interests of parallel construction throughout this section I would recommend including supporting services in this figure or maybe a brief sentence explaining why it was left out. I really like this part of Figure 5.15 because it does a great job of summarizing the confidence around a lot of information presented in this section. [APECS Group Review, Germany]	The figure has been revised
9538	5	73	1	73	1	Figure 5.15 Perhaps one way to save space with this figure could be to combine the results/summary of confidence around ecosystem services for mangrove and coral reef ecosystems under one grouping (e.g. Coastal Ecosystems). This could be done by splitting the coloring of the boxes with coral reef results on the left and mangroves on the right - or something like that. [APECS Group Review, Germany]	The figure has been revised
9540	5	73	1	73	1	Figure 5.15 The color palette in B2-E2 is difficult to look at. It appears that the authors have done a thorough job of finding a color combination that is suitable for colorblind people and has different enough shading that it can probably be printed in black and white and still be discernable. However, outside of these situations, these colors are very bright and it makes it really hard to focus on the text. Perhaps a tweak to the color palette would fix this? [APECS Group Review, Germany]	The figure has been revised
9542	5	73	1	73	1	Figure 5.15 I really like how this figure synthesizes a lot of the data/points brought up in this section. However, it is only referenced once. Perhaps at relevant points in the various parts of this section, it might be helpful to draw the reader back to this synthesis with additional citations of Figure 5.15. [APECS Group Review, Germany]	The figure has been revised
20448	5	73	1			Such a lovely figure, very informative. Only one small comment, it would be better if the font in the B2-E2 diagrammes was a couple of points larger, at the moment it is very difficult (impossible) to read. [Michelle A. North, South Africa]	The figure has been revised
2222	5	73	2			Figure 5.15, font size in figure too small [Chandani Appadoo, Mauritius]	The figure has been revised
2764	5	73	12	91	26	5.3.1(changes in Key Ecosystem services) describes ecosystem services for three ecosystems; coastal ecosystems, pelagic ecosystems, and deep sea floor ecosystems. However it would help readers to understand the ecosystem service by addressing service types; provisional, regulating, supporting and cultural. This can also help avoid duplication and compare the size of services between ecosystems. [Suk Hui Lee, Republic of Korea]	The figure has been revised

SROCC First Order Draft Expert Review Comments - Chapter 5							
Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
10764	5	73	12	74	16	The section needs to better integrate a broader set of social perspectives into the ecosystem services framework, to enable a fuller characterization and representation of diverse ecosystem values. Costanza et al. (1997) defined cultural values-cum-services as “aesthetic, artistic, educational, spiritual and/or scientific values of ecosystems” (p. 254). The Millennium Ecosystem Assessment (2005, p. 894) expanded this definition to include the “non-material benefits people obtain from ecosystems through spiritual enrichment, cognitive development, reflection, recreation, and aesthetic experience, including, e.g., knowledge systems, social relations, and aesthetic values”. Costanza et al. (1997) define cultural ES as values, while the Millennium Ecosystem Assessment (2005) defines services as benefits; similarly de Groot et al. (2005) include a diverse set of things in their list of categories of services: benefits, services, values, and activities. In the interest of conceptual clarity, some authors distinguish between these diverse things: services are the production of benefits (where benefits may take the form of activities), which are of value to people. Accordingly, cultural services can be defined inclusively as ecosystems' contributions to the non-material benefits (e.g., capabilities and experiences) that arise from human–ecosystem relationships [Coswig Kalikoski Daniela, Italy]	Taken into account - combined with other comments in clarifying the framing of ecosystem services
12112	5	73	12	73	12	Practitioners are moving towards the more value-neutral "nature's contributions to people" instead of "ecosystem services". Although the classical framing of ES into four categories is convenient, wouldn't it be more in keeping with the most recent developments in the field to use the NCP/PBES framing? I note the Diaz 2018 paper is cited, but the phrasing isn't used. Why? I encourage an update of the phrasing and framing used in this section to be in line with the NCP framing. [Sarah Cooley, USA]	The linkage to the recent introduction of Nature's contribution to people is noted in the chapter. However, the term and framing of "ecosystem service" is still dominate the bulk of the literature used in this assessment. Thus, we use the term "ecosystem services" in the chapter.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
13816	5	73	14			Benefits to humans. It is a mistake to discount the fact that many people have a deep sense of respect and responsibility towards earth and life that goes beyond and stands apart from "how we benefit". Perhaps recent science discourse has lost the language for this. Humanity has inherited a living earth and we are systematically destroying it. In attempt to be so scientific and unbiassed, we are missing what some people would consider the main point: saving life on earth. This is the one thing that interests children for instance. And big sectors of the general population: knowing what is going on, and knowing what needs to change. There is a large body of biophilia-related literature that is relevant and does not get a single mention. Many people work in environmental fields because of this very factor. How then does it never come up? It's all down to resources and food and money and tourism. And biodiversity is all down to a 'source for genetic material'. There is repeated talk of 'cultural services' (recreational fishing, whale-watching?!?) but the inherent, immeasurable value of life, all for its own sake, just because it is there and unique and lovely and irreplaceable - that is hardly mentioned. Coral reefs deserve to survive whether a single human ever sees them or benefits from them, ever. Later in the report the inherent value of life does get mentioned briefly. But there should be an entire section devoted to the ethics and imperative of preserving life on earth. [Debra Roberts and Durban Team, South Africa]	Taken into account - we have strengthened the section on climate change impacts on the intrinsic values of ecosystem services. We also clarify that benefits include contribution to human wellbeing that include diverse values including monetary and intrinsic.
19130	5	73	14	74	16	lots of copy edits needed [Anna Zivian, USA]	Text copy-edited
22024	5	73	15	73	15	nature's [Bryony Caswell, UK]	The text was altered as suggested by the reviewer.
9544	5	73	17	74	16	Subsection 5.3.1 begins by defining the four basic groupings of ecosystem services to be discussed, beginning on page 73, line 17. In this section, the ecosystem services are defined as provisioning services, regulating services, supporting services, and cultural ecosystem services. In the interests of consistency, it could help if the authors use the same exact term throughout. As written, some of the subheadings/figures use 'Regulation' and 'supportive' services instead of 'regulating' or 'supporting' services (as defined here). [APECS Group Review, Germany]	Accepted - text revised
22026	5	73	20	73	20	decrease singular [Bryony Caswell, UK]	The text was altered as suggested by the reviewer.
9546	5	73	21	74	16	Good and informative introduction, however in my opinion there should be in general more pressure put on the fact that climate change is caused by an anthropogenic activity. Authors present many results of climate change, but in my opinion they should emphasise the reason of these changes, or give appropriate reference to proper chapter. [APECS Group Review, Germany]	Taken in account - attribution of climate change to human activites are now referred to earlier sections where such attribution assessment are undertaken.
22028	5	73	21	73	22	reword to '…those ecosystem processes that ensure…' [Bryony Caswell, UK]	The text was altered as suggested by the reviewer.
22030	5	74	1	74	3	this process is not clearly explianed [Bryony Caswell, UK]	This is clarified
4130	5	74	2	74	3	Global distribution of seagrasses (Mcowen et al., 2017) saltmarshes (Spalding, 2010), mangroves… --> Global distribution of seagrasses (Mcowen et al., 2017), saltmarshes (Spalding, 2010), mangroves [Jinsoon Park, Republic of Korea]	The text was altered as suggested by the reviewer.
22032	5	74	11	74	11	humans plural [Bryony Caswell, UK]	The text was altered as suggested by the reviewer.
10766	5	74	13	74	15	Message not clear [Coswig Kalikoski Daniela, Italy]	This is now clarified
22034	5	74	13	74	13	reword to simply 'climate can change' [Bryony Caswell, UK]	The text was altered as suggested by the reviewer.

SROCC First Order Draft Expert Review Comments - Chapter 5							
Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
22674	5	74	13	74	15	This sentence is grammatically incorrect, and it is also not clear what is meant, with regards to services that rely on Indigenous knowledge and local knowledge. Please revise and explain. [Eva Kruemmel, Canada]	This is now clarified
22036	5	74	14	74	15	reword to'..particularly those services that rely on…' [Bryony Caswell, UK]	The text was altered as suggested by the reviewer.
9548	5	74	15	74	16	The overall structure of this assessment is described here as summarizing the ecosystem services of 3 oceanic biomes - coastal, pelagic, and deep sea floor, perhaps also consider organizing the information presented in Figure 5.15 to save on a little space and maintain consistency in structure and terms throughout this section. [APECS Group Review, Germany]	Taken in account - Figure revised and consistency of terms ensured.
4120	5	74	20	74	21	While the authors mentioned saltmarshes, mangroves, coral reefs, and seagrass beds as the examples of coastal ecosystems of interests, tidal flat is also not to be omitted. The very habitat provide great ecosystem services too. [Jinsoon Park, Republic of Korea]	Taken in account - tidal flat is considered as part of the assessment of coastal ecosystem services
9550	5	74	20	82	24	I suggest add more information and literature connected with brackish seas like e.g the Baltic Sea. The acidification, hypoxia or too high eutrophication because of fertilization exists there as well and these problems will be growing. [APECS Group Review, Germany]	Taken in account - examples of Baltic Sea are included when it is relevant
18708	5	74	20	104	14	The loss of each coastal ecosystems should be individually highligted in order to show to public the immense of the loss and the damage that occur [Listyati Palupi, Indonesia]	Taken in account - estimates of loss of each main coastal ecosystem types are highlighted.
20586	5	74	20			I would add 'an other biogenic reefs" after "coral reefs". [Chiara Lombardi, Italy]	Accepted - text revised
22038	5	74	26	74	26	replace 'error margin' with 'uncertainties' [Bryony Caswell, UK]	The text was altered as suggested by the reviewer.
13818	5	74	28	74	43	Recommend adding some of the factual information here to the ES. [Debra Roberts and Durban Team, South Africa]	Taken in account - factual information is added.
22040	5	74	35	74	35	delete 'loss' [Bryony Caswell, UK]	The text was altered as suggested by the reviewer.
24226	5	74	36	74	38	This sentence is difficult to understand. Try to rephrase it [Hans-Otto Poertner and WGII TSU, Germany]	The text was altered as suggested by the reviewer.
22042	5	74	37	74	37	datasets plural [Bryony Caswell, UK]	The text was altered as suggested by the reviewer.
22044	5	74	40	74	41	Seems too few (coastal protection, carbon sequestration, fisheries, nutrient cycling, primary production, flooding to name a few), also effects many functions [Bryony Caswell, UK]	Taken in account.
22046	5	74	45	74	45	Are 'biological invasions' a service? [Bryony Caswell, UK]	Accepted - text revised
22048	5	74	47	74	47	studies plural [Bryony Caswell, UK]	The text was altered as suggested by the reviewer.
5560	5	75	1	75	3	About human population count. If this is defined as population count per grid cell the grid size should be indicated. [Roderik Van De Wal, Netherlands]	Figure is revised. Comment is no-longer relevant.
24228	5	75	1	75	1	In Fig 5.17E: units are missing behind legend [Hans-Otto Poertner and WGII TSU, Germany]	Figure is revised. Comment is no-longer relevant.
22050	5	75	8	75	10	But its more than that its also about providing shelter from predators etc [Bryony Caswell, UK]	Accepted - text revised
3696	5	75	10	75	10	The sentence finishing '.. Nutrients for marine and estuarine fanua (Pauly and Zeller, 2014)' says little about essential provisioning ecosystem services for marine fish culture. Propose adding a sentence: 'Marine fish culture relies on coastal and estuarine ecosystems to provide dissolved oxygen and to disperse and assimilate wastes' [Malcolm Beveridge, UK]	Taken in account - text revised

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
10602	5	75	15	75	17	Particularly for South-East Asia (Pendleton et al. 2016b). Reference : Pendleton et al. (2016b). Coral Reefs and People in a High-CO2 World: Where Can Science Make a Difference to People? PLoS ONE [Adrien Comte, France]	Accepted - text revised
22052	5	75	15	75	16	replace 'importance' with 'an important' [Bryony Caswell, UK]	The text was altered as suggested by the reviewer.
22054	5	75	15	75	16	insert 'human' in front of 'communities' [Bryony Caswell, UK]	The text was altered as suggested by the reviewer.
22676	5	75	15	75	16	Grammatically incorrect sentence (should be "an important nutrient source"). [Eva Kruemmel, Canada]	The text was altered as suggested by the reviewer.
3612	5	76	0	104		To introduce options for reducing risks and vulnerabilities of coastal communities through accelerated program of research supporting multi-hasard early warning systems and settling series of oceans observatories, including increased capabilities to predict dangerous ocean extreme events. Other areas to clearly include upfront: plastic debris and their impacts on contamination; risk analysis and research priorities. [E. Salif Diop, Senegal]	Taken in account - these are discussed in SOD 5.5 and the final section of the chapter.
5562	5	76	1	76	13	Figure 5.17; E,F. Unclear what the numbers 3400.000 tonne/*C and -6.7%/*C mean, as the signs of these numbers does not match with the graphs. [Roderik Van De Wal, Netherlands]	The figure has been revised and clarified
11046	5	76	1	76	1	The maps in panels C & D should be labelled 'among' models not 'between' models as there are more than two models being compared. [Tyler Eddy, Canada]	The text was altered as suggested by the reviewer.
11048	5	76	3	76	13	This legend needs work. I'm not sure the two studies referenced in the first sentence were used in any of the figures? The labelled panels do not correspond with the text descriptions of them and not all of the studies have been referenced. [Tyler Eddy, Canada]	The figure has been revised and clarified
19132	5	76	3	76	3	add "in" or "to" between "changes" and "fisheries" [Anna Zivian, USA]	The text was altered as suggested by the reviewer.
3382	5	76	10	76	10	Migh be (F) and (G)? [Castor Muñoz Sobrino, Spain]	The figure has been revised and clarified
9552	5	76	10	76	10	The letter references here for "catch potential (E) and species turnover (F)" appear to be mislabeled. Based on the labels in the figure, it looks like this line should read "catch potential (F) and species turnover (G)" [APECS Group Review, Germany]	The figure has been revised and clarified
11050	5	77	3	77	14	I am surprised that the recent study by Stock et al. 2017 in PNAS isn't discussed and referenced here as it showed that NPP only explains about half of the variation in historical fisheries catches among LMEs. [Tyler Eddy, Canada]	Taken in account - the reference is now cited.
22056	5	77	4	77	4	change to 'affecting species composition and biomass production in coastal and shelf sea...' [Bryony Caswell, UK]	The text was altered as suggested by the reviewer.
22058	5	77	6	77	6	delete 'have shown to' [Bryony Caswell, UK]	The text was altered as suggested by the reviewer.
9554	5	77	9	77	9	in whole Chapter 5 in the main text there is no explanation of SST abbrviation (it is only in Figure 1 caption). [APECS Group Review, Germany]	Accepted - text revised
19134	5	77	18	77	18	remove "not" [Anna Zivian, USA]	The text was altered as suggested by the reviewer.
22060	5	77	18	77	18	delete 'not' [Bryony Caswell, UK]	The text was altered as suggested by the reviewer.
24230	5	77	18	77	19	If they are not impacting ecosystem functions and fisheries productivity, what do they impact then? [Hans-Otto Poertner and WGII TSU, Germany]	Editorial error - corrected
22062	5	77	19	77	19	As far as I'm aware ecosystem resilience and stability are NOT functions [Bryony Caswell, UK]	Taken in account - text revised
22064	5	77	22	77	22	Inconsistent should be 'fuel, timber and food' not 'crustaceans' you havent named what type of timber so why name the food source? [Bryony Caswell, UK]	Taken in account - text revised
24232	5	77	22	77	22	What does "species exploited for crustaceans mean"? Shrimp fisheries? [Hans-Otto Poertner and WGII TSU, Germany]	Taken in account - text revised

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
22066	5	77	23	77	24	A link has also been shown between mangroves and reef productivity, fish need migrate off to the reef from the mangrove [Bryony Caswell, UK]	Taken in account - text revised
22068	5	77	24	77	25	I'm sure the same will apply to seagrass and saltmarshes [Bryony Caswell, UK]	Taken in account - text revised
13820	5	77	27	77	49	Recommend adding some of the factual information here to the ES. [Debra Roberts and Durban Team, South Africa]	Taken in account - factual information of ES of coastal ecosystems are provided in the introduction paragraphs.
19136	5	77	27	77	27	pluralize "ensemble" [Anna Zivian, USA]	The text was altered as suggested by the reviewer.
11052	5	77	30	77	30	Is this the correct reference? [Tyler Eddy, Canada]	An error occurred when chapter 5 references were compiled in Endnote by the TSU resulting in a displacement of all the references by one position. This resulted in a great number of misplaced references which we have since then fixed.
24234	5	77	34	77	34	Better write "efficient energy transfer" [Hans-Otto Poertner and WGII TSU, Germany]	The text was altered as suggested by the reviewer.
11054	5	77	40	77	49	I am skeptical of the projections for regional and and shallow coastal waters due to limitations in the global earth system models and the global fisheries and ecosystem models at these scales. These limitations should be made clear and also that these are the most productive areas of the ocean and also the most important for fisheries. [Tyler Eddy, Canada]	Taken in account in the confidence assessment, and now explicitly discussed in the SOD.
22070	5	77	51	77	52	A profound influence on what? Human diets? Can you cite the FAO reports? (2016 is most current I think) [Bryony Caswell, UK]	This comment arise from an error occurred when chapter 5 references were compiled in Endnote by the TSU resulting in a displacement of all the references by one position. This resulted in a great number of misplaced references which we have since then fixed.
22072	5	77	52	77	54	Cite the FAO the source of all the data [Bryony Caswell, UK]	This comment arise from an error occurred when chapter 5 references were compiled in Endnote by the TSU resulting in a displacement of all the references by one position. This resulted in a great number of misplaced references which we have since then fixed.
22074	5	78	1	78	2	Yes, but this can positive and negative effects - able to culture warmer water species [Bryony Caswell, UK]	Taken in account - text revised
2876	5	78	2	78	3	Disease is another major treat (singular) [Geir Ottersen, Norway]	The text was altered as suggested by the reviewer.
22076	5	78	3	78	3	typo shpuld be 'threats' not 'treats' [Bryony Caswell, UK]	The text was altered as suggested by the reviewer.
24236	5	78	3	78	3	threat not treats [Hans-Otto Poertner and WGII TSU, Germany]	The text was altered as suggested by the reviewer.
16426	5	78	4	78	5	Barange et al. 2014 does not report parasite increases associated with climate change in aquaculture [Coswig Kalikoski Daniela, Italy]	This comment arise from an error occurred when chapter 5 references were compiled in Endnote by the TSU resulting in a displacement of all the references by one position. This resulted in a great number of misplaced references which we have since then fixed.
22078	5	78	4	78	6	Also oyster diseases on east coast of USA [Bryony Caswell, UK]	Taken in account - however, we cannot provide an exhaustive list of exmaples
22090	5	78	12	78	27	There is an extreme lack of information on cultural services here - far less than has been attempted in the literature. Even a few examples would help. [Bryony Caswell, UK]	Treatment of culture services in the assessment have been expanded in SOD

SROCC First Order Draft Expert Review Comments - Chapter 5							
Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
6508	5	78	19	80	22	The text on blue carbon ommits important recent understanding on the contribution of other ocean components. Recent published work has highlighted large uncertainties around the present understanding of the blue carbon potential of seaweed and other, connected, organic carbon sinks in the coastal and open ocean. Questions have also been placed around whether managing these sinks is indeed less feasible than managing the traditionally considered blue carbon habitats in the coastal ocean. See for instance: Krause-Jensen et al. 2018 Biology Letters 14: DOI: 10.1098/rsbl.2018.0236; Smale et al 2018 Front Ecol and Env 16: DOI: 10.1002/fee.1765; Krause-Jensen and Duarte 2016 Nature Geoscience 9: DOI 10.1038/ngeo2790. In addition, several initiatives are currently underway around the world to address existing uncertainties and data availability. It would therefore suggest that this section requires revision: it is not in line with current understanding nor does it reflect a consensual view within this research community. [Ana Queiros, UK]	This is now considered in preparing in SOD
9556	5	78	19	80	22	Perhaps consider restructuring the discussion of the regulation, supportive, and cultural ecosystem services in this section so that they are discussed in the same order as listed in the section heading. As currently written, it seems to me that supporting services are discussed first (page 78, lines 33-45), followed by cultural services (page 78-79, lines 52-51, 1-2), and then regulation (pages 79-80, lines 4-19, 5-22). Because this section is covering so much material, I think that it could help the reader if the authors strictly adhere to discussing each ecosystem service type in the same order as they appear in headings for each subsection. [APECS Group Review, Germany]	Taken in account - text revised
17866	5	78	19	78	19	Should this section be titled 'Regulating' rather than 'Regulation'? This also appears elsewhere (pg. 5-82 line 37 and 5-87 line 6) where 'regulating' makes more sense. [Roberta Hansman, France]	The text was altered as suggested by the reviewer.
13822	5	78	20	78	20	Change 'additional' to 'addition' [Debra Roberts and Durban Team, South Africa]	The text was altered as suggested by the reviewer.
13824	5	78	21	78	26	Recommend adding some of the factual information here to the ES. [Debra Roberts and Durban Team, South Africa]	The text was altered as suggested by the reviewer.
22080	5	78	21	78	26	Can you add 'For instance,' before coral reefs? Most subtidal and intertidal habitat is NOT coral reef but that does not mean it is not important ecologically or socially [Bryony Caswell, UK]	Text-revised
22082	5	78	21	78	26	You should rebalance the first paragraph to mention some of these other very important habitats (see above comment) [Bryony Caswell, UK]	Accepted - text revised
22084	5	78	28	78	28	DO you mean 'cultural services' rather than 'environmental'? We can at least measure environmental more easily than cultural [Bryony Caswell, UK]	The definition of cultural service is stated in the introduction paragraph
22086	5	78	33	78	37	Again this over-emphasis on coral reefs - this is biased without basis. The reefs are dependent on all the other habitats which are arguably more important (seagrass, saltmarsh, mangrove, estuaries, mudflats, sandflats all provide important functions and services in coastal areas and cover THE majority of the area) [Bryony Caswell, UK]	Accepted - SOD has a more balanced treatment of with other non-coral reef coastal habitats.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
22088	5	78	33	78	37	This subsection is entitled 'regulatory, supportive and cultural services' but seems to be an essay on reefs. I was expecting some disucssion of regulatory, supporting and cultural services (given the title) but there is almost none? There arent even any services named until the third paragraph - and then again its all about reefs [Bryony Caswell, UK]	Accepted - SOD has a more balanced treatment of with other non-coral reef coastal habitats.
10604	5	78	37	78	41	For additional references on climate effects on coral reefs ecosystem services : Cinner et al. (2015). A framework for understanding climate change impacts on coral reef social–ecological systems. Regional Environmental Change. - See particularly Figure 1 Pendleton et al. (2016b). Coral Reefs and People in a High-CO2 World: Where Can Science Make a Difference to People? PLoS ONE Pendleton et al. (2016c). Multiple Stressors and Ecological Complexity Require a New Approach to Coral Reef Research. Frontiers in Marine Science - see particularly Figure 1 [Adrien Comte, France]	The references have been considered carefully.
5564	5	78	38	78	38	It refers to highlighted temperature, but highlighted has not been defined. [Roderik Van De Wal, Netherlands]	The text has been revised to address this.
19138	5	78	40	78	41	missing verb? [Anna Zivian, USA]	The text has been revised to address this.
19140	5	78	41	78	41	reefs' [Anna Zivian, USA]	The text was altered as suggested by the reviewer.
19142	5	78	42	78	42	I am not sure that you can go from "will alter" to "consequently degrade" until after you explain why (which the next sentence starts to get at). [Anna Zivian, USA]	The text has been revised to address this.
10606	5	78	53			Also see : Spalding et al. (2017). Mapping the global value and distribution of coral reef tourism. Marine Policy [Adrien Comte, France]	Accepted - text revised
20588	5	79	0			Figure 5. 18. I would edit the figure, the images have low resolution (chart B), font proerties and colours are different. So, it needs to be revised. [Chiara Lombardi, Italy]	The figure has been removed in SOD.
5566	5	79	4	79	19	In some cases the surface area is refered to as ha-1, and sometimes m-2. Can this be made consistent to have the same surface area? [Roderik Van De Wal, Netherlands]	The text was altered as suggested by the reviewer.
13826	5	79	4	79	18	Units are sometimes per m and sometimes per ha. Please be consistent. Use same units in figure. [Debra Roberts and Durban Team, South Africa]	Accepted - text revised
724	5	79	7	79	7	The role of algae in carbon sequestration is not clearly defined and hence delete "and potentially algae" and add "and" before "seagrasses" [Kathiresan Kandasamy, India]	Accepted - text revised
12114	5	79	7	79	12	citations needed? [Sarah Cooley, USA]	Reference added
21572	5	79	7	79	12	These two sentences together are unclear. The first refers to the storage capacity in sediments; the second begins: "In addition to the carbon captured by plants…" [Robie Macdonald, Canada]	The text was altered to address the reviewer comment
21574	5	79	13	79	15	This sentence and Figure 5.18 show global rates for seagrass sediment carbon capture published by McLeod et al 2011 and Fourqurean et al 2012. Those rates have been shown to be incorrect and strongly biased high ((Johannessen & Macdonald, 2016 Environmental Research Letters 11: 113001; Johannessen & Macdonald 2018 Environmental Research Letters 13: 028002; Johannessen & Macdonald 2018 Environmental Research Letters 13: 038002). The rates are based on a naive interpretation of how marine sediments process and sequester carbon, which neglects six decades of published marine geochemical literature. [Robie Macdonald, Canada]	The figure has been removed in SOD.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
11518	5	79	14	79	19	Although these sentences are correct in their comparison of the contribution to overall carbon storage from land-based compared to 'blue carbon' storage, the final sentence of this paragraph could be understood by the reader to negate the significance of 'blue carbon' in terms of global carbon budget (on the basis that terrestrial sinks are, in total, around ten times larger). This then contrasts with, and may even appear to contradict, the emphasis placed on the importance of 'blue carbon' to the global carbon budget in the very next sentence (lines 5-6 on page 80). This could be fixed with some minor edits to the text of either sentence in order to link the two concepts, by stressing that, despite the contrast between 'blue carbon' and terrestrial storage, the former makes a significant contribution nonetheless. [Taehyun Park, Republic of Korea]	This is considered in preparation for SOD
24238	5	79	15	79	15	it seems odd to explain the word Giga [Hans-Otto Poertner and WGII TSU, Germany]	The text was altered as suggested by the reviewer.
9558	5	79	21	79	21	typo: Boral Forest - Boreal Forest [APECS Group Review, Germany]	Revised
13828	5	80	0			Fig 5.18 Please emphasise that the graph shows C storage and burial per m (and not total). [Debra Roberts and Durban Team, South Africa]	The figure has been removed in SOD.
3384	5	80	1	80	3	Fig. 5.18. I miss the tidal marshes containing very organic shallow marine sediments (are they included in salt marshes?) [Castor Muñoz Sobrino, Spain]	The figure has been removed in SOD.
11654	5	80	25			It would be helpful to set fluxes and stocks into context. For example, the release of C from blue carbon ecosystems should be compared with total emissions by fossil fuel and LULUC. [Fortunat Joos, Switzerland]	This is considered in preparation for SOD
20590	5	81	0			Figure 5. 19: low quality of the immages. [Chiara Lombardi, Italy]	The text was altered as suggested by the reviewer.
13198	5	81	1	81	1	the figure resolution is too poor [Baerbel Hoenisch, USA]	The text was altered as suggested by the reviewer.
2684	5	81	3	81	9	Does the proposed shape of the effect of sea level rise on plants apply to all plants or is based on a specific range of plants? [Mohammad Javad Zareian, Iran]	Clarified
2770	5	81	3	81	8	Figure 5.19 is used to describe the biogeomorphic feedbacks of the carbon accmunlation in the saltmarsh soil. However the 'negative' and 'positive' feedback in this figure is based on the atmospheric CO2. This would make sense to express 'positive' and 'negative' as a soil carbon perspective. In this case, increased carbon accumulationfrom improved plant growth would be positive feedback and inhibition of plant would be negative feedback. For this concept, you can refer Vandenbruwaene et al(2011); Flow interaction witih dynamic vegetation patches:Implications for biogeomorphic evolution of a tidal landscape. [Suk Hui Lee, Republic of Korea]	Considered, but we think highlighting the feedback to atmoshpere is important
13830	5	81	5			Figure legend: "negative feedback" - to a non-specialist this implies a bad effect, whereas in climate modelling it means "reducing climate change"? - which to a layperson would be a "positive outcome". This is potentially confusing and authors could perhaps be mindful of this. [Debra Roberts and Durban Team, South Africa]	Clarified
13832	5	81	12	81	27	Entire par extremely vague and opaque. [Debra Roberts and Durban Team, South Africa]	The text has been revised to address this.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
9560	5	81	29	81	30	In the other subsections (5.3.1.1 Coastal Ecosystems and 5.3.1.3 Deep Sea Floor Ecosystems) there is an introductory/summary section before moving on to the sections that Provisioning service and Regulation, supportive and cultural services. Is there a plan to add paragraph here to provide balance to each of the three highlighted ocean biomes discussed? This unbalance caught my attention due to the extra-long discussion in the Coastal Ecosystem (5.3.1.1) section and the moderate discussion in the Deep Sea Floor Ecosystems (5.3.1.3) section. At this point I assume this difference in treatment is due to available information? If not, perhaps fleshing this section out for the Pelagic Ecosystems subsection (5.3.1.2) or trimming it in the other subsections. Maybe moving Box 5.3 to this section could help flesh this part out without adding a lot of new text, while contributing to a more balanced construction of this section of Chapter 5. [APECS Group Review, Germany]	An introduction paragraph has been added in SOD. In SOD, a more balanced treatment is now given to the three ecosystem types.
17400	5	81	29	81	29	This Pelagic heading should be 5.3.1.1 (i.e. before Coastal) to match other sections. [Helen Kettles, New Zealand]	The sectioning has been revised in SOD - comment no longer applies
5568	5	82	3	82	3	It refers to "Enviromentental gradients", but this has not been defined. [Roderik Van De Wal, Netherlands]	Environmental gradient is revised to be temperature gradient.
3386	5	82	6	82	12	Sardine (and also cod) may be other good examples in the North Atlantic. E.g. Muñoz Sobrino et al. 2014. Quaternary Science Reviews, 93: 11-33. [Castor Muñoz Sobrino, Spain]	Thank you for the suggestion.
22092	5	82	8	82	8	Replace 'latitude' with 'latitudinal' [Bryony Caswell, UK]	The text was altered as suggested by the reviewer.
15206	5	82	13	82	16	The Fisheries and Marine Ecosystem Models Intercomparion Project (FISH-MIP), which is based on three fisheries models driven by the outputs of two CMIP5 earth system models, suggest a high decrease (more than -30% between now and 2100) of the catch potential in the tropical open oceans, particularly in the western central Pacific Ocean, the Eastern central Atlantic Ocean and the Western Indian [Christophe Deissenberg, Luxembourg]	The text has been revised in the SOD and the comment is no longer relevant.
15208	5	82	17	82	17	(likely, Figure 5.17). By contrast, the catch potential [Christophe Deissenberg, Luxembourg]	The text was altered as suggested by the reviewer.
2878	5	82	18	82	18	Don't quite get this. What does "intermodal" mean here? Among the models? [Geir Ottersen, Norway]	It should be inter-model. Corrected
24240	5	82	27	87	1	This Box is too long. Try to reduce its content [Hans-Otto Poertner and WGII TSU, Germany]	The box will be reorganized in order to reduce.
15210	5	82	32	82	33	In close proximity to vast coastal human populations, the Eastern Boundary Upwelling Systems (EBUS) encompasses some of the the most productive ocean ecosystems in the world (García-Reyes et al.). [Christophe Deissenberg, Luxembourg]	The text has been revised in the SOD and the comment is no longer relevant.
15218	5	82	32	82	32	encompasses ==> encompass IN MY CORRECTION [Christophe Deissenberg, Luxembourg]	The text has been revised in the SOD and the comment is no longer relevant.
23316	5	82	32			Editing for grammar and flow is necessary. Wording is imprecise. At this stage, this section of the chapter is still too rough to be given an appropriate review, as it is sometimes unclear whether the wording indicates the need for scientific revisions or simply improved grammar. [Ryan Rykaczewski, USA]	Box 5.3 has been substantially revised to address the reviewers' comments and suggestions.
9562	5	82	33	82	33	lack of publication date [APECS Group Review, Germany]	The text was altered as suggested by the reviewer.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
15212	5	82	35	82	36	The main services provided by EBUS include fisheries and aquaculture (provisioning), the generation of moisture and precipitations (regulation), whale-watching (cultural), and the provision of nutrients to support coastal foodweb (supporting) (Bakun et al., 2015; Pauly and Zeller, 2016). For example, the total annual fisheries catch from the [Christophe Deissenberg, Luxembourg]	The text has been revised in the SOD and the comment is no longer relevant.
15424	5	82	41	82	41	This is not the correct reference. This paper doesn't provide this information. [Marisol Garcia-Reyes, USA]	An error occurred when chapter 5 references were compiled in Endnote by the TSU resulting in a displacement of all the references by one position. This resulted in a great number of misplaced references which we have since then fixed.
15214	5	82	43	82	45	The high concentration of marine mammals supported by the upwelling ecosystem allows a lucrative eco-tourism such as whale-watching in the California Current (Gutiérrez et al. YEAR?????). [Christophe Deissenberg, Luxembourg]	Revised
9564	5	82	45	82	45	lack of publication date [APECS Group Review, Germany]	The text was altered as suggested by the reviewer.
15216	5	82	47	82	48	Thus, although its area is small compared to other pelagic ecosystems, the impacts of climate change on EBUS are likely to have disproportionately large consequences for human societies (very high confidence). [Christophe Deissenberg, Luxembourg]	The text was altered as suggested by the reviewer.
21524	5	82	47	82	48	I believe there is should be period at the end of Line 48 to complete the sentence that reads, "Thus, climate change impacts on EBUS would have disproportionately large ramification on human societies relative to its smaller area compared to other pelagic ecosystems (very high confidence) *period here*" [Tseng Rose, USA]	The text was altered as suggested by the reviewer.
15220	5	82	49	82	53	In spite of their high resilience due to the high natural intrinsic variability (see review in Allison and Bassett (2015), also see Box 5.3, Table 1), the EBUS are vulnerable to the multiple effects of climate change (Bakun et al., 2015, medium confidence). There is a large regional variation in how the natural-human systems are changing under anthropogenic stress and how they might change in the future (Demarcq, 2009; Gattuso et al., 2015). [Christophe Deissenberg, Luxembourg]	The text has been revised in the SOD and the comment is no longer relevant.
15222	5	82	54	82	57	The climate-induced changes in biophysical conditions under increasing CO2 emissions may differ among the major EBUS. On the average, the EBUS show the same general century scale increases in sea surface temperature (Chavez et al., 2017; Pennington et al., 2017) and decreases in pH (Turi et al., 2016; Levin, 2018) and dissolved oxygen (Bakun, 1990) than the global estimates, but these changes are not steady and vary from EBUS to EBUS (Table [Christophe Deissenberg, Luxembourg]	The text has been revised in the SOD and the comment is no longer relevant.
15430	5	82	54	82	55	Atlhough this line is correct, it have some caveats: in the EBUS SST trends showdifferences between regions and different latitutes (Pardo et al. 2011, Climate Research, goi:10.3354/cr00989), between offshore and onshore regions (Santos et al 2012, Continental Shelf research doi:10.1016/j.csr.2011.12.004) and among data sets (Narayan et al. 2010, Oscience Science. goi:10.5194/os-6-815-2010). [Marisol Garcia-Reyes, USA]	We will include some caveats, about the EBUS SST trends show differences, regions, latitude, and between offshore and onshore regions.
15426	5	82	55	82	55	References here are not correct. It should be Chavez et al. 2011(already in the list of references. This seems a typo) for the first one, and remove Pennington et al. 2017 (not pertinent). [Marisol Garcia-Reyes, USA]	An error occurred when chapter 5 references were compiled in Endnote by the TSU resulting in a displacement of all the references by one position. This resulted in a great number of misplaced references which we have since then fixed.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
15428	5	82	55	82	55	Another reference pertinent in this line is Deser et al 2010 GRL. Twentieth century tropical sea surface temperature trends revisited [Marisol Garcia-Reyes, USA]	An error occurred when chapter 5 references were compiled in Endnote by the TSU resulting in a displacement of all the references by one position. This resulted in a great number of misplaced references which we have since then fixed.
20592	5	82	55			Space need between ") "and "and" [Chiara Lombardi, Italy]	The text was altered as suggested by the reviewer.
17856	5	82	56	82	56	Cited ref Levin, 2018 should refer to dissolved oxygen not decreases in pH [Roberta Hansman, France]	Accepted the substance comment. The text was altered as suggested by the reviewer.
15224	5	83	1	83	3	The predicted increases in upwelling-favourable winds, caused by the increase in land-ocean differential heating due to global warming (Sydeman et al., 2014), are also uncertain because of large regional differences (low confidence). Some [Christophe Deissenberg, Luxembourg]	The text was altered as suggested by the reviewer.
15432	5	83	1	83	3	This sentence has a incorrect reference and is misleading of the rest of the paragraph. I suggest: Predicted increases in upwelling-favourable winds, caused by enhanced land-ocean differentail heating due to global warming (Bakun, 1990. Science) has been observed (Sydeman et al. 2014; Wang et al., 2015) but there are regional differences in the trends and uncertainty about the mechanism behind them (Rykaczewski et al. 2015). [Marisol Garcia-Reyes, USA]	An error occurred when chapter 5 references were compiled in Endnote by the TSU resulting in a displacement of all the references by one position. This resulted in a great number of misplaced references which we have since then fixed.
15434	5	83	3	83	3	It requires a sentence about new proposed mechanisms, before the "Some recent" sentence: A poleward displacement of the subtropical high pressure systems (Rykaczweski et al. 2015 or Garcia-Reyes et al 2015 or Bedmadani 2013 Climate Dynamics, doi: 10.1007/s00382-013-2015-2) due to the expansion of the Hadley Cell (Lu et al.2007 GRL doi:10.1029/2006/GL028443) might explain latitudinal differences better than land-ocean temperature differences. [Marisol Garcia-Reyes, USA]	We accept the suggest about "some recent" proposed mechanisms.
15436	5	83	5	83	7	Rewrite:" … by the end of the 21st century, however this patters are not consistent across all EBUS (Sydeman et al., 2014; Garcia-Reyes et al. 2015; Rykaczewski et al. 2015; Wang et al. 2015)." [Marisol Garcia-Reyes, USA]	We accept the rewrite the sentence.
23318	5	83	9	83	12	An additional conclusion of Xiu et al. (2018) was that large-scale changes in the nutrient concentrations supplied to the EBUS may be more important than the large-scale winds. This mechanism of nutrient enrichment of the deep source waters may be important to mention, as it is not mentioned elsewhere. The mechanism was described more thoroughly in Rykaczewski and Dunne (2010). [Ryan Rykaczewski, USA]	We accept to include the additional conclusion of Xiu et al. 2018 in the large-scale changes in the nutrients concentrations supplied to the EBUS in the section 5.2.1. Changes in physical and biogeochemical properties.
15226	5	83	11	83	11	are thought to have the greatest impact on regional productivity [Christophe Deissenberg, Luxembourg]	The text was altered as suggested by the reviewer.
23320	5	83	12	83	13	The paper cited for this statement about the California Current is cited incorrectly (Gómez-Letona et al., 2017), as that paper refers only to the Canary Current. I think it is inappropriate to note small changes in primary production over very short periods of time and imply that they may be attributable to anthropogenic climate change. These areas exhibit high levels of interannual to multidecadal variability, and noting changes that have occurred over less than two decades will be misleading. [Ryan Rykaczewski, USA]	An error ocurred with that reference. In relation to the attributable to anthropogenic CC changes in short time series, we agree that the major signal of variability are the interannual to multidecadal varibility, but we will consider to rewrite that lines.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
15438	5	83	16	83	16	Wrong reference (Garcia-Reyes), the correct one is probably Chavez et al. 2011 (previously cited) [Marisol Garcia-Reyes, USA]	An error occurred when chapter 5 references were compiled in Endnote by the TSU resulting in a displacement of all the references by one position. This resulted in a great number of misplaced references which we have since then fixed.
15228	5	83	20	83	29	The historical inter-annual variability (e.g. ENSO events) evidences the consequences on human communities of changing oceanographic conditions in the upwelling systems. The main industrial-scale fisheries are highly sensitive to the upwelling conditions. For example, El Niño causes large decreases in anchoveta population in the Humboldt Current, with corresponding impacts on the fishing industries (Merino et al., 2010). Since the small pelagic fisheries from the upwelling regions are the main source of the global fishmeal market, the decreasîng production leads to an increase of the international fishmeal price and thus of the price of other foods that are produced using fishmeal, through aquaculture e.g. (Golden et al., 2016; Carlson et al., 2017). Moreover, the decrease in catches also affects the regional food security as catches from the upwelling region are an important source of nutrients. [Christophe Deissenberg, Luxembourg]	The text was altered as suggested by the reviewer.
24242	5	83	20	83	20	what are human dependent communities? Do you mean marine dependent communities? [Hans-Otto Poertner and WGII TSU, Germany]	We mean the human dependent communities impacted by El Niño Southern Oscillation events, we will rewrite that sentence.
726	5	83	23	83	23	"sensitivity" be changed as "sensitive" [Kathiresan Kandasamy, India]	The text was altered as suggested by the reviewer.
1526	5	83	23	83	23	sensitivity--> sensitive? [Davide Bonaldo, Italy]	The text was altered as suggested by the reviewer.
24244	5	83	28	83	37	this section needs careful copyediting [Hans-Otto Poertner and WGII TSU, Germany]	The text was altered as suggested by the reviewer.
15230	5	83	30	83	33	are important source of micronutrients for the nearby West African countries (Guevara-Carrasco and Lleonart, 2008), where the climate risk is particularly high because of a strong dependence on the fisheries, a rapidly growing population, and regional conflicts. Thus, these countries these have a high sensitivity to climate impacts and a low adaptive capacity (Box 5.3, Figure 1). [Christophe Deissenberg, Luxembourg]	The text was altered as suggested by the reviewer.
728	5	83	34	83	34	add "in" after "Decrease", change "increase" to "increases" and "reduce" to "reduces" [Kathiresan Kandasamy, India]	The text was altered as suggested by the reviewer.
15232	5	83	34	83	36	A decrease of pelagic stocks of small fish also increases the mortality and reduces the reproduction of large vertebrates such as hake (Essington et al., 2015), whales and seabirds (Arntz et al., 2006) while the reduction in upwelling strength may improve the oxygenation of the sea floor, and thus could be beneficial to demersal fisheries (Blasiak et [Christophe Deissenberg, Luxembourg]	The text was altered as suggested by the reviewer.
23322	5	83	39	83	39	While highlighting the impacts on the Canary Current is nice as an example, I find it inappropriate to rank the Canary Current as more sensitive than the other regions. I have not seen a comparison of the differing sensitivities of EBUS to climate change, but I would not immediately expect the Canary to rank as most sensitive. [Ryan Rykaczewski, USA]	I agree, but we have more information (published) from California, the and Benguela last years, we will need to discuss more about the "ranking of sensitivities". We will to rewrite that paragraph.
15234	5	83	42	83	43	Overall, the impact of climate change on the upwelling system can have far reaching consequences on human society, both on coastal-dependent communities and on those that are far away from the coast (high confidence). [Christophe Deissenberg, Luxembourg]	The text was altered as suggested by the reviewer.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
U	5	84	0			Fig 5.3 This diagram, with all the small icons, really does not convey a clear message. The point of this figure is not clear is it to compare the four EBUS? If so, show a map of where they are on the globe? Then have a 4x8 bar chart showing confidence level of each. No icons, just words. [Debra Roberts and Durban Team, South Africa]	The figure has been revised
13836	5	84	0			Table 1 is not user friendly - is there a better way of presenting this information? [Debra Roberts and Durban Team, South Africa]	Table moved to SM
9566	5	84	1	84	4	Box 5.3, Figure 1. This is a very nice summary of the data presented but it is almost too small to read or differentiate between symbols. Perhaps consider enlarging A - D by eliminating some of the white space around each panel or increasing the font size of the writing. Also, the symbols for Livelihood dependency and Nutrition dependency are smaller than all of the other symbols in panels A -D and are somewhat difficult to tell apart - perhaps consider enlarging these symbols so they are the same size as the other symbols. [APECS Group Review, Germany]	The font and symbols are enlarged.
11056	5	84	1	84	1	California Current threat levels missing for environmental variables (in red). [Tyler Eddy, Canada]	Ok, we will correct the figure.
21002	5	84	1			In Box 5.3, Fig 1 the confidence levels are missing for the California Current example panel A. [Adrienne Sutton, USA]	The text was altered as suggested by the reviewer.
23324	5	84	2	84	4	The origin of these data is unclear. García-Reyes et al. (2015) did not conduct a vulnerability assessment that considered differences among coupled natural-human systems. [Ryan Rykaczewski, USA]	There are an error with the reference when compile by endnote.
15440	5	84	4	84	4	This reference doesn't cover the social aspects depict in this graphics. A reference to where that data is available is needed. [Marisol Garcia-Reyes, USA]	An error occurred when chapter 5 references were compiled in Endnote by the TSU resulting in a displacement of all the references by one position. This resulted in a great number of misplaced references which we have since then fixed.
24246	5	84	7	87	1	explain acronyms used in this table in the legend [Hans-Otto Poertner and WGII TSU, Germany]	Table removed to SM and acronyms explained
15442	5	84	8	84	8	Thisi s not the correct reference for this table. Garcia-Reyes et al, 2015 and Bakun et al 2015 (already referenced above) are better basis for this table. For the services impacts though, it requieres an appropriate reference [Marisol Garcia-Reyes, USA]	An error occurred when chapter 5 references were compiled in Endnote by the TSU resulting in a displacement of all the references by one position. This resulted in a great number of misplaced references which we have since then fixed.
23326	5	84	8	84	8	The relevance of the Sydeman et al. (2014) manuscript for this table is tangential. [Ryan Rykaczewski, USA]	Considered
15444	5	84	9	84	9	Table 5.3 last column, first row. References: Garcia-Reyes is repeated, but Rykaczewski et al. 2015 is missing fropm the list. [Marisol Garcia-Reyes, USA]	An error occurred when chapter 5 references were compiled in Endnote by the TSU resulting in a displacement of all the references by one position. This resulted in a great number of misplaced references which we have since then fixed.
15446	5	84	9	84	9	Table 5.3 last column, second row. References: Chavez et al. 2011 (already in the reference list), Narayan et al. 2010, Oscience Science. doi:10.5194/os-6-815-2010 and Pardo et al. 2011, Climate Research, goi:10.3354/cr00989 should be included [Marisol Garcia-Reyes, USA]	An error occurred when chapter 5 references were compiled in Endnote by the TSU resulting in a displacement of all the references by one position. This resulted in a great number of misplaced references which we have since then fixed.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
14070	5	85	0	85		I think that projecting that by 2050 that all ocean waters above 1.5 will lhave largely disappared is again a WAY oversimplificiation and should either be removed or modified to say that this may be true for polar regions and much of the surface waters of the open ocean but likely not for coastal systems which are modified by other inputs and processes. Rest of this paragraph should be proofed and cleaned. Major evidence for OA comes from internationally supported repeat hydrography cruises which have tracked carbonate system parameters for decades - not from upwelling systems. [Elizabeth Jewett, USA]	We will clean and rewrite the paragraph.
20594	5	85	0			Box 5.3 Acidification- " A time series.....In CalC pH and ?? arag..." Please, revise the symbol, which is not an omega. DEOXYGENATION: "Oxygen....", font is not homgenous neither color (back and gret), please revise it. [Chiara Lombardi, Italy]	The text was altered as suggested by the reviewer.
13200	5	85	1	85	1	the omega symbol in omega_aragonite has turned into a speaker symbol [Baerbel Hoenisch, USA]	The text was altered as suggested by the reviewer.
17402	5	85	8	85	8	For Acidification also see a 20 year time series in NZ https://www.tandfonline.com/doi/abs/10.1080/00288330.2017.1374983 [Helen Kettles, New Zealand]	This information will be useful to the Box about acidification.
23328	5	86	0	86		For “Nutrients, Plankton and Primary Production” the “Projections” column is difficult to interpret, as it notes both “elevated flux,” “variable trends,” and” non-linear responses.” The meaning of these phrases is unclear. [Ryan Rykaczewski, USA]	We will rewrite that phrases.
23330	5	86	0	86		Statements in “Nutrients, Plankton and Primary Production” and “Provisioning Services” are contradictory. In the former, there was a high level of uncertainty described, especially for fisheries. In the latter, the geographical shifts of specific species are described. Aldo, the level of confidence appears to increase from nutrient changes to changes in services. This is unrealistic. [Ryan Rykaczewski, USA]	We will rewrite the contratictory sentences.
24248	5	86	0	86		column Evidence for projected scenarios (Expected); row Provisioning Services : what are human dependent communities? Do you mean marine dependent communities? [Hans-Otto Poertner and WGII TSU, Germany]	We mean the human dependent communities impacted by El Niño Southern Oscillation events, we will rewrite that sentence.
13838	5	87	6			What is the value of this section? Carbon absorption and recreational fishing - two random points that have been mentioned elsewhere. [Debra Roberts and Durban Team, South Africa]	Synthezie climate regulation and cultural services
1528	5	87	8	87	8	includes --> include? [Davide Bonaldo, Italy]	The text was altered as suggested by the reviewer.
15236	5	87	8	87	8	include carbon storage as a regulating servic), tourism and recreational fishing as a cultural service, [Christophe Deissenberg, Luxembourg]	The text was altered as suggested by the reviewer.
15238	5	87	9	87	9	and biodiversity as a supporting service (IPCC, 2007). All these services will be impacted by climate change (medium [Christophe Deissenberg, Luxembourg]	The text was altered as suggested by the reviewer.
13840	5	87	10	87	12	The ocean … making up the biggest contribution … relative to coastal and deep sea ecosystems - isn't the deep sea part of the ocean? [Debra Roberts and Durban Team, South Africa]	Revised
15240	5	87	11	87	12	(see Section 5.2.1.3) (IPCC, 2014; World Bank, 2014) thus making a larger contribution in carbon sequestration than the coastal and deep sea ecosystems. [Christophe Deissenberg, Luxembourg]	The text was altered as suggested by the reviewer.

SROCC First Order Draft Expert Review Comments - Chapter 5							
Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
2766	5	87	12	87	13	Monetary value of carbon storage as a regulating service has been addressed both in the pelagic ecosystem(5.3.1.2.2) and in the deep sea floor ecosystem(5.3.1.3.2). However the cited unit price of carbon is different from two sections; USD7/tC for pelagic ecosystem and USD62/tC for a deep sea floor ecosystem. This would be better to be compared with each other within a single paragraph as it would confuse readers to understand the value of service. [Suk Hui Lee, Republic of Korea]	Carbon pricing is complex and different carbon prices are often used in different context. Therefore, we quoted the carbon price used in the reference where the estimates are from.
15242	5	87	13	87	14	USD200 billion. The net ocean global carbon uptake by the ocean projected by the CMIP5 earth system models for 2080 is between 1.0–5.5 [Christophe Deissenberg, Luxembourg]	The text was altered as suggested by the reviewer.
15244	5	87	16	87	18	2010). The upper range of the projected changes exceeds the current observed variability of the global ocean carbon uptake from observations, which varies between 1.0–2.5 PgC yr–1 between 2000–2012 (see Figure 5.8). Because of saturation effects, the ocean carbon update is projected to decrease even under increased atmospheric [Christophe Deissenberg, Luxembourg]	The text was altered as suggested by the reviewer.
15246	5	87	22	87	23	For example, the estimated total expenditure and employment generated worldwide by whale watching operations are USD413 million and 5762 jobs respectively (Gallagher et al., 2017). [Christophe Deissenberg, Luxembourg]	The text was altered as suggested by the reviewer.
15254	5	87	23	87	23	Sport fishing on large pelagic species such as tuna, [Christophe Deissenberg, Luxembourg]	The text was altered as suggested by the reviewer.
13842	5	87	32	87	33	How can deep sea ecosystems generate cultural services? There is lots of very vague language here. It's worth noting that humanity probably spends more money looking for life on other planets than on the deep ocean and its life forms. It is worth preserving for its own sake, whether or not it holds a wealth of resources or not. [Debra Roberts and Durban Team, South Africa]	Cultural services range from education and scientific research to art, film, and literature - to graveyard for slaves along former transport routes. While I agree - the need to preserve the deep sea for its own sake may be taken as opinion . Some of this sentiment appears in a later sentence There is a need for advanced thinking about ecosystem services in the deep ocean, going beyond intrinsic and instrumental values to incorporate relational values (Eudaimonia) that collectively acknowledge human associations with nature in multiple forms across different cultural practices (Chan et al., 2016).
15248	5	87	32	87	32	Deep-ocean processes and organisms (Table 5.5) generate many types of provisioning, regulating, supporting [Christophe Deissenberg, Luxembourg]	The text was altered as suggested by the reviewer.
15250	5	87	35	87	39	area of the planet and most of the habitable volume, are all the people on the earth. Thie Deep Ocean holds a wealth of living and inanimate resources and provides services that are likely to sustain humans for centuries to come. Understanding and assessing the impacts of climate change on the deep-sea ecosystem services is particularly challenging as the Deep Ocean is vast, remote and only partially explored. Many deep-sea habitats are unfamiliar, and their ecology is poorly known. [Christophe Deissenberg, Luxembourg]	The text was altered as suggested by the reviewer.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
15252	5	87	35	87	35	area of the planet and most of the habitable volume, are all the people on the earth. The Deep Sea holds a wealth of living and inanimate resources and provides services that are likely to sustain humans for centuries to come. Understanding and assessing the impacts of climate change on the deep-sea ecosystem services is particularly challenging as the Deep Sea is vast, remote and only partially explored. Many deep-sea habitats are unfamiliar, and their ecology is poorly known. [Christophe Deissenberg, Luxembourg]	The text was altered as suggested by the reviewer.
5570	5	87	36	87	36	consider to reserve the term "likely" for the defined uncertainty language. [Roderik Van De Wal, Netherlands]	The text was altered as suggested by the reviewer.
21526	5	87	44	87	55	Comma after "In shallow water" [Tseng Rose, USA]	The text was altered as suggested by the reviewer.
15258	5	87	46	87	46	contribute to climate solutions as well as to biodiversity and conservation goals (Gattuso et al., 2015), but [Christophe Deissenberg, Luxembourg]	The text was altered as suggested by the reviewer.
22416	5	88	0	88		Table 5.5: What do the different colors mean? [Debora Ley, Guatemala]	The color coding will appear in the table caption.
15260	5	88	4	88	7	most important variable to explain the respondents' WTP for CWC protection (Chan et al., 2016). There is a need for advanced thinking about ecosystem services in the deep ocean, going beyond intrinsic and instrumental values to incorporate relational values (Eudaimonia) that collectively acknowledge the human associations with the nature in multiple forms across different cultural practices (Thurber et al., 2014). [Christophe Deissenberg, Luxembourg]	The text was altered as suggested by the reviewer.
2224	5	88	10			Table 5.5 font size too small [Chandani Appadoo, Mauritius]	The font was enlarged to improve readabiility
9568	5	88	10	88	11	The text of Table 5.5 is very difficult to impossible to read, if possible please consider a larger/different font to make this table easier to interpret. The color coding in the table is helpful for a quick assessment of confidence associated with each of these reports however, it would help if the definition of the color coding is also colored with the same pattern as in the table. By stating the color coding in text alone, it will be difficult for someone who is color blind or printing this table in black and white to tell which shading color corresponds to the yellow, orange and red mentioned in the key at the top of the table. [APECS Group Review, Germany]	The font was enlarged to improve readabiility
24250	5	88	10	88	11	please explain color code in table [Hans-Otto Poertner and WGII TSU, Germany]	It was in the 2nd row but will now be put in the table caption. Colors reflect confidence level
5288	5	89	0			Fig 5.20. A lot of processes not related to deep sea floor, consider renaming section [Emma Cavan, Australia]	This figure is being removed from the chapter
4122	5	89	1	89	4	The resolution of the figure seems to be lower than usually expected. [Jinsoon Park, Republic of Korea]	The text was altered as suggested by the reviewer.
5572	5	89	1	89	1	Include timescale in CO2 graph to show that this is based on past emissions. [Roderik Van De Wal, Netherlands]	The text was altered as suggested by the reviewer.
24252	5	89	5	89	6	Patagonian toothfish is Dissostichus eleginoides, Antarctic toothfish is Dissostichus mawsoni; clarify which species you mean [Hans-Otto Poertner and WGII TSU, Germany]	This was meant to be Antarctic toothfish and text is now changed
2880	5	89	21	89	21	Do Kleisner et al. (2015) mention bottom trawling? I don't think so. Consider removing reference from here. [Geir Ottersen, Norway]	An error occurred when chapter 5 references were compiled in Endnote by the TSU resulting in a displacement of all the references by one position. This resulted in a great number of misplaced references which we have since then fixed.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
15262	5	90	3	90	4	is predicted to reduce available rockfish habitat (Gallo and Levin, 2016) and rockfish (Sebastes spp.). Crabs (Cancer magister) are also likely to be negatively impacted by expanded hypoxia (Rosenberg et al., [Christophe Deissenberg, Luxembourg]	The text was altered as suggested by the reviewer.
2722	5	90	10	90	10	Stewart et al., 2014 is the wrong citation. It did not study Pleurocodes planipes. After a quick search, a study by Seibel et al., 2017 did. Seibel, B. A., B. E. Luu, S. N. Tessier, T. Towanda, and K. B. Storey. 2017. Metabolic suppression in the pelagic crab, Pleuroncodes planipes, in oxygen minimum zones. Comparative Biochemistry and Physiology. Part B, Biochemistry & Molecular Biology. [Kirk Sato, Japan]	An error occurred when chapter 5 references were compiled in Endnote by the TSU resulting in a displacement of all the references by one position. This resulted in a great number of misplaced references which we have since then fixed. Pineda et al. 2016 was the original reference. The Seibel reference was added however, as a good fit.
2720	5	90	11	90	13	Sato et al. (2017) studied the pink urchin Strongylocentrotus fragilis, not Paulmier et al., 2011. Stewart et al., 2014 studied Dosidicus gigas and should be correctly referenced. Also, Sato et al., 2018b should be changed to Sato et al. 2018 and added to the reference list on page 201. Sato, K. N., J. Powell, D. Rudie, and L. A. Levin. 2018. Evaluating the promise and pitfalls of a potential climate change–tolerant sea urchin fishery in southern California. ICES Journal of Marine Science. 75: 1029-1041. https://doi.org/10.1093/icesjms/fsx225. [Kirk Sato, Japan]	An error occurred when chapter 5 references were compiled in Endnote by the TSU resulting in a displacement of all the references by one position. This resulted in a great number of misplaced references which we have since then fixed.
9570	5	90	16	90	16	Perhaps consider using the same subtitle as the other subsections (5.3.1.1 and 5.3.1.2) so this title would be "Regulation, supportive and cultural services" instead of "Other services." If this change is made, it would also be helpful if these services are discussed in the same order as listed in the subsection title. [APECS Group Review, Germany]	The text was altered as suggested by the reviewer.
15264	5	90	20	90	20	climate is the sequestration of carbon, both through storage in the deep-sea pool and through long-term burial in [Christophe Deissenberg, Luxembourg]	The text was altered as suggested by the reviewer.
2768	5	90	21	90	24	Same to above comment; Monetary value of carbon storage as a regulating service has been addressed both in the pelagic ecosystem(5.3.1.2.2) and in the deep sea floor ecosystem(5.3.1.3.2). However the cited unit price of carbon is different from two sections; USD7/tC for pelagic ecosystem and USD62/tC for a deep sea floor ecosystem. This would be better to be compared with each other within a single paragraph as it would confuse readers to understand the value of service. [Suk Hui Lee, Republic of Korea]	The assigned value of carbon varies among studies and the values given here reflect those used by the authors cited. The range of values is acknowledged in the text.
5290	5	90	23			Martin 2016 study - isnt this just from the N. Altantic? if so state this. [Emma Cavan, Australia]	This was Barrange et al., (references were misalligned) and the North Atlantic is now called out.
16424	5	90	24	90	30	The text attributed to Melaku Canu 2015 and Barange 2017 seems to be mixed up [Coswig Kalikoski Daniela, Italy]	An error occurred when chapter 5 references were compiled in Endnote by the TSU resulting in a displacement of all the references by one position. This resulted in a great number of misplaced references which we have since then fixed. Pineda et al. 2016 was the original reference. The Seibel reference was added however, as a good fit.
21528	5	90	31	90	31	"=" not needed [Tseng Rose, USA]	Could not find this.
15266	5	90	50	90	50	but are increasingly recognized to be crucial [Christophe Deissenberg, Luxembourg]	The text was altered as suggested by the reviewer.
730	5	90	52	90	52	"can motivate the further of conservation ecosystem services' be changed as "can motivate further conservation of ecosystem services" [Kathiresan Kandasamy, India]	The text was altered as suggested by the reviewer.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
15268	5	91	6	91	6	much as in shallow water systems. ???? [Christophe Deissenberg, Luxembourg]	Taken into account - covered in Section 5.3 Coastal section
18710	5	91	21	104	14	The definition of human wellbeing should not only include external context (social & cultural, economic, and environment) but also internal context or the how human think, feel about what they have, and can do which known as subjective wellbeing. [Listyati Palupi, Indonesia]	We have added a new text about psychometrics and psycholigical aspects
9576	5	91	31	91	31	Consider adding reference to Constanza et al. (1997) (which is cited elsewhere in the chapter) [APECS Group Review, Germany]	Considered in preparation of SOD
22678	5	91	36	91	43	These are not only due to social and economical changes, but also due to pollution (which can be enhanced due to climate change). It is also not just climate change effects on fish stocks, but the whole ocean ecosystem (also in the Arctic). Such impacts are well described for the Arctic and Arctic Indigenous Peoples in the AMAP Human Health and other assessments (e.g. the Human Health Assessment from 2009), available on AMAP's website (www.amap.no). [Eva Kruemmel, Canada]	We want to avoid references to Arctic and Antactica, which are considered in Chapter 3
5574	5	91	40	91	43	Increased prevalence of obesity etc. is a consequence from the earlier mentioned social/economic change in consumption. Direct relation to climate change should be specified. [Roderik Van De Wal, Netherlands]	Agree, there is no direct effect of climate change (through oceans) on obesity but theere are potential indiret pathways, including impact mediated by socioeconomy, culture and adaptation (adapting by changing food habits).
9572	5	91	40	91	43	As a first paragraph in this section it would also be beneficial to mention impacts beyond human health. Specicially, line 43 could be expanded to say "as well as the related decrease in access to culturally or religiously significant food items." This may require the addition of a reference. [APECS Group Review, Germany]	Considered in preparation of SOD
9574	5	91	40	91	40	Perhaps it would be more precise to say "marine resources" rather than "fish stocks", to reflect that broad diversity of marine food items consumed by indigenous peoples. [APECS Group Review, Germany]	Considered in preparation of SOD
9578	5	91	40	91	40	Comma missing. 'Such changes, however, (…)' [APECS Group Review, Germany]	Edited
732	5	91	41	91	41	and parallel" be changed as "parallel" [Kathiresan Kandasamy, India]	Edited
9580	5	91	41	91	43	This sentence is hard to understand and would benefit from rewriting. Perhaps the following re-phrasing could be useful: 'and in parallel have led to an increased prevalence of obesity, diabetes, and other diet-related chronic diseases (..)' [APECS Group Review, Germany]	Edited
16102	5	91	41	91	46	Beyond saying what decision makers should do, it is necessary to establish that more vulnerable regions must see the ocean as a source of sustainable investment. [Fátima Castaneda, Guatemala]	Edited
13844	5	91	51	91	51	Delete 'WBCSD'. Acronym used only once. [Debra Roberts and Durban Team, South Africa]	The text has been modified. No longer relevant
9582	5	92	1	92	3	This table could benefit from expanded explanation, some reorganization, or both. It is unclear why "key risks" in "Environment" contains impacts on mental well-being. Perhaps this risk would be better included in the "Social and Cultural" row. Additionally the loss of access to resources of cultural importance should be included as "key risks" of the social and cultural row. Currently this risk is not included in the table. [APECS Group Review, Germany]	The table has now been edited

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
10772	5	92	1	92	3	Table 5.6: key risks under social Pilar should be revisited. There are other risks such as community erosion, displacement, cultural losses, loss on traditional knowledge, among others that should be taken into account. [Coswig Kalikoski Daniela, Italy]	The table has now been edited
22680	5	92	1	92	3	Please refer to "Indigenous knowledge", instead of "traditional knowledge". Indigenous knowledge is different from local knowledge and should be considered on its own. It would be also good to consistently capitialize "Indigenous" - sometimes it is capitalized in this report (and even in this table), sometimes it isn't. [Eva Kruemmel, Canada]	Chapter 5 has been homogenised with ILK box directives and wording.
9586	5	92	2	92	3	Table row 3 (Economic), table column 5 (Key risk): Does this include loss of land, e.g. through erosion/sea level rise, which otherwise could have been used for living, agriculture or aquaculture? If so, it may be worthwhile mentioning this more explicitely. [APECS Group Review, Germany]	The table has now been edited
9588	5	92	7	92	7	Do the authors mean "social" or "societal" realms? Perhaps societal would be more clear [APECS Group Review, Germany]	Yes societal is fine
15270	5	92	7	92	7	domains at the intersection [Christophe Deissenberg, Luxembourg]	OK
9590	5	92	8	92	9	It is unclear how human health comes into this. The previous sentence ends on the notion of the built environment. Consider the following: '(…), focusing on human engagement with and within nature including the built environment. Further, the linkages between the health of the environment, ecosystem health and human health are considered' [APECS Group Review, Germany]	OK
9592	5	92	8	92	9	It is unclear whether it is refered to the environment, the ecosystems and human health; or rather the health of the environment, the health of ecosystems and the health humans. [APECS Group Review, Germany]	Ok
9584	5	92	9	92	9	This section is on social and cultural dimensions, and on line 9 states that it will explore llinkages between " the environment, ecosystem and human health". Using environment and ecosystem seems redundant. Is this phrase supposed to be " environment, economics and human health" ? [APECS Group Review, Germany]	OK
9594	5	92	10	92	10	(..) security as a result of climate(…) [APECS Group Review, Germany]	OK
15272	5	92	10	92	10	as a result of climate [Christophe Deissenberg, Luxembourg]	OK
9596	5	92	13	92	13	It would be helpful if the use of the word 'education' was more specific. E.g. education of the indigenous communities, education about marine systems, education of coastal communities… [APECS Group Review, Germany]	To be checked in the text
9598	5	92	14	92	14	It would be helpful to explain what is meant by cultural dimensions? An example would be helpful. [APECS Group Review, Germany]	This is now explained
3270	5	92	16	93	20	This reference should be cited in this section (at the moment there is just a study in the Baltic Sea). This referecence gives a much more global view over many decades: Vezzulli, L., Grande, C., Reid, P. C., Hélaouët, P., Edwards, M., Höfle, M. G., Brettar, I., et al. (2016). Climate influence on Vibrio and associated human diseases during the past half-century in the coastal North Atlantic. Proceedings of the National Academy of Sciences, 201609157. DOI: 10.1073/pnas.1609157113 [Martin Edwards, UK]	Yes, very good suggestion. The Baltic study has additonal value though, as it is looking at future scenarios too.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
15274	5	92	19	92	19	poisoning after [Christophe Deissenberg, Luxembourg]	OK
9600	5	92	20	92	20	Please correct "exposing" to "exposure" [APECS Group Review, Germany]	OK
9602	5	92	25	92	25	Please correct "area" to "areas" [APECS Group Review, Germany]	OK
9604	5	92	25	92	28	Consider rewriting as: 'Vibrio is expected to grow faster in coastal areas where, under climate change projections, waters are expected to be warmer, less saline due to reduced precipitation and have higher chlorophyll concentrations.' Alternatively: ' (…) where due to climate change waters are expected to (…)' [APECS Group Review, Germany]	OK
5576	5	92	26	92	26	Unclear wether this refers to waters that are expected to be warmer than their environment or waters that are expected to become warmer under climate change. [Roderik Van De Wal, Netherlands]	The statement refers to water that are expected to become warmer with climate change. I suggest reformulating this sentece by removing: "are expected to be warmer," to make this clear.
15276	5	92	26	92	27	warmer, have lower salinity from decreased precipitation, and higher chlorophyll concentration (see Section 5.2.2.3), [Christophe Deissenberg, Luxembourg]	ok
9606	5	92	28	92	28	Please correct "was" to temperatures above 16°C "were" expected [APECS Group Review, Germany]	OK
9608	5	93	1	93	2	Suggest splitting the sentence by introducing a fullstop: '(…). However, the global surveillance (…)' [APECS Group Review, Germany]	OK
15278	5	93	3	93	4	and the nontoxigenic Vibrio infection is rarely notified to the health agencies, leading worldwide to a limited understanding of the disease epidemiology and risks and their links to climate change (low [Christophe Deissenberg, Luxembourg]	OK
9610	5	93	4	93	4	Please delete the comma before "wordlwide". [APECS Group Review, Germany]	OK
9612	5	93	7	93	7	Suggest replacing 'Increase frequency' with "The higher frequency". [APECS Group Review, Germany]	OK
9614	5	93	9	93	9	There is a comma missing between "water" and "leading" '(..) fresh water,leading to (…)'. [APECS Group Review, Germany]	OK
15280	5	93	11	93	11	is known to increase vulnerability of populations and to contribute to the spread of infectious diseases. [Christophe Deissenberg, Luxembourg]	ok
22682	5	93	15			Grammatically incorrect - should be either singular ("impact on health is") or plural (impacts on health are). [Eva Kruemmel, Canada]	ok
22684	5	93	15	93	16	Health impacts are very much an economic problem, due to many reasons. It is not only "undernourishment" of workers, it is peoples' general health that impacts societal and thereby also economic functioning for many reasons. [Eva Kruemmel, Canada]	ok
9616	5	93	17	93	17	It is unclear whether this refers to bio-prospecting and marine biotechnology; or simply the sourcing of ingredients for pharmaceutical production. [APECS Group Review, Germany]	Both
24254	5	93	19	93	19	Can you quantify the "huge impact"? [Hans-Otto Poertner and WGII TSU, Germany]	We remove "will" have huge impact to "may" or can "potentially have".
15282	5	93	20	93	21	Climate change impacts on rural communities may displace towards cities, although such migration may not occur for low-income countries (Fort et al., 2008). ????????????? [Christophe Deissenberg, Luxembourg]	ok
136	5	93	22	93	37	Hg health effects literature is broader than only neurotoxicity. There is literature that should be cited on Hg immunotoxicity and cardiovascular toxicity (low confidence). [Matthew Gribble, USA]	This is now considered in preparing in SOD

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
9618	5	93	22	94	34	In this section (especially in the first paragraph), it is unclear how climate change leads to an increased interaction with contaminants. Perhaps it would be helpful to link directly to Figure 5.21 to give the reader an overview. However, it would be useful to explicitly mention the climate-change relevant links such as alteration of concentrating mechanisms due to climate change, e.g. increased availability of POPs due to melting of Polar regions in which these are deposited in ice; or alteration of pathways, e.g. due to changes in ocean circulation. See Macdonald, Mackay, Li & Hickie (2003); and Schiedek, Sundelin, Readman & Macdonald (2007). Macdonald, R. W., Mackay, D., Li, Y.-F. and Hickie, B. (2003). How Will Global Climate Change Affect Risks from Long-Range Transport of Persistent Organic Pollutants? Hum. Ecol. Risk Assess. An Int. J. 9, 643–660. Schiedek, D., Sundelin, B., Readman, J. W. and Macdonald, R. W. (2007). Interactions between climate change and contaminants. Mar. Pollut. Bull. 54, 1845–1856. [APECS Group Review, Germany]	This is now considered in preparing in SOD
9620	5	93	22	93	37	In this paragraph it would be important to mention the risk of re-volitalization of these pollutants from the water and ice into the atmosphere. See Ma, Hung, Tiang & Kallenborn (2011). Ma, J., Hung, H., Tian, C. and Kallenborn, R. (2011). Revolatilization of persistent organic pollutants in the Arctic induced by climate change. Nat. Clim. Chang. 1, 255–260. [APECS Group Review, Germany]	This is now considered in preparing in SOD
22686	5	93	22	93	26	There are not only climate change interactions on bioaccumulation and biomagnification of fat-soluble POPs and MeHg, there are interactions on all POPs (which includes those that are not fat-soluble, such as brominated and fluorinated POPs), as well as impacts on the release and re-distribution of the contaminants). There is a lot of literature on this, also see the 2016 AMAP report "Influence of Climate Change on Transport, Levels, and Effects of Contaminants in Northern Areas" (available on www.amap.no) and AMAP Human Health Assessments, as well as papers such as Ma et al. 2011 | DOI: 10.1038/NCLIMATE1167 [Eva Kruemmel, Canada]	This is now considered in preparing in SOD
22096	5	93	26	93	26	The citation referring to Desforges et al. (2016) is not the correct citation/reference to support this statement. The correct citations/references are McKinney et al., 2015 and Alava et al. (2017). Please, correct, accordingly. [Juan Jose Alava, Canada]	ok
22098	5	93	26	93	26	Lallas is not the correct citation/reference to support this statement. The correct citations/references are McKinney et al., 2015 and Alava et al. (2017). Please, correct, accordingly. [Juan Jose Alava, Canada]	ok
22100	5	93	31	93	31	Please, delete Fort et al., 2015 and replace this citation with Desforges et al. 2016 and Alava et al., 2017. Please, change. [Juan Jose Alava, Canada]	ok
22102	5	93	32	93	32	Please, delete Ishikawa and Ikegaki, 1980 and replace this citation with Fort et al., 2015; Scheuhammer et al., 2015; Wiener et al., 2007. Please, change. [Juan Jose Alava, Canada]	ok
9622	5	93	39	93	41	How does climate change exacerbate the exposure to these pollutants? A brief explanation would be helpful. [APECS Group Review, Germany]	This is now considered in preparing in SOD

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
9624	5	93	44	93	46	Why is mercury methylation exacerbated by ocean warming? What is the mechanism that leads to this exacerbation? Would be helpful to briefly explain. [APECS Group Review, Germany]	This is now considered in preparing in SOD
22104	5	93	44	93	44	Please, delete Celo et al 2066 and replace with Marques et al. 2010 in addition to Tirado et al., 2010; Alava et al., 2017. [Juan Jose Alava, Canada]	Ok
9626	5	93	46	93	48	Why are these more bioavailable in acidified habitats? A short mention of the bio-physical mechanism will be helpful. [APECS Group Review, Germany]	Ok
9628	5	93	48	93	50	To clarify, suggest: '(..) the metabolic activity of bacteria which will augment the cycling and conversion of mercury into MeHg(..)' [APECS Group Review, Germany]	Ok
22106	5	93	49	93	49	Please, delete Morrissey et al., 2005 and replace rthis citation with Alava et al., 2017. Please, change. [Juan Jose Alava, Canada]	Ok
22108	5	93	52	93	52	The correct citation to support this statement or information should be Morrissey et al., 2005 instead of Lean, 2003. Please, change. [Juan Jose Alava, Canada]	Ok
5578	5	93	53	93	53	"likely" should only be used in terms of uncertainty language. [Roderik Van De Wal, Netherlands]	Ok
22110	5	93	54	93	54	The correct citation to support this statement or information should be Lean, 2003 instead of Morrissey et al., 2005 . Please, change. [Juan Jose Alava, Canada]	Ok
22112	5	94	11	94	11	In the legend for Figure 5.21, the correct and appropiate citation for the conceptual framework depicted in this Figure is Alava et al. (2017) instead of Balbus et al. (2013). Alava et al. (2017) originally created and developed this framwework to ilustrate the interaction and flows between climate change and pollutants. Please, see page 3990 and Figure 1 in Alava et al. (2017 https://onlinelibrary.wiley.com/doi/epdf/10.1111/gcb.13667) to confirm this. [Juan Jose Alava, Canada]	Ok
9636	5	94	14	94	26	For balance, it may be helpful to mention that the impact of POPs on top predators such as marine mammals leads to changes in their population density, which then perpetrate through the entire Arctic food web and ecosystem, ultimately affecting global fisheries. [APECS Group Review, Germany]	Ok
734	5	94	19	94	19	delete "through" [Kathiresan Kandasamy, India]	Ok
736	5	94	20	94	20	"the particular" be changed as "and the" [Kathiresan Kandasamy, India]	Ok
9630	5	94	24	94	25	Suggest deleting "Inuit" as the next term "indigenous communities" includes Inuit and all other indigenous communities [APECS Group Review, Germany]	Ok
9634	5	94	24	94	24	Please consider deleting "obviously" as it can be interpreted as an opinion opposed to fact. [APECS Group Review, Germany]	Ok
22114	5	94	24	94	24	Please, delete Alava et al., 2017 and replace this citation with Letcher et al., 2010. Please, change. [Juan Jose Alava, Canada]	Ok
22688	5	94	24	94	26	This has not only "potential" health impacts for Inuit, is has factual health impacts for Inuit (also see AMAP Human Health Assessments). Please do not separate "Inuit" and "Indigenous communities", since Inuit ARE Indigenous. Maybe it is better to refer to "Inuit and other Arctic Indigenous Peoples". [Eva Kruemmel, Canada]	Ok
22116	5	94	26	94	26	Please, also inlcude Alava et al. 2017 as part of the citations, in addition to Cisneros-Montemayor et al., 2016 [Juan Jose Alava, Canada]	Ok
9632	5	94	28	94	29	Suggest deleting "First Nations", which is restricted in use to Canada. The preceeding term "indigenous communities" is comprehensive. [APECS Group Review, Germany]	Ok

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
22690	5	94	28	94	29	It would be better to just refer to "Indigenous Peoples", please also see comment above. [Eva Kruemmel, Canada]	Ok
146	5	94	31	94	31	Citation Error - Citation to Gilmore 2017 (an editorial/commentary introduction to an issue) for scientific claim (coastal indigenous consumption of seafood 15x general population) that is actually made in Cisneros-Montemayor 2016 - in general, check your citations as I think you might citations pointing to editorials where it would be more appropriate to reference the work that was cited in that editorial: http://journals.plos.org/plosone/article?id=10.1371/journal.pone.0166681 [Matthew Gribble, USA]	Ok
22118	5	94	31	94	31	The correct citation to support this statement and data should be Cisneros-Montemayor et al., 2016 instead of Gilmore, 2017. Please, change. [Juan Jose Alava, Canada]	Ok
738	5	94	33	94	33	"are" be changed as "have" [Kathiresan Kandasamy, India]	Ok
9638	5	94	33	94	33	Change "exposure" to "exposed" [APECS Group Review, Germany]	Ok
13846	5	94	34	94	34	Replace 'exposure' with 'exposed' [Debra Roberts and Durban Team, South Africa]	ok
10774	5	95	1	95	25	This subsection should include a discussion on the adaptive capacity. Human security and conflicts will be exacerbated by a lack of adaptive capacity and maladaptation. Displacement for instance is not only a matter of creating conflicts in receiving areas. It is also a matter of community disruption that increases the vulnerabilities, marginalization, inequalities, and overall poverty of migrants. The 2017 UNHCR Report may be a good source to expand this part of the Report. [Coswig Kalikoski Daniela, Italy]	This has been done in this section
23302	5	95	1	95	25	The chapter 5.3.2.1.3 Human 1 security and conflicts is formulated as mix of different migration environmental motives. It is usually fine, however in this example the jumps from fishering to conceptual level to urbanization is confused. I recommend to rewrite the chapter with any fundamental idea or goal and give any structure. I am happy to contriburte if any help is needed. [Robert Stojanov, Czech Republic]	We have revised this section. Thanks!
23304	5	95	1	95	25	The concept of migration as adaptation is missing here as well as role of resilience. And the topic of migration or popuation dynamics and sea level rise at low laying islands is also missing here or other parts of the reports. [Robert Stojanov, Czech Republic]	We have revised this section. Thanks!
23300	5	95	20	95	21	There is a massive number of literature supporting evidence about climate change impacts on migration, together with other factors, just in ow-income countries such as Bangladesh. I thinkt this argument iin the report is incorrect. [Robert Stojanov, Czech Republic]	This is now considered in preparing in SOD
9674	5	95	21	95	25	Perhaps the ranking of the human security and conflicts category should be revised to medium confidence. Conflicts over fish are well documented (for example: the Icelandic/Norwegian disputes over mackerel (Popescu, I. & Poulsen, K. (2012). Icelandic fisheries: A review. Policy Department B: Structural and Cohesion Policies, European Parliament. http://www.europarl.europa.eu/RegData/etudes/note/join/2012/474540/IPOL-PECH_NT(2012)474540_EN.pdf). Yet the impact of outmigration to coastal fishing communities is not well documented and this shoud contribute to low confidence. It might be desirable to adopt a more moderate confidence level to better reflect the range of docuemtentation available. [APECS Group Review, Germany]	This is now considered in preparing in SOD

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15284	5	95	24	95	24	affected by sampling [Christophe Deissenberg, Luxembourg]	OK
9644	5	95	25	95	25	Please consider reworking the sentence structure. Suggest: '(…) rendering low confidence in the assessment of climate change effects on human conflicts.' [APECS Group Review, Germany]	OK
9646	5	95	28	95	30	Suggest rewriting this sentence to improve clarity and flow, perhaps something like: 'The case of the Pacific is a good example for illustrating the effects of climate change on indigenous knowledge, the transmission thereof, and ocean education. This is because in the Pacific the (climatic) changes are different in nature and refer to different time frames.' [APECS Group Review, Germany]	OK
9676	5	95	28	95	28	It is unclear what ocean education means? If it is related to the items in this paragraph perhaps it would be clearer to call it " transmission of cultural knowledge about the ocean" or something similar. Education is a western concept and is not appropriate to apply to indigenous transfer of knowledge in some instances. [APECS Group Review, Germany]	OK
9648	5	95	29	95	30	Please clarify what is meant by 'different time frames'. What are they in relation to, the Atlantic, the Southern Ocean, soemthing else? It would be helpful if this was specified precicely. [APECS Group Review, Germany]	OK
15286	5	95	29	95	29	the Pacific. Problems arise from the fact that climate change has diverse impacts that refer to different time. [Christophe Deissenberg, Luxembourg]	OK
9650	5	95	30	95	31	It would be helpful to rewrite this sentence to improve clarity and to better link better with the previous and following sentence. It would be useful to explicitly state who conducts "evaluation" and why this is relevant to knowledge transmission. [APECS Group Review, Germany]	OK
15288	5	95	30	95	33	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. [Christophe Deissenberg, Luxembourg]	OK
22692	5	95	31	95	35	This is very unclear in terms of what is meant by the time periods provided. The problem is also related to the mixing of Indigenous knowledge and local knowledge here - there is a difference between the two. In particular, Indigenous knowledge develops over extremely long time periods and is part of complex cultural systems, while local knowledge is usually based on shorter-term knowledge and local observations. [Eva Kruemmel, Canada]	This has been revised in the light of ILK box
15290	5	95	33	95	35	Thus, the adjustment of the transmission and of the network of local knowledge on the ocean , of the related perceptions and practice, implies a reworking of the knowledge where the individuals and the groups are actors in a narrative and historical construction (Roué, 2012; Tamatoa and Latouche, 2016). In [Christophe Deissenberg, Luxembourg]	OK
9652	5	95	38	95	38	Please delete "is" so that the sentence reads: '(…) consider it to be an outside discourse (…)' [APECS Group Review, Germany]	OK
9654	5	95	40	95	40	Please make "seashore" plural, "seashores" [APECS Group Review, Germany]	OK
9656	5	95	40	95	40	Please make "sandbank" plural, "sandbanks" [APECS Group Review, Germany]	OK
740	5	95	41	95	41	"desappearing" be changed as "disappearing" [Kathiresan Kandasamy, India]	OK
742	5	95	41	95	41	delete "that shows"; and change "shows" to "show" [Kathiresan Kandasamy, India]	OK
9658	5	95	41	95	42	Please delete the repetitive 'shows that' [APECS Group Review, Germany]	OK

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13848	5	95	41	95	41	Delete one 'shows that' [Debra Roberts and Durban Team, South Africa]	OK
15292	5	95	41	95	45	Other studies in Tuvalu shows that show that during the past four decades the sea level rise and the climate change have resulted in a net increase in land area (Camus, 2017) but may affect the mobility of people, the residence patterns, the overcrowding, and the structure of traditional knowledge in the sense that more mythological syncretism may be produced by the concentration of people in the safest places. [Christophe Deissenberg, Luxembourg]	Please change text starting at line 41 "other…." with: Other studies in Tuvalu show that during the past four decades, sea level rise and climate change have resulted in a net increase in land area (Camus, 2017) affecting the mobility of people, residence patterns, overcrowding, and the structure of traditional knowledge in the sense that more mythological syncretism may be produced by the concentration of people in the safest places.
9660	5	95	43	95	43	Please make "pattern" plural, patterns [APECS Group Review, Germany]	OK
744	5	95	47	95	47	"plays" be changed as "that play" [Kathiresan Kandasamy, India]	OK
9640	5	95	47	95	51	This whole sentence is very unclear and should just be combined with the above paragraph. Here is a suggestion: "Origin stories related to the ocean that form a major background of indigenous cultures therefore may be changed or re-elaborated because the local population observes change, rather than because they hear about climate change from scientists. Increasing scarcity of coastal and marine resources and transformatin of geographical features such as the disappearance of a mythical sandbank in Tabiteua (Kiribata) are already documented examples of climate change forever altering the historical trajectory of a population and its cultural relationship to the ocean" [APECS Group Review, Germany]	Yes - the suggested paragraph is much better. Please replace the paragraph with the suggestion
9662	5	95	47	95	47	Please clarify and improve specificity. What is meant by "foundation" and which myths are being referenced. [APECS Group Review, Germany]	This sentence/concern will be replaced with new text as suggested directly above.
9664	5	95	47	95	47	Depending on the rewrite, "plays" may need to be changed to "playing" [APECS Group Review, Germany]	This sentence/concern will be replaced with new text as suggested above.
9670	5	95	47	95	51	Suggest re-wrting this paragraph as it is unclear. Consider: 'Thus, the great myths of foundation and the ocean that play a central role in these communities are re-elaborated, and the knowledge and practices are modified. From the perspective of these communities, these changes do not come about because of science prophesying a major climate change, but because the local populations observe that climate change induces change in their environment. For example, the scarcity of pelagic resources and lagoons, and the disappearance of a mythical sandbank at Tabiteua (Kiribati) alter the historical trajectory of a population and its relationship to the ocean forever.' [APECS Group Review, Germany]	Yes - the suggested paragraph is much better. Please replace the paragraph with the suggestion. Please keep the reference (Bambridge and Le Meur 2018)
9678	5	95	47	95	47	Myth is an appropriate word here but could be misread as the opposite of "fact." It might be more clear to say "origin stories related to the ocean". [APECS Group Review, Germany]	This sentence/concern will be replaced with new text as suggested above.
15294	5	95	47	95	51	Thus, the great myths where the ocean plays a central role are re-elaborated, the knowledge and the practices are modified, not because science predicts a major climate change, but because the local populations observe it: scarcity of the pelagic resources, changes in the lagoon, disappearance of a mythical sandbank at Tabiteua (Kiribati) that forever alter the historical trajectory of a population and its relationship to the ocean (Bambridge and Le Meur, 2018). [Christophe Deissenberg, Luxembourg]	This sentence/concern will be replaced with new text as suggested above.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
9666	5	95	48	95	48	Please change "prohphesies" to "prophesises" [APECS Group Review, Germany]	yes- please change
9668	5	95	49	95	49	Please reoder the first part of the sentence after the colon to read (…) pelagic resources and lagoons, and the disappearnce (…)' [APECS Group Review, Germany]	yes- please change
9672	5	95	56	95	56	Please rewrite the first calsue of the sentence: (…) not only does this plurality of modes of transmission and such concentration of people (…)' [APECS Group Review, Germany]	yes- please change
15296	5	95	56	96	4	This plurality of modes of transmission and the concentration of the population not only contribute to the erosion of local knowledge about the ocean (Alì, 2016), but has also almost totally impaired any opportunity for social rise for most people (Bambridge and Le Meur, 2018). It should be noted, however, that the traditional lunar calendars, which predict fishing and farming seasons by species and guide the choice of techniques, are still used (D'Arcy and Bambridge, 2014), and that the validity of their prediction is often discussed and compared to the supposed effects of change climate. [Christophe Deissenberg, Luxembourg]	please change text with the suggested text in column 5 for line 56..
9642	5	95	57	95	57	It is unclear what socal rise means in this context. [APECS Group Review, Germany]	This sentence/concern will be replaced with new text as suggested above.
1530	5	96	4	96	4	maybe "climate change" instead of "change climate"? [Davide Bonaldo, Italy]	yes- please change
9686	5	96	18	96	18	Please change "environmental" to "environmentally" displaced. [APECS Group Review, Germany]	yes- please change
9688	5	96	18	96	20	As written the sentence is unclear. Why would they UN need to grant special status from islanders that are gaining land? [APECS Group Review, Germany]	I am not sure. Unless there is a better suggestion - please change the sentence to: Finally, "environmentally displaced" Pacific Islanders are aquiring land in the Pacific regions bordering their areas (New Zealand, Australia, and the USA) to secure the future of next generations.
138	5	96	22	96	31	Inuit dependence on marine mammals may also be highly relevant to mention under examples (e.g., die-off of walrus from St. Lawrence Island) [Matthew Gribble, USA]	please include the following words at line 28 after the Lynn reference: Indigenous people can also be highly dependent on various marine mammals that are vulnerable to climate change impacts. Any change in numbers, quality or access to these mammals (for example through die-off of walrus from St. Lawrence Island) increases the vulnerability of local indigenous communities.
9690	5	96	22	96	22	Please correct "as" to "has" [APECS Group Review, Germany]	yes- please change
13850	5	96	22	96	22	Change 'as' to 'has' [Debra Roberts and Durban Team, South Africa]	yes- please change (repeated comment)

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
18908	5	96	32	97	2	Education section. This one is of the utmost importance. The necessity to educate the general public (and not only children at schools but also increase awareness of the present, adult generation, is key to a significant change in practices. I believe words could (should) be stronger here. Sections devoted to ecomical impacts are well developed and place humans at the core of the Earth system, emphasizing on the necessity to remediate climate change in order to sustain the services that ecosystems offer to human populations. The present, educational section could devlop on the importance to present a less economical, more scientific vision of ecosystems, in which human populations are part of a whole equilibrium (and not the core). Emphasizing on the imbalance in the Earth system caused by climate change and the necessity to adopt radically different behaviours at all stages (individual, society, politics, economy…) will help populations gain awareness and find ways to take actions. The Education section here would gain further impact if it found stronger echo in the following sections, with the concept of behavioural adaptation of people (e.g. p. 123, p. 125 lines 25-26, p. 128 in the tourism section, p. 129 behavioural changes). The growing popularity of outreach initiatives and scientific communication to the general audience can be a critical instrument to increase awareness and concern. [Sophie Rabouille, France]	Please include the following text at line 42 (end of first paragraph): 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. It is essential that people are informed that local and small scale behaviours accummulate very quickly and contribute to the global scale phenomenon of climate change. People need very clear messages and consistent messages that reiterate that new behaviours are very much needed at the individual, household and local business scale as well as when individuals travel and participate in tourism opportunities. People urgently need to be educated about cumulative impacts and feel empowered and inspired to take positive actions. The growing popularity of outreach initiatives and scientific communication to the general audience can be a critical instrument to increase awareness and concern.
9684	5	96	33	97	2	Many scholars also argue that educaiton is not meaningful if there is not proper governmental or other institutional support to support that education. For example, ingenenous communities are well aware and educated about cliamte change, but do not have the political backing or cohesive social voice to make the changes they know will protect their communities. It may be helpful to would add 2-3 sentences noting that education also needs to be combined with other institutional support. [APECS Group Review, Germany]	Please add the following sentence at the very end of this section: Education needs to be combined with other institutional support for the full benefits to emerge and for education to be meaningful. For example, indigenous communities can be very aware and educated about climate change, but can be unempowered to make decisions tht would protect their communities without the appropriate institutional support.
1364	5	96	34	96	42	agree and am pleased attention is given to education – this could be linked to community-based capacity building. [Marcus Haward, Australia]	yes- please advise other section
9692	5	96	41	96	42	Are there specific case studies or educational resources that make ocean acidification such an excellent tool? Would be useful to give evidence/reference was to why this tool is so effective. [APECS Group Review, Germany]	I am unable to find the reference. I suggest we change the last sentence to: Ocean acidification may be an excellent educational tool to address climate change inssues (Qin et al.,) because the acidification process can be clearly explained.
9680	5	96	44	96	44	Perhaps it would be more accurate to say "A lack of education clearly.." [APECS Group Review, Germany]	yes- please change
9682	5	96	47	96	47	Perhaps it would increase clarity to add "single" before natural resource [APECS Group Review, Germany]	yes- please change
9696	5	96	54	96	56	Suggest rewriting this sentence, as meaning is not fully clear. Consider: 'Additionally, education can increase the likelihood that existing technologies which aid the community to better cope with and adapt to climate change are used.' [APECS Group Review, Germany]	yes- please change
9694	5	96	55	96	55	Please delete "to" so that the sentence reads: (…) existing technologies aid the community (…)' [APECS Group Review, Germany]	No - this is dealt with above comment and solution.
9702	5	97	5	97	5	Please replace "they" with "this" so that the sentence read: '(…) it is unclear how this will affect (…)' [APECS Group Review, Germany]	yes- please change

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
9708	5	97	6	97	8	The meaning of this sentence is unclear. Perhaps the following edit would improve clarity: 'Among the aspects of cultural wellbeing supported by the ocean, education based on scientific knowledge of the marine environments, and the economic and technical benefits generated by exploration and discover play an important role.' [APECS Group Review, Germany]	Yes - the suggested text is better. Please replace (and keep the reference). Also please include the following new sentence: The appreciation of scientific, artistic, spiritual, and health opportunities, as well as the appreciation of biodiversity, lifestyle and aesthetics, as well as intrinsic values, are other cultural dimensions becoming more widely acknowledged as key cultural dimensions potentially disturbed by climate change (Marshall et al. 2018). the full reference for this paper is: Marshall, N. A., M. Barnes, A. Birtles, K. Brown, J. E. Cinner, M. Curnock, H. Eakin, A. G. Goldberg, M. Gooch, J. N. Kittinger, P. Marshall, D. Manuel-Navarrete, M. Pelling, P. Pert, B. Smit, and A. Tobin. 2018. Measuring What Matters in the Great Barrier Reef. Frontiers in Ecology and the Environment 16:271-277.
9698	5	97	7	97	7	The reference to education from scientific knowledge obtained from marine environments as an aspect of cultural well-being seems mis-worded. Cultural well-being does not come from education or scientific knowledge, and it is unlcear what the authors mean here. For example there is little mention to this point on religion, or connection with nature, autonmy or freedom, which are often the first aspects described in "well-being" [APECS Group Review, Germany]	this concern will be dealt with through the new text provided directly above.
9704	5	97	7	97	7	Please make "oceans" singular, 'ocean' [APECS Group Review, Germany]	yes- please change
9706	5	97	7	97	7	Please change "education from scientific knowledge" to 'education based on scientific knowledge' [APECS Group Review, Germany]	yes- please change
9710	5	97	13	97	13	Please add 'and' before French Polynesia so that the sentence reads:'(...) Pascau Island, and French Polynesia, (...)' [APECS Group Review, Germany]	yes- please change
17404	5	97	14	97	14	It would be good to see more about value of MPAs for adaptation/resilence and also mitigation as there is potential for them to be carbon sinks. [Helen Kettles, New Zealand]	yes- please change text at the end of the paragraph at line 15 to: Marine Protected Areas also offer a cultural opportunity in impacted areas to constructively and collaboratively discuss adaptation plans and plans to increase resilience, whilst simultaneously reinforcing cultural identity and pride.
9700	5	97	15	97	15	Please delete either catch or capture, having both is redundant. [APECS Group Review, Germany]	yes- please change to catch
9712	5	97	15	97	15	Please change 'fleet' to 'fleets'. [APECS Group Review, Germany]	yes- please change
9714	5	97	19	97	19	Please change "offers" to "presents" so that the sentence reads: 'Nature presents a place (...)' [APECS Group Review, Germany]	yes- please change
746	5	97	27	97	27	"suggesting' be changed as "suggest" [Kathiresan Kandasamy, India]	yes- please change
9716	5	97	27	97	27	Please rephrase the middle part of the sentence to: '(...) Turner et al. (2008) suggests that (...)' [APECS Group Review, Germany]	yes- please change

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
10608	5	97	30			One prism through which the effects of climate change on cultural dimensions could be directly seen is through mental health. Climate-related exteme events and impacts on ecosystems is causing mental health issues such as depression (Helm et al., 2018 ; Willox et al., 2014 ; Fritz et al., 2008) References : Helm et al. (2018). Differentiating environmental concern in the context of psychological adaption to climate change. Global Environmental Change Willox et al. (2014). Examining relationships between climate change and mental health in the Circumpolar North. Regional Environmental Change Fritze, J. G., Blashki, G. A., Burke, S., & Wiseman, J. (2008). Hope, despair and transformation: Climate change and the promotion of mental health and wellbeing. International journal of mental health systems [Adrien Comte, France]	At the very end of the paragraph (currently at line 30 on page 97, please add: Cultural losses or impacts associated with climate change can most directly be observed as mental health issues, such as depression (Helm et al. 2018, Wilcox et al. 2014, Fritze et al. 2008). References : Helm et al. (2018). Differentiating environmental concern in the context of psychological adaption to climate change. Global Environmental Change Willox et al. (2014). Examining relationships between climate change and mental health in the Circumpolar North. Regional Environmental Change Fritze, J. G., Blashki, G. A., Burke, S., & Wiseman, J. (2008). Hope, despair and transformation: Climate change and the promotion of mental health and wellbeing. International journal of mental health systems
748	5	97	38	97	38	"lose" be changed as "loose" [Kathiresan Kandasamy, India]	yes- please change
22694	5	97	42	97	45	This is a very important point and should also be mentioned/cross-referenced in other parts of the report, where relocation of communities is being discussed, in particular in Cross-Chapter Box 5, p 9, lines 4 - 6, where it says that "Relocation of communities and economic activities in response to the effects of climate change is increasingly being considered as an adaptation option". [Eva Kruemmel, Canada]	yes. Please advise other authors
10776	5	98	11	99	12	In order to complement this sub-section suggest to read: Hallegatte, S., Bangalore, M., Bonzanigo, L., Fray, M., Kane, T., Narloch, U., Rozenberg, J., Treguer, D. & Vogt-Schilb, A. 2016. Shock Waves: Managing the Impacts of Climate Change on Poverty. Climate Change and Development. Washington, DC, World Bank. Kalikoski et al. 2018. Climate change implications for fisheries and aquaculture: applying a poverty lens. Chapter 25 in: Barange et al. 2018. Impacts of Climate Change on fisheries and aquaculture: Synthesis of current knowledge, adaptation and mitigation options. FAO, Rome. [Coswig Kalikoski Daniela, Italy]	Add a sentence to page 98 Line 48: "Climate change may also worsen the climate-related shocks and stresses, and hence is an obstacle for the progress of poverty reduction (Hallegatte et al. 2018). "Add a sentence to page 98 Line 51: "Hence, climate change adaptation and mitigation strategies must be human-centered with emphasis on the need for poverty eradication, food security, empowering the local stakeholders, addressing power imbalances and inequity in fishing and aquaculture communities (Kalikoski et al. 2018)."
3388	5	98	39	98	39	Barbier et al. (2015)? [Castor Muñoz Sobrino, Spain]	P. 98 Line 39: change Barbier (2015) to Barbier et al. 2015
750	5	98	50	98	50	"lose" be changed as "lost" [Kathiresan Kandasamy, India]	P. 98 Line 50: change "lose" to "lost"

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
9718	5	98	53	98	54	There is an important gender component to the social aspects of climate change. Women most often work in canning processing and other ancillary economic activites related to marine systems, and are also invovled in the bookkeeping operations and taking care of the home while fishermen are away. Either near line 53-54 or above in the "other cultural dimensions" section, there needs to be 3-5 sentences on the gender soecific impacts of climate change in coastal communities and marine systems. It is listed in connection with SDG on pg103-104 but should be here as well. [APECS Group Review, Germany]	P. 98 Line 54: After" ....and boat repair.". Add "Women are heavily engaged in the post-harvesting sectors, they mainly involve in selling and processing fish in the fish landing sites and local markets. Also, women mostly often work in canning processing and other ancillary economic activities related to marine resources, and are also involved in the bookkeeping operations and taking care of the home whle the fishermen are away. However, women in the post-harvest sector are usually in a disadvantage position because of the marginalizaton of the fishing communities and their lack of acess to credits and capacity development. Gender equity and empowering women's participation in climate change discourse and actions have been included in the Gender Action Plan of the United Nations Framework Convention on Climate Change (UNFCCC) (Kalikoski et al. 2018).
9720	5	98	54	98	54	Please change 'related' to 'relate' [APECS Group Review, Germany]	P 98 Line 54: change "related" to "relate"
9722	5	99	2	99	2	Considering replacing 'But' with 'However' [APECS Group Review, Germany]	P.99 Line 2: change "But " to "However,"
24256	5	99	14	99	14	wrong number (should be 5.3.2.2.2) [Hans-Otto Poertner and WGII TSU, Germany]	The final outline has been revised
752	5	99	23	99	23	"supports' be changed as "support" [Kathiresan Kandasamy, India]	ok
9724	5	99	23	99	23	Replace 'supports' with "suppport' [APECS Group Review, Germany]	ok
9726	5	99	39	99	39	Replace 'Area' with 'Areas' [APECS Group Review, Germany]	ok
22696	5	99	42	99	45	AMAP's Arctic Ocean Acidification assessment update on societal/economic impacts that is currently in devlepment would be good to use here. It will be released this fall at the Arctic Biodiversity Congress (https://arcticbiodiversity.is/congress). [Eva Kruemmel, Canada]	This concerns chapter 3
9728	5	100	2	100	2	Change 'reliant' to "reliance" [APECS Group Review, Germany]	ok
9730	5	100	12	100	13	Change 'economics' to 'economic' [APECS Group Review, Germany]	ok
9732	5	101	4	101	4	The statement regarding the effectiveness of traditional ways of managing the reefs needs a citation. [APECS Group Review, Germany]	Reference needed
13852	5	101	23	102	27	All examples used in this section are from advanced economies. It is important to include examples from developing economies and/or low lying Island states. [Debra Roberts and Durban Team, South Africa]	I am unable to find good examples. Advice welcomed.
9734	5	101	25	101	27	Suggest splitting the sentence at 'however': '(…) their environment. However, climate change threatens (…)' [APECS Group Review, Germany]	yes- please change
9736	5	101	28	101	28	Please elaborate and clarify what is meant by 'are many'. [APECS Group Review, Germany]	Please change this sentence to: Positive externalities generated from ecosystems, or cultural ecosystem services, include a range of values such as appreciation of biodiversity and scientific opportunities as well as aesthetic stimulus or aesthetic appreciation.
1532	5	101	33	101	37	is it totally unlikely that this can actually create also new aesthetical ecosystem services? [Davide Bonaldo, Italy]	Actually this work was done by Marshall et al. 2018 (not Putra et al. 2018). Please add to the end of the sentence, "and possible creating new aesthetical ecosystem services".

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
9738	5	101	40	101	43	What was the outcome/findings of the study by McNamara & Keeler (2013)? Instead of outlining the methods, it would be useful to learn something about the conclusions of this study. [APECS Group Review, Germany]	please include the following sentence at line 43 before the sentence starting with Argueso: They found that property owners that were well informed about cliamte change would invest heavily in defensives in the near term but then abandon coastal real estate at some later time when the costs become too risky.
9740	5	101	48	101	48	uncomfortable' as in less inhabitable? Consider using a more precise adjective. [APECS Group Review, Germany]	please replace the word more uncomfortable with: warmer and less comfortable
5580	5	101	55	102	7	Are there references to back these statements? [Roderik Van De Wal, Netherlands]	Please refer to: Fu, X. Y., J. Song, B. W. Sun, and Z. R. Peng. 2016. "Living on the edge": Estimating the economic cost of sea level rise on coastal real estate in the Tampa Bay region, Florida. Ocean & Coastal Management 133:11-17. Rubin, B. M., and M. D. Hilton. 1996. Identifying the local economic development impacts of global climate change. Economic Development Quarterly 10:262-279. McNamara, D. E., and A. Keeler. 2013. A coupled physical and economic model of the response of coastal real estate to climate risk. Nature Climate Change 3:559-562.
13854	5	102	1	102	7	This is an important information that requires some quantification (e.g. what is the potential monetary loss). If the information is currently not available in the literature, the authors should point this out as a gap in the current literature. [Debra Roberts and Durban Team, South Africa]	We include the sentence: In 2050, in the Tampa Bay region, Florida, it is estimated that the inundation of 3-foot sea level rise could cost Hillsborough and Pinellas County over 300 and 900 million dollars respectively for the real estate market alone (Fu et al. 2016).
9744	5	102	2	102	2	Please add 'and' before 'lack of' so that the sentence reads '(...) estate values, and lack of rental incomes (...)' [APECS Group Review, Germany]	Yes- please change
2882	5	102	29	103	32	I'm afraid that I find the present version of 5.3.2.3.2 rather weak. It needs substantial rewriting if it is to be kept. It now partly lists well-known facts, partly gives numerous unsubstantiated claims with hardly any references. I know this is the FOD and things may be changed, but it mainly deals with the Arctic and Antarctic and this is already better covered in Ch 3 (and for Arctic shipping in 5.4.3.1.2). Actually I though the CLAs had agreed that this should be covered in Ch 3, not Ch 5? [Geir Ottersen, Norway]	This section will be completely revised and polar aspects will be removed. Should we adress the comments? Maybe it would be a loss of time.
13856	5	102	29	103	32	The content of this sub-section does not do justice to the sub-heading title. Why is transportation not discused? Or is it seen as a non-industrial activity? [Debra Roberts and Durban Team, South Africa]	This section will be completely revised and polar aspects will be removed. Should we adress the comments? Maybe it would be a loss of time.
9746	5	102	30	102	30	Pleace change 'oceans' to 'ocean'. [APECS Group Review, Germany]	This section will be completely revised and polar aspects will be removed. Should we adress the comments? Maybe it would be a loss of time.
5582	5	102	48	102	49	Statement should be coupled to reference. [Roderik Van De Wal, Netherlands]	This section will be completely revised and polar aspects will be removed. Should we adress the comments? Maybe it would be a loss of time.
9742	5	102	48	102	49	This paragraph is unclear and does have any references supporting the statements made in this paragraph. Does it mean that melting ice actually can lead to greater economic activity in energy production? Maybe this should not be its own paragraph but just added with the section that follows. [APECS Group Review, Germany]	This section will be completely revised and polar aspects will be removed. Should we adress the comments? Maybe it would be a loss of time.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
9748	5	102	48	102	49	Suggest rephrasing: 'Although the impacts of climate change can be seen globally, the Arctic and Antarctic regions are particularly sensitive.' [APECS Group Review, Germany]	This section will be completely revised and polar aspects will be removed. Should we adress the comments? Maybe it would be a loss of time.
9750	5	102	51	102	51	Would "does" be a more accurate word than "would"? [APECS Group Review, Germany]	This section will be completely revised and polar aspects will be removed. Should we adress the comments? Maybe it would be a loss of time.
9752	5	102	52	102	53	Suggest rephrasing: 'According to some studies on fossil fuels, the Arctic is expected to hold 29% of gas reserves in the basement, 10% of oil reserves, and coal. [APECS Group Review, Germany]	This section will be completely revised and polar aspects will be removed. Should we adress the comments? Maybe it would be a loss of time.
9756	5	102	52	102	54	These two sentences are duplicative of each other. However they eacch presetn slightly different estimates. Please delete the less accurate sentence and add appropriate references to support estimates. [APECS Group Review, Germany]	This section will be completely revised and polar aspects will be removed. Should we adress the comments? Maybe it would be a loss of time.
9754	5	102	53	102	53	Do these percentages refer to oil/gas reserves globally? [APECS Group Review, Germany]	This section will be completely revised and polar aspects will be removed. Should we adress the comments? Maybe it would be a loss of time.
13858	5	102	55	102	55	Suggest replacing 'Alaska' with 'USA' for consistency since all others are countries. [Debra Roberts and Durban Team, South Africa]	This section will be completely revised and polar aspects will be removed. Should we adress the comments? Maybe it would be a loss of time.
13860	5	102	55	102	55	Suggest deleting 'the' before 'technologies' [Debra Roberts and Durban Team, South Africa]	This section will be completely revised and polar aspects will be removed. Should we adress the comments? Maybe it would be a loss of time.
9760	5	103	1	103	1	Please add references for these 'different studies'. [APECS Group Review, Germany]	This section will be completely revised and polar aspects will be removed. Should we adress the comments? Maybe it would be a loss of time.
24258	5	103	1	103	32	These paragraphs all need references [Hans-Otto Poertner and WGII TSU, Germany]	This section will be completely revised and polar aspects will be removed. Should we adress the comments? Maybe it would be a loss of time.
9762	5	103	3	103	5	Is it correct to say that the central part of the Arctic falls under no national jurisdiction in light of the existing territorial claims by Denmark, Russia and Canada for the most central part of the Arctic (around Lomonosov Ridge)? There are only three Arctic areas which are currently unclaimed, the largest being the one which extends towards the Alaskan coasts for which the US was ineligible to file an official claim as it failed to ratify UNCLOS. [APECS Group Review, Germany]	This section will be completely revised and polar aspects will be removed. Should we adress the comments? Maybe it would be a loss of time.
9764	5	103	3			It would be worthwhile to mention the Declaration Concerning the Prevention of Unregulated High Seas Fishing in the Central Arctic Ocean (2015). See Nyman (2018). Nyman, E. (2018). Protecting the poles: Marine living resource conservation approaches in the Arctic and Antarctic. Ocean Coast. Manag. 151, 193–200. [APECS Group Review, Germany]	This section will be completely revised and polar aspects will be removed. Should we adress the comments? Maybe it would be a loss of time.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
2362	5	103	7	103	14	Increased traffic in either the Arctic or Antarctic would contribution additional pollutants in the region, having a direct impact on the climate and exacerbating localized warming. (Arctic Council Task Force on Short-Lived Climate Forcers (2013) RECOMMENDATIONS TO REDUCE BLACK CARBON AND METHANE EMISSIONS TO SLOW ARCTIC CLIMATE CHANGE; Arctic Council Secretariat (2017) EXPERT GROUP ON BLACK CARBON AND METHANE: SUMMARY OF PROGRESS AND RECOMMENDATIONS 2017; Arctic Monitoring and Assessment Programme (AMAP) (2015) SUMMARY FOR POLICYMAKERS: ARCTIC CLIMATE ISSUES 2015 SHORT-LIVED CLIMATE POLLUTANTS; International Council on Clean Transportation (ICCT) (2017) GREENHOUSE GAS EMISSIONS FROM GLOBAL SHIPPING, 2013–2015; Wan Z., et al. (2016) Pollution: Three steps to a green shipping industry, NATURE 530:275–277.) [Kristin Campbell, USA]	This section will be completely revised and polar aspects will be removed. Should we adress the comments? Maybe it would be a loss of time.
2488	5	103	7	103	14	Increased traffic in either the Arctic or Antarctic would contribution additional pollutants in the region, having a direct impact on the climate and exacerbating localized warming. (Arctic Council Task Force on Short-Lived Climate Forcers (2013) RECOMMENDATIONS TO REDUCE BLACK CARBON AND METHANE EMISSIONS TO SLOW ARCTIC CLIMATE CHANGE; Arctic Council Secretariat (2017) EXPERT GROUP ON BLACK CARBON AND METHANE: SUMMARY OF PROGRESS AND RECOMMENDATIONS 2017; Arctic Monitoring and Assessment Programme (AMAP) (2015) SUMMARY FOR POLICYMAKERS: ARCTIC CLIMATE ISSUES 2015 SHORT-LIVED CLIMATE POLLUTANTS; International Council on Clean Transportation (ICCT) (2017) GREENHOUSE GAS EMISSIONS FROM GLOBAL SHIPPING, 2013–2015; Wan Z., et al. (2016) Pollution: Three steps to a green shipping industry, NATURE 530:275–277.) [Durwood Zaelke, USA]	This section will be completely revised and polar aspects will be removed. Should we adress the comments? Maybe it would be a loss of time.
9792	5	103	7	103	14	This paragraph is quite subjective and vague. For example, it is stated that "Melting ice has opened up new waterways such as the Northwest Passage and the Northeast Passage." In what way have these passages been 'opened up'? There have been more transits through the passages in recent years, mostly by ice-reinforced ships, but also occasionally by a non-reinforced vessel. More detail and some numbers on these transits is provided here Eguíluz, V.M., Fernández-Gracia, J., Irigoien, X. and Duarte, C.M., 2016. A quantitative assessment of Arctic shipping in 2010–2014. Scientific reports, 6, p.30682. Also the phrase "As long as these passages remain few used, the risks of pollution are rather low" is vague and non-commital. In contrast to the statement "the potential of drifting icebergs could increase the risk of accident", it is most often thick sea ice floes moving faster than icebergs that pose most problems for tankers and large vessels: Gascard, J.C., Riemann-Campe, K., Gerdes, R., Schyberg, H., Randriamampianina, R., Karcher, M., Zhang, J. and Rafizadeh, M., 2017. Future sea ice conditions and weather forecasts in the Arctic: Implications for Arctic shipping. Ambio, 46(3), pp.355-367. [APECS Group Review, Germany]	This section will be completely revised and polar aspects will be removed. Should we adress the comments? Maybe it would be a loss of time.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
12986	5	103	7	103	14	Increased traffic in either the Arctic or Antarctic would contribution additional pollutants in the region, having a direct impact on the climate and exacerbating localized warming. (Arctic Council Task Force on Short-Lived Climate Forcers (2013) RECOMMENDATIONS TO REDUCE BLACK CARBON AND METHANE EMISSIONS TO SLOW ARCTIC CLIMATE CHANGE; Arctic Council Secretariat (2017) EXPERT GROUP ON BLACK CARBON AND METHANE: SUMMARY OF PROGRESS AND RECOMMENDATIONS 2017; Arctic Monitoring and Assessment Programme (AMAP) (2015) SUMMARY FOR POLICYMAKERS: ARCTIC CLIMATE ISSUES 2015 SHORT-LIVED CLIMATE POLLUTANTS; International Council on Clean Transportation (ICCT) (2017) GREENHOUSE GAS EMISSIONS FROM GLOBAL SHIPPING, 2013–2015; Wan Z., et al. (2016) Pollution: Three steps to a green shipping industry, NATURE 530:275–277.) [Gabrielle Dreyfus, USA]	This section will be completely revised and polar aspects will be removed. Should we adress the comments? Maybe it would be a loss of time.
22698	5	103	7	103	14	This paragraph should be revised: it contains several grammatically errors and also contradicts statements elsewhere about the high increase of shipping due to enhanced resource extraction in the Arctic (which is already ongoing and has been widely documented), as well as the increased likelyhood of accidents and resulting pollution, also due to unsafe sea-ice conditions. [Eva Kruemmel, Canada]	This section will be completely revised and polar aspects will be removed. Should we adress the comments? Maybe it would be a loss of time.
9766	5	103	18	103	18	Suggest replacing 'for' with 'at' so that the sentence reads: '(…) unsustainable at the moment (…)' [APECS Group Review, Germany]	This section will be completely revised and polar aspects will be removed. Should we adress the comments? Maybe it would be a loss of time.
9768	5	103	19	103	19	Suggest suggest replacing 'for' with 'regarding' so that the sentence reads : 'Regarding oil and gas, (…)' [APECS Group Review, Germany]	This section will be completely revised and polar aspects will be removed. Should we adress the comments? Maybe it would be a loss of time.
9770	5	103	21	103	21	This sentence needs clarification. Suggest: 'A barrel of Antarctic sourced oil would cost 100 US dollars, while a barrel from existing sources currently costs 58 US dollars. [APECS Group Review, Germany]	This section will be completely revised and polar aspects will be removed. Should we adress the comments? Maybe it would be a loss of time.
13862	5	103	21	103	21	Hard to understand this sentence 'Indeed, the barrel would be 100 US dollars, while it is actually 58 US dollars'. Consider rephrasing. [Debra Roberts and Durban Team, South Africa]	This section will be completely revised and polar aspects will be removed. Should we adress the comments? Maybe it would be a loss of time.
9772	5	103	22	103	22	For clarity, please consider rephrasing the sentence after 'extreme conditions ' to read: (…) and the current state of knowledge about the existence and availability of these resources.' [APECS Group Review, Germany]	This section will be completely revised and polar aspects will be removed. Should we adress the comments? Maybe it would be a loss of time.
9774	5	103	23	103	24	Suggest combining these two sentences: 'The issue of resource exploitation in the Antarctic is not relevant, because the Antarctic Treaty prohibits the exploitation of natural resources.' [APECS Group Review, Germany]	This section will be completely revised and polar aspects will be removed. Should we adress the comments? Maybe it would be a loss of time.
13864	5	103	23	103	23	Modify 'In any case, the issue of resource exploitation in Antarctica is not relevant' to reflect that this could change depending on what parties decide to do in future. [Debra Roberts and Durban Team, South Africa]	This section will be completely revised and polar aspects will be removed. Should we adress the comments? Maybe it would be a loss of time.
9776	5	103	27	103	27	Please replace 'Thus' with 'Consequently' [APECS Group Review, Germany]	This section will be completely revised and polar aspects will be removed. Should we adress the comments? Maybe it would be a loss of time.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
9758	5	103	30	103	32	The writing seems casual and its meaning and intent are unclear. There are no references supporting the statement that hydropower is risky, and there is no discussion of those risks. [APECS Group Review, Germany]	This section will be completely revised and polar aspects will be removed. Should we adress the comments? Maybe it would be a loss of time.
9778	5	103	30	103	30	This sentence seems contradictory. Consider: 'As long as a large-scale switch to renewable energy does not occur in the coming years, the risks associated with hydropower will be minimal.' Alternatively: 'As we switch to renewable energy, the risks associated with hydropower will increase.' [APECS Group Review, Germany]	This section will be completely revised and polar aspects will be removed. Should we adress the comments? Maybe it would be a loss of time.
10610	5	103	30	103	32	The quality of this statement is below what is expected from an IPCC report. See for example : Magagna, D., & Uihlein, A. (2015). Ocean energy development in Europe: Current status and future perspectives. International Journal of Marine Energy, 11, 84-104. Pérez-Collazo, C., Greaves, D., & Iglesias, G. (2015). A review of combined wave and offshore wind energy. Renewable and Sustainable Energy Reviews, 42, 141-153. [Adrien Comte, France]	This section will be completely revised and polar aspects will be removed. Should we adress the comments? Maybe it would be a loss of time.
13866	5	103	30	103	32	This sounds quite prescriptive and the point being made is not clear. [Debra Roberts and Durban Team, South Africa]	This section will be completely revised and polar aspects will be removed. Should we adress the comments? Maybe it would be a loss of time.
9780	5	103	31	103	32	What makes this technology risky, and is it more or less risky than oil or gas exploitation? Would be worthwhile to expand on this a little. [APECS Group Review, Germany]	This section will be completely revised and polar aspects will be removed. Should we adress the comments? Maybe it would be a loss of time.
10780	5	103	34	104	14	SDG 1 should be mentioned because one of its targets specifically mentions climate related events: "By 2030, build the resilience of the poor and those in vulnerable situations and reduce their exposure and vulnerability to climate-related extreme events and other economic, social and environmental shocks and disasters". [Coswig Kalikoski Daniela, Italy]	We have added the following: "Similarly, failing to avoid or eliminate climate change impacts likely means that not enough has been done to achieve clean energy (SDG 7)), and the poor are more vulnerable and exposed to climate-related extreme events (decreasing the probability of achieving SDG 1)."

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
9788	5	103	36	103	53	While it is clear how climate change impacts link to the loss of ecosystem services and the SDGs, it is not clear enough how climate change impacts relate to the ocean in particular link to the SDGs. The link to the ocean in this section could be more explicitly mentioned/stressed. [APECS Group Review, Germany]	We have added the following paragraph before all of the other paragraphs in the section: "In the oceans, climate impacts on coastal mangroves, estuaries, marshes, and seagrasses to sequester and store carbon, as well as climate impacts on kelp beds, seagrasses and mangroves to regulate coastal erosion and buffer extreme events all represent specific ways that regulating services in the ocean are affected. These regulating services all protect human communities from natural hazards and provide enough stability for sustainable development. Coral bleaching, climate impacts to reefs, kelp beds and seagrasses all represent climate impacts on ocean supporting ecosystem services, and negative impacts to fish and other marine life, as well as changes to their distributions represent climate impacts on marine provisioning services. These provisioning services are directly related to good jobs, economic growth, and cultural values of many people. Many coastal areas are also important for tourism and spiritual and cultural values, including for many indigenous people (Cisneros-Montemayor, Pauly, Weatherdon, & Ota, 2016). Through climate change, coastal areas are threatened by increasing mean temperatures, ocean acidification, sea level rise, and increased coastal storm frequency and intensity, among other impacts, which all have consequences for human well-being."
9782	5	103	37	103	37	Please delete 'the' before '17' so that the sentence reads: (…) upon 17 Sustainable Development Goals (…)' [APECS Group Review, Germany]	We have deleted "the"
9784	5	103	38	103	38	Please change 'climate change impacts will already fail to achieve' to 'climate change impacts will already prevent achieving' [APECS Group Review, Germany]	We have made this change
10778	5	103	39	103	39	typo: "…related to climate action (SDG 12)…"it should be SDG 13 [Coswig Kalikoski Daniela, Italy]	Thank you, we have made this change
12154	5	103	39			SDG for climate action is #13 not #12 [Marie-Fanny Racault, UK]	Thank you, we have made this change
9786	5	103	40	103	41	It would be helpful to more clearly link this sentence to the previous sentence and specifically to add some refernce to or hint of clean energy in the previous sentence [APECS Group Review, Germany]	We have added the following: "Similarly, failing to avoid or eliminate climate change impacts likely means that not enough has been done to achieve clean energy (SDG 7), since energy systems produce a majority of anthropogenic emissions of greenhouse gases and changing to clean energy systems is a core focus to combat climate change (Nerini et al., 2018) "
9790	5	103	55	104	2	This sentence needs rewording. Suggest: 'However, globally the role of women in primary sectors such as fisheries is different to that of men in that their work remains more often officially unrecognised by established markets. Consequently, climate change may disproportionately affect women in these roles if governments do not protect their jobs as they might for men. As such, climate change may negatively affect our ability to achieve gender equality (SDG 5). ' [APECS Group Review, Germany]	Thank you, we have made this change. We have also moved this to the end of the last paragraph as it shows a clear link (this paragraph is for talking about less-than-clear links between climate impacts and SDGs)

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
10618	5	103	55			SGD14, life below water, and especially the subgoals to increase economic benefits for SIDS and LDCs for sustainable marine uses, and the elimination of illegal marine fishing and overfishing, will benefit the other SDGs (Singh et al, 2017). Reference : Singh et al. (2017). A rapid assessment of co-benefits and trade-offs among Sustainable Development Goals. Marine Policy [Adrien Comte, France]	This is a good point. We have added the following sentences: "However, the SDGs are interlinked, and achieving SDG 14, and especially the targets of increasing economic benefits to Small Island Developing States and Least Developed Countries, as well as eliminating illegal fishing and overfishing, will benefits all other SDGs (Singh et al., 2018). Achieving these targets is sometimes necessary to achieve other SDGs. Climate change effects that make achieving SDG 14 less likely, therefore, will make our ability to achieve the other SDGs less likely as well."
13868	5	103	55	104	2	The point being made here is not clear. It needs to be presented in a more clearly written manner. [Debra Roberts and Durban Team, South Africa]	We have moved the statement about gender equality to the paragraph above. We have now clarified this section in the following way: "Less certain is the consequence of climate change on oceans to the remaining SDGs. However, the SDGs are interlinked, and achieving SDG 14, and especially the targets of increasing economic benefits to Small Island Developing States and Least Developed Countries, as well as eliminating illegal fishing and overfishing, will benefits all other SDGs (Singh et al., 2018). Achieving these targets is sometimes necessary to achieve other SDGs. Climate change effects that make achieving SDG 14 less likely, therefore, will make our ability to achieve the other SDGs less likely as well."
21004	5	103	55	103	57	This is not my area of expertise, but it may be important to acknowledge that climate change will not only affect women in unique ways related to the fisheries sector. For example, in many coastal regions women are the main cultivators of rice, where sea level rise is causing salinization of rice fields. See report here and citations within: https://giwps.georgetown.edu/resource/women-and-climate-change/ [Adrienne Sutton, USA]	We thank you for this suggestion. We have added the following: "Beyond climate change in effects through fisheries, unequal gender consequences may manifest. In Senegal, women disproportionately cultivate rice crops (Linares, 2009), and in coastal areas they may be more effected by rising sea levels and resulting salinization (Dennis, Niang-Diop, & Nicholls, 1995). Flooding in Bangladesh has increased the vulnerability of women to harassment and abuse as the flooding upends normal life and increases crime rates (Azad, Hossain, & Nasreen, 2013)."
22720	5	104	0			Seasonal-to-decadal prediction / forecasting of the state of the ocean can be particularly valuable for supporting adaptation measures of the SIDS that are worst effected by climate change (as many of these SIDS lie in the most predictable parts of the oceans). We are preparing an analysis to support this that will be submitted before the 15 October deadline for inclusion in SROCC. A copy of this manuscript will be submitted to the TSU for potential inclusion. The reference is: Payne et al 2019 Seasonal-to-decadal forecasting can support climate adaptation in the world's most ocean-dependent nations. Nature Communications. [Mark Payne, Denmark]	We have added a sentence after our statement about increasing innovation: "A reduction in cooperation may also negatively affect our abilities for innovation and education (SDGs 9 and 4). However, climate change impacts may also mean that innovation is necessary, leading to leaps in invention and adaptation. For example, seasonal-to-decadal forecasting of the state of the ocean can be valuable for supporting adaptation measures, and such work is in development (Payne et al. 2019)."
9796	5	104	7	104	7	Suggest splitting sentence by introducing fullstop before 'however' so the new sentence would start: '(…). However, climate change impacts (…)' [APECS Group Review, Germany]	Thank you, we have made this change
12156	5	104	13			SDG for health and well-being is #3 not #2 [Marie-Fanny Racault, UK]	Thank you, we have made this change

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
23096	5	104	17	104	17	Somewhere, we probably should say also something about the impact of possible land-based solution on the ocean. E.g. what are impact of BECCS on the ocean? [Nicolas Gruber, Switzerland]	Out-side the scope of our assessment
17406	5	104	19	104	19	Revisit these headings in line with standardised other sections "pelagic, coastal and deep sea floor ecosystems" in that order. [Helen Kettles, New Zealand]	The text was altered as suggested by the reviewer.
23082	5	104	19	112	30	Section 5.4.1. needs serious attention. Most importantly, it puts way too much emphasis on blue carbon and refrectory DOC in comparison to other mitigation options. This section also contains some untenable statements. [Nicolas Gruber, Switzerland]	This section is revised in preparing in SOD
2364	5	104	21	104	28	Mitigating SLCPs will reduce the rate of warming and avoid more warming in the near-term than CO2 mitigation efforts alone. SLCPs can avoid 0.6ºC of warming by mid-century and 1.2ºC of warming by 2100; comparatively, avoided warming of CO2 at 2100 is 1.6ºC if CO2 emissions peak at 2030 and 1.9ºC if CO2 emissions peak at 2020. (Xu Y. & Ramanathan V. (2017) Well below 2 °C: Mitigation strategies for avoiding dangerous to catastrophic climate changes, PROC. NAT'L. ACAD. SCI. 114(39):10315–10323; Report of the Committee to Prevent Extreme Climate Change (Chairs: V. Ramanathan, M. L. Molina, and D. Zaelke) (2017) Well Under 2 Degrees Celsius: Fast Action Policies to Protect People and the Planet from Extreme Climate Change; Haines et al (2017) "Short-lived climate pollutant mitigation and the Sustainable Development Goals".) [Kristin Campbell, USA]	Considered
2490	5	104	21	104	28	Mitigating SLCPs will reduce the rate of warming and avoid more warming in the near-term than CO2 mitigation efforts alone. SLCPs can avoid 0.6ºC of warming by mid-century and 1.2ºC of warming by 2100; comparatively, avoided warming of CO2 at 2100 is 1.6ºC if CO2 emissions peak at 2030 and 1.9ºC if CO2 emissions peak at 2020. (Xu Y. & Ramanathan V. (2017) Well below 2 °C: Mitigation strategies for avoiding dangerous to catastrophic climate changes, PROC. NAT'L. ACAD. SCI. 114(39):10315–10323; Report of the Committee to Prevent Extreme Climate Change (Chairs: V. Ramanathan, M. L. Molina, and D. Zaelke) (2017) Well Under 2 Degrees Celsius: Fast Action Policies to Protect People and the Planet from Extreme Climate Change; Haines et al (2017) "Short-lived climate pollutant mitigation and the Sustainable Development Goals".) [Durwood Zaelke, USA]	Considered
9794	5	104	21	104	28	This paragraph references sections 5.2 and 5.3 and may be duplicative of those sections. [APECS Group Review, Germany]	Thank you, we have given attention to maximising complementarity and minimising duplication

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
12988	5	104	21	104	28	Mitigating SLCPs will reduce the rate of warming and avoid more warming in the near-term than CO2 mitigation efforts alone. SLCPs can avoid 0.6ºC of warming by mid-century and 1.2ºC of warming by 2100; comparatively, avoided warming of CO2 at 2100 is 1.6ºC if CO2 emissions peak at 2030 and 1.9ºC if CO2 emissions peak at 2020. (Xu Y. & Ramanathan V. (2017) Well below 2 °C: Mitigation strategies for avoiding dangerous to catastrophic climate changes, PROC. NAT'L. ACAD. SCI. 114(39):10315–10323; Report of the Committee to Prevent Extreme Climate Change (Chairs: V. Ramanathan, M. L. Molina, and D. Zaelke) (2017) Well Under 2 Degrees Celsius: Fast Action Policies to Protect People and the Planet from Extreme Climate Change; Haines et al (2017) "Short-lived climate pollutant mitigation and the Sustainable Development Goals".) [Gabrielle Dreyfus, USA]	Considered
15606	5	104	21	104	45	It's important to note that mitigation may lead to potentially surprise responses and unintended consequences - there may be winners and losers. See e.g. John et al., A more productive, but different, ocean after mitigation, GRL, https://doi.org/10.1002/2015GL066160, 2015 [Jasmin John, USA]	Considered
17946	5	104	21	104	22	Reference needed from AR5 in definition of mitigation. Also link to UNFCCC provisions on mitigation. [Jeffrey Mcgee, Australia]	Reference made to AR5, UNFCCC and SROCC Glossary
18408	5	104	21	104	22	Please clarify what the IPCC definition of mitigation is and where is can be found. Might be helpful for the reader to quote this definition here. This is important to understand why CDR geoenigneering proposals are being categorised as mitigation throughout the rest of the chapter (as opposed to falling under a third "geoengineering" category). [Kerryn Brent, Australia]	Reference made to AR5, UNFCCC and SROCC Glossary
22128	5	104	25	104	25	It should be valuable to quote Article 2.1 (a) of the Paris Agreement while referring to the 2°C objective. [Bleuenn Gaëlle Guilloux, Germany]	Quote from Article 2.1 (a) now included
17948	5	104	34	104	34	Solar Radiation Management is the more accepted term for 'SRM'. Need to explain more clearly why this has been excluded from this report. [Jeffrey Mcgee, Australia]	SRM explained as both Solar Radiation Management and Sunlight Reflection Methods; the latter has been used by the CBD (and is more understandable). Consideration of SRM excluded from scoping of the report; cross-referencing to Chapter 1 (Section 1.5) now added to make that clear.
17950	5	104	35	104	35	The term 'climate engineering' is generally defined as encompassing both SRM (ie solar radiation mangement) and CDR (ie carbon dioxide removal) methods. This report is focussing on CDR involving the marine environment. [Jeffrey Mcgee, Australia]	Comment noted. Not clear that any edit is needed

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
11520	5	104	39	104	45	Reference here to the potential to promote additional carbon uptake by marine ecosystems, both in the coastal zone and the open ocean, could be understood as a reference in part to deliberate ocean fertilization (with iron or other nutrients). The text on page 104 goes on to stress that ocean based removals of CO2 from the atmosphere 'will be needed', albeit not as a substitute for emissions reductions. This contrasts with other parts of the chapter which rightly identify the limitations and dangers of ocean fertilization, recognising it as likely to have very low effectiveness and governability, as well as having the potential for unintended consequences (see e.g. section 5.4.1.2.2 on page 112). It is also something that is not explicitly supported by the reference cited (Williamson & Bodle 2016), which makes no reference to ocean based removals of CO2 as being a necessity, and which further emphasises the fundamental limitations of ocean fertilization and other proposed ocean-based geoengineering approaches. One possible solution would be to replace the text of the sentence in lines 42-43 with "Any ocean based removals of CO2 from the atmosphere could only be an addition to, and not a substitute for, very rapid reductions in greenhouse gas emissions" [Taehyun Park, Republic of Korea]	Suggested re-wording adopted. Also note that an error occurred when chapter 5 references were compiled in Endnote by the TSU resulting in a displacement of all the references by one position. This resulted in a great number of misplaced references which we have since then fixed.
18410	5	104	44	104	45	The draft states that "such negative emissions are considered to be a form of climate geoengineering, as well as part of climate mitigation". It might be helpful to incorporate the term 'carbon dioxide removal' to be more specific about the category of geoengineering techniques and complement the use of the term "solar radiation management" above on line 34 of the same page. [Kerryn Brent, Australia]	The text was altered as suggested by the reviewer.
5584	5	104	47	105	6	The blue carbon that is mentioned in this line 6 of page 105, to which definition of blue carbon is it refering to mentioned earlier [Roderik Van De Wal, Netherlands]	Defined
11522	5	104	47	104	48	The term 'blue carbon' is not normally used to refer to mitigation approaches per se, but rather (as in its other uses in the chapter) to the stores of carbon themselves in marine ecosystems. To use the term 'blue carbon' to refer to reducing emissions and enhancing sinks in a very broad context is likely to introduce inconsistencies and confusion. The definition and use of the term 'blue carbon' should be consistent throughout the report, and be consistent with its usage elsewhere. Mitigation measures may, in part, look to protect or enhance blue carbon, but they are not blue carbon in themselves. [Taehyun Park, Republic of Korea]	Text re-worded to take account of comment
754	5	104	49	104	49	"sea grassess" be changed as 'seagrasses" [Kathiresan Kandasamy, India]	The text was altered as suggested by the reviewer.
2092	5	104	50	104	54	Citation of the following book is suitable for explaining the recent geral use of the term, blue carbon: Kuwae, T. and Hori, M.(2018): Blue Carbon in Shallow Coastal Ecosystems: Carbon Dynamics, Policy, and Implementation, Springer, DOI: 10.1007/978-981-13-1295-3 [Tomohiro Kuwae, Japan]	Reference added

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11524	5	104	53	104	55	This sentence makes reference to a very broad range of proposed coastal and open ocean mitigation measures, including (through reference to the figure below) ocean fertilization, within a paragraph that discusses the concept of 'blue carbon'. Given the limitations and legal restritions relating to ocean fertilization as a concept, it should be considered and discussed in this report separately and distinctly from discussions on 'blue carbon'. To mix the two risks discrediting the protection and restoration of blue carbon ecosystems by association. [Taehyun Park, Republic of Korea]	Comment noted. However, the most logical usage of blue carbon is to refer to the continuum of carbon removal and storage processes, discussing the aspects that make some more useful for mitigation purposes than others.
1366	5	105	0			Figure 5.23 need to make explicit that continental shelf only relates to sea bed and sub seabed [Marcus Haward, Australia]	Comment noted - but the continental shelf also has biophysical effects on the water column, and it is not possible to cover all details of marine governance zones in a single figure.
13870	5	105	0			Fig 5.23 It takes a long time to understand what the diagram is of, what the solid and dotted lines represent. Sugest adding some colour or using pictures of land / sea scapes used elsewhere in the report. What is NM? [Debra Roberts and Durban Team, South Africa]	Colour will be added to figure to improve interpretation. NM = nautical miles (as used in UNCLOS for ocean governance); now added to legend
18412	5	105	0	105	0	This comment relates to figure 5.23: 'Marine legal zoning relevant to ocean-based mitigation of CO2'. In this figure, ocean fertilization and enhanced upwelling are plotted in the "high seas" and "deep seabed" region only. This suggests that these activities will only be conducted in this area and/or have impacts on these areas, and not impact on a state's EEZ or Territorial Sea. As the effects of ocean fertilization and upwelling/downwelling cannot be contained to a specific area, there is a risk of impacts/harm occuring across boarders in an EEZ or Territorial Sea. This figure could also be mistakenly interpreted to suggest that the only governance regimes and legal rules relevant to ocean fertilization and upwelling will be rules concerning activites in the high seas and deep seabed. Other legal regimes, such as the Convention on Biological Diversity, may be relevant. The domestic laws of individual states may also apply to these activities depending on the nationality of a ship, where it departs from or is loaded, and what international laws the state in question has ratified (e.g. London Protocol). It may therefore be more accurate to extend the "legal zoning" across the different categories as has been done with alkalinisation. [Kerryn Brent, Australia]	Clarifications added to figure legend to cover issues raised
5586	5	105	1	105	1	The message of the figure is unclear to me. [Roderik Van De Wal, Netherlands]	The message is to show the overlapping spectrum of proposed marine-based mitigation measures, covering different governance zones
13202	5	105	1	105	1	the figure would benefit from some color: e.g. brown for land, different shades of blue for near coastal to deep ocean [Baerbel Hoenisch, USA]	Agreed; colours to be added.
17952	5	105	1	105	1	Figure 5.23 would benefit from an arrow showing the 12nm territorial sea extending from the mainland coastal baseline. [Jeffrey Mcgee, Australia]	Comment noted, but not considered necessary
22130	5	105	1	105	1	Figure 5.23: Exclusive rights in the economic exclusive zone; freedom in the high seas; Deep seabed known as the Area; reference to UNCLOS corresponding parts for each maritime zones. [Bleuenn Gaëlle Guilloux, Germany]	Comments noted, but additional detail not considered necessary
23084	5	105	6	105	28	This section essentially just paraphrases the work of Gattuso et al. (in review). Where is the assessment? [Nicolas Gruber, Switzerland]	Edits made to text and table to address this comment

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
18414	5	105	22	106	1	This comment relates to table 5.7. The term 'governablility' needs to be defined for the reader. At the present, it is unclear whether this term refers to the capacity to enforce legal rules, negotiate/develop governance rules/regimes, or the "controllability" (ability to start and stop) an option. For example, it is unclear why marine renewable energy and relocation/reef restoration are consider to have "high governability", and ocean fertilization and alkalinization are consider to have "low governability". [Kerryn Brent, Australia]	Governability is briefly explained
5588	5	105	25	105	26	Unclear what techniques is referred to. [Roderik Van De Wal, Netherlands]	Unclear what this comment relates to
9798	5	105	31	105	31	Line 22 (just above on page 105) cites Gattuso et al (2018) as the source of the effectiveness scores. The caption for table 5.7, which seems to portray effectiveness scores lists Dai et al. (2012) as the source. This is a bit confusing. Perhaps one of these references was invoked in error? If not please elaborate how the two are different [APECS Group Review, Germany]	An error occurred when chapter 5 references were compiled in Endnote by the TSU resulting in a displacement of all the references by one position. This resulted in a great number of misplaced references which we have since then fixed.
21576	5	105	31	106	1	Table 5.7. Ocean fertiliation, Major Disadvantages. Add: "long-term reduction in ocean productivity, alteraction of the structure of marine food webs, increase in the rate of ocean acidification, and increased production of the greenhouse gas N2O." (Denman, 2008. Marine Ecology Progress Series 364: 219-225.) [Robie Macdonald, Canada]	Table now revised. Although suggestions for additional text in the Table are appreciated, this assessment needs to match Gattuso et al, rather than adding material from other sources
21578	5	105	31	106	1	Table 5.7. Restoration and conservation of coastal vegetation. Add "Overestimation of carbon sequestration could, if used to offset greenhouse gas emissions elsewhere, lead to a net increase in the flux of carbon dioxide to the atmosphere." [Robie Macdonald, Canada]	Table now revised. Although suggestions for additional text in the Table are appreciated, this assessment needs to match Gattuso et al, rather than adding material from other sources
24608	5	106	0			Assessing the contribution of seaweeds to a CCS approach (burying excess production such as sargassum seaweeds) would complement the interesting discussion of ocean solution options. [Hans-Otto Poertner and WGII TSU, Germany]	Seaweeds are considered later (5.5.1.1.3) - with update to reflect recent literature
5590	5	106	1	106	1	In the table for the major disadvantages of marine renewable energy, there are 3 question marks. Are there no disadvantages or are they not known? [Roderik Van De Wal, Netherlands]	Table now revised. Question marks were meant to indicate "not assessed)
17408	5	106	1	106	1	Is "Restoration and conservation of coastal vegetation" "moderate" for places with relatively long coastlines such as island nations like NZ? Can that be explained further. [Helen Kettles, New Zealand]	There isn't space to present information on a country-by-country basis: the 'moderate' represents a global-scale assessment
17410	5	106	1	106	1	"MPAs" could also offer more than this? See - http://www.pnas.org/content/114/24/6167; Also all these marine reserves possessed higher mean cover of kelp because of trophic cascades https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5443496/; And https://www.ncbi.nlm.nih.gov/pubmed/27396719. [Helen Kettles, New Zealand]	Point noted - but not possible to present all nuances here
17954	5	106	1	106	1	In the Table, need to explain what 'governability' means and what factors drive it. [Jeffrey Mcgee, Australia]	Additional (brief) explanation of governability given in text
2094	5	107	14	107	15	Citation of the following book is suitable for explaining the extension of the blue carbon concept: Kuwae, T. and Hori, M.(2018): Blue Carbon in Shallow Coastal Ecosystems: Carbon Dynamics, Policy, and Implementation, Springer, DOI: 10.1007/978-981-13-1295-3 [Tomohiro Kuwae, Japan]	Citation now given (in earlier text)
17956	5	107	14	107	14	the word 'extending'' should be 'extend'. [Jeffrey Mcgee, Australia]	The text was altered as suggested by the reviewer.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
6516	5	107	17	109	31	Recent published work has highlighted large uncertainties around the present understanding of the blue carbon potential of seaweed and other, connected, organic carbon sinks in the coastal and open ocean. Questions have also been placed around whether managing these sinks is indeed less feasible than managing the traditionally considered blue carbon habitats in the coastal ocean. See: Krause-Jensen et al. 2018 Biology Letters 14: DOI: 10.1098/rsbl.2018.0236; Smale et al 2018 Front Ecol and Env 16: DOI: 10.1002/fee.1765; Krause-Jensen and Duarte 2016 Nature Geoscience 9: DOI 10.1038/ngeo2790. In addition, several initiatives are currently underway around the world to address existing uncertainties and data availability. It would therefore suggest that this section requires revision: it is not in line with current understanding nor does it reflect a consensual view within this research community, especially with regard to opportunities to expand Blue Carbon schemes. [Ana Queiros, UK]	Comments appreciated. Edits made (and references used) in 5.5.1.1.3
23086	5	107	17	109	31	This section needs to be completely overhauled. It first suggests as if these systems can represent a serious mitigation option, only to later fail to give any quantitative estimate. [Nicolas Gruber, Switzerland]	Extensive revisions have been made to take account of this comment and clarify the arguments. The information presented reflects both the 'optimism' of the literature relating to the potential for blue carbon, and also the more recent identification of the uncertainties.
6510	5	107	18	107	21	These numbers (the proportion of atmospheric CO2 captured by the ocean for which traditional coastal vegetated habitats are responsible) have been questioned by several studies, which indicate that the total blue carbon capacity of the ocean is underestimated at present. See e.g.Krause-Jensen and Duarte 2016 Nature Geoscience 9: DOI 10.1038/ngeo2790. This is not up to date. [Ana Queiros, UK]	Comment noted. The uncertainty is reflected in the discussion, with Krause-Jensen & Duarte cited later.
21580	5	107	20	107	21	This estimate of the global uptake of carbon dioxide by the three types of coastal system is too high, because the rate for seagrasses is too high. See first comment. [Robie Macdonald, Canada]	Comment noted. The uncertainty is reflected in the discussion, with additional papers on seagrasses cited later.
23088	5	107	20	107	21	These numbers are untenable. The cited reference is a policy brief, which itself references not really a global assessment. Blue carbon is locally clearly an important issue, but not globally. The stocks and storage are just too small. [Nicolas Gruber, Switzerland]	Comment noted, partly arising from referencing error. However, other reviewers consider the quoted figures too low, rather than too high, reflecting the uncertainties in this topic area.
23224	5	107	20	107	21	I think the 0.1% of the earth'surface is less importrant to give a estimate of the covering rate of the coastal area; and the ratio of these three kinds of vegetation in the global and coastal total vegetation will be more important. [Dongxiao Wang, China]	Comment noted. Best-estimate data for areas now given - although not for ratios (since range of values would be large, due to high uncertainties for seagrass data)
21582	5	107	27	107	27	After "...light availability," add "and because carbon sequestration rates in seagrass meadow sediments have not yet been properly assessed, using robust methods that respect six decades of published knowledge of marine sediment geochemistry. [Robie Macdonald, Canada]	Extensive edits made to text - with additional references to cover these issues
9800	5	108	5	108	5	Please add 'the' before' 'Paris Agreement' [APECS Group Review, Germany]	The text was altered as suggested by the reviewer.
24434	5	108	9	108	12	this figure would make a stornger statement if it was combined with informtation on distribution of coastal blue carbon ecpsystems and carbon stocks [Hans-Otto Poertner and WGII TSU, Germany]	Figure deleted; cross-reference to a new (more informative) figure in earlier section

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
6512	5	108	33	108	36	The effect of bioturbators on carbon burial, as described here, is inaccurate/misleading. Bioturbators can also enhance carbon burrial , depending on their specific functional group. This sentence needs addressing. See Snelgrove et al 2017 Trends Ecol Evol 33: 10.1016/j.tree.2017.11.004. [Ana Queiros, UK]	Minor edit made to clarify context: in mangroves, the main bioturbators (crabs) disturb the sediment, rather than enhancing carbon burial
3390	5	109	12	109	12	Biogenic gassy sediments may be another form of C sequentration in coastal ecosystems. Capacity of retain C (as methane and others) may depend on the lithologies, hydrostatic presion, changes in RSL, oxigenation of the bottom (depending on the climate and changes in the upwelling regimes, etc). E.g.: Martínez-Carreño, N. & García-Gil, S. 2013. Marine Geology 344, 82–100. [Castor Muñoz Sobrino, Spain]	Comment noted. However, 'gassy sediment' would not seem a very stable form of carbon storage - with leakage likely, as methane. Indeed that process occurs.
19094	5	109	14	109	15	This paragraph states that "there are undoubtedly opportunities to include and expand blue carbon ecosystems in the revised NDCs of most, if not all, coastal countries" should be removed as this is a political statement rather than a scientific one. The guidance for NDCs has yet to be decided, and it is not the role of hte IPCC to suggest what should be included. Furthermore, there are other vehicles under the UNFCCC (e.g. adaptation communications) that may also be relevant for the inclusion of coastal- and oceans-based issues, e.g. coastal adaptation. Lastly, it's the role of the IPCC to also assess the scientific feasibility of robust accounting regimes for something like blue carbon that are not yet existing. [Carl-Friedrich Schleussner, Germany]	Sentence deleted, as suggested
21410	5	109	14	109	15	This sentence does not contain evidence to support the use of the word “undoubtedly.” It should be removed. [Alice Alpert, USA]	Whole sentence now deleted
5592	5	109	17	109	21	Here are two sentences that are almost the same. One of the two should be removed. [Roderik Van De Wal, Netherlands]	Repetition removed
11526	5	109	17	109	21	There is either something missing from the first of these two sentences or there is text repeated unnecessarily [Taehyun Park, Republic of Korea]	Repetition removed
13872	5	109	17	109	20	Sentence doesn't make sense. [Debra Roberts and Durban Team, South Africa]	Repetition removed
24260	5	109	17	109	20	These two sentences almost repeat each other--> try to combine them (Or delete the first) [Hans-Otto Poertner and WGII TSU, Germany]	Repetition removed

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
6514	5	109	33	109	37	The degree of confidence placed in these assertions does not reflect the views of this research community. Recent published work has highlighted large uncertainties around the present understanding of the blue carbon potential of seaweed and other, connected, organic carbon sinks in the coastal and open ocean. Questions have also been placed around whether managing these sinks is indeed less feasible than managing the traditionally considered blue carbon habitats in the coastal ocean. See: Krause-Jensen et al. 2018 Biology Letters 14: DOI: 10.1098/rsbl.2018.0236; Smale et al 2018 Front Ecol and Env 16: DOI: 10.1002/fee.1765; Krause-Jensen and Duarte 2016 Nature Geoscience 9: DOI 10.1038/ngeo2790. In addition, several initiatives are currently underway around the world to address existing uncertainties and data availability. It would therefore suggest that this section requires revision: it is not in line with current understanding nor does it reflect a consensual view within this research community. This ommission from section 5.4.1.1.2, especially with regard to opportunities, will also raise some concern. This view is repeated in previous sections of the report. [Ana Queiros, UK]	Comments noted, and changes made to text (here, and to 5.5.1.1.3). However, there are major uncertainties regarding the magnitude of natural carbon sequestration (longterm removal) by blue carbon habitats and by seaweeds, and the scope for its management, to increase potential benefits. The additional references that are suggested have been checked, and are now cited.
18416	5	109	40	109	41	"...that could be linked to carbon capture and storage..." Consider adding to this sentence "and, hence, potentially produced negative emissions". Or otherwise, be more specific about the potential for enhanced kelp farming to contribute to BECCS as a negative emission/CDR geoengineering proposal. [Kerryn Brent, Australia]	The text was altered as suggested by the reviewer.
21130	5	109	45			In South Korea, macroalgae have been utilized as part of a climate change mitigation program under the Coastal CO2 Removal Belt (CCRB) which removes CO2 via marine forests (Chung et al., 2009; OECD, 2015). With the perennial brown alga Ecklonia, a pilot CCRB farm can draw down about 10 t of CO2 per ha per year (Chung et al., 2013). Chung, I.K., T. Na, T. Lee, J.H. Kim, J.A. Lee, and J.H. Oak, 2009: The conceptual Coastal CO2 Removal Belt and estimation of carbon sequestration by seaweeds, Phycologia, 48, 21 Chung, I.K., J.H. Oak, J.A. Lee, J.-A. Shin, J.G. Kim and K-S. Park, 2013: Installing kelp forests/seaweed beds for mitigation and adaptation against global warming: Korean Project Overview. ICES Journal of Marine Science, 70, 1038–1044, doi:10.1093/icesjms/fss206 OECD, 2015: Green Growth in Fisheries and Aquaculture, OECD Green Growth Studies, OECD Publishing, Paris. http://dx.doi.org/10.1787/9789264232143-en, 101 https://en.wikipedia.org/wiki/Blue_carbon [Ik Kyo Chung, Republic of Korea]	Comments noted; extra reference added, as suggested
1534	5	109	51	109	57	Could it be worth explicitating here the links with off-shelf export processes? [Davide Bonaldo, Italy]	Earlier edit made to text to cover large-transport processes
21006	5	110	21	110	22	It seems appropriate to cite the experimental example of ocean alkanization in the Great Barrier reef: Albright, R., Caldeira, L., Hosfelt, J., Kwiatkowski, L., Maclaren, J.K., Mason, B.M., Nebuchina, Y., Ninokawa, A., Pongratz, J., Ricke, K.L., Rivlin, T., Schneider, K., Sesboüé, M., Shamberger, K., Silverman, J., Wolfe, K., Zhu, K., Caldeira, K. (2016) Reversal of ocean acidification enhances net coral reef calcification. Nature 531, 362. [Adrienne Sutton, USA]	This comment does not seem relevant here (since the Albright et al reference is already included, in the 'enhanced weathering' text)

SROCC First Order Draft Expert Review Comments - Chapter 5							
Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
23090	5	110	34	111	4	This is very speculative and can remain only if properly assessed. [Nicolas Gruber, Switzerland]	Comment noted. This text (Section 5.5.1.1.5) is problematic not only because it is very speculative but also because it covers the same topic as already discussed under 5.5.1.1.3. Such duplication is (presumably) not acceptable, therefore a decision needs to be made by CLAs as to which text should remain.
2096	5	110	37	110	49	An opposite mechanism has also been propsed (Kuwae et al., 2016) and more balanced explanation is needed. Kuwae T., J. Kanda, A. Kubo, F. Nakajima, H. Ogawa, A. Sohma, and M. Suzumura (2016.3): Blue carbon in human-dominated estuarine and shallow coastal systems, Ambio, 45, pp 290-301, DOI: 10.1007/s13280-015-0725-x [Tomohiro Kuwae, Japan]	Reference checked and included under 5.5.1.1.3
9802	5	110	39	110	42	Please consider adding a fulll stop after the reference (Jiao et al 2018a) and starting the new sentence with 'This can create' [APECS Group Review, Germany]	Not clear where this edit needs to be made (assuming text is retained; to be decided)..
3392	5	110	43	111	42	See previous comment. [Castor Muñoz Sobrino, Spain]	Comment noted (relating to gassy sediment)
13204	5	111	1	111	1	perrty figure, please spell our/define the abreviations in the figure (POC, DOC, RDOC) [Baerbel Hoenisch, USA]	Figure to be deleted? (tbc by Chapter CLAs).
9804	5	111	2	111	2	Please replace 'brings' with 'introduces' and 'policy' with 'policies'. [APECS Group Review, Germany]	No longer relevant in SOD
9806	5	111	3	111	3	Please delete 'being' so that the sentence reads 'is currenlty in practice' [APECS Group Review, Germany]	No longer relevant in SOD
5594	5	111	7	111	7	Figure does not provide any added value to the text. Features are drawn but no process is clarified. Figure can be left out or replaced with a figure in which additional information is presented, e.g. carbon stocks and fluxes are visualized. [Roderik Van De Wal, Netherlands]	Figure edited to present additional informatin.
2226	5	111	8			seagrass in Figure 5.25 is one word [Chandani Appadoo, Mauritius]	Figure edited
24262	5	111	8	111	10	abbreviations in Fig are not explained [Hans-Otto Poertner and WGII TSU, Germany]	Figure edited
23092	5	111	13	112	12	This is incorrect. The ocean uptake of anthropogenic CO2 has nothing to do with the solubility pump. Also the references are not the right ones [Nicolas Gruber, Switzerland]	Edit made re 'solubility pump' . Also note that an error occurred when chapter 5 references were compiled in Endnote by the TSU resulting in a displacement of all the references by one position. This resulted in a great number of misplaced references which we have since then fixed.
21132	5	112	12			(see Section 5.4.2.2.2) – in this section I could not find any related topics. [Ik Kyo Chung, Republic of Korea]	Edit made (removing cross-reference)

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
1160	5	112	14	30		Ocean fertilisation has, to my knowledge, only been attempted using: expensive, fast-release commercial nutrients, typically produced from fossil fuels or high-grade mineral deposits, that may produce boom-bust cycles and eutrophication; ones that sink fairly rapidly away from the euphotic zone, thereby incurring high wastage; and ones that need to be replenished frequently. None of these demerits pertain to the Climate Restoration Foundation's buoyant flakes. Moreover, except for reactive nitrogen to be supplied by typically buoyant diazotrophs, the nutrient mix in these flakes can be tailored to both local and seasonal deficiencies. Whilst carbon sequestration effectiveness does require better measurement for longer durations, there will be little doubt regarding the greening of the ocean surface and the additional marine catch. Governance issues are much less of a problem in territorial and EEZ waters, whilst the CRF has proposed solutions for both equitable funding based on the re-insurance industry and for high seas applications. The nutrients used appear to meet the inert criteria of the London Convention and Protocol as well as being of good marine intent. [William Clarke, Australia]	Comment noted. However, the ideas proposed by the reviewer do not seem to have published in peer-reviewed literature.
11528	5	112	15	112	30	It would be worthwhile making a cross-reference in one of these two paragraphs to the legal status of ocean fertilization as a concept, under the London Protocol, with reference to section 5.4.4.1, and in particular to pages 138-139. It is important that discussion of proposals for ocean fertilization and of their likely effectiveness are viewed within the context of decisions already taken about the acceptability and governance of such proposed activities. [Taehyun Park, Republic of Korea]	Cross-referencing added, as suggested.
17958	5	112	15	112	25	need to mention London Protocol 2013 amendments on iron fertlization (not yet in force) [Jeffrey Mcgee, Australia]	Edit accepted: London Protocol now mentioned
18418	5	112	15	112	30	The report specifically acknowledges potential adverse impacts of nitrate fertilization. However, it does not explicitely acknowledge the potential for iron fertilization to have adverse impacts. It instead uses the term 'secondary' at line 22. The potential for iron fertilization to have adverse impacts should be made more explicite. It might also be useful to provide a few key examples from the literature as to the nature of these risks (as has been done for some of the other activities listed in this section). [Kerryn Brent, Australia]	Edit accepted: adverse impacts now mentioned
9808	5	112	16	112	16	Please replace 'also' with 'as well as' so that the sentence reads: ' modelling, as well as by observation ' [APECS Group Review, Germany]	sentence re-structured to take account of comment
23226	5	112	17	112	19	what is the global effect and the variability among different regions? [Dongxiao Wang, China]	Comment noted - but not considered appropriate to discuss in greater detail.
23094	5	112	31	112	31	I am missing a discussion of open ocean alkalinization [Nicolas Gruber, Switzerland]	Not considered in scope for report (although briefly mentioned earlier)
22418	5	112	32	131	29	In assessing efficacy of adaptation options, how is efficacy defined and assessed? It seems there needs to be a greater explanation, including potentials for maladaptation. [Debora Ley, Guatemala]	Accepted_ the reader is directed to the CCB1 for an overview of the adaptation framework that is used in this section.

SROCC First Order Draft Expert Review Comments - Chapter 5							
Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
22702	5	112	32	131		An important recent development that has been overlooked in this report is the development of skillful seasonal-to-decadal predictions/forecasts of the state of the ocean. While this material was covered in AR5 (WGI, Chapt 11), the time since has seen rapid improvements these forecasts, together with their application to aid management of living marine resources – see e.g. (Payne et al., 2017; Tommasi et al., 2017) for reviews. These developments are particularly valuable as an adaptation tool, and should be included specifically in section 5.4.2, but also more generally throughout the Chapter. I have highlighted specific places where this could be done in other comments, but some text dealing with it as a specific adaptation technique would also be beneficial - I would also be happy to contribute text in this regard if it is useful to the author team. Payne, M. R., Hobday, A. J., MacKenzie, B. R., Tommasi, D., Dempsey, D. P., Fässler, S. M. M., Haynie, A. C., et al. 2017. Lessons from the First Generation of Marine Ecological Forecast Products. Frontiers in Marine Science, 4. Tommasi, D., Stock, C. A., Hobday, A. J., Methot, R., Kaplan, I. C., Eveson, J. P., Holsman, K., et al. 2017. Managing living marine resources in a dynamic environment: The role of seasonal to decadal climate forecasts. Progress in Oceanography, 152: 15–49. [Mark Payne, Denmark]	Accepted. Text altered as suggested
9810	5	112	34	131	29	The reference list is full with spelling errors, misspelled journals names, some dois are formatted as links etc. and needs major revision. I will not point out mistakes hereinafter. [APECS Group Review, Germany]	The text was altered as suggested by the reviewer.
756	5	112	35	112	35	"of" be deleted [Kathiresan Kandasamy, India]	Accepted_The text was altered as suggested by the reviewer.
13874	5	112	35	112	35	Replace 'climate change impacts of' with 'impacts of climate change'. [Debra Roberts and Durban Team, South Africa]	Taken into account_the text was altered to remove "the" which corrects the grammar.
9812	5	112	36	112	36	"Very high confidence" should be in italic, because of the "Consistent Treatment of Uncertainties". [APECS Group Review, Germany]	Rejected_this is reporting back from AR5, so it is not to be confused with an assessment made for SROCC. The text was altered as follows: "Although an assessment was made on the adopted adaptation practices, there was limited... "
9814	5	112	37	112	37	"Limited evidence" should be in italic, because of the "Consistent Treatment of Uncertainties". [APECS Group Review, Germany]	Rejected_for the same reason as given in comment 9812
9816	5	112	40	112	40	"Section (5.4.2)" - without (). [APECS Group Review, Germany]	Accepted_The text was altered as suggested by the reviewer.
9818	5	112	49	112	50	I have difficulties to clearly understand how and why consideration would be given to gender and I couldn't find an element of answer in the mentionned table (5.8). [APECS Group Review, Germany]	Accepted_The text was deleted.
9820	5	113	0	113	0	Table 5.8, SROCC description, first row: wrong citation, it is not ForzieriA but Forzieri (wrong throughout the text). [APECS Group Review, Germany]	Accepted_The text was altered as suggested by the reviewer.
9822	5	113	0	113	0	Table 5.8, SROCC description, second row: Mutombo and Ölçer, 2016 A or B? (or 2017; see comment below). [APECS Group Review, Germany]	Accepted_The text was altered as suggested by the reviewer.

SROCC First Order Draft Expert Review Comments - Chapter 5							
Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
9824	5	113	12	113	20	Those studies should not be used to refer to a general/global overview, as they were mainly on a local level. It could be indicated that that those studies were conducted in specific regions/localities instead. [APECS Group Review, Germany]	Taken into account_those studies were given as examples, but text was added directing readers to an appendix containing a list of all publications assessed in eaach sub-section of 5.5.2. The following text was inserted: "Appendix 5.5.2 lists all publications used for assessment in each sub-section of 5.5.2."
9826	5	113	12	113	12	There is a coma at the end of the line while the following line (13) starts with a capital letter. [APECS Group Review, Germany]	Accepted_The text was altered as suggested by the reviewer.
9828	5	113	13	113	13	Cheung et al. 2015 is in my opinion not a good reference for a complete ecosystem, as they were mainly focusing on fish species. So maybe Cheung et al. 2015 is better for the next point: "species" (line 13)? [APECS Group Review, Germany]	Accepted_The reference was replaced with "Kuhfuss et al., 2016"
9830	5	113	15	113	18	In my opinion, Cerkasova et al. 2016 is a better reference for "modelling" (line 16). [APECS Group Review, Germany]	An error occurred when chapter 5 references were compiled in Endnote by the TSU resulting in a displacement of all the references by one position. This resulted in a great number of misplaced references which we have since then fixed. Cerkasova was originally cited for modelling.
10612	5	113	22	113	24	Suggested reference of a review of scientific efforts on adaptation strategies for coral reefs and a design of a conceptual framework : Comte and Pendleton. (2018). Management strategies for coral reefs and people under global environmental change: 25 years of scientific research. Journal of Environmental Management [Adrien Comte, France]	An error occurred when chapter 5 references were compiled in Endnote by the TSU resulting in a displacement of all the references by one position. This resulted in a great number of misplaced references which we have since then fixed.
9832	5	113	28	113	29	The statement "near universal agreement" seems to be exaggerated, because only two citations are given. Maybe a few more references would support this statement. Moreover, both references do not even provide a "global" statement. Abedin and Shaw, 2015 could be another suitable reference for this statement. [APECS Group Review, Germany]	Taken into account. Response is the same as for Comment 9824. The two citations are examples, but were not the only two used in the assessment to make the statement.
10614	5	113	30			Scientific efforts on adaptation are currently not undertaken in the most vulnerable countries but mostly in developed countries (United States, Australia…) (Comte and Pendleton, 2018). Reference : Comte and Pendleton. (2018). Management strategies for coral reefs and people under global environmental change: 25 years of scientific research. Journal of Environmental Management [Adrien Comte, France]	Taken into account_An error occurred when chapter 5 references were compiled in Endnote by the TSU resulting in a displacement of all the references by one position. This resulted in a great number of misplaced references which we have since then fixed. Text has been altered.
9834	5	113	35	113	35	Merkens et al. 2016 is possibly a better reference for "socio-economic". [APECS Group Review, Germany]	An error occurred when chapter 5 references were compiled in Endnote by the TSU resulting in a displacement of all the references by one position. This resulted in a great number of misplaced references which we have since then fixed. Merkens was in the original version.
9836	5	113	36	113	36	I could not find an explanation or meaning for BoG. [APECS Group Review, Germany]	Accepted_ the reader is now directed to CCB1,w hich deals with this topic, framing adaptation.
758	5	113	39	113	39	"prediction sand" be changed as "predictions and" [Kathiresan Kandasamy, India]	The text was altered as suggested by the reviewer.
9838	5	113	39	113	39	I guess it should be "predictionS and climate drivers" and not "prediction sand climate driver"? [APECS Group Review, Germany]	The text was altered as suggested by the reviewer.
9840	5	113	40	113	41	The expression "a notable lack of studies" is a little unfortunate, as the two previous references actually refer to least developed countries. [APECS Group Review, Germany]	Accepted_text changed to "In this respect, there is a dearth of studies from African and Caribbean least developed countries…"
760	5	113	41	113	41	"." be deleted [Kathiresan Kandasamy, India]	The text was altered as suggested by the reviewer.

SROCC First Order Draft Expert Review Comments - Chapter 5							
Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
3394	5	113	41	113	41	Delete . [Castor Muñoz Sobrino, Spain]	The text was altered as suggested by the reviewer.
9842	5	113	41	113	41	There is a point after "developping states", before the citation of Torresan et al., 2017 while the sentence continue. [APECS Group Review, Germany]	The text was altered as suggested by the reviewer.
9844	5	113	42	113	44	But especially Araos et al. 2016 were working on urban areas not coastal environments. Is this reference therefore the best one? [APECS Group Review, Germany]	Accepted_citation was changed to Rumson et al 2017.
9846	5	113	42	113	44	The last sentence is hard to understand. I would add an "and" between 'big data' and 'using high end' - instead of a comma. [APECS Group Review, Germany]	Accepted_the text was changed to "big data and using high end…"
9848	5	114	2	114	4	I would provide a few examples where and why those adaptation assessments have been utilized. [APECS Group Review, Germany]	Taken into account_the paragraph was deleted.
9848	5	114	2	114	4	I would provide a few examples where and why those adaptation assessments have been utilized. [APECS Group Review, Germany]	Taken into account_the paragraph was deleted.
762	5	114	3	114	3	delete "as" [Kathiresan Kandasamy, India]	Taken into account_the paragraph was deleted.
9850	5	114	10	114	35	I propose to revise the order. The 'Australian paragraph' should be after the following one about the 'northern hemisphere'. The section 5.4.2.1.2 starts with 'global' information, followed by Australia and then northern hemisphere. Australia is more specific than the "northern hemisphere". This order would also work with the sentence in line 35. [APECS Group Review, Germany]	Accepted_in the text, all text referring to Australian publications were dealt with together, then European, then North American, with a collective assessment completed thereafter.
9852	5	114	17	114	17	Here I would remove "by Australian households" as it is already mentionned in the above line. [APECS Group Review, Germany]	Accepted_The text was altered as suggested by the reviewer to "and coping strategies; the approach is associated with household risk perception…"
764	5	114	21	114	21	add "that" after "conclude" [Kathiresan Kandasamy, India]	Accepted_The text was altered as suggested by the reviewer.
9854	5	114	22	114	22	The term "Australian cities" is too general and imprecise. Probably there were only a few studied? [APECS Group Review, Germany]	Rejected_the assessment was based on all the publications contained in Appendix 5.5.2, and considering the number of examples given in the original text, I am of the opinion that the term "Australian cities" is not too general.
9856	5	114	26	114	37	The term "northern hemisphere" is too general again. The northern hemisphere is so diverse, thus I find a comparison between northern hemisphere and Australian cities (line 35) too imprecise. Which cities? Were those cities only in the US and in Great Britain? What about the rest of Europe? China? [APECS Group Review, Germany]	Rejected_in Appendix 5.5.2, numerous examples of adaptation frameworks are assessed covering Europe (besides the UK) and other developed economy countries. China is not included in the comparison as the comparison is between countries with developed economies.
766	5	114	29	114	29	"managers" be changed as "managers' " [Kathiresan Kandasamy, India]	Taken into account_Text was changed to "managers, …" to clarify meaning.
9858	5	114	34	114	35	How are those assessments similar and who says that (reference?)? [APECS Group Review, Germany]	Taken into account_This is an assessment of the literature, and to clarify, the sentence has been edited as "The adaptation frameworks assessment for northern hemisphere cities is similar to that of Australian cities (medium evidence, medium agreement)."
9860	5	114	37	114	37	Corresponding to the previous comment, the paucity of papers is apparently not only for developing countries. [APECS Group Review, Germany]	Rejected_for the same reason as given in comment 9812
9862	5	114	49	114	50	I understand the meaning of this sentence and the idea below it but I believe it could be moderate a bit. The fact that no litterature is available yet for developping countries does not necessarly mean/suggest their cities are in the lag behind cities from countires that are developped. [APECS Group Review, Germany]	Accepted_This sentence has been deleted.
9864	5	114	52	115	12	As the report is for policy-makers, I would suggest giving some more examples for those "key principles". A reference to table 5.9 could be helpful as well. [APECS Group Review, Germany]	Noted_the rest of this sentence describes exactly the key principles allured to.

SROCC First Order Draft Expert Review Comments - Chapter 5							
Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
768	5	114	54	114	54	delete "and" [Kathiresan Kandasamy, India]	The text was altered as suggested by the reviewer.
16440	5	115	0			Under the response box for aquaculture, I suggest adding fish meal-free feed. One reference is "Feed Matters: Satisfying the Feed Demand of Aquaculture" by Macon and Metian. URL: https://www.tandfonline.com/doi/abs/10.1080/23308249.2014.987209 [Frank Ling, Japan]	The comment does not related to pg 115 ln 0; it is incorrectly located here.
21008	5	115	0			In Table 5.9 under aquaculture, this seems to be specific to finfish aquaculture, but what about ocean acidification impact to shellfish aquaculture? See Barton, A., Waldbusser, G. G., Feely, R. A., Weisberg, S. B., Newton, J. A., Hales, B., Cudd, S., Eudeline, B., Langdon, C. J., Jefferds, I., King, T., Suhrbier, A., and McLaughlin, K.: Impacts of coastal acidification on the Pacific Northwest shellfish industry and adaptation strategies implemented in response, Oceanography, 28, 146–159, doi:10.5670/oceanog.2015.38, 2015. Cooley, S. R., C. R. Ono, S. Melcer and J. Roberson, 2016: Community-Level Actions that Can Address Ocean Acidification. Frontiers in Marine Science, 2 (128), 1-12, doi:10.3389/fmars.2015.00128. [Adrienne Sutton, USA]	Taken into account. Publications were considered for assessment.
9866	5	115	1	115	1	Do those principles only aim for efficiency and robustness? [APECS Group Review, Germany]	Noted_the principles do not only aim for these two traits, but this is not intended to be an exhaustivelistof traits.
9868	5	115	3	115	4	Using Zandvoort et al. 2017 to give such a general statement is maybe not ideal, as they mainly worked on three different localities - in Europe. [APECS Group Review, Germany]	Rejected_for the same reason as given in comment 9812
9870	5	115	12	115	12	A point is missing at the end of the sentence. [APECS Group Review, Germany]	Accepted_The text was altered as suggested by the reviewer.
1536	5	115	14	115	14	assesses --> assess? [Davide Bonaldo, Italy]	Accepted_The text was altered as suggested by the reviewer.
6334	5	115	23	116	26	Climate impacts related to fisheries and aquaculture may be both positive and negative (as inland production systems are based on more resilient species - carp and Tilapia). The table should include impcats from flooding, higher mortality rates and lower productivity under warming conditions and ocean accidification. See for example Rosa et al. 2014 and Bell J. D. et al. 2013 . As the greates tproducers of aquaculture,small-scale Asian practices in coastal bays are at high risk from storms,wave surges,and high winds,with the potential for significant losses for local livelihoods [Alvin Chandra, Australia]	Taken into account. This table is not meant to be an exhaustive list.
#NAME?	5	115	23			See Perry et al 2018 for the most recent assessment of the effect of sea level rise on coral reefs (Perry, C. T., Alvarez-filip, L., Graham, N. A. J., Mumby, P. J., Wilson, S. K., Kench, P. S., & Derek, P. (2018). Loss of coral reef growth capacity to track future increases in sea-level. Nature. https://doi.org/10.1038/s41586-018-0194-z [Luis Eduardo Calderon-Aguilera, Mexico]	The citation was added to the appropriate text
9872	5	115	23	115	23	Table 5.9 is hard to understand. I am not sure whether the formatting will be adjusted later, but I suggest adding more paragraphs in the cells in order to enhance understanding which information belong together. [APECS Group Review, Germany]	Accepted. Text in the table has been delineated with commas to clarify wording.
9874	5	115	23	117	1	I am wondering whether a few references per statement would be interesting and useful, as more information would be provided. References could show also where the confidence statements come from. [APECS Group Review, Germany]	Taken into account. Table legend has been altered to direct readers to references.

SROCC First Order Draft Expert Review Comments - Chapter 5							
Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
9876	5	115	26	115	26	Second row (coral reefs): dissolution and structural damage belong to the process of bioerosion. Although dissolution and structural damage may also happen without being associated with bioerosion, bioerosion might be a hazard as well, as bioerosion is increasing with OA (https://doi.org/10.1093/icesjms/fsw254). However, bioerosion may also be listed under "impacts & drivers". [APECS Group Review, Germany]	Dissolution of coral reefs is most appropriate to the 'Hazards' section. It is mentioned there.
9878	5	115	26	115	26	Second row (coral reefs): it should be "Ocean Acidification" and "Ocean warming". [APECS Group Review, Germany]	Accepted_the text was altered as suggested by the reviewer.
9880	5	115	26	115	26	Third row (mangroves): extreme storm events do also lead to storm damage in coral reefs (second row). [APECS Group Review, Germany]	Noted_this is recorded as structural damage in row 2.
22706	5	116	0			"Species" and "Fisheries" rows: Changes in species distributions are not the only impact of climate change on species or on fisheries - changes in phenology (timing of key events) and productivity (growth, recruitment) are potentially expected to be just as important but have been missed from the table [Mark Payne, Denmark]	Rejected_these suggestions are captured in the species row under direct physiological impacts and reflect in fisheries as reduction in landings and changes in species composition and ecosystem changes.
22708	5	116	0			Fisheries row: Seasonal-to-decadal prediction / forecasting of dynamics of living marine resources should be included as an adaptation response (Column 4) [Mark Payne, Denmark]	Accepted. Text altered as suggested
13876	5	116	6	114	7	Would be useful to indicate if this was a global or region-specific study. If the latter, indicate where. [Debra Roberts and Durban Team, South Africa]	There is no line 6 on pg 116. Clarity is required on where this comment refers to in the text.
9882	5	117	7	117	15	The sentences in this paragraph are so confusing that I had to read this paragraph several times to actually understand its meaning. I suggest to delete some commas and to make shorter sentences. This would enhance the comprehensibility. [APECS Group Review, Germany]	accepted_This paragraph has been completely rewritten to improve clarity.
770	5	117	10	117	10	"creates" be changed as "create" [Kathiresan Kandasamy, India]	Accepted_this paragraph has been deleted.
9884	5	117	17	120	47	I have the feeling more explanations for the coastal dune transformation are given than for coral reefs. For example for the dune human impacts are mentionned while it is not the case for corals. It could maybe be mention in a short sentence refering to chemical or dynamite fishing impact in some areas for exemple. [APECS Group Review, Germany]	This is now re-balanced and edited
10616	5	117	17	118	14	#NAME?	Coral restoration is not costly as stated (Rinkevich, B. Rebutting the inclined analyses on the cost-effectiveness and feasibility of coral reef restoration. Ecological Applications 27, 1970-1973, 2017). Other solutions, including the conservation tools (MPAs, fisheries management) cannot be regarded as feasible measures as applied in so many sites and were not successful.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
9886	5	117	18	118	14	What about cold-water coral reefs? Already in the first sentence, it is stated that warm-water coral reefs are degraded. But cold-water corals are also of great importance and should be considered! "Cold-water corals are also threatened by warming temperatures and ocean acidification although evidence of the direct effect of climate change is less clear" (https://doi.org/10.3389/fmars.2017.00158). However, maybe there are no adaptation assessments on coral-water coral reefs (as they are difficult to access), but if so the title of this chapter should be improved. [APECS Group Review, Germany]	This chapter deals with warm water coral reefs. Indeed very little is known about the adaptation of cold water coral reefs.
6488	5	117	24	118	37	Paragraph from line 24 -36 at page 117 says basically the same that paragraph at p.118 line 37-53 [Luis Eduardo Calderon-Aguilera, Mexico]	The text was altered as suggested by the reviewer.
9888	5	117	24	117	26	Something is wrong with the brackets of the references and it should be "have" and not "has". Also the name of the strategy should be written in a different way - either capitalized or in quotation marks. It is otherwise difficult to understand. [APECS Group Review, Germany]	The text was altered as suggested by the reviewer.
24264	5	117	24	117	25	Explain “silviculture” and consider also other literature than that by Rinkevich [Hans-Otto Poertner and WGII TSU, Germany]	Done, per the reviewer request
772	5	117	25	117	26	delete "has proposed" and insert "has been proposed" after "coral reefs" [Kathiresan Kandasamy, India]	The text was altered as suggested by the reviewer.
9890	5	117	45	117	45	I suggest adding a reference for the statement "representing all major reef regions". I could not find this statement myself and this is crucial. If this is only the outcome of the previous mentioned studies, I would delete the sentence in the brackets, as I am sure that (again) no cold-water reefs are included. Their reef structures should not be swept under the carpet, as they definitely represent major reef regions. [APECS Group Review, Germany]	worldwide in wide range of reefs,representing all major reef regions. The reference has been added, per the reviewr request
9892	5	118	2	118	2	Recent studies - plural - but only one is cited. [APECS Group Review, Germany]	The text was revised accordingly
9894	5	118	2	118	2	The study focused only on the Great Barrier Reef and not on other reef systems. Thus, the statement should be weakened, as a global change/compensation has not been proven and has not even been studied yet. [APECS Group Review, Germany]	The text was revised accordingly
774	5	118	6	118	6	add fullstop after "(high confid+H2159:M2159ence)" and "contemporary" be changed as "Contemporary" [Kathiresan Kandasamy, India]	The text was altered
9896	5	118	13	118	13	Who suggests to prepare the “coral restoration toolbook”? [APECS Group Review, Germany]	The references were added
5596	5	118	17	119	34	Not very clear to me why coral gardening is not mentioned as (bio)engineering. Additionally I would like to have a little bit more information about how the newly grown corals are resistant against warming and acidification. Also a little more information on what scales coral gardening could be done. [Roderik Van De Wal, Netherlands]	The text was revised per the referee queries and several citations were added
9898	5	118	19	118	19	Again: "coral reef restoration" in the title should be replaced with "warm-water coral ..." or add something about cold-water reefs to the box. [APECS Group Review, Germany]	The text was altered as suggested by the reviewer.
24266	5	118	27	118	27	add reference [Hans-Otto Poertner and WGII TSU, Germany]	The text was revised accordingly
776	5	118	47	118	47	"advance" be changed as "advancement" [Kathiresan Kandasamy, India]	The text was altered as suggested by the reviewer.
9900	5	118	55	118	57	There seems to be one word missing in the second sentence. It does not seem to be complete. [APECS Group Review, Germany]	The text was altered as suggested by the reviewer.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
5598	5	119	1	119	3	"Whether reef restoriation is applicable for low lying ocean states scenarios". What is meant with this? Why would a low lying ocean state scenario be important when we face SLR? [Roderik Van De Wal, Netherlands]	The text was revised following the referee query
9902	5	119	1	119	1	The beginning of the sentence is not good to read. I would not start with "The second", better: "The second challenge". [APECS Group Review, Germany]	The text was altered as suggested by the reviewer.
9904	5	119	9	119	12	The sentence starting with "If reef restoration" should be revised. It is too long and counterintuitive. [APECS Group Review, Germany]	The text was revised
9906	5	119	13	119	15	Coral reefs are also very vulnerable to bioerosion, which will increase with ongoing OA (https://doi.org/10.1093/icesjms/fsw254). Although there is probably nothing to protect a coral reef from bioerosion, this relation has not been stated anywhere. [APECS Group Review, Germany]	The bioerosion issue and a citation were added
9908	5	119	17	119	17	The figure ‘a’ is not very good: it appears overall blurry. Moreover, the two actual photos (‘b’ and ‘c’) are also not of great quality. [APECS Group Review, Germany]	The figure has been altered per the reviewer request
9910	5	119	20	119	32	I do not understand the importance of and the idea behind figure ‘a’. It seems to be only a schema and no actual data is shown. Moreover, the description for ‘a’ is very hard to follow and one has to read it several times to actually understand the meaning. As I, however, do not see the value in this picture (no surprising sights or outcomes and nothing which cannot be described in the text), I would only keep ‘b’ and ‘c’. Those pictures are actually useful. [APECS Group Review, Germany]	The figure has been altered per the reviewer request
9912	5	119	20	119	20	In the Figure caption I would keep the same typology for the letters and use "a", "b" and "c" instead of capital letters. [APECS Group Review, Germany]	The figure has been altered per the reviewer request
13206	5	119	25	119	25	the caption does not sufficiently explain why there are two restored reef options and what distinguishes them. Can that be added? [Baerbel Hoenisch, USA]	The figure has been altered per the reviewer request
9914	5	120	13	120	13	Maybe explain in a few words the reason for the projected increasing impact of cyclones? I did not find it that quickly in both citations. [APECS Group Review, Germany]	Accepted_The text was changed to clarity meaning to "…fringing coral reefs would result in the loss of coastal protection services by these ecosystems against future cyclones…"
2228	5	120	17			typing mistake for the word instruments [Chandani Appadoo, Mauritius]	Accepted_The text was altered as suggested by the reviewer.
9916	5	120	20	120	25	I would add some references in this paragraph. There are none. [APECS Group Review, Germany]	Rejected_This is a summary assessment of the literature that is reported in the paragraph above, which is why there are no citations.
9918	5	120	23	120	23	What kind of examples for maladaptation? What kind of effect? Maybe no need to point that out but a reference would give the possibility to look for more details. [APECS Group Review, Germany]	Taken into account_Nguyen et al in the previous sentence provided an example of maladaptation.
13878	5	120	28	120	40	Suggest replacing 'There are a number of examples of sand replenishment projects as a soft measures approach to combat erosion; see (Shumack and Hesse, 2017) for an example' with 'There are a number of examples of sand replenishment projects as soft measures to combat erosion (Shumack and Hesse, 2017)'. [Debra Roberts and Durban Team, South Africa]	Accepted_The text was altered as suggested by the reviewer.
9920	5	120	35	120	35	How are coastal dune systems desirable? [APECS Group Review, Germany]	Taken into account_This sentence was deleted.
9922	5	120	39	120	39	Shumack and Hesse, 2017 worked only in Australia, so I would add "an example for Australia" [APECS Group Review, Germany]	Rejected_this citation is given for illustrative purposes only. The assessment was done on a range of literature from around the globe, and this can be found in Appendix 5.5.2.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
9924	5	120	39	120	39	Moreover, it has been stated that there were a “number of examples”, but only one example is named. [APECS Group Review, Germany]	Rejected for the same reason as given in Comment 9922.
9926	5	120	40	120	43	This sentence is way too long and nested. [APECS Group Review, Germany]	Accepted_The text was changed to "...coastal processes. In some cases projects failed due to stakeholder..."
9928	5	120	50	120	51	The previous sections were not introduced in this way. [APECS Group Review, Germany]	Accepted_The text was altered as suggested by the reviewer.
9930	5	120	50	121	32	The whole section 5.4.2.2.4 is difficult to understand. Maybe that is because I am not an expert on this topic, but I suggest to add several examples for specific words e.g. "soft engineering options" (line 55), "integration of traditional and natural infrastructure" (line 10-11). I believe that examples would increase the understandability. [APECS Group Review, Germany]	Accepted. This section was edited to improve clarity.
13880	5	120	53	120	55	Suggest relacing 'The efficacy of EBA is supported by a growing body of evidence in the literature and the increased level of funding for this approach, and yet a synthesis of context-specific application and cost-effectiveness is a remaining gap' with 'Although the efficacy of EBA is supported by a growing body of evidence in the literature and there increased level of funding for this approach, a synthesis of context-specific application and cost-effectiveness remains a gap in the literature' [Debra Roberts and Durban Team, South Africa]	Accepted_The text was altered similar to that suggested by the reviewer.
9932	5	121	2	121	2	Cheaper? If the word is meant money-wise, I would provide a little bit more details of costs. There are no other statements about that topic. [APECS Group Review, Germany]	Rejected_the absolute cost of the measure is not important here. Rather it is the relative cost of the two approaches. Giving absolute values would be meaningless, as these values would have a wide range depending upon where they are implemented.
9934	5	121	4	121	4	What kind of traditional practices and knowledge? [APECS Group Review, Germany]	Rejected_there are many types of traditional practices and knowledge that could be given as examples, but would this strengthen the text. The reference given here, and in the paragraph below, can direct the interested reader to examples.
9936	5	121	6	121	7	It is a little bit hard to follow along this section. Therefore, I would add examples for "synergistic combinations". What kind of combinations? And what are socio-institutional approaches? [APECS Group Review, Germany]	Accepted_The text has been edited to direct the reader to examples in the text above, "combinations of ecosystems, as described in the mangrove section above, can provide a range of co-benefits"
9938	5	121	8	121	8	I think a space is missing between the two couples of parenthesis. [APECS Group Review, Germany]	Accepted_The text was altered as suggested by the reviewer.
9940	5	121	15	121	22	This sentence is way too long and nested. [APECS Group Review, Germany]	Accepted_The text was deleted.
3396	5	121	18	121	18	example [Castor Muñoz Sobrino, Spain]	Accepted_The text was altered as suggested by the reviewer.
9942	5	121	21	123	30	I am definitely missing examples for built infrastructure. What kind? Where? Examples would increase the understandability also of section 5.4.2.3. and 5.4.2.3.1. and would give a better idea for climate impacts. [APECS Group Review, Germany]	Accepted. Examples added of the impact of climate variables on built infrastructure.
3398	5	121	35	121	39	Besides the extinction risk it may be also considered (they are different matters!) here the regional desaparition of species/ecosystems promoted by climatic change. (e.g .Muñoz Sobrino et al. (2018). Vegetation History and Archaeobotany 27: 551-576). [Castor Muñoz Sobrino, Spain]	Taken into account. This topic is dealt with in more detail in Section 5.3.
9944	5	121	35	121	35	The first sentence is redundant. [APECS Group Review, Germany]	Accepted_The text was altered as suggested by the reviewer.
9946	5	121	35	121	50	The title of this section is "species adaptation", but I miss actual information about some actual species. Therefore, I suggest moving the last sentence (line 49-50) to the top. Another idea could be to change the title. [APECS Group Review, Germany]	Accepted_text has been revised to improve clarity.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
2884	5	121	39	121	41	To consider both direct and indirect impacts is indeed important, but I don't really understand the example. Which kind of species is this about? The validity of this example surely is species dependent?? [Geir Ottersen, Norway]	Taken into account_the text deliberately does not set out to give examples, as these are dealt with in other secdtions of the report (5.2) in Marine mamals and seabirds.
9948	5	122	20	123	30	What about temperature? Escobar et al., 2016 for example modelled also the influence of temperature. I guess that temperature has not a big influence upon built infrastructure, but that should still be stated, as temperature (rise) is a huge climate variable. [APECS Group Review, Germany]	Taken into account. The text has been changed to indicate (using citations) the climate variables which are most likely to have impacts upon built infrastructure, and then thse impacts are assessed.
778	5	122	32	122	32	"include" be changed as "includes" [Kathiresan Kandasamy, India]	The text was altered as suggested by the reviewer.
780	5	122	39	122	39	delete full stop [Kathiresan Kandasamy, India]	The text was altered as suggested by the reviewer.
2896	5	122	39	122	40	I would include also the reference Mingyu et al., 2017: Numerical studies on added resistance and motions of KVLCC2 in head seas for various ship speeds. Ocean Engineering, 140, 466-476. [M. Dolores Garza-Gil, Spain]	An error occurred when chapter 5 references were compiled in Endnote by the TSU resulting in a displacement of all the references by one position. This resulted in a great number of misplaced references which we have since then fixed.
2898	5	122	43	122	44	The reference Mingyu et al. (2017) may be included. These authors analyse the added resistance and the vertical ship motions for a wide range of wave conditions. Minguy et al, 2017 : Numerical studies on added resistance and motions of KVLCC2 in head seas for various ship speeds. Ocean Engineering, 140, 466-476. [M. Dolores Garza-Gil, Spain]	Accepted. Reference added
1538	5	122	44	122	48	It could be worth mentioning here the increasing effort on climatological wave modelling for the prediction of possible wave regime modification under climate change conditions, particularly in coastal environments [Davide Bonaldo, Italy]	Taken into account. Covered in Section 5.2
782	5	122	47	122	47	"sea water" be changed as "seawater" [Kathiresan Kandasamy, India]	The text was altered as suggested by the reviewer.
784	5	122	55	122	55	"sea water" be changed as "seawater" [Kathiresan Kandasamy, India]	The text was altered as suggested by the reviewer.
23228	5	122	55	122	57	what is the effect of the salinity change on global meridional overturning and water cycle? And its role in the polar ice melting [Dongxiao Wang, China]	Taken into account. Covered in Section 5.2 and Chapter 3
1540	5	123	2	123	9	This obviously affects also wave climate, particularly in elongated basins in which a small change in directional wind distribution can result in a significant fetch modification [Davide Bonaldo, Italy]	Taken into account. Text changed to reflect the diversity of wind responses globally.
9950	5	123	2	123	9	But wind = high waves? I noticed that there is a separate section about waves, but higher waves are still the outcome of more wind and may be included very briefly also in this section. [APECS Group Review, Germany]	Taken into account. The text reflects direct impacts by wind on built infrastructure. Indirect impacts, through the development of swell and storm surge is dealt with early in this sub-section.
5600	5	123	5	123	8	"Factoring accurately wind factor during design". Unclear sentence. Additionally, not much is known with high confidence about changes in prevailing wind directions. [Roderik Van De Wal, Netherlands]	Accepted. The text was altered as suggested by the reviewer.
9952	5	123	8	13	9	What kind of tremendous opportunities? [APECS Group Review, Germany]	Taken into account. This sentence has been deleted.
13882	5	123	25	123	30	How is this linked to the Oceans? [Debra Roberts and Durban Team, South Africa]	Taken into account. This links to coastal built infrastructure. Increases in heat and evaporation leading to increased humidity.
5602	5	123	26	123	27	Sentence implies CO2 directely affects humidity, however, CO2 only indirectely, via temperature, increases humidity. Rephrase in 'Increased temperatures affect humidity/amount of water evaporated per unit air'. [Roderik Van De Wal, Netherlands]	The text was altered as suggested by the reviewer.
9954	5	123	26	123	30	I am missing some references. What are the proofs for stating that steel structures are affected by corrosion? [APECS Group Review, Germany]	An error occurred when chapter 5 references were compiled in Endnote by the TSU resulting in a displacement of all the references by one position. This resulted in a great number of misplaced references which we have since then fixed.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
U	U	123	27	123	30	Why is humidity globally identified as low risk to the built environment? [Roderik Van De Wal, Netherlands]	Taken into account. Text edited to reflect the relative risk of humidity compared with the other variables being assessed in this sub-section.
9956	5	123	33	126	14	I miss the central idea of this section. The paragraphs are not very well connected and the central theme is missing in my opinion. I also do not see the relation to the title of this section. Maybe it would be an idea to subdivide the section? [APECS Group Review, Germany]	Accepted. The text has been edited to improve clarity.
9958	5	123	33	126	14	What are the actual solutions (except for p. 124, line 1-13)? Maybe start with listing those solutions. [APECS Group Review, Germany]	Taken into account. This text has been edited to improve flow.
9960	5	123	41	123	44	This sentence is too long and nested. [APECS Group Review, Germany]	accepted. The text was altered as suggested by the reviewer.
9962	5	123	51	123	56	I suggest revising this paragraph: I would start with listing the tools, followed by the statement that those tools are not even used that much. [APECS Group Review, Germany]	accepted. The text was altered as suggested by the reviewer.
9964	5	124	56	126	14	Maybe it is my lack of knowledge, but I suggest explaining the difference between resistance and resilience. I find the difference not straightforward (google did not help much) and knowing the difference would increase the outcome of this section a lot. P. 124, line 57 to p.125, line 2 do not provide sufficient information. [APECS Group Review, Germany]	accepted. The text was altered as suggested by the reviewer, and the reader is referred to CCB1 for further clarity.
9966	5	125	7	125	9	This sentence does not make any sense with the usage of that many commas. I suggest revising or shortening the sentence into two. [APECS Group Review, Germany]	The text was altered as suggested by the reviewer.
3400	5	125	26	125	26	Barbier et al. (2015)? [Castor Muñoz Sobrino, Spain]	The text was altered as suggested by the reviewer.
9968	5	125	45	125	52	How is this paragraph important for "climate change adaption solutions for built infrastructure"? I also do not see the importance of the following paragraphs for this section. So maybe those could be part of a subdivision and a social aspect. [APECS Group Review, Germany]	Taken into account. The paragraph highlights how planning for built infrastructure adaptation can be based upon incorrect assumptions from a particular point of view.
9970	5	125	54	126	14	There are no citations in those three paragraphs, so there is no proof for any of those statements. [APECS Group Review, Germany]	Taken into account. Text was deleted where appropriate.
9972	5	126	2	126	3	Is there a proof for "widely emphasized"? [APECS Group Review, Germany]	The text was altered as suggested by the reviewer.
9974	5	126	16	126	16	However, I would consider to change the name of this section, as only one specific example is given. [APECS Group Review, Germany]	The text was altered as suggested by the reviewer.
786	5	126	17	126	17	"enigineeringfor" be changed as "engineering for" [Kathiresan Kandasamy, India]	The text was altered as suggested by the reviewer.
9976	5	126	17	126	30	What is the actual paradigm? The "artificial upwelling engineering" (line 17) or that this is "powered by green energy" (line 29)? [APECS Group Review, Germany]	The text was altered as suggested by the reviewer.
9978	5	126	17	126	17	Space missing between engineering and for. [APECS Group Review, Germany]	The text was altered as suggested by the reviewer.
21134	5	126	17			upwelling enigineeringfor aquaculture - upwelling engineering for aquaculture [Ik Kyo Chung, Republic of Korea]	The text was altered as suggested by the reviewer.
9980	5	126	25	126	26	The links/references should be adjusted and GeoMar should be referred to as "GEOMAR". [APECS Group Review, Germany]	The text was altered as suggested by the reviewer.
9982	5	126	25	126	26	How successful are those experiments? Are they applicable? [APECS Group Review, Germany]	Explained
9984	5	126	28	128	28	What is the key to which goal - the artificial upwelling? [APECS Group Review, Germany]	Explained
788	5	126	38	126	38	"caluture" be changed as "culture" [Kathiresan Kandasamy, India]	The text was altered as suggested by the reviewer.
9986	5	126	38	126	38	There might be a problem with the 3rd word: caluture instead of culture? [APECS Group Review, Germany]	The text was altered as suggested by the reviewer.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
9988	5	126	54	126	54	CBA has already been introduced in line 50, so I would shorten the beginning of the sentence. [APECS Group Review, Germany]	Accepted_The text was altered as suggested by the reviewer.
790	5	127	4	127	4	delete full stop [Kathiresan Kandasamy, India]	Accepted_The text was altered as suggested by the reviewer.
13884	5	127	6	127	8	Meaning is unclear. [Debra Roberts and Durban Team, South Africa]	Accepted_The text was altered to improve clarity as suggested by the reviewer.
792	5	127	7	127	7	delete "ext," [Kathiresan Kandasamy, India]	Accepted_The text was altered as suggested by the reviewer.
9990	5	127	7	127	7	What does ext mean? [APECS Group Review, Germany]	Accepted_The text was altered as suggested by the reviewer.
9992	5	127	11	127	11	Again: CBA has been introduced (I will not point this out again hereinafter). [APECS Group Review, Germany]	Rejected_CBA is not being introduced here again. Rather, examples of where successful implementation has been reported is given, hence this is not repeating the introduction of CBA. The paragraph goes on to give further examples, building an evidence based of successful implementaton of CBA.
9994	5	127	12	127	12	Point missing after brackets, before "In Sri Lanka" [APECS Group Review, Germany]	Accepted_The text was altered as suggested by the reviewer.
794	5	127	13	127	13	"strressors" be changed as "stressors" [Kathiresan Kandasamy, India]	Accepted_The text was altered as suggested by the reviewer.
17420	5	127	21	127	30	There should be more studies and example on this issue. One example for local area cannot be generate as global issue. The issue in Indonesia is more complex than what it is stated on the paragraph and it will more issues should be raise from other countries. [Anastasia Rita Tisiana Dwi Kuswardani, Indonesia]	Accepted_this paragraph has been deleted.
796	5	127	23	127	23	delete full stop after "past" [Kathiresan Kandasamy, India]	Accepted_this paragraph has been deleted.
9996	5	127	23	127	23	What kind of exposure? [APECS Group Review, Germany]	Accepted_this paragraph has been deleted.
9998	5	127	23	127	24	I find it a little bit extreme to generalize "local inhabitants", after only providing one example from Jakarta. [APECS Group Review, Germany]	Accepted_this paragraph has been deleted.
10000	5	127	23	127	25	This sentence is too neested and therefore hard to understand. [APECS Group Review, Germany]	Accepted_this paragraph has been deleted.
10002	5	127	26	127	27	It is not clear to which "this example" refers to. [APECS Group Review, Germany]	Accepted_this paragraph has been deleted.
10004	5	127	29	127	29	Why is "sensitivity" in brackets? [APECS Group Review, Germany]	Accepted_this paragraph has been deleted.
10006	5	127	32	127	35	I would add the location of the maladaptation to the first sentence. [APECS Group Review, Germany]	This is made clear by the citation of Nguyen, but to further clarify, I have added "in Vietnam" to the text. Accepted.
798	5	127	37	127	37	"maladapive" be changed as "maladaptive" [Kathiresan Kandasamy, India]	Accepted_The text was altered as suggested by the reviewer.
10008	5	127	37	127	37	Maladaptive instead of maladapive [APECS Group Review, Germany]	Accepted_The text was altered as suggested by the reviewer.
1368	5	127	41	127	48	some more depth could be given to integrated coastal zone management and address the rich literature on climate adaptation and responses in coastal zone. Consider more literature on participation [Marcus Haward, Australia]	Taken into account_Although only three papers are cited, the assessment was based upon 21 papers, as outlined in Appendix 5.5.2.
18736	5	127	41	127	52	It would be interesting to see a clear and precise explanation on how marine protected contribute to adaptation to climate and particularly on their role in enhancing marine ecosystems resilience. The role of marine protected areas is not explicit enough in chapter 5. They are not very useful in climate change mitigation but are very effective in adapting to climate change. As they limit the non-climatic anthropic stressors they foster the resilience of marine species and ecosystems, allowing them to better adapt to the changing environment. They are also an important tool in order to maintain the ecosystem services. See Leenhardt, Low, Pascal, Micheli, and Claudet, The role of Marine Protected Areas in Providing Ecosystem Services, in Aquatic Functional Biodiversity, chap.9, p.211-239, 2015. [Antoine Pebayle, France]	Accepted. The text was added as suggested by the reviewer.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
18738	5	127	41	127	52	Concerning the management of MPAs required to limit the impact of climate change, the network design is a promising approach. See Lefebvre, Marine Protected Areas Networks and Climate Change, a Political Advocacy, in OCEAN AND CLIMATE (p. 63-65), 2016 – Scientific Notes, Second edition, Tome 2 [Antoine Pebayle, France]	Taken into account.
10010	5	127	42	127	42	I would explain ICM very briefly. [APECS Group Review, Germany]	Accepted_The text was altered as suggested by the reviewer.
10012	5	127	46	127	46	bracket missing before the "medium" [APECS Group Review, Germany]	Accepted_The text was altered as suggested by the reviewer.
10014	5	127	53	127	54	I do not understand the sentence. [APECS Group Review, Germany]	Accepted_the sentence was edited to improve clarity: "…approaches need to accommodate a 'shifting baseline' as climate change becomes the new normal, and novel dispersal movements…"
10016	5	127	53	127	54	And what is meant with "shifting baselines"? [APECS Group Review, Germany]	Accepted_the sentece was edited as given in the response for comment 10014.
10018	5	128	4	128	6	This sentence is too nested and therefore hard to understand. I also believe that something is missing in that sentence. [APECS Group Review, Germany]	Accepted_The text was altered to improve clarity as suggested by the reviewer.
10020	5	128	9	128	11	Regarding sea level rise: SLR impacts also salt water input into fresh water and thus less available fresh water - which would be a problem with more tourists. [APECS Group Review, Germany]	Taken into account_the comment is true, but the focus of this sentence is not so much on SLR, but on the interaction of SLR with other non-climate related co-impacts. It would, therefore, not make sense to include the full range of impacts SLR could have, as SLR is dealt with in Ch4.
10022	5	128	9	128	11	Why is sand mining a factor for tourism? [APECS Group Review, Germany]	Taken into account_the word "illegal" was added to sand mining to emphasise the environmental impacts implied previously. Changes in sediment dynamics potentially causing erosion or sedimentation in sensitive ecosystems like coral reefs are just two examples. I do not believe it is necessary to give examples in the text.
17490	5	128	10	128	11	Promote a shift infishing gears like change in fishing methods and gears can be promoted by removing environmentally harmfull fuel subsidies [Anastasia Rita Tisiana Dwi Kuswardani, Indonesia]	Taken into account_this appears to be the incorrect page number reference. This is addressed in the fisheries adaptation section.
1542	5	128	12	128	12	recommnedation --> recommendation [Davide Bonaldo, Italy]	Accepted_The text was altered as suggested by the reviewer.
10024	5	128	12	128	12	First word of the line: recommendation instead of recommednation [APECS Group Review, Germany]	Accepted_The text was altered as suggested by the reviewer.
24268	5	128	24	129	2	references and referencing need revision [Hans-Otto Poertner and WGII TSU, Germany]	An error occurred when chapter 5 references were compiled in Endnote by the TSU resulting in a displacement of all the references by one position. This resulted in a great number of misplaced references which we have since then fixed.
10026	5	128	25	219	40	The order of all paragraphs in this section could be revised. The paragraph of South Africa (lp. 129, line 15-19) with a specific example does not fit there. [APECS Group Review, Germany]	Accepted_the order of paragraphs in this section has been revised.

SROCC First Order Draft Expert Review Comments - Chapter 5							
Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
22712	5	128	25			Disagree with the statement that there is a "substantial body of literature" around the impacts of climate change on tropical fisheries. A review by Poloczanska et al 2013 showed that just 2% of the impact literature falls between the tropics.Can the authors provide more details about why they think it is substantial, and how the Poloczanska result fits in with this? Poloczanska, E. S., Brown, C. J., Sydeman, W. J., Kiessling, W., Schoeman, D. S., Moore, P. J., Brander, K., et al. 2013. Global imprint of climate change on marine life. Nature Climate Change, 3: 919–925. [Mark Payne, Denmark]	Taken into account_14 of the 20 papers used for the assessment in this section focussed on tropical fisheries, with 2 of the 20 non-regional in focus. The question here is what constitutes 'substantial". For the purposes of this assessment, I have focussed primarily on tropical fisheries, where the major social implications of fisheries collapse will have the highest impact, in terms of populations impacted and ability of populations to adapt. I have changed the text to: " The fisheries assessment was based on a majority of papers on the impacts of climate change in tropical regions,whilst South and South East Asia was prevalent for the aquaculture assessment. "
10028	5	128	26	128	32	If possible, I would split the sentence that is rather long in order to help reading and understanding it more easily. [APECS Group Review, Germany]	Accepted_the sentence has been split.
22714	5	128	30		40	Seasonal-to-decadal prediction / forecasting as a tool of use in the management of living marine resources is overlooked here and should be included. Relevant reviews include Hobday, A. J., Spillman, C. M., Paige Eveson, J., and Hartog, J. R. 2016. Seasonal forecasting for decision support in marine fisheries and aquaculture. Fisheries Oceanography, 25: 45–56. Payne, M. R., Hobday, A. J., MacKenzie, B. R., Tommasi, D., Dempsey, D. P., Fässler, S. M. M., Haynie, A. C., et al. 2017. Lessons from the First Generation of Marine Ecological Forecast Products. Frontiers in Marine Science, 4. Tommasi, D., Stock, C. A., Hobday, A. J., Methot, R., Kaplan, I. C., Eveson, J. P., Holsman, K., et al. 2017. Managing living marine resources in a dynamic environment: The role of seasonal to decadal climate forecasts. Progress in Oceanography, 152: 15-49 [Mark Payne, Denmark]	Accepted_The text was altered as suggested by the reviewer.
10030	5	128	34	128	41	This sentence is way too long and nested, it should be shortened. [APECS Group Review, Germany]	Accepted_The text was altered by deleting from ",including employing…fishing communities (REFS)".
10032	5	128	34	128	41	If possible, I would either split the sentence in two or write the examples (fish aggregating, switching to pelagic fisheries, etc…) as bullet point. This way, it will be easier to understand its meaning. [APECS Group Review, Germany]	Accepted_see response to comment 10030 above.
13886	5	128	37	128	41	This is a replication of the contents in lines 26-30 [Debra Roberts and Durban Team, South Africa]	Accepted_The text was deleted as described in response to Comment 10030.
2900	5	128	41	128	41	Dey et al., 2016a, 2016b; [M. Dolores Garza-Gil, Spain]	Accepted_both citations included and corrected.
2902	5	128	41	128	41	Valmonte-Santos et al., 2016; [M. Dolores Garza-Gil, Spain]	Accepted_citation corrected.
16150	5	128	41	128	47	Missing year in the references, i.e. [xxxxx] [Adi Nugraha, USA]	Accepted_citation corrected.
20596	5	128	41		47	"XXX "in references should be dates [Chiara Lombardi, Italy]	Accepted_citation corrected.
10034	5	128	42	128	43	I would add a few references for the "few studies". [APECS Group Review, Germany]	Accepted_the references given in the paragraph were used to formulate this assessment. The text has been edited.
2904	5	128	47	128	47	(Busch et al., 2016) [M. Dolores Garza-Gil, Spain]	Accepted_citation corrected.
2906	5	129	2	129	2	(Heenan et al., 2015) [M. Dolores Garza-Gil, Spain]	Accepted_citation corrected.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
16152	5	129	2	129	2	Missing year in the references, i.e. [xxxxx] [Adi Nugraha, USA]	Accepted_citation corrected.
20598	5	129	2			"XXX "in references should be dates [Chiara Lombardi, Italy]	Accepted_citation corrected.
10036	5	129	15	129	19	There is no reference in the whole paragraph - thus I am missing proofs for the statements. [APECS Group Review, Germany]	Accepted_citations inserted
16442	5	129	38			Online marine protected area (MPA) maps like this website (https://protectedseas.net/mpa-mapping/) are now available to provide precise data to enhance situational awareness of regulations and conservation measures for long-term marine management. [Frank Ling, Japan]	Taken into account_this is appreciated, but a spatial analysis of MPAs is not included in this assessment.
800	5	129	40	129	40	delete full stop after "allowed" [Kathiresan Kandasamy, India]	Accepted_The text was altered as suggested by the reviewer.
13888	5	129	47	129	47	Sounds too policy prescriptive. Consider rephrasing the sentence. [Debra Roberts and Durban Team, South Africa]	Accepted_The text was altered as suggested by the reviewer.
1698	5	129	57	129	57	"but adaptation progress is hampered by competing economic interests and worldviews (Hamilton and Safford 2015) as well as lack of knowledge ..." add ref to Hamilton, L.C. & T.G. Safford. 2015. “Environmental views from the coast: Public concern about local to global marine issues.” Society and Natural Resources 28(1):57–74. doi: 10.1080/08941920.2014.933926 [Lawrence Hamilton, USA]	Accepted_The text was altered as suggested by the reviewer.
10038	5	130	2	130	4	Maybe it would be interesting to mention here other important factors such as 1) financial help communities will get from their government or 2) the involvment government will have in communities projects --> if the government gives plan without following project realisations or conservation, communities might give up on the projects. [APECS Group Review, Germany]	Taken into account_I am happy to consider any publications from which an assessment could be made in this respect.
10040	5	130	3	130	3	I guess there is something wrong with the formatting of the two references. Or if not, there is something wrong with the sentence. [APECS Group Review, Germany]	Accepted_the word "actions" was deleted to improve clarity of meaning.
802	5	130	16	130	16	insert full stop after bracket [Kathiresan Kandasamy, India]	Accepted_The text was altered as suggested by the reviewer.
10042	5	130	22	130	24	I do not understand the meaning of the sentence as it is and would thus suggest to re-write it. [APECS Group Review, Germany]	Accepted_This sentence has been deleted.
10044	5	130	28	130	28	I would add "omitting ocean warming and acidification". [APECS Group Review, Germany]	Accepted_This sentence has been deleted.
10046	5	130	28	130	28	But what is with all the other impact & drivers shown in table 5.9 (p. 115)? All of the others ones are apparently also omitted (see previous comment). [APECS Group Review, Germany]	Accepted_This sentence has been deleted.
10048	5	130	33	130	34	This sentence is very hard to understand. I suggest revising the sentence. [APECS Group Review, Germany]	Accepted_This sentence has been deleted.
10050	5	130	42	130	45	How would such technology help the local people? As has been stated before (p. 127, line 22-23), local inhabitants underestimate the severity of hazards. And how would technology change that? Especially as those people would very likely not have access to the outcome. [APECS Group Review, Germany]	Taken into account_"local" in this instance, refers to practitioners and local government officials, or researchers at the local level, employing such technologies. It does not refer to local communites. The text has been altered to clarify this.
10052	5	130	49	130	52	This sentence is too long and nested. And without the subordinate clauses, there is still something wrong and the sentence makes no sense. [APECS Group Review, Germany]	Accepted_The text was altered as suggested by the reviewer.
3402	5	130	56	130	56	Barbier et al. (2015)? [Castor Muñoz Sobrino, Spain]	Accepted_The text was altered as suggested by the reviewer.
10054	5	130	56	130	56	I guess that the complete reference of "Barbier" is still missing or at least the year, as "Barbier, 2015" is already included in the reference list. [APECS Group Review, Germany]	Accepted_The text was altered as suggested by the reviewer.
10056	5	131	2	131	2	The first part of the sentence seems unnecessary or incomplete. ”It has been pointed out in the sections above…”. [APECS Group Review, Germany]	Accepted_The text was altered as suggested by the reviewer.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
10782	5	131	10	131	16	Suggest referring to the role of social protection as a strategy to increase resilience and the adapative capacity of the poor and vulnerable to build productive assets in local communities that enable households to invest in health and education, access better jobs and make productive investments. Also important is to discuss the importance of coherent policies (on climate change, development and humanitarian) in helping the poor and marginalized to reduce their vulnerability and increase their resilience to climate change and climate related impacts. [Coswig Kalikoski Daniela, Italy]	The text was altered as suggested by the reviewer.
16154	5	131	11	131	11	Missing year in the references, i.e. [xxxxx] [Adi Nugraha, USA]	Accepted_The text was altered as suggested by the reviewer.
20600	5	131	11			"XXX "in references should be dates [Chiara Lombardi, Italy]	Accepted_The text was altered as suggested by the reviewer.
10058	5	131	14	131	14	After the first word (change) and before the bracket, a space is missing [APECS Group Review, Germany]	Accepted_The text was altered as suggested by the reviewer.
22716	5	131	31			The newly emerging field of Dynamic Ocean Management can help allieviate some of the tradeoffs associated with ocean economies by allowing greater flexibility while still achieving the desired management goals (e.g. species protection, minimisation of by catch) by utilisinng developments within seasonal-to-decadal prediction / forecasting of the ocean and of marine organisms. Good reviews and examples of this include Hazen, E. L., Scales, K. L., Maxwell, S. M., Briscoe, D. K., Welch, H., Bograd, S. J., Bailey, H., et al. 2018. A dynamic ocean management tool to reduce bycatch and support sustainable fisheries. Science Advances, 4: eaar3001. Hobday, A. J., Hartog, J. R., Spillman, C. M., Alves, O., and Hilborn, R. 2011. Seasonal forecasting of tuna habitat for dynamic spatial management. Canadian Journal of Fisheries and Aquatic Sciences, 68: 898–911. Maxwell, S. M., Hazen, E. L., Lewison, R. L., Dunn, D. C., Bailey, H., Bograd, S. J., Briscoe, D. K., et al. 2015. Dynamic ocean management: Defining and conceptualizing real-time management of the ocean. Marine Policy, 58: 42–50. [Mark Payne, Denmark]	These are considered in the preparation of SOD
12206	5	131	32	131	46	There is no sufficient data and analysis on how ecosystems (mainly fish species) are shifting regionally and/or sub-regionally subsequent to ocean aciditifaction and potential effects on growth. [Louis Mitondo Lubango, Ethiopia]	ok, done
804	5	131	41	131	41	change "as" to 'is" [Kathiresan Kandasamy, India]	SIDS insert complete wording in th etext
13208	5	131	41	131	41	what are SIDS? [Baerbel Hoenisch, USA]	Figure needs revision
5606	5	132	1	132	1	The figure seems to be stretched horizontally. This makes the figure harder to read. [Roderik Van De Wal, Netherlands]	Figure needs revision
24270	5	132	1	132	1	The figure looks a bit stretched. Is it possible to adjust the width/length? [Hans-Otto Poertner and WGII TSU, Germany]	Figure needs revision
4612	5	132	2	132	3	There is no quote of the Figure 5.26 in the manuscript. Please add… [Alessandro Pezzoli, Italy]	Nathan?
13890	5	132	6	132	10	This should be included in the Executive Summary. [Debra Roberts and Durban Team, South Africa]	Figure needs revision

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
24272	5	132	7	132	7	Please refer to the fig correctly (i.e. Fig. 5.26) [Hans-Otto Poertner and WGII TSU, Germany]	Done, thanks
24274	5	132	8	132	8	Try to unify currency units (e.g. I saw USD and US$) throughout the report [Hans-Otto Poertner and WGII TSU, Germany]	Done, thanks
13892	5	132	23	132	23	Doesn't seem like a good way to start a paragraph. Consider rephrasing. [Debra Roberts and Durban Team, South Africa]	This whole section on polar tourism will be removed because chapter 3 is focused on polar regions.
23230	5	132	30	132	32	how much tourism has increase now and in the future [Dongxiao Wang, China]	This whole section on polar tourism will be removed because chapter 3 is focused on polar regions.
10060	5	132	32	132	32	Please add a reference to support the growth of Arctic tourism. In Arctic Canada the distance travelled by ships has nearly tripled in recent decades. (Dawson et al., 2018). Pleasure craft are the fastest growing vessel type by far (Dawson et al., 2018). Reference: Dawson J., Pizzolato, L., Howell, S.E.L., Copland, L., & Johnston, M.E. 2018. Temporal and Spatial Patterns of Ship Traffic in the Canadian Arctic from 1990 to 2015. Arctic. 71(1):15-26. https://doi.org/10.14430/arctic4698. [APECS Group Review, Germany]	This whole section on polar tourism will be removed because chapter 3 is focused on polar regions.
10062	5	132	33	132	34	Please consider adding 'Residents of the region, including Indigenous peoples, rely year-round on the marine ecosystem for travel, sustenance and livelihoods'. Reference: Panikkar, B., Lemmond, B., Else, B. and Murray, M. 2018. Ice over troubled waters: navigating the Northwest Passage using Inuit knowledge and scientific information. Climate Research. Vol.75:81-94. https://doi.org/10.3354/cr01501 [APECS Group Review, Germany]	This whole section on polar tourism will be removed because chapter 3 is focused on polar regions.
10064	5	132	36	132	36	Please rewrite the first sentence of the paragraph to say: 'Increased tourism can have a positive impact on the economy, however the degree to which local economies benefit, varies.'' [APECS Group Review, Germany]	This whole section on polar tourism will be removed because chapter 3 is focused on polar regions.
806	5	132	45	132	45	"vulnerability" be changed as "vulnerable" [Kathiresan Kandasamy, India]	This whole section on polar tourism will be removed because chapter 3 is focused on polar regions.
13894	5	132	45	132	45	Change 'depend of tourism' to 'dependent on tourism' [Debra Roberts and Durban Team, South Africa]	This whole section on polar tourism will be removed because chapter 3 is focused on polar regions.
13896	5	133	1	133	12	A point to bear in mind here is that no culture is static. There are arguments against presenting any cultural group as a 'pristine' population which in itself could be a form of structural violence. Suggest more careful thinking needs to go into how arguments in this paragraph are presented. [Debra Roberts and Durban Team, South Africa]	This whole section on polar tourism will be removed because chapter 3 is focused on polar regions.
10068	5	133	2	133	4	These lines need rewriting as their meaning is unclear. [APECS Group Review, Germany]	This whole section on polar tourism will be removed because chapter 3 is focused on polar regions.
808	5	133	3	133	3	"he" be changed as "it" [Kathiresan Kandasamy, India]	This whole section on polar tourism will be removed because chapter 3 is focused on polar regions.
810	5	133	3	133	3	"is relation on" be changed "relation to" [Kathiresan Kandasamy, India]	This whole section on polar tourism will be removed because chapter 3 is focused on polar regions.
13898	5	133	3	133	3	Not clear what 'he has a regulatory function for tourism in is relation on otherness' means. [Debra Roberts and Durban Team, South Africa]	This whole section on polar tourism will be removed because chapter 3 is focused on polar regions.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
10066	5	133	5	133	12	Somewhere in the second half of this paragragh add: Increased tourism can also put local residents' livelihoods and harvesting practices at risk (environmental degradation, wildlife disturbance, groundings or spills from cruise ships) yet they may experience little to no benefits from tourism. Carter, N.A., Dawson, J., Knopp, J., Joyce, J., Weber, M., Kochanowicz, Z., Mussells, O. (2018). Arctic Corridors and Northern Voices: governing marine transportation in the Canadian Arctic (Cambridge Bay, Nunavut community report). Ottawa: University of Ottawa. http://ruor.uottawa.ca/handle/10393/37325 DOI: 10.20381/RUOR3732 [APECS Group Review, Germany]	This whole section on polar tourism will be removed because chapter 3 is focused on polar regions.
10072	5	133	8	133	9	Please rewrite the sentence for clarity and add a supporting reference Locals may feel their privacy is invaded, and that local practices are misunderstood by visitors making observations but lacking related context. Carter, N., Dawson, J., Joyce, J., Ogilvie, A. (2017) Arctic Corridors and Northern Voices:governing marine transportation in the Canadian Arctic (Gjoa Haven, Nunavut community report). Ottawa:University of Ottawa. http://hdl.handle.net/10393/36911 DOI: 10.20381/RUOR36911 [APECS Group Review, Germany]	This whole section on polar tourism will be removed because chapter 3 is focused on polar regions.
10070	5	133	9	133	11	Kariminia et al., 2013 discusses environmental impacts of tourism and does not support the authors statements here about local modification of behaviour to suit tourists'expectations. [APECS Group Review, Germany]	This whole section on polar tourism will be removed because chapter 3 is focused on polar regions.
812	5	133	10	133	10	"other" be changed as "others" [Kathiresan Kandasamy, India]	This whole section on polar tourism will be removed because chapter 3 is focused on polar regions.
10074	5	133	14	133	18	Please add the sentence: Tourists have potential to impact species directly and indirectly: through physical and noise disturbance, littering, and collection of natural objects, as well as through introduction of invasive species and disease (Karimini et al., 2013). Also please give citations for the Antarctic studies mentioned [APECS Group Review, Germany]	This whole section on polar tourism will be removed because chapter 3 is focused on polar regions.
13900	5	133	16	133	16	Delete 'then' before 'tourists' [Debra Roberts and Durban Team, South Africa]	This whole section on polar tourism will be removed because chapter 3 is focused on polar regions.
10076	5	133	17	133	18	"because visits are located on the same sites". What is meant here by same site? Do the authors mean may contribute to eroson and disturb fragile environments when visiting sensitive sites? It might be helpful to elaborate that Antarctiic toursim is largely concentrated in 20 discrete locations (IAATO's top 20 isited sites) that are covered by the Antarctic Treaty endorsed site guidelines for visitors which seek to minimize the enivironmental impacts of tourism. In some fragile locations foot traffic is restricted to pre-defined paths which limits the spatial scale of impact but can increase the risk of erosion. [APECS Group Review, Germany]	This whole section on polar tourism will be removed because chapter 3 is focused on polar regions.
10078	5	133	18	133	19	Please consider rephrasing the sentence that starts' So greater is the numbers…' to the follwoing: The degree to which sensitive ecosystems are impacted is proportional to the intensity of tourist traffic; if the number of visitors exceeds the environment's capacity for disturbance, irreparable damage to fragile environments will occur. [APECS Group Review, Germany]	This whole section on polar tourism will be removed because chapter 3 is focused on polar regions.
2886	5	133	25	133	27	Don't understand the logic here, is there something wrong with the sentence? Why should increased tourism be negative for the economy? [Geir Ottersen, Norway]	This whole section on polar tourism will be removed because chapter 3 is focused on polar regions.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
5608	5	133	26	133	27	'it may impact negatively their economies because they will be more attractive for tourists''. This seems wrong. I expect tourism to have a positive impact on economies. [Roderik Van De Wal, Netherlands]	We agree. The importance of port infrastructure and ist vulnerability to climate change are summarized on page 134 lines 7-14. As chapter 5 focusses on the impact of climate change and mitigation strategies on economies, we think that reviewer's points 1-3 , though important, are not fitting.We suggest adding these points to another chapter.
12208	5	133	30	133	47	As highlighted in Chapter 1, there is a huge gap on the analysis of seaports as 1) major sources of GHG emissions and wastes, 2) interface between land and maritime transport 3) important source of income in many developing countries that can contribute to climate change, and 4) an essential (public) infrastructure facilitating global trade highly vulnerable to climate change. This gap should be fixed. [Louis Mitondo Lubango, Ethiopia]	Thank you. We will include your comment on the potential contribution of pollutants and their impact on the Arctic environment on page 134 paragraph on "increased risk from weather and changing global trade patterns"
2366	5	133	31	133	57	Increased traffic in either the Arctic or Antarctic would contribution additional pollutants in the region, having a direct impact on the climate and exacerbating localized warming. (Arctic Council Task Force on Short-Lived Climate Forcers (2013) RECOMMENDATIONS TO REDUCE BLACK CARBON AND METHANE EMISSIONS TO SLOW ARCTIC CLIMATE CHANGE; Arctic Council Secretariat (2017) EXPERT GROUP ON BLACK CARBON AND METHANE: SUMMARY OF PROGRESS AND RECOMMENDATIONS 2017; Arctic Monitoring and Assessment Programme (AMAP) (2015) SUMMARY FOR POLICYMAKERS: ARCTIC CLIMATE ISSUES 2015 SHORT-LIVED CLIMATE POLLUTANTS; International Council on Clean Transportation (ICCT) (2017) GREENHOUSE GAS EMISSIONS FROM GLOBAL SHIPPING, 2013–2015; Wan Z., et al. (2016) Pollution: Three steps to a green shipping industry, NATURE 530:275–277.) [Kristin Campbell, USA]	same comment as comment 2366!
2492	5	133	31	133	57	Increased traffic in either the Arctic or Antarctic would contribution additional pollutants in the region, having a direct impact on the climate and exacerbating localized warming. (Arctic Council Task Force on Short-Lived Climate Forcers (2013) RECOMMENDATIONS TO REDUCE BLACK CARBON AND METHANE EMISSIONS TO SLOW ARCTIC CLIMATE CHANGE; Arctic Council Secretariat (2017) EXPERT GROUP ON BLACK CARBON AND METHANE: SUMMARY OF PROGRESS AND RECOMMENDATIONS 2017; Arctic Monitoring and Assessment Programme (AMAP) (2015) SUMMARY FOR POLICYMAKERS: ARCTIC CLIMATE ISSUES 2015 SHORT-LIVED CLIMATE POLLUTANTS; International Council on Clean Transportation (ICCT) (2017) GREENHOUSE GAS EMISSIONS FROM GLOBAL SHIPPING, 2013–2015; Wan Z., et al. (2016) Pollution: Three steps to a green shipping industry, NATURE 530:275–277.) [Durwood Zaelke, USA]	Thank you very much for your comment. We will change these two sentences considering your suggestions. We will add your comment on "Changing sea ice regimes… " to the paragraph on changes in global trade patterns.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
10080	5	133	31	133	33	As written the sentence does not acknowledge that climate change can change the sea ice regime and cause dangerous conditions for ships. Please consider rewriting the paragraph as follows: Ship navigation is not dependent upon the health of the ocean but marine vessel traffic affects the ocean environment. Changing sea ice regimes and increased presence of multi-year ice pose signficant navigational hazards (Howell SEL, Wohlleben T, Komarov A, Pizzolato L, Derksen C (2013) Recent extreme light sea ice years in the Canadian Arctic Archipelago: 2011 and 2012 eclipse 1990 and 2007. Cryosphere 7:1753-1768). [APECS Group Review, Germany]	same comment as comment 2366!
12990	5	133	31	133	57	Increased traffic in either the Arctic or Antarctic would contribution additional pollutants in the region, having a direct impact on the climate and exacerbating localized warming. (Arctic Council Task Force on Short-Lived Climate Forcers (2013) RECOMMENDATIONS TO REDUCE BLACK CARBON AND METHANE EMISSIONS TO SLOW ARCTIC CLIMATE CHANGE; Arctic Council Secretariat (2017) EXPERT GROUP ON BLACK CARBON AND METHANE: SUMMARY OF PROGRESS AND RECOMMENDATIONS 2017; Arctic Monitoring and Assessment Programme (AMAP) (2015) SUMMARY FOR POLICYMAKERS: ARCTIC CLIMATE ISSUES 2015 SHORT-LIVED CLIMATE POLLUTANTS; International Council on Clean Transportation (ICCT) (2017) GREENHOUSE GAS EMISSIONS FROM GLOBAL SHIPPING, 2013–2015; Wan Z., et al. (2016) Pollution: Three steps to a green shipping industry, NATURE 530:275–277.) [Gabrielle Dreyfus, USA]	We will rewrite the sentence, also considering suggestions from other reviewers.
13902	5	133	31	133	31	The second part of the sentence seems disconnected from the first. [Debra Roberts and Durban Team, South Africa]	We will rewrite this section and add references
24276	5	133	31	133	57	This whole section needs references [Hans-Otto Poertner and WGII TSU, Germany]	As the mentioned impacts are valid not only for cruise ships but shipping in general, we will delete "About cruises transporting perons" and keep the paragraph more general.
10082	5	133	35	133	35	Replace "About cruises transporting persons, the environmental impact of shipping includes" with: 'Environmental risks posed by cruise ships include:' [APECS Group Review, Germany]	yes, that`s correct.
10084	5	133	35	133	35	It may be mmore precise to say should greenhouse gas emissions instead of "greenhouse". [APECS Group Review, Germany]	thank you very much for this aspect. We will add it on page 135 at line 40.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
10086	5	133	35	133	40	Please add information about human waste and shipping to this paragraph For example: Given the recent increase in cruise ship tourism the matter of human sewage may become increasingly important (Dawson et al., 2018; 2004 U.S. Commission on Ocean Policy). The 2004 U.S Commission on Ocean Policy reports that “The average cruise ship passenger generates about eight gallons (30 litres] of sewage per day and an average cruise ship can generate a total of 532,000 to 798,000 liters of sewage”. Arctic communities are challenged to deal with the waste generated in their own communities let alone that of cruise ships (Arctic Council 2009). Ships must stockpile waste onboard, since onshore facilities do not exist to receive the waste, increasing the risk of illegal or accidental dumping of sewage (Arctic Council 2009). However, at the same time “the cruise ship industry has vested interest in maintaining health wildlife populations” thus has an incentive to manage sewage disposal in a manner that will be protective of Arctic waters and marine mammals (Arctic Council 2009). References: An Ocean Blueprint for the 21st Century. http://govinfo.library.unt.edu/oceancommission/documents/full_color_rpt/000_ocean_full_report.pdf. Reference: Dawson J., Pizzolato, L., Howell, S.E.L., Copland, L., & Johnston, M.E. 2018. Temporal and Spatial Patterns of Ship Traffic in the Canadian Arctic from 1990 to 2015. Arctic. 71(1):15-26. https://doi.org/10.14430/arctic4698. Reference: Arctic Council (2009). Arctic Marine Shipping Assessment Report, April 2009, second printing. https://oaarchive.arctic-council.org/handle/11374/54?show=full. [APECS Group Review, Germany]	Thank you. This aspect will be included on the next page in the section on changing global trade patterns
10092	5	133	35	133	40	Neither at this point, nor any point in the chapter, did I see anything on the role of sea ice in exacerbating accidental marine spills of oil or other chemicals. It is a major concern and unknown how sea ice would affect the spread and/or evolution of an oil spill in ice-infested waters. In particular the potential for spilled oil to be trapped within or under sea ice as its growing in the fall represents a significant challenge for mitigation, detection & tracking via satellites, and clean-up; thus enhacing the potnetial for wide-scale Arctic incidents. I think some attention needs to be given to this topic here, if only a few sentences. A few relevant citations are: Wilkinson, J.P., Boyd, T., Hagen, B., Maksym, T., Pegau, S., Roman, C., Singh, H. and Zabilansky, L., 2015. Detection and quantification of oil under sea ice: The view from below. Cold Regions Science and Technology, 109, pp.9-17. Wilkinson, J., Beegle-Krause, C.J., Evers, K.U., Hughes, N., Lewis, A., Reed, M. and Wadhams, P., 2017. Oil spill response capabilities and technologies for ice-covered Arctic marine waters: A review of recent developments and established practices. Ambio, 46(3), pp.423-441. [APECS Group Review, Germany]	Thank you. We will rewrite this paragraph considering your suggestion
10088	5	133	42	133	43	For calrity please replace" Merchandises transportation increases also the threats on the ocean because commercial shipping mainly uses HFO…' with: 'Commercial shipping also poses risks to the ocean environment including through routine use of Heavy Fuel Oil (HFO)…' [APECS Group Review, Germany]	Thank you for this addition. We will rewrite this paragraph considering your suggestion

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
10090	5	133	52	133	52	To improve clarity, please replace the first sentence of this pararaph with replace with: 'The impacts of climate change on marine life, maritime industries, and coastal communities are complex.' [APECS Group Review, Germany]	According to IMO "Heavy fuel oil is banned in the Antarctic (under MARPOL) and ships are encouraged not to use or carry heavy fuel oil in the Arctic. We will add you comment taht this recommendation should be converted in an obligation.
2368	5	134	3	134	30	IMO should also strengthen current policies to include SLCPs, particularly black carbon. This could include extending the Polar Code to include a ban on heavy fuel oil (HFO) in the Arctic. (Arctic Council Secretariat (2017) EXPERT GROUP ON BLACK CARBON AND METHANE: SUMMARY OF PROGRESS AND RECOMMENDATIONS 2017; Wan Z., et al. (2016) Pollution: Three steps to a green shipping industry, NATURE 530:275–277.) [Kristin Campbell, USA]	same comment as comment 2368!
2494	5	134	3	134	30	IMO should also strengthen current policies to include SLCPs, particularly black carbon. This could include extending the Polar Code to include a ban on heavy fuel oil (HFO) in the Arctic. (Arctic Council Secretariat (2017) EXPERT GROUP ON BLACK CARBON AND METHANE: SUMMARY OF PROGRESS AND RECOMMENDATIONS 2017; Wan Z., et al. (2016) Pollution: Three steps to a green shipping industry, NATURE 530:275–277.) [Durwood Zaelke, USA]	same comment as comment 2368!
12992	5	134	3	134	30	IMO should also strengthen current policies to include SLCPs, particularly black carbon. This could include extending the Polar Code to include a ban on heavy fuel oil (HFO) in the Arctic. (Arctic Council Secretariat (2017) EXPERT GROUP ON BLACK CARBON AND METHANE: SUMMARY OF PROGRESS AND RECOMMENDATIONS 2017; Wan Z., et al. (2016) Pollution: Three steps to a green shipping industry, NATURE 530:275–277.) [Gabrielle Dreyfus, USA]	Thank you for you input. We will add this sentence.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
10094	5	134	26	133	26	After (Wassmann et al., 2010) add: 'Climate change is one of many factors influencing Arctic marine traffic trends. As decribed in Dawson et al. (2018) these trends may also be influenced by societal trends, demographics, commodity prices, globalization, and tourism demand (see Prowse et al., 2009; George, 2013; Hodgson et al., 2013; Pelletier and Guy, 2015; Pizzolato et al., 2016; Council of Canadian Academies, 2017; Dawson et al., 2017)'. References: Prowse, T.D., Furgal, C., Chouinard, R., Melling, H., Milburn, D., and Smith, S.L. 2009. Implications of climate change for economic development in northern Canada: Energy, resource, and transportation sectors. AMBIO: A Journal of the Human Environment 38(5):272 – 281. https://doi.org/10.1579/0044-7447-38.5.272. George, R. 2013. Ninety percent of everything: Inside shipping, the invisible industry that puts clothes on your back, gas in your car, and food on your plate. New York: Metropolitan Books. Hodgson, J.R.F., Russell, W.D., and Megannety, M. 2013. Exploring plausible futures for marine transportation in the Canadian Arctic: A scenarios' based approach. Prepared for Transport Canada. https://cdn.dal.ca/content/dam/dalhousie/pdf/faculty/science/marine-affairs-program/Marine Transportation in Canadian Arctic Report 2014.pdf. Pelletier, J.F., and Guy, E. 2012. Évaluation des activitiés de transport maritime en Arctique Canadien. Cahiers Scientifiques du Transport 61:3 – 33. Pizzolato, L., Howell, S.E.L., Dawson, J., Laliberté, F., and Copland, L. 2016. The influence of declining sea ice on shipping activity in the Canadian Arctic. Geophysical Research Letters 43(23):12146 – 12154. https://doi.org/10.1002/2016GL071489. Council of Canadian Academies. 2017. The value of commercial marine shipping to Canada: Ottawa: The Expert Panel on the Social and Economic Value of Marine Shipping to Canada, Council of Canadian Academies. http://www.scienceadvice.ca/uploads/eng/assessments publicationsnewsreleases/valuemarineshipping/value marineshipping_fullreport_en.pdf. Dawson, J., Copland, L., Johnston, M.E., Pizzolato, L., Howell, S., Pelot, R., Etienne, L., Matthews, L., and Parsons, J. 2017. Climate change adaptation strategies and policy options for Arctic shipping: A report prepared for Transport Canada. https://ruor.uottawa.ca/handle/10393/36016 [APECS Group Review, Germany]	Ths sentence will be changed to "A CO2 reduction strategy has been developed and adopted at the IMO in April 2018 (RESOLUTION MEPC.304(72), 2018). It aims to reducing total annual greenhouse gas emissions from international shipping by 50% by 2050 compared to reference year 2008."
13904	5	134	50	134	50	Insert 'be' before 'adopted' [Debra Roberts and Durban Team, South Africa]	The "(…)" shortens the original sentence "By 2025, prevent and significantly reduce marine pollution of all kinds, in particular from land-based activities, including marine debris and nutrient pollution" (Source: www.un.org). In order to clarify, that the original sentence is shortened, we added the "(…)".
814	5	135	18	135	18	"(…)" ? [Kathiresan Kandasamy, India]	We agree that this paragraph is a little bit off topic and will shorten it to few sentences. We want to keep the aspect of scrubber utilization as an economic (but environmentally questionable) measure to comply with a recent environmental regulation (in this case the global sulfur cap). Though not directly related to climate change, the global sulfur cap may have an influence on climate.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
2772	5	135	23	135	40	IMO regulation to permit sulfur content in fuel to 0.5% can have a positive or negative effect on ocean acidification due to reduction of SOx in the atmosphere or an increase of scrubber effluent. However it would be better not to describe here because this has little to do with trade-offs caused by climate change or climate change response policies. [Suk Hui Lee, Republic of Korea]	i suggest changing the title of the section to"Implications for Sustainable Development". Re coastal communities dependancy on ecosystem services, the compensation mechanism (in kind, in site) aims to restore the ecosystems and compensate losses with "more" habitat (and therefore the ES).
10096	5	135	50	136	36	Section 5.4.3.2.1 makes no mention of community livelihoods (despite its title) or indigenous peoples living in coastal regions whose relationship with the ocean environment is central to their way of life. Sustainable Development must consider the people who stand to be most impacted by development. Subsistence harvesting practices, local travel, and local marine usage must be considered when planning any development with potential to impact the marine ecosystem. Paragraphs about this need to be included in this section. Article 20 of the United Nations Declaration on the Rights of Indigenous People Article 20 states that Indigenous peoples have the right to maintain and develop their political, economic and social systems or institutions, to be secure in the enjoyment of their own means of subsistence and development, and to engage freely in all their traditional and other economic activities. This should be discussed in this section. http://www.un.org/esa/socdev/unpfii/documents/DRIPS_en.pdf [APECS Group Review, Germany]	the text has been modified and references added.
10100	5	135	51	135	55	Please add a sentence simmilar to 'Tensions exist within human usage of the marine/coastal interface as the same characteristics that draw humans to them (eg. aesthetics, wildife) can lead to activities that negatively impact such ecosystems (construction, harvesting)' and refernces are needed to support this and what was previously written. [APECS Group Review, Germany]	ok
10098	5	135	53	135	53	Please consider replacing "control" with "manage"" i.e There is a need to manage development ... [APECS Group Review, Germany]	Adapted and added.
10102	5	136	23	136	23	Please add some sentences like: 'Given the implications for the ecology, environment, and local way of life, the perspectives of members of coastal communities should be a fundamental consideration during the implementation and management of development projects that may impact the marine environment. The consequences of an incident would have deep, lasting, and potentially irreversible ecological, environmental, and cultural impacts.' References: Carter, N.A., Dawson, J., Knopp, J., Joyce, J., Weber, M., Kochanowicz, Z., Mussells, O. (2018). Arctic Corridors and Northern Voices: governing marine transportation in the Canadian Arctic (Cambridge Bay, Nunavut community report). Ottawa: University of Ottawa. http://ruor.uottawa.ca/handle/10393/37325 DOI: 10.20381/RUOR3732 [APECS Group Review, Germany]	ok to be removed
10104	5	136	30	136	36	This paragraph does not fit/contribute to this topic. Please consider deleting from this section [APECS Group Review, Germany]	I agree with the reviewever. The sentence can be revised as follows: "Most seas surrounding large continents suffer from ocean acidification and increasing ocean temperatures."

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
24278	5	136	42	136	42	It seems unnecessary to emphasise Europe in this context, either mention all affected continents surrounded by acidified seas, or none of them [Hans-Otto Poertner and WGII TSU, Germany]	Mismatch between page and section numbering. Please include at the end of section 5.4.3.2.3, the following text: Indigenous local knowledge can also make a substantial contribution to enable climate change adaptation. For instance Panikaar et al., 2018 explain that Inuit have shown tremendous coping skills and adaptability to changing climate, both in the past and the present (Krupnik 1993, Freeman 1996, Pearce et al. 2015). These observations may be occurring because of extensive knowledge of the land (land skill) and from profound knowledge of the Arctic ecosystems and environment, which together are sometimes referred to as traditional ecological knowledge (TEK) (Pearce et al. 2015) or more commonly now, Inuit knowledge (IK). REFERENCES Panikkar, B., Lemmond, B., Else, B. and Murray, M. 2018. Ice over troubled waters: navigating the Northwest Passage using Inuit knowledge and scientific information. Climate Research. Vol.75:81-94. https://doi.org/10.3354/cr01501. Also see Berkes, F. and D. Jolly. 2001. Adapting to climate change: social-ecological resilience in a Canadian western Arctic community. Conservation Ecology 5(2): 18. [online] URL: http://www.consecol.org/vol5/iss2/art18. Also see Ford JD, Pearce T, Duerden F, Furgal C, Smit B (2010) Climate change policy responses for Canada's Inuit population: The importance of and opportunities for adaptation. Global Environ Change 20:177–191.
10106	5	137	24	137	48	Section 5.4.3.2.3 is lacking mention of traditional ecological knowledge, Indigenous Knowledge etc and its contributions to enabling climate change adaptation. This oversight should be corrected. For instance Panikaar et al., 2018 explain that "Inuit have shown tremendous coping skills and adaptability to changing climate, both in the past and the present (Krupnik 1993, Freeman 1996, Pearce et al. 2015). These result from extensive knowledge of the land (land skill) and from profound knowledge of the Arctic ecosystems and environment, which together are sometimes referred to as traditional ecological knowledge (TEK) (Pearce et al. 2015) or more commonly now, Inuit knowledge (IK)". Panikkar, B., Lemmond, B., Else, B. and Murray, M. 2018. Ice over troubled waters: navigating the Northwest Passage using Inuit knowledge and scientific information. Climate Research. Vol.75:81-94. https://doi.org/10.3354/cr01501. Also see Berkes, F. and D. Jolly. 2001. Adapting to climate change: social-ecological resilience in a Canadian western Arctic community. Conservation Ecology 5(2): 18. [online] URL: http://www.consecol.org/vol5/iss2/art18. Also see Ford JD, Pearce T, Duerden F, Furgal C, Smit B (2010) Climate change policy responses for Canada's Inuit population: The importance of and opportunities for adaptation. Global Environ Change 20:177–191. [APECS Group Review, Germany]	Accepted. The text was altered as suggested by the reviewer.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
6332	5	137	40	137	48	More recent research indicaties that 'local knowledge' of fishers and tourism operators is not enough for adaptation. For example a key issue discussed by Nobel et al., 2014 is that knowledge of the effectiveness of these adaptation practices often lag sbehind their implementation. Suggest that the sentence in line 48-49 "In these instances, local knowledge acts to promote adaptation" is changed to "In these instances, local knowledge accompanied with assessments of social and economic costs of adaptation options acts to promote long term adaptation" [Alvin Chandra, Australia]	Considered. Section revised substantially.
14010	5	137	50			The role of local government in section 5.4.4. is not clear [Debra Roberts and Durban Team, South Africa]	Considered, section revised
18426	5	137	50	143	1	This section refers to various international agreements such as UNCLOS, UNFCC and the London Protocol. However, in addition to relevant international agreement, this section should also briefly acknowledge the existance of relevant rules of customary international law. These are "unwritten" rules of international law in that they are not contained in a treaty, but are developed through widespread international practice. In particular, this report should note that under customary international law all states have a binding duty to prevent activities under their jurisdiction and control from causing significant harm to the territory of other states and to areas beyond the jurisdiction of individual states (i.e. global common areas such as the high seas). This duty is often referred to as the "no-harm" rule. Under this rule, states have a due diligence obligation to identify when their activities pose a risk of significant transboundary harm and must undertake their best possible efforts to prevent it. This includes conducting transboundary environmental impact assessments and consulting and notifying and consulting with potentially affected states. The no-harm rule is legally binding on all states, regarless of what other international agreements they have agreed to. It has the same legal status as a treaty obligation. This means that if states breach their obligations under this rule they can be held accountable before an international court or tribunal (This occured most recently in the International Court of Justice in 2015 between Costa Rica and Nicaragua in the Certain Activities case). I also noticed that this section does not deal with prominent, emerging rules of customary international law, such as the precautionary principle. [Kerryn Brent, Australia]	Considered, section revised

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
18432	5	137	50	143	5	This is a general comment on 5.4.4.1. Overall, this section was poorly structured and written. Certain instruments and rules seemed to have been cherry picked for elaboration and explanation, while the relevance of others listed in table 5.10 was not explained at all. No reason was given for this selective approach. It might make more sense for relevant rules of international law and international governance frameworks to be dealt with thematically following a similar structure to 5.4.1. Where explanations were given, they tended to be vague. Stronger connections needed to be drawn between rules/regimes and the risk responses raised earlier in section 5.4. I strongly recommend restructuring this section, and developing a more detailed and clear analysis of relevant rules of international law. There are also numerous typos and grammatical errors throughout this section. [Kerryn Brent, Australia]	Considered, section revised
22154	5	137	50	146	23	Substantial Law of the sea references are missing. [Bleuenn Gaëlle Guilloux, Germany]	An error occurred when chapter 5 references were compiled in Endnote by the TSU resulting in a displacement of all the references by one position. This resulted in a great number of misplaced references which we have since then fixed.
23014	5	137	50	139	21	Other questions not addressed here in this section are (Eddebbar et al 2015): 1) how will changes in ocean carbon and heat sinks relate to international policy targtes (e.g. 2ºC of Paris Agreement) that do not take into consideraton changes in these natural sinks, 2) How will ocean observations be funded through ocean governance within climate policy, and 3) how ocean impacts will be taken into considerations when using surface/land-centric international climate policy targets. Understanding the role of the changes in ocean properties described in this report on current climate policies negotiated or developed is important and merits more detailing in this section. Eddebbar Y. A., Gallo N. D., and Linsmayer L. B. 2015. The Oceans and the UN Framework Convention on Climate Change. Limnology and Oceanography Bulletin, 24: 69–72. DOI:10.1002/lob.10059. [Yassir Eddebbar, USA]	Considered, section revised
24280	5	137	50			sections 5.4.4 can be significantly shortened (this is an assessment, not a review) [Hans-Otto Poertner and WGII TSU, Germany]	Considered, section revised
816	5	137	56	137	56	"to response" be changed as "in response" [Kathiresan Kandasamy, India]	The text was altered as suggested by the reviewer.
17270	5	138	5	138	26	Consider indicating that the Paris Agreement and decision 10/CP.21 established a limit for global warming that refers to combined land and ocean temperature (SST). This could be seen as limiting ocean warming. Second, please see the comment above regarding considering progress on addressing ocean acidification and consider mentioning that if the Paris Agreement is successful, then the ocean acidification will be limited (as indiacted in table 5.10). It will be useful to provide values of change of sea surface pH (relative to 1870-1879). Figure 3.19 of IPCC SR1.5 SOD shows that an change of 0.04 would be expected for a 2C scenario. [Iulian Florin Vladu, Germany]	Considered, section revised

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
21412	5	138	5	138	30	According to IPCC principles and procedures, it is not the role of IPCC authors or assessment reports to opine on international governance proposals. In particular, the use of the word “adequate” is vague and unnecessary. It is not the role of IPCC authors or assessment reports to characterize the UN Convention on the Law of the Sea as “the constitution of the ocean.” Suggest that this section be kept to a minimum length including factual information only, or removed altogether. These changes should be reflected in table 5.10 on page 140. [Alice Alpert, USA]	Considered, section revised
13906	5	138	11	138	11	Add 'in the literature' after 'attention' to avoid misinterpretation that you have not properly covered this issue in the assessment. [Debra Roberts and Durban Team, South Africa]	The text was altered as suggested by the reviewer.
17960	5	138	12	138	12	the word 'exiting' should be 'existing'. [Jeffrey Mcgee, Australia]	The text was altered as suggested by the reviewer.
17962	5	138	16	138	27	this paragraph needs redrafting to be more specific about the failure of the UNFCCC, Kyoto Protocol and Copenhagen Accord to deal with ocean related climate change impacts. Also, please check the Redgwell 2012 reference as this is commenting on NDCs but appears to pre-date that 2105 Paris Agreement [Jeffrey Mcgee, Australia]	The text was altered as suggested by the reviewer.
13908	5	138	25	128	28	The language here seems quite prescriptive [Debra Roberts and Durban Team, South Africa]	The text was altered as suggested by the reviewer.
1370	5	138	29		36	UNCLOS synopsis in this section should mention that the convention provides a regime governing marine scientific research [Marcus Haward, Australia]	Considered, section revised
18420	5	138	29	138	36	This section should more broadly highlight PartXII of UNCLOS: Protection and Preservation of the Marine Environment, including article 192, that 'States have the obligation to protect and preserve the marine environment'. This section mentions that there are provisions regarding 'prevention of marine pollution', but should specificly reference article 194 (as has been done for articles 56, 6, 62, 63... etc). There also appears to be a typo here, with article '6' being listed after '56'. Articles should be listed sequentially to enhance readability. [Kerryn Brent, Australia]	An error occurred when chapter 5 references were compiled in Endnote by the TSU resulting in a displacement of all the references by one position. This resulted in a great number of misplaced references which we have since then fixed.
22132	5	138	29	138	29	The accepted expression is "consitution for the Oceans" (Koh, 1982) [Bleuenn Gaëlle Guilloux, Germany]	Considered, section revised
22134	5	138	30	138	30	rights and obligations [Bleuenn Gaëlle Guilloux, Germany]	Considered, section revised
22136	5	138	32	138	32	the Area is missing [Bleuenn Gaëlle Guilloux, Germany]	Considered, section revised
22138	5	138	33	138	33	the protection and preservation of marine environment (Part XII of the Unclos) is missing [Bleuenn Gaëlle Guilloux, Germany]	Considered, section revised
818	5	138	39	238	39	delete "or" [Kathiresan Kandasamy, India]	The text was altered as suggested by the reviewer.
820	5	138	42	138	42	"sea water" be changed as "seawater" [Kathiresan Kandasamy, India]	The text was altered as suggested by the reviewer.
22166	5	138	42	138	43	indicative list of sources of pollution [Bleuenn Gaëlle Guilloux, Germany]	Considered, section revised
1372	5	138	45	138	47	Suggest reworking of text o avoid erroneous reading of material. The comment here seems to imply that UNCLOS has an independent existence from its member states . This is clearly not the case, the provisions of UNCLOS like all international agreements, are e implemented by member states,– ie they are the are key actor in UNCLOS [Marcus Haward, Australia]	The text was altered as suggested by the reviewer.
17964	5	138	51	138	52	the London Protocol needs to be introduced above at page 112 when discussing ocean fertilization [Jeffrey Mcgee, Australia]	The text was altered as suggested by the reviewer.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
22140	5	138	55	138	55	reference to the 2013 amendments is missing. [Bleuenn Gaëlle Guilloux, Germany]	An error occurred when chapter 5 references were compiled in Endnote by the TSU resulting in a displacement of all the references by one position. This resulted in a great number of misplaced references which we have since then fixed.
18422	5	138	56	139	2	This section mentions the London Protocol amendment on marine geoengineering (LP.4(8)) and states that "One of these new amendment prohibits ocean fertilization except for research purposes'. First, 'amendment' should be 'amendments'. Second, this statement is an oversimplification, and does not accurately represent the content and legal status of this prohibition. It should be acknowledged that the amendment is not yet in force and that parties to the London Protocol therefore are not legally bound to comply with it at the present time (see, eg, McGee et al (2018) as cited in this report; Jesse L. Reynolds 'International Law' in Michael B Gerrard and Tracy Hester (eds) Climate Engineering and the Law (CUP, 2018) pp89-93). Instead of 'research purposes' it is more accurate to say 'legitimate scientific research'. This is to be determined in accordance with a detailed assessment framework that takes into account the scientific attributes of a proposed ocean fertiliation activity, as well as environmental impact and risk management considerations. This section then states "Nevertheless, there are concerns for these activities." This sentence is vague. The report needs to be clear as to what the nature of these concerns are. It might also help to provide one or two examples. For example, is the "concern" about OF itself and the risks it presents? Or is this concern about the capacity of the amendments to effectively govern marine geoengineering and/or the fact that they are not legally binding? This section should also acknowledge and/or briefly explain attempts to govern ocean fertilization and geoengineering more generally under the Convention on Biological Diversity. This is listed in Table 5.10, but it would enhance the structure of the analysis to discuss CBD decisions IX/16 and X-33 here if possible (including the fact that these decisions are similarly non-binding and therefore do not need to be complied with). [Kerryn Brent, Australia]	Considered, section revised
822	5	139	1	139	1	"amendment" be changed as "amendments" [Kathiresan Kandasamy, India]	The text was altered as suggested by the reviewer.
11530	5	139	1	139	2	It is important to stress that the exception from the London Protocol prohibition on ocean fertilization is specifically for 'legitimate scientific research', which would need to pass a detailed assessment framework and be subject to a permit, and not for research purposes more generically. Reference could be made directly to the two Resolutions under the London Convention and London Protocol which established the concept of 'legitimate scientific research' (http://www.imo.org/en/OurWork/Environment/LCLP/EmergingIssues/geoengineering/Documents/2008resolutionOF.doc) and subsequently the assessment framework under which the judgment is to be made (http://www.imo.org/en/OurWork/Environment/LCLP/EmergingIssues/geoengineering/Documents/OFassessmentResolution.pdf) [Taehyun Park, Republic of Korea]	An error occurred when chapter 5 references were compiled in Endnote by the TSU resulting in a displacement of all the references by one position. This resulted in a great number of misplaced references which we have since then fixed.
22142	5	139	3	139	3	Marpol 1973/1978 [Bleuenn Gaëlle Guilloux, Germany]	Considered, section revised

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22144	5	139	6	139	6	Some regional rules are already existing [Bleuenn Gaëlle Guilloux, Germany]	Considered, section revised
17966	5	139	10	139	12	Need to explain whether CCAMLR or OSPAR has actually done anything substantive on ocean acidification [Jeffrey Mcgee, Australia]	Considered, section revised
1374	5	139	16	139	17	this is a good point and there is some criticism of the failure of fisheries bodies in addressing climate change. [Marcus Haward, Australia]	The text was altered as suggested by the reviewer.
17968	5	139	19	139	21	This paragraph needs reworking as it is not clear and the table of treaties which follows is not properly introduced. [Jeffrey Mcgee, Australia]	The text was altered as suggested by the reviewer.
22146	5	139	24	143	1	It should e relevant to add the date of signature and entry into force (if so) of all mentionned I	Considered, section revised
24436	5	139	24			This table is very detailed, consider if it is best placed in supplementary material and instead use a figure showing major ocean governance jurisidictions? [Hans-Otto Poertner and WGII TSU, Germany]	Considered, section revised
18424	5	140	0	143	0	This comment refers to Table 5.10 'Existing international institutions and legal instruments of	The text was altered as suggested by the reviewer.
17970	5	140	1	140	1	In discussing the UNFCCC and Paris Agreement, need to carefullly comment on whether the 2 degree goal is positive for reducing impacts on ocean and coastal areas. If so, compared to what future? [Jeffrey Mcgee, Australia]	The text was altered as suggested by the reviewer.
17972	5	141	1	140	1	I did not find the table of ocean treaties on these pages very useful. I would consider reducin	The text was altered as suggested by the reviewer.
824	5	142	0	142		last column, "mijaor refrom" be changed as "major reform" [Kathiresan Kandasamy, India]	The text was altered as suggested by the reviewer.
17974	5	143	7	140	7	correct the reference to the Paris Agreement [Jeffrey Mcgee, Australia]	The text was altered as suggested by the reviewer.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
21414	5	143	7	143	9	The legal requirement of Parties to the Paris Agreement concerns reporting of greenhouse gases emission inventories, and sub-national actors are not Parties to the Paris Agreement. Suggest revision of the sentence to read: Nationally Determined Contributions for the Paris Agreement may describe efforts climate change adaptation." [Alice Alpert, USA]	Considered, section revised
17976	5	143	8	143	8	The Paris Agreement, being a treaty, binds states, but not sub-state actors, in international la	The text was altered as suggested by the reviewer.
17978	5	143	9	143	11	Need to clearly define governance and also explain different approaches to measuring performance or effectiveness of environmental law at a domestic level [Jeffrey Mcgee, Australia]	Considered, section revised
13910	5	143	19	147	19	Suggest replacing 'be' with 'are'. Correct spelling error fo 'ctrical'. Qualify critical factors in wh	The text was altered as suggested by the reviewer.
22148	5	143	19	143	19	critical (see also, p. 142, major; reform, etc.) [Bleuenn Gaëlle Guilloux, Germany]	Title changed to provate sector stakeholders
22150	5	143	30	144	46	the content is not consistent with the title or at least, incomplete. What about NGOs, local and professional communities, etc.? [Bleuenn Gaëlle Guilloux, Germany]	totally agree with the argument. Nonetheless, PPP are usually negotiated with government and local authorities. These institutions represent the interests of indigeneous people (when present).
10108	5	143	32	144	46	Section 5.4.4.3 Here members of coastal communities including Indigenous peoples should be mentioned. Despite being interested, invested, stakeholders they are often excluded from decision-making and policy development. The UN declaration of Human Rights Articles 18 through 20 are of critical importance here. "Article 18 States Indigenous peoples have the right to participate in decision-making in matters which would affect their rights, through representatives chosen by themselves in accordance with their own procedures, as well as to maintain and develop their own indigenous decision making institutions. Article 19 indicates that States shall consult and cooperate in good faith with the indigenous peoples concerned through their own representative institutions in order to obtain their free, prior and informed consent before adopting and implementing legislative or administrative measures that may affect them. Article 20 1. Indigenous peoples have the right to maintain and develop their political, economic and social systems or institutions, to be secure in the enjoyment of their own means of subsistence and development, and to engage freely in all their traditional and other economic activities". http://www.un.org/esa/socdev/unpfii/documents/DRIPS_en.pdf [APECS Group Review, Germany]	Added .
18740	5	143	32	143	37	In the different chapters, there is no specific mention of the benefits of marine protected area	These are considered in the preparation of SOD
22152	5	144	48	144	48	The conflictual and ineffective characters of the governance is not prooven. It is rather overlapping and incomplete. [Bleuenn Gaëlle Guilloux, Germany]	Considered, section revised
21532	5	145	0	145		Consider talking about (or showing with figures) which regions are most susceptible to ocean a	Considered, section revised

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3616	5	145	9		55	Policy Responses to Ocean Acidification: Is there a Governance Gap? What are the future projections? The suggestion is to clearly highlight that the issue of ocean acidification and its overall effects and impacts will be solved ONLY if RADICAL mitigation measures are adopted by the biggest GHG's emitters, including China, USA, Europe and others OECD important GHG's emitters countries. Of course marine pollution could increase acidification phenomenon - but first and foremost responsability relies to GHG's emmiters countries... It is great time to envisage legally bidding instrument to seriously address such ocean acidification issue that jeopardize the immediate future of our Oceans, their resources, biodiversity and coastal communities that depend on them e.g. in tropical and inter-tropical regions including in developing countries. [E. Salif Diop, Senegal]	Comment noted; no specific edits suggested
21416	5	145	11	146	25	According to IPCC principles and procedures, it is not the role of IPCC authors or assessmen	Comment noted; edits made to avoid being policy prescriptive ('neces
17272	5	145	13	145	23	The COP by its decision 10/CP.21 (FCCC/CP/2015/10/Add.2) toke note of the work of the structured expert dialogue, which contributed to completing the phases of the 2013–2015 review reflected in decision 2/CP.17, paragraph 164, and of the report on the structured expert dialogue, including the 10 messages highlighted therein. Message 1 – A long-term global goal defined by a temperature limit serves well its purpose, and indicates that adding other limits to the long-term global goal, such as sea level rise or ocean acidification, only reinforces the basic finding emerging from the analysis of the temperature-related limit, namely that we need to take urgent and strong action to reduce GHG emissions. However, the limitations of working only with a temperature limit could be taken into account, for example, by aiming at limiting global warming below 2 °C. This message, noted by the COP, could provide a basis for monitoring progress on addressing ocean acidification. This may happen in the Global Stocktake, under the Paris Agreement. [Iulian Florin Vladu, Germany]	Comment noted; minor edit made to reflect this information
21530	5	145	13	145	13	Consider using "is not featured" or "has not been featured" in lieu of "has not featured" as Oc	Minor edits made in response
6336	5	145	25	146	41	The draft report point out the large knowledge gap and needs on ocean acidification. Lines 28-30 should include the need for information on assessent of impacts at the level of organisms, populations, communities and ecosystems (co-occuring environmental changes) to inform better policies. Riebesell and Gattuso's (2015) paper in the Nature CC discusses these knowlefge gaps that could be a useful addition to this paragraph. [Alvin Chandra, Australia]	Comment noted - but not appropriate to cover all OA impacts here
6490	5	145	25			I disagree with the argument that literature on ocean acidification is relatively recent; since th	An ambiguity here has been corrected (Browman's paper is a review o
17274	5	145	25	145	41	Consider indicating that WMO prepare a Statement on the State of the Global Climate, which includes up-to-date information on ocean acidification (see https://public.wmo.int/en/our-mandate/climate/wmo-statement-state-of-global-climate). This information is presented to the COP. [Iulian Florin Vladu, Germany]	WMO's interest is noted
13210	5	145	43	146	23	it would be nice to highlight the success of oyster farming after OA measures had been taken	Comment noted, edit made

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18428	5	145	51	145	52	This section states "...whilst some CO2 techniques (negative emissions) such as ocean fertilization, as likely to..." When readig this chapter, I have noticed that different terminolgy is used at various times tto refer to what are essentially CDR geoengineering proposals. At times it is referred to a 'negative emissions'. 'Negative emissions technologies' would be more accurate when refering to proposals like ocean fertilization (i.e. they are technologies that aim to achieve or produce negative emissions, rather than negative emissions themselves). At other times, the term "geoengineering" is used (for example, this term is used in the context of governance on pages 138-143). In order to make things clearer for readers, the authors should chose one key term (be it CDR or negative emissions technologies) and use it consistently throughout the chapter. [Kerryn Brent, Australia]	Different words are used because they have different meanings. Whilst CDR (CO2 removal) is a form of negative emissions, other approaches (eg methane removal) are also possible - as "greenhouse gas removal". Whilst negative emissions are a group of geoengineering techniques, that term also incldes SRM.
17980	5	146	1	146	8	Alkalinisation activities should be mentioned here and linked to the early discussion in the cha	Covered by 'water treatment'
6338	5	146	10	146	11	The sentence containing 'ocean acidification monitoring' should be changed to ' long-term integrated monitoring'. As above 'integrated' monitoring will better reflect assessment of short- to long-term responses to multiple drivers and their underlying mechanisms at the level of organisms, populations, communities and ecosystems. [Alvin Chandra, Australia]	Comment noted, edit made
14074	5	146	10	146	23	It would be good to add some information in this paragraph about the creation of the Global O	Comment noted, edit made
14072	5	146	12	146	12	Barton et al 2015 should be added to the Sutton reference for this sentence. [Elizabeth Jewett, USA]	An error occurred when chapter 5 references were compiled in Endnote by the TSU resulting in a displacement of all the references by one position. This resulted in a great number of misplaced references which we have since then fixed.
21012	5	146	12			These are likely better references for the impact to the oyster industry: Barton, A., Waldbuss	An error occurred when chapter 5 references were compiled in Endnot
21010	5	146	18	146	20	The Clean Water Act does set pH water quality standards within state waters, some of those being estuarine and coastal systems. Many resources available on this, for example http://climatecasechart.com/case/center-for-biological-diversity-petition-to-epa-regarding-ph-standard/ and Kelly, R.P., Foley, M.M., Fisher, W.S., Feely, R.A., Halpern, B.S., Waldbusser, G.G., Caldwell, M.R. (2011) Mitigating Local Causes of Ocean Acidification with Existing Laws. Science 332, 1036-1037. [Adrienne Sutton, USA]	Comment noted, edit made
13912	5	146	39	146	39	What does '81' stands for in this sentence? Is it the resolution number? Thhis is not clear to t	The text was altered as suggested by the reviewer.
13914	5	147	1	147	5	Relevance of this not clear. [Debra Roberts and Durban Team, South Africa]	The text was altered as suggested by the reviewer.
18430	5	147	8	147	8	"The 1982 Convention". Is this UNCLOS? The authors need to go through the section on gove	The text was altered as suggested by the reviewer.
13916	5	147	43	147	43	Close backet after '5.3' not after '70' [Debra Roberts and Durban Team, South Africa]	The text was altered as suggested by the reviewer.
22718	5	148	6			While there is no text yet for section 5.6 on uncertainties, the following two references may b	An error occurred when chapter 5 references were compiled in Endnot
4614	5	148	56	148	57	I suggest to add a list of acronyms... [Alessandro Pezzoli, Italy]	Considered, section revised
4616	5	149	1	209	43	Check the entire Reference because some of these references are uncorrected (see page 16	The text was altered as suggested by the reviewer.
22704	5	154	12	154	15	This appears to be a double entry, with two different years - everything else in the reference is identical, including the DOI [Mark Payne, Denmark]	The text was altered as suggested by the reviewer.
10110	5	157	31	157	35	The reference Buurman and Babovic is double - although the publication year is wrong for the	An error occurred when chapter 5 references were compiled in Endnot

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11356	5	168	14	168	19	References repeated - miissing umlauts from the first authors name in the first call to this work [Croot Peter, Ireland]	The text was altered as suggested by the reviewer.
2150	5	169	19	169	22	Double citation [Fiz Fernandez Perez, Spain]	The text was altered as suggested by the reviewer.
1700	5	171	45	171	45	Hamilton, L.C. & T.G. Safford. 2015. “Environmental views from the coast: Public concern about local to global marine issues.” Society and Natural Resources 28(1):57–74. doi: 10.1080/08941920.2014.933926 [Lawrence Hamilton, USA]	Considered, section revised
17854	5	182	14	182	17	Levin ref listed twice but with different years; needs to be corrected here and where cited in c	The text was altered as suggested by the reviewer.
10112	5	188	40	188	41	Mutombo and Ölçer: This reference should be cited as published in 2017 not 2016. [APECS Group Review, Germany]	An error occurred when chapter 5 references were compiled in Endnote by the TSU resulting in a displacement of all the references by one position. This resulted in a great number of misplaced references which we have since then fixed.
11302	5	193	28	193	28	Citation formatting for Purkey (2014) includes authors first names [Croot Peter, Ireland]	The text was altered as suggested by the reviewer.
4124	5	208	58	208	58	Pastâ€“Presentâ€“Future --> Past-Present-Future [Jinsoon Park, Republic of Korea]	The text was altered as suggested by the reviewer.