

***Climate Science Special Report (CSSR):
Fourth National Climate Assessment, Volume I***

Public Comment Period Annotation

The U.S. Global Change Research Program (USGCRP) released the draft CSSR for public comment from 15 December 2016 to 3 February 2017, concurrent with review by a special committee convened by the National Academies of Sciences, Engineering, and Medicine (NAS, 21 December 2016 - 13 March 2017).

The NAS panel evaluated the draft CSSR and published a document that captured consensus responses to questions posed within a carefully designed Statement of Task. The final report can be accessed [here](#) and an acknowledgment generated by USGCRP leadership [here](#). This memo explains actions taken by the CSSR writing team to accommodate the expert judgment of the committee.

A [Federal Register Notice](#) publicized the Public Comment Period and a web-based system collected input from the general public and external disciplinary experts. The tool also facilitated collection of author responses. Chapter writing teams considered each comment, noted edits and rationale within the web-based system, and revised the report. The Public Comment Period annotation can be accessed [here](#).

Three independent Review Editors evaluated author responses to both the NAS review and public comments, and the revised chapter drafts themselves, to confirm that the chapter writing teams had given due consideration to all review comments prior to submission for final agency clearance via USGCRP-participating agencies and departments of the U.S. Government, and ultimately by Federal officials comprising the Subcommittee of Global Change Research (SGCR) [Committee on the Environment, Natural Resources, and Sustainability (CENRS), a component of the National Science and Technology Council (NSTC)].

Names and affiliations of participants in the CSSR Public Comment Period were withheld from the authors, review editors, science steering committee, and staff throughout review and revisions. Anonymity helped preserve integrity of the drafting process. During registration, all reviewers consented to have their names associated with relevant comments once the report was published. The full report underwent two additional rounds of review after these responses were generated and, therefore, edits may have been made that are not part of the attributed set of comments included on the following pages.

First Name	Last Name	Comment Type	Chapter	Figure/Table No.	Start Page	End Page	Start Line	End Line	Comment	Response
Allison	Crimmins	Text Region	Front Matter		1	1	10	10	Suggest not saying it allows NCA4 to focus elsewhere, but noting that the findings of the NCA4 will be based on the physical climate findings of this report	Agreed. Text revised.
Harold	Tattershall	Text Region	Front Matter		1		11		In particular with regard to observed and projected risks: I feel that this statement is very misleading and inaccurate; it needs qualifying. Having read the entire document I find that there are observed and projected risks discussed but in the vast majority of cases these assessments are directly related to climatic or climate change events. Interconnected risks, specifically economic and those concerning societal disruptions, are hardly discussed, if at all. If climate change, in terms of cause and effect, posed no potential problems for society then why is any action to mitigate it required?	The first sentence in that paragraph states this is an assessment of the science. The NCA4 is intended to provide the information this reviewer wants to see. The sentence in question has been revised for further clarity in this regard.
Michael	MacCracken	Text Region	Front Matter		1	1	12	13	What are "known" mitigation actions? What I would like to know about are the effects of a range of actions, from doing nothing to a range of increasingly aggressive actions by world community—a lot would be feasible were we really serious.	This was eliminated during other text changes.
Allison	Crimmins	Text Region	Front Matter		1	1	14	15	Strongly suggest not calling readers of this report "savvy" (i.e., if you don't understand it, it's your fault and not the author's inability to write in accessible terms) and perhaps consider deleting both these lines or more clearly describing the difference between CSSR audience and NCA4 audience (the ES will be part of NCA4, so that falls in with that audience).	Text revised for better clarity but leaving the general statements of there being a difference in the audiences for the main report and the Executive Summary.
Allison	Crimmins	Text Region	Front Matter		1	1	18	18	In the entire 545 pages, you only use the acronym SSC twice (except for the glossary) and they both occur in this paragraph. Suggest not putting forth yet another acronym that is meaningless to readers. May also want to spell out NASA and DOE in line 19 since it is the first time using the acronyms and the #2 footnote comes later/ doesn't have acronyms listed.	Agreed. Text revised.
Michael	MacCracken	Text Region	Front Matter		1	1	18	20	No one from NSF representing the integrated views across the academic community it supports. Rather surprising?	D. Wuebbles represented NSF while a CLA.
Michael	MacCracken	Text Region	Front Matter		1	1	18	18	Regarding SSC and footnote 1—they seem incompatible. If they are Federal employees (for one, is an IPA really considered a "Federal employee"?), why is the group a federal advisory committee? That makes no sense as Federal advisory committee is composed mainly of non-government employees. If all the selected authors are also members of the SSC so they can meet together, then the text through line 24 needs to be clarified and it that there were notices of their meetings, etc., should be stated.	The SSC is a FAC but the full author team does not directly constitute a FACA committee (this was carefully dealt with by NOAA). An IPA is a Fed. Authors are not part of SSC. No change to the text.
Allison	Crimmins	Text Region	Front Matter		1	1	23	24	You may want more detail on the process and criteria for selecting contributing authors and whether they were brought in via contracts, etc., to avoid FACA complaints.	Text revised towards handling this concern. No contracts were made; the Contributing Authors were asked to provide their expertise for specific issues to the Lead Authors in cases where we had insufficient expertise on the author team.
Allison	Crimmins	Text Region	Front Matter		2	2	1	4	Not sure why the language here is throwing other sustained assessment products under the bus. Suggest dropping "Relative to other analyses" and "more comprehensive" and just say it is a comprehensive assessment of the science.	Good point—certainly not the intended consequence. Text revised.
Allison	Crimmins	Text Region	Front Matter		2	2	10	10	Spell out IQA. May also want to point readers to an appendix that will explain this and the process for literature review in more detail.	Text revised.
Michael	MacCracken	Text Region	Front Matter		2	2	10	10	This should define IQA, and it should also indicate compliance with the OMB guidelines for the Federal Data Quality Act, etc. -- both for references and process.	Text revised.
Kathy	Jacobs	Text Region	Front Matter		2	2	10	11	Need to define IQA if this explanation is provided - not clear that people need to know this but perhaps link to the guidance itself if they do.	Good point. Text revised.
Michael	MacCracken	Text Region	Front Matter		2	2	13	13	IPCC should be defined--and in this case making it clear it is an international assessment process with very rigorous review, etc.--you actually wait to page 5 to do this, quite strange.	Good point. Text revised.
Michael	MacCracken	Text Region	Front Matter		3	3	2	2	"The following" what? To be really clear, say following subsections describe the general content of the major sections of the report or something or this could refer to the whole report. Dangling participle.	Agreed. Text revised.
Allison	Crimmins	Text Region	Front Matter		3	3	8	8	Again, maybe be careful about how you're characterizing the audience. "Non-expert" sounds judgment-y. You can just say that it is written to be accessible to a wide range of audiences (especially since it will be in the NCA and therefore is in accordance with the NCA guidelines).	Text revised. Note that the Executive Summary will not be directly in NCA4; it is the starting point for writing the chapter that will appear in NCA4.
Michael	MacCracken	Text Region	Front Matter		3	3	8	8	Saying "non-expert" is really demeaning as it categorizes a person rather than indicating level of knowledge of a person. So, it is written for, for example, readers with interest in the subject, but only a general knowledge of the workings and physical, and biogeochemical interactions among the atmosphere, oceans, glaciers, ice sheets, and land surface.	Agreed. Text revised.
Michael	MacCracken	Text Region	Front Matter		3	3	11	11	So, are the authors the SSC? Do they include those identified as the SSC at the start of the section, etc.?	The SSC are those identified on page 1. The authors are not the SSC, and not all SSC are authors.
Michael	MacCracken	Text Region	Front Matter		3	3	13	13	Delete "be"	Agreed. Text revised.
Michael	MacCracken	Text Region	Front Matter		4	4	6	10	This seems to be a separate thought and paragraph, and it would seem it should be placed in a more prominent location.	Good point. These sentences moved to About This Report, page 1.
Kathy	Jacobs	Text Region	Front Matter		4	4	11	12	Since the public is not familiar with American and International units, recommend including degrees Fahrenheit and degrees Celsius so people have examples.	That is what the sentence says, but am including examples for clarification.
Nancy	Green	Text Region	Front Matter		4	5	13	10	Additional text is needed at the beginning of the "Reference time periods for graphics" section to explain that the scientific community does not have standard reference time periods, and that the reference periods used in this document are not the same as those used by the IPCC. Given the stage of the work on the assessment, I assume it is not possible to change the reference periods. I strongly encourage making that change in the future so that the reference periods will match those used for the next round of IPCC reports. Since that change is not likely to be possible for this current USGCRP effort, it will help to provide text regarding the differences in various reference periods used in major scientific documents on climate change, per the suggestions below. In the text regarding the 1901-1960 reference period (p. 4, lines 17-26), it will help to add specific text about the change in climate as indicated by the change in global average temperature, that occurred during that reference period. Providing such information will help readers/users interpret the information on temperature changes observed since then, as well as projections of future changes. It also will help to add text which acknowledges some climate change already had occurred prior to the reference period, and that the reference period does not represent a "pre-industrial" period. In the section on the "other commonly used reference period, 1976-2005 (p. 4, lines 27-34), add text to specifically state that this is different than the recent reference period used in the IPCC Fifth Assessment Reports, which was 1985-2005; this will help readers/users who are going to continue to find it challenging to make sense of the temperature projections (global, US, CONUS, and regional) in relation to different reference periods. In relation to the text on using 30-year time blocks for future projections (p. 4, lines 35-37), it will help to add text explaining that this differs from the use of 20-year time blocks in the IPCC Fifth Assessment reports and other sources (e.g., the use of 20-year time blocks in the USGS National Climate Viewer). In my experience, the 20-year timeframes used by the IPCC reports are a much better match for purposes of adaptation planning, so I strongly encourage the USGCRP to switch to using 20-year timeframes in the future (recognizing this is unlikely to happen at this point in the process for the upcoming report).	Text added to clarify the first point. Other points are handled in various chapters (e.g., the change in temperature over the entire time period is examined in Chapter 1). Authors were careful to state why they used the time periods chosen for this assessment. Chapter 4 discusses the Hawkins and Sutton papers.

First Name	Last Name	Comment Type	Chapter	Figure/Table No.	Start Page	End Page	Start Line	End Line	Comment	Response
Allison	Crimmins	Text Region	Front Matter		4	5	14	10	This section is really well done and very helpful. I can almost picture a nice simple graphic demonstrating the baseline versus projected time frames.	Thank you.
Michael	MacCracken	Text Region	Front Matter		4	4	14	21	In that the international negotiations are based on the change in conditions since preindustrial, I would suggest, even urge, that all plots shown should be showing the change in conditions since preindustrial and not using updated baselines that has the effect of giving an indication that the changes are less. For purposes of public education, having different baselines for graphs than preindustrial is really confusing.	Some results are provided relative to the preindustrial. The choice of 1901-1960 was discussed in NCA3.
Michael	MacCracken	Text Region	Front Matter		4	4	17	19	This is a very misleading sentence—it really fails to say that a lot of the graphics are pulled from other sources and all sorts of baselines are used. Chapter 1 graphics have baselines that are all over the place; it would seem that NOAA could quite readily prepare graphics so that all are based on the 1901-60 baseline—this would be well worth doing as the situation right now makes comparison of numbers across graphics simply not possible.	Text revised to provide further clarity on this point.
Michael	MacCracken	Text Region	Front Matter		4	4	17	34	Based on all of this discussion, it appears that the numbers and changes will thus not be consistent with IPCC presentations nor with the baseline time period used in international negotiations. This seems particularly inconvenient. I would urge a footnote indicating how much to add to the changes from baseline in order to be consistent with the international negotiations, especially given the baseline period that is used here includes the WWII period where there is still a clear warm bias in the ocean observations that will be lifting this baseline up from what is considered the preindustrial baseline. I think it absolutely essential that a clear explanation be given about how to translate from the baseline used here to the international preindustrial baseline.	The individual chapters do provide other information (e.g., Chapter 1 does discuss the change in temperature since preindustrial). We cannot deal with all of the different choices out there for time periods. A sentence is provided for clarity.
Michael	MacCracken	Text Region	Front Matter		4	4	22	22	Not only "less reliable" but having significantly less complete spatial coverage and instrument homogeneity.	Agreed, but don't need more text.
Michael	MacCracken	Text Region	Front Matter		4	4	22	22	Phrase "These graphs" is not very clear about what "these" refers to (several sentences earlier).	Text revised for clarity.
Michael	MacCracken	Text Region	Front Matter		4	4	24	24	What does "these" refer to?	Text revised for clarity.
Michael	MacCracken	Text Region	Front Matter		4	4	27	29	It seems to me that the notion of defining the climate as a three-decade average needs to be rethought in a situation when the climate is changing essentially monotonically. Using NOAA decadal averages, this means that in the worst case the present climate norm could be from 40 to 10 years ago. If this is so, then those planning buildings, water infrastructure, etc., who are, at least in some cases, required to be using the climate norms for their planning will be fighting against the norm of date. Using past decades was fine when the climate was stable and so one was averaging across natural variability, but significant problems are created when the underlying climate is changing. Related to this, decadal updating what is considered the baseline climate to use in calculating departures from the norm is also problematic, for it does not convey the total stress being applied to some systems (such as established forests, city locations with respect to sea level, etc.) that developed based on climate conditions from much earlier than the constantly updated normal. Hansen et al. in their paper on shifting summer temperature departures over the Northern Hemisphere use the mid-20th century norm as a persistent baseline and show that over only a few decades conditions that were three-sigma events (likelihood 0.1%) are now occurring about 10% of the time, and that what were five-sigma events in the mid 20th century (so virtually never occurred) are now starting to appear. This type of significant change with respect to many types of impacts just does not get captured if one keeps updating the climatic normals. It really seems to me that some discussion of this issue is needed—changes since a century ago have been really large, and a century ahead compared to the baseline will be astoundingly different—way out of what was once the normals that we were used to, and the report just does not seem to really convey the likely seriousness of such dramatic changes when it shows plots of just changes with respect to the present, which sort of presumes that some systems are not already under severe stress from the changes (or at least the greater extremes) that have occurred to date.	Figures are provided throughout that provide some this requested info, but it is not possible to consider all possibilities without making the document even longer than it is. We will provide special analyses for the NCA4 authors to deal with their specific needs for impacts and resilience analyses. No further changes to this text other than some clarifications already added.
Michael	MacCracken	Text Region	Front Matter		4	4	33	34	This is simply an inadequate explanation for why this is done and what it implies. Recall how Santer's study got blasted for not being current for leaving out only a few years—here, a whole decade has been left out. There needs to be a clear explanation of why this was done (e.g., to allow comparability among present runs with older ones) and to indicate that because natural forcings over the period beyond 2005 are not included in the continuing model simulations, there cannot be a comparison of observations and model simulations beyond this time without explanation (maybe saying it takes time to pin down all natural and other forcings, etc.). I frankly think at least a few key modeling groups should have by now extended the simulations to 2005 using estimates of natural forcings up to through 2015 so that one can really do a comparison instead of what is inevitably going to occur—namely a claim that model simulations don't match out past 2005, and then implying model simulations are unreliable, etc.—the present approach just creates an opening that will surely be exploited, indeed it already is being exploited and this report should be covering this and closing that gap.	Sorry, but there was a disconnect in many of the modeling studies for the two periods, so it is not possible in this assessment to do other than we did. Authors wanted to choose 1986-2015, but could not do so because of this problem. In any case, it does not greatly affect the results as discussed in the chapters.
Michael	MacCracken	Text Region	Front Matter		4	5	35	3	It really needs to be explained why 30-year periods are chosen (the original intent was to smooth out variability due to variations in natural forcings and oscillations and to have a reasonable sampling in order to estimate likelihoods of extremes and variations). What needs to be explained also is how weather and climate differ—that you will be presenting statistics of the daily weather assembled by looking over 30-year periods, that, in most ways, people and the environment live the weather rather than the climate—that the climate is made up of the weather, etc. Somehow, the text needs to help people relate to the longer time periods—most people and interests really want information on a much finer time scale, which can be done using pdfs, etc.—so talk about sliding periods and give indications of expected ranges of outcomes, without unusual changes in natural forcings and then with (e.g., how could a major volcanic eruption affect the expectation?).	Text revised for further clarity.
Michael	MacCracken	Text Region	Front Matter		5	5	12	15	The wording here is quite confusing—needs work. Indeed, the whole sentence is pretty long—and there is really no indication how the fifth CMIP differs from earlier ones—a footnote on that would help.	Text revised for clarity.
Michael	MacCracken	Text Region	Front Matter		5	5	15	15	How about changing word "focus in" to "resource for" or something similar.	Text revised as suggested.
Michael	MacCracken	Text Region	Front Matter		5	5	19	21	Is "fullest extent possible" meant to include that you referred to all the "Skeptics" literature as well (and the "Deniers" too, who do not even accept that CO2 plays a role in the greenhouse effect)? I'd urge a bit of qualifying here as I would think these groups might then expect to see the ranges include their values. You indicated earlier that you draw from the authoritative literature—fine to separately say that you also considered the basis for even wider ranges of estimates and found them wanting, etc.	Good point. Sentence revised for further clarity.
Allison	Crimmins	Text Region	Front Matter		5	5	22	22	Suggest deleting "in this understanding as". It is unclear what understanding you're talking about.	Agreed. Text revised.
Michael	MacCracken	Text Region	Front Matter		5	5	22	22	BIG OBJECTION: There are no degrees of "certainty"—that makes no sense. There can be degrees of uncertainty and degrees of confidence, but no degrees of certainty!!!!!! In the sentence here, I'd urge changing "state of certainty" to "extent of understanding" or something similar.	Sentence revised to provide better clarity.

First Name	Last Name	Comment Type	Chapter	Figure/Table No.	Start Page	End Page	Start Line	End Line	Comment	Response
Michael	MacCracken	Text Region	Front Matter		5	5	24	30	I am curious why "Confidence" comes before "Likelihood"--I would think people would first want to have an estimate of what is likely to occur (in words or pdf, etc.--so informal to rigorous) and then second have an indication of how confident the scientific community is in the result. I'd suggest reversing the order of the definitions of the terms, and this would then carry over to reversing the order of the paragraphs on page 6.	This section follows the order used in the NCA3, the Health, and the IPCC assessments. It would require extensive rewriting to reverse the order. Also confidence statements are required for all Key Findings. No change to the text.
Michael	MacCracken	Text Region	Front Matter		5	5	28	29	It is not just the measures of uncertainty that determines the decision, but more important the degree of understanding and knowledge about an issue--and then the remaining uncertainty and author estimates of unknown unknowns (It is not really necessary here to have a robust probabilistic estimate here--again, there is judgment involved), etc.	Good point. Sentence revised for further clarity.
Keely	Brooks	Text Region	Front Matter		6	6	7	17	In the text please note the limitations associated with using climate model projections to define likelihoods and probabilities.	Sentence added to provide further clarity on this point.
Michael	MacCracken	Text Region	Front Matter		6	6	15	17	BIG OBJECTION: Echoing a serious criticism I have had of IPCC, and that was a criticism of API for the first national assessment, I just do not think that such two-precision estimates of likelihood are justified, especially as one looks ahead in time. The notion that one can differentiate between 65 and 66% or 89 and 90% is just non-scientific. A much more scientifically justifiable way of differentiating the 66% boundary would be to fuzz it by saying "with a likelihood of more than about 2 out of 3" and the 90% boundary by saying "with a likelihood of more than about 9 out of 10." I do agree IPCC has done otherwise, but I think it is simply not justified given all the various uncertainties, and that a fuzzing is essential if one is to be rigorous about expressing our understanding.	Text revised for further clarity.
Michael	MacCracken	Text Region	Front Matter		6	6	30	30	What does "expert assessment" mean? Does this mean all 30 or so members have reviewed each one and all agree exactly with everything--are they all experts on all subjects. I really think making the likelihood terminology fuzziest makes much more sense in arguing that you are getting to agreement among the experts--this notion of sharp, two-figure precision on judgments seems to me to defy logic of how group decision-making works.	Text revise for clarity (and caption revised for Figure 2) to satisfy similar statements made by this reviewer in other places.
Harold	Tattershall	Text Region	Front Matter		7	7	4	5	This includes attention to the tails of the probability distribution of future climate change: Examining the tails of the probability distribution of future climate change is only one way these issues can be examined. It is equally arguable that the existing distributions apply to the Holocene and that as we enter the Anthropocene that entirely new distributions are forming. This would imply that certain observations, e.g., James Hansen's work on Northern Hemisphere summertime temperatures where he identified a 6-sigma event in 2015, could be the low end of the new distribution that is now in formation. The idea that a distribution containing 1.506 million events can be used as a guideline for predicting future events would not be considered in any business, military or by any parent; recognizing, and discussing the alternative of a new distribution brings more clarity to the overall situation.	It's not just the tails themselves but how the tails are changing as a result of climate change. What was a very unusual event could become much more common. The sentence has been modified for further clarity.
Michael	MacCracken	Text Region	Front Matter		7	7	7	7	I'd urge insertion of the word "potential" or "plausible" before the word "low-probability" as these are situations that could occur, not necessarily will occur.	Sentence revised as suggested.
Nancy	Green	Text Region	Front Matter		7	7	8	8	The phrase "best guess" is not a good description of expert opinion, and is very likely to be the basis for attacks on the credibility of any associated information -- which would be characterized as "guesswork." I strongly suggest replacing the term here and throughout the document, e.g., use "expert judgment" or some other term that better describes the basis for the information.	Good point. Text revised for clarity.
Harold	Tattershall	Text Region	Front Matter		7	7	9	11	This report also provides information on the outcomes lying outside this range which nevertheless cannot be ruled out, and may therefore be relevant for assessing overall risk. Overall the report is laden with discussions of uncertainty characterized by "if, and but" statements that have the hallmark of what is known in business as CYA (cover your ass) or Pearl Harbor (I told you this would happen) memos. Although scientists may feel it essential to express their concerns, how this is phrased is critical; as written in many areas this report plays straight into the narrative of those who claim the science is not settled.	Authors provide an assessment of the state of the science. The observed and projected trends say plenty about the importance of climate change and the resulting effects that matter to society but the reality is science is never fully settled. One should not expect it to be. We will try to check for statements that go overboard throughout the document. No changes to this text.
Allison	Crimmins	Text Region	Front Matter		7	7	15	15	While this section is great overall, I don't like the casual use of the word "surprises" here. Can we say they are unexpected if we are describing their potential in chapter 15? I understand what you mean, but perhaps suggesting these events have low probability/ high consequence is more clear, or noting that we have less ability to judge how likely they are, but they could be very important? At the very least, putting this phrase in quotations would hint that you mean it colloquially.	Good point. Text revised for clarity.
Kathy	Jacobs	Text Region	Front Matter		7	7	16	16	Tipping elements is not common usage, could you define what you mean? These are often called thresholds or tipping points?	Good point. Text revised.
Allison	Crimmins	Text Region	Front Matter		9	9	1	1	Note that this likelihood scale is NOT what was used in the health assessment. I know you say it is based on it, but it has a lot more categories and is more IPCC than NCA. That is fine, but you may want to be more clear that it is a departure from the recent assessments.	Authors have the IPCC reference specifically because they wanted to allow the authors to use a wider range of likelihoods. Not so sure this is so important to add another sentence because the reference is there, but a phrase was added to the caption to handle this.
Kathy	Jacobs	Text Region	Front Matter		9			1	It might be useful to link to a guidance document or appendix here. The difference between confidence and likelihood is not an easy thing for people to understand and providing more background explanation could be helpful. This language is much more prominent in this document than it was in NCA3 (deliberately avoided it in main document due to issues with communications).	IPCC provide much further discussion if the reader feels this is necessary. No further changes needed for this figure.
Keely	Brooks	Figure	Front Matter		2	9			The confidence levels metric is great! Thanks for including this.	Thank you.
Erica	Brown	Figure	Front Matter		2	9			Including (or shifting) Figure 2 from page 9 (part of Front Matter) to the summary will make it easier for readers to evaluate the statements made in the Executive Summary.	The Core Writing Team will consider this in the revision of the Executive Summary, especially for any standalone document, where just referring to the Front Matter may not be adequate. But no change needed to the Front Matter.
Michael	MacCracken	Figure	Front Matter	Figure 2	9				Regarding the definitions, I simply must object that I find it scientifically implausible, given uncertainties in both observations and modeling, that one can divide categories with two-figure precision. As indicated earlier, I have objected to IPCC on this point and API justifiably objected to the draft of the first national assessment regarding this (and the draft was changed in response to theirs and other comments on this point). There simply needs to be a change to saying something similar to, for example, "likely" being "greater than a likelihood of about 2 chances out of 3," etc. I'd note that, as well, Jerry Mahlman of NOAA/GFDL used an approach such as this in his most important Congressional testimony--the two-figure precision used, even if based on results from an ensemble of models (as the Weather Service derives their two-figure precision definitions of terminology) I just do not find plausible for projections, or even for past periods given various limitations in observations.	These are the definitions used by IPCC and were based on an overall analyses by a large group of scientists. The intention is to provide a shortcut for the language you suggest. A sentence has been added to the caption to clarify the interpretation for the reader.
Michael	MacCracken	Figure	Front Matter	Figure 2	9				Following up on a comment I made on this figure, I much prefer the expression of what words mean as used in the explanations of key findings in chapters 3 and 5, for example, so see page 145 (lines 17-21) and pages 199 (lines 25 to 31). Using odds to express what the words mean (I do wish they had said about) is much more justifiable than using two-figure precision for defining some of the boundaries.	Thank you. No further changes to the Front Matter.
Erica	Brown	Whole Chapter	Front Matter						This chapter has more than 10 pages so it was hard to manage comments here. Hence the whole chapter comments.	This is not a comment for the Front Matter.
									P.22 (of the printed document, p. 12 of PDF of this chapter) What is the confidence level in the higher bound for 2030? It is the only one that is not referenced. (lines 4-7)	

First Name	Last Name	Comment Type	Chapter	Figure/Table No.	Start Page	End Page	Start Line	End Line	Comment	Response
Erica	Brown	Whole Chapter	Front Matter						This chapter has more than 10 pages so i was hard to manage comments here. Hence the whole chapter comments. P.29 of printed document (line 5), There should be a hyphen after 'snow'.	Unclear comment. The word "snow" does not appear in the chapter and there are only 10 pages so no page 29.
Allison	Crimmins	Text Region	Executive Summary		11	12	1	7	This ES would be strengthened by giving us a bigger picture- have the results of the CSSR changed anything from NCA3? Have they improved upon the science, strengthened the evidence behind the same findings, found something new, or tightened our certainty? You can help give the NCA a raison d'être by describing why this report was so needed instead of just repeating or referring people back to NCA3-- how has the science advanced? You may even want to be so bold as describing what the findings mean about our potential futures (stopping just shy of policy recommendations, but giving us an idea of what scenarios are on the table). Though the CSSR is not about "secondary" impacts, this ES is also devoid of talking about PEOPLE. You could be making a very pithy, clear (easily quotable) statement about climate change putting Americans at risk, or even that the risk is even greater than the last NCA, etc. etc.	Thank you. The Core Writing Team added a new 2-page highlights section to the Executive Summary, to deliver the most important findings more clearly up front. The Core Writing Team has also slightly re-organized and improved the key findings in the rest of the Executive Summary to address this overall suggestion. As you note, this report is focused on the climate science rather than the impacts, and so there is still limited mention of societal impact statements.
Allison	Crimmins	Text Region	Executive Summary		11	11	10	18	I find this paragraph long winded (no pun intended) and not particularly helpful. It focuses so much on weather and actually makes what should be a simple distinction between climate and weather more complicated than necessary. I'm also not sure it belongs in the executive summary in the year 2018- it is not a key finding of this report. I'd stick this in the first chapter or a little text box somewhere and focus more on summarizing the findings in the executive summary.	Thank you. The Core Writing Team has deleted this section.
Michael	MacCracken	Text Region	Executive Summary		11	11	10	18	IMPORTANT: Scientifically, we do not "predict" climate change for future decades--we project that change based on conditions that we presume will occur, essentially based on scenarios of future societal and technological evolution. I think it absolutely essential that the difference between project and predict be clearly explained--and this is the place to do this. On line 10, the first word needs to be changed from "Predicting" to "Projecting". Especially in a sentence where a comparison is made to predicting the weather, this distinction needs to be very clearly explained and the proper word used. It seems to me that this paragraph does a good job of explaining the difference between weather and climate, and it would really be better to revise the first sentence so it does not use the word "predicting" at all, but indicates what the paragraph is really about, and then in a separate paragraph explain the difference between predicting (which is unconditional regarding human activities, etc.) and projecting (which is conditional regarding human activities, technological choices, etc.)	Thank you. The Core Writing Team has deleted this section and has also scrubbed the rest of the report and the Executive Summary for mis-used instances of predicted vs projected.
Keely	Brooks	Text Region	Executive Summary		11	11	12	12	Try to make 1.6F more comprehensible here.	Thank you. The Core Writing Team has added a new 2-page highlights section to the Executive Summary, to deliver the most important findings more clearly up front and with more context.
Keely	Brooks	Text Region	Executive Summary		11	11	18	18	WMO defines climate change as 30 years. The "decade to decade" will confuse practitioners.	Thank you. The Core Writing Team has deleted this section.
Keely	Brooks	Text Region	Executive Summary		11	11	20	20	Please add an example or context to make the 1.6F real. For example, during the last ice age the planet was YdegF cooler.	Thank you. The Core Writing Team has added a new 2-page highlights section to the executive summary, to deliver the most important findings more clearly up front and with somewhat more context.
Allison	Crimmins	Text Region	Executive Summary		11	11	20	21	A couple problems with "spatial and temporal non-uniformity". First, it is not written in language for "non-experts" as you call them. Second, is it the non-uniformity that has triggered other changes, or is it a combination of global warming at a large scale and regional non-uniformity at a small scale acting in concert? I think you could easily just drop everything in this sentence after the comma, or say something like "...over the last 150 years (1865-2015). The impacts of this warming has affected all parts of the Earth, but these resulting impacts have not been uniform over time or location." Or drop the sentence and say "Evidence for a changing climate abounds, from the top of the atmosphere to the depths of the oceans, though these changes have not been uniform."	Thank you. The Core Writing Team has deleted this section as written - in response to several comments - and focuses on the role of variability in box ES.1 instead, where it can be explained with more context.
Michael	MacCracken	Text Region	Executive Summary		11	12	34	7	Except for the sentence starting on page 11, line 10, this opening section reads as if it is all about the past and trends in observations to date. This is fine, but this is the introduction to the Executive Summary for the whole report, and thus there really needs to be some discussion about the future, why to be looking ahead (in particular that we have strong indications the changes are being caused by human activities, and these actions are ongoing) and then briefly explain how we project into the future. As noted in a previous comment, there really needs to be a discussion of the difference between predicting/forecasting and projecting, and there needs to be a discussion about scenarios being used, what they are composed of and our sense of confidence and uncertainty about all of this.	Thank you. The Core Writing Team agrees. The Core Writing Team has added a new 2-page highlights section to the executive summary, to deliver the most important findings (across the past and future) more clearly up front and with more context. The Core Writing Team has also added a box on future scenarios.
Michael	Kolan	Whole Page	Executive Summary		11				2nd to last sentence, 2nd paragraph. Recommend revising to "Thus, we can characterize the climate of a specific location (e.g., Chicago) or a region (e.g., Midwest) based on these long-term patterns. Last sentence 2nd paragraph. Recommend re-wording this sentence as climate change is more than weather patterns. Recognizing the introduction is providing some basic concepts there may be too much focus on weather and terminology. This introduction should not read as an FAQ. 1st sentence, 3rd paragraph. "The world has warmed (based on evidence from globally and annually averaged surface air temperature records) by about 1.6F (0.9C) over the last 150 years (1865-2015)," Also, should this be 1880-2015? 4th paragraph. This is an excellent point but it should include more than just weather extremes (sea level, ocean acidification, sea ice, etc.).	Thank you. The Core Writing Team has deleted this section as written. Regarding the 4th paragraph, the Core Writing Team has now added sea ice, ocean temperatures, and acidification.
Erica	Brown	Whole Page	Executive Summary		11				It is helpful to explain the relationship between climate and weather. This should help readers with a non-technical background distinguish between the two.	Thank you. The Core Writing Team received multiple comments that suggested that this didn't belong in the Executive Summary and there was some confusion between prediction of weather vs projection of climate, and so the Core Writing Team deleted this section as written. The Core Writing Team still discusses climate variability in Box ES.1.
Erica	Brown	Figure	Executive Summary	1	11				Figure ES.1 is useful because it makes projected temperature changes *and their distribution* clear to individuals with non-technical backgrounds.	Thank you. The Core Writing Team has kept this figure more or less 'as is'.
Michael	MacCracken	Text Region	Executive Summary		13	13	1	1	The preceding introduction provides no basis at all for the title's explanation about what is projected to happen in the future-- nothing on emissions scenarios, about how projections are made, the basis for having confidence in the projections; that is, based on physics, also evaluated against paleoclimatic history--indeed, it needs to be explained that the fact that the climate has changed the past is not a reason not to be concerned about future change, but indeed shows that climate can change, explain that we now understand what the major factors causing past changes were, and it is indeed our understanding of this that makes us concerned about what human activities are doing and can do to the climate. I just do not think that adequate introductory material has been presented for jumping to this finding.	Thank you. The Core Writing Team has added a new 2-page highlights section to the Executive Summary, to deliver the most important findings (across the past and future) more clearly up front and with more context. The Core Writing Team has re-organized and improved some key findings to give the recent change more context. The Core Writing Team has also added a box on future scenarios to this section to explain this process.
Michael	MacCracken	Text Region	Executive Summary		13	13	2	5	This is the one paragraph explaining how the conclusion on line 1 is justified. Well said, but these lines are all about the past. How can this opening paragraph supporting this important conclusion just talk about the value of observations?	Thank you. The Core Writing Team has re-organized, added to, and improved the key findings to better explain this conclusion.
Keely	Brooks	Text Region	Executive Summary		13	13	3	5	We recommend you explicitly note water resources in the examples due to the strong correlation between warming and hydrologic change.	Thank you. The Core Writing Team has added water resources.
Sarah	Zerbonne	Text Region	Executive Summary		13	13	6	10	In the text box, it is not totally clear in the sentence "Since the last National Climate Assessment was published..." whether the statement "2014 became the warmest year on record..." refers to the U.S. or global temperatures.	The Core Writing Team has slightly re-worded for clarity and added the word 'globally'. Thank you.

First Name	Last Name	Comment Type	Chapter	Figure/Table No.	Start Page	End Page	Start Line	End Line	Comment	Response
Michael	MacCracken	Text Region	Executive Summary		13	13	6	6	I would think this would have to be referring to "Temperatures" plural as the observed temperatures are not the same. It also might be considered whether the title should be about "Changes in Observed Global and U.S. Temperatures" as what is discussed is not about temperatures but about changes in temperature--indeed, it has yet to be indicated how we get at the global temperature (as a global or US integral of changes in temperature), and this is a point that is confusing to the public and merits clarification.	Thank you. The Core Writing Team has changed this sub-title to read 'Changes in Observed and Projected Global Temperatures'.
Allison	Crimmins	Text Region	Executive Summary		13	13	9	9	Update with 2016 data.	Thank you. Done.
Allison	Crimmins	Text Region	Executive Summary		13	13	11	20	Editorial: Check that you conf/likelihood rankings have same format throughout report. Are they capitalized? First word capitalized? Or no capitalization? Do they go before the punctuation like on line 12 or after, like on line 19. Also editorial, but you may want to put a comma in number like 1700 on line 14, so that it doesn't look like the year 1700 but is 1,700 years.	Thank you. The Core Writing Team placed the confidence/likelihood inside the period when it referred to one sentence of a longer key finding, and placed it outside the period (and thus capitalized the confidence/likelihood) when it referred to the whole key findings (multiple sentences). And thank you - the Core Writing Team has fixed the formatting according to our style guide (which does include a comma) for 1,700 years.
Michael	MacCracken	Text Region	Executive Summary		13	13	11	11	I am not sure that "measured" is the right word given how the large-scale integral of temperature is determined.	Thank you. This now reads "as calculated from instrumental records over both land and oceans".
Michael	MacCracken	Text Region	Executive Summary		13	13	11	12	I'd suggest making it clear that the period 1880-2015 is the period for which we have wide spread observations made in a reasonably comparable way (i.e., thermometers).	Thank you. The Core Writing Team added "from instrumental records".
Michael	MacCracken	Text Region	Executive Summary		13	13	12	14	It seems to me that the term "climate records" needs a bit of elaboration (perhaps in a footnote), and that why just records back 1700 years are chosen, and not using records going back much longer, and much can be learned from this longer record. We have climate records of other types that can take the record over back far more than a century--indeed, back near a million years using data from ice cores, and then over much longer with geological records, etc. Somehow, a bit more needs to be said about the longer-term record.	Thank you. The Core Writing Team has added detail to this key finding to clarify that this is the period where we can reconstruct the "distribution" of temperatures.
Kathy	Jacobs	Text Region	Executive Summary		13	13	12	12	Will you be updating this through 2016? to 1/7 degrees C?	Yes, the Core Writing Team has added 2016 data.
Melanie	Mayes	Text Region	Executive Summary		13	14	14	2	warmer at any time in the last 1700 or 1500 y?	Global 1,700 years, and U.S. 1,500 years. The Core Writing Team has re-organized the key findings slightly so that Global and U.S. are more clearly identified.
David	Hawkins	Text Region	Executive Summary		13	13	16	27	The findings on human contribution are robust. This aspect of climate science is critical to an informed process for managing climate change risks. The overall conclusion that humans are primarily responsible for observed changes, particularly since 1951 is important to focus response measures on the human activities that have contributed to these observed changes in temperature. It seems to me that this sentence could also usefully mention how rapid the current change is in comparison to the geological record.	Thank you. The Core Writing Team has further clarified this statement and added more about climate causes in a new 2-page highlights section at the beginning of the Executive Summary.
Michael	MacCracken	Text Region	Executive Summary		13	13	16	18	This is a very important and sound conclusion, and is indeed very high confidence.	Thank you - the Core Writing Team agrees and has added 'and have risen faster than...'
Michael	MacCracken	Text Region	Executive Summary		13	13	16	20	for lines 17-18: it is an overly broad statement to say "[a]l] observed climate changes in the industrial era"? Shouldn't human-caused climate change related to greenhouse gas emissions be specific to such things as global mean temperature increase, global patterns of change in the cryosphere, increasing heat content of the global ocean, etc., mostly in the period since ~1950? The industrial era goes back to the 1700s, but the human imprint on climate change is concentrated in the late 20th and early 21st century. The information in the next bullet point (lines 27-27) is better for its specificity.	Thank you. The Core Writing Team has further clarified this statement and added more about climate causes in a new 2-page highlights section at the beginning of the Executive Summary.
Nathan	Mantua	Text Region	Executive Summary		13	13	17	31	lines 28-31: this bullet point claiming that natural variability is only important on "short time scales" is not consistent with recently published research aimed at estimating the relative contribution of natural interdecadal variations (specifically the AMO and PDO/PO) to global mean temperature trends. In fact, the role of natural climate variations in changing global mean temperatures and temperature trends is discussed at some length in Chapter 5	Thank you. The Core Writing Team has added emphasis for the last 6 decades. And for the natural variability key finding, the Core Writing Team has significantly re-worded to clarify.
Allison	Crimmins	Text Region	Executive Summary		13	13	18	18	I LOVE this line about "no alternative explanations". Clear, straightforward. I would suggest adding this to the overarching text at the beginning of the ES. This is something likely to be quoted.	Thank you. The Core Writing Team has further clarified this statement and also added this into a new 2-page highlights section at the beginning of the Executive Summary.
Michael	MacCracken	Text Region	Executive Summary		13	13	18	18	There are no alternative explanations is not a good phrase in this world of "alternative facts" - so I would say "no credible alternative explanations"	Thank you - yes, the Core Writing Team has added 'solar output' and re-organized the statement slightly to accommodate this point.
Kathy	Jacobs	Text Region	Executive Summary		13	13	19	20	of the warming has triggered many other changes to the Earth's climate	Thank you - the Core Writing Team has added the word 'credible'.
Kevin	Trenberth	Text Region	Executive Summary		13	13	21	22	It is the global heating (radiative forcing and feedbacks) that caused these changes not the temperature change. The latter is also a consequence, not a cause.	Thank you. This comment appears to refer either to page 11, line 21, or page 33, line 3. In either case, this section has been significantly reworded and no longer appears.
Allison	Crimmins	Text Region	Executive Summary		13	13	24	24	After saying 1.2 falls right in the middle of 1.1-1.3, the word "most" seems tepid here. It is not just "most" in the sense of greater than 50%, yes? It is almost all... Or even "all, or nearly all"? I recommend making clear bold statements.	Thank you - yes, this was confusing for several reviewers. The Core Writing Team has reworded to clarify.
Michael	MacCracken	Text Region	Executive Summary		13	13	25	26	I think that it might be useful to say "The net estimated influence" or something similar. The volcanic influences are not small in the first year of the influence--it is their average or net influence. And solar has gone up and down, so again, saying "net" or something similar would help. So, I'd say that the word "small" thus needs a bit of qualification, etc.	Thank you. The Core Writing Team has added clarity that it refers to the whole period, not to any specific year.
Allison	Crimmins	Text Region	Executive Summary		13	13	29	29	Should the word "climate" in "has important climate impacts" actually be "weather"? You were careful to point out the difference earlier.	The word 'climate' no longer appears in the first part of this sentence and the key finding has been slightly re-worded for clarity. Thank you.
Michael	MacCracken	Text Region	Executive Summary		13	13	29	29	Need to define "short"--perhaps say seasonal to decadal or something similar (or perhaps say up to a decade or two).	Thank you. The Core Writing Team has added 'months to years' and the key finding has been slightly re-worded for clarity.
Michael	Kollan	Whole Page	Executive Summary		13				State: 'Evidence of warming and changes in the climate systems continues to grow stronger.' Adding 2016 global mean temperature to next draft. Emphasize what is "new" right up front with this report. Since IPCC 2013, since NCA3 - What in the science is new.	Thank you. The Core Writing Team has added 2016 data, and has added a 2-page highlights section at the beginning of the executive summary to capture an even higher level summary of what's important. The Core Writing Team has also reworded the box that summarizes 'Advances since NCA3', but continues to emphasize what is strengthened as well as what is emerging. What's 'new' isn't always as robust a finding as what has gained new degree of confirmation.
Michael	MacCracken	Text Region	Executive Summary		14	14	2	2	Without having explained the factors affecting millennial and longer time change, I'd expect reader to be a bit confused by the "at least the past 1500 years"--there needs to be an explanation about how orbital elements might well have made NH overall warmer peaking about 6000 years ago, but at time SH would have likely been cooler (though really only a small amount of land would likely have damped this out by larger ocean area). But some context is really needed about what we know over longer term, and so why the large global warming is important, etc.	Thank you. The Core Writing Team discussed this comment and felt as though this is too much detail, with too much nuance for an Executive Summary.
Michael	MacCracken	Text Region	Executive Summary		14	14	3	7	You might explain that drier areas will warm more than wetter areas due to evaporative cooling, so this differentiation is expected (and explained).	This key finding is actually no longer present in the same form. The Core Writing Team also generally left explanations of climate processes to the chapters, rather than adding too much background to the Executive Summary.
Kathy	Jacobs	Text Region	Executive Summary		14	14	3	14	It is important to explain why the contiguous U.S. temp change is different from global; also, because the global surface temp trends figure shows the warming hole in the SE U.S. it would be good to explain that as well.	Thank you, but respectfully, the Core Writing Team feels as though this is too much detail on climate processes for the Executive Summary. The Core Writing Team also hopes that Figure ES.1 helps to highlight that not everywhere in the globe has warmed at the same pace.

First Name	Last Name	Comment Type	Chapter	Figure/Table No.	Start Page	End Page	Start Line	End Line	Comment	Response
Michael	MacCracken	Text Region	Executive Summary		14	14	9	12	It is pretty clear from looking at records over the ocean that the high temperature bump during WWII is still a remaining bias in the record—such a bump is not evident in land records. I'd suggest that some indication of greater uncertainty during WWII should be mentioned as it looks suspicious and misleading interpretations about the strength of solar forcing have been made as a result of this misleading record. The caption might also indicate that at least some of the greater variability during the 19th century is due to limited coverage of the observations.	Thank you. The take-away from this graphic and from the key findings is designed to emphasize the long-term trend and the Core Writing Team feels as though it might get confusing to add too much detail to explaining a short period in the middle of the century. However, in Chapter 1, a fuller discussion of the trends is provided.
Allison	Crimmins	Text Region	Executive Summary		14	14	11	11	It may be confusing to say on page 13 line 12 that temps increased 1.6F from 1880 to 2015, but then to also say on page 14 line 11 that temps rose 1.6F between the first half of the century and the last 30 years. Though both may be true, it may be easier to understand how these things are measured if you say it in both places in the same way. Also, since this is the NCA ES, I wonder if observed temp change in the US would make a better figure, or a possible second figure for this section.	Thank you. Yes, the Core Writing Team has now made this consistent. And has added a more obvious section on the U.S. temperature, along with a projected temperature graphic.
Kevin	Trenberth	Text Region	Executive Summary		14	14	15	15	Projected values are given with no basis. Models are used but are far from perfect and they are not even mentioned.	Thank you. The Core Writing Team has added a box on future scenarios used.
Marcus	Sarofim	Text Region	Executive Summary		14	14	16	19	"Even if humans immediately ceased emitting greenhouse gases into the atmosphere, existing levels would commit the world to at least an additional 0.5°F (0.3°C) of warming over this century relative to today" Chapter 4 is clear that it is a "constant concentration" scenario that leads to 0.3°C warming, not a "zero emissions" scenario. There is an important difference between the two.	Yes, thank you. The Core Writing Team has changed the wording to better clarify.
Michael	MacCracken	Text Region	Executive Summary		14	14	16	16	Good job using "projected" here, but there has been no explanation of how this word differs from "predicted", and there needs to be, as noted in an earlier comment.	The Core Writing Team has scrubbed the report to ensure that predicted is not erroneously used. Thank you. And has added a box on future scenarios and how climate is 'projected'.
Michael	MacCracken	Text Region	Executive Summary		14	14	18	18	"levels" needs to be changed to "concentrations" or else it could equally be read to refer to emissions, and then the whole sentence would be wrong. There is a wide misconception that stopping the increase in emissions is all one has to do instead of cut emissions to zero, so statements like this need to be very clear.	Thank you. Changed to concentrations. And whole key finding has been improved for clarity and precision.
Michael	MacCracken	Text Region	Executive Summary		14	14	18	19	Does this half degree value include the warming effect of cutting SO2 emissions? My sense is that this value only includes the amount of warming from continuing to thermal equilibrium.	Thank you. The Core Writing Team has included a significantly greater amount of discussion in Chapters 4 and 14 on how these projections are made, but decided not to add more detail in the Executive Summary.
Sarah	Zerbonne	Text Region	Executive Summary		14	14	19	19	It may be prudent to put a year in place of the word 'today' given it may not be clear what date or year 'today' refers to.	Thank you. The Core Writing Team has changed this to say 'relative to the last few decades'.
David	Hawkins	Text Region	Executive Summary		14	14	19	22	The dependence of the magnitude of climate change on future emissions starting today is a key finding. Future emissions, especially those in the next few decades, are the factor over which today's decision makers have the most control.	Thank you. The Core Writing Team has split this key finding and added more detail to emphasize this point, and added a new 2-page highlights section at the beginning of the Executive Summary to further emphasize the major points.
Michael	MacCracken	Text Region	Executive Summary		14	14	19	19	I'd suggest changing "magnitude" to "amount"—magnitude (as in order of magnitude) often refers to changes of by a factor of 10 or so, so be clearer here.	Thank you. The Core Writing Team understands your point, however 'amount' is already used in the other part of the sentence, and the authors prefer to use this more frequently used word when referring to the degree of climate change.
Melanie	Mayes	Text Region	Executive Summary		14	14	21	21	should add that the time to equilibrate also factors into the fate that warming will continue even if greenhouse gas emissions stopped immediately	Thank you. The Core Writing Team has reworded these key findings and a new KF now addresses projections for stabilized greenhouse gas concentration.
Steve	Albers	Figure	Executive Summary	ES1	14				There are two baseline periods referred to in the Left Figure caption. For simplicity can the caption be modified to use just one of them?	Yes. Thank you. Both graphics now have the same base periods.
Michael	Kolian	Whole Page	Executive Summary		14				Figure ES.1 Global Temperatures Continue to Rise: The caption describes the change of 1.6F between 1986-2015 relative to 1901-1960 but this is inconsistent with the first bullet on page 13. Also, the graph itself describes anomalies from the complete period of record 1880-2015 - this may be confusing. Interestingly, the difference value for 2015 appears to be 1.6F.	Thank you. The Core Writing Team has now standardized all statements to the 'difference' calculation.
Michael	MacCracken	Figure	Executive Summary	ES.1	14				The title of the chart says "Surface Temperature Trends" but the key shows that the chart is temperature changes, which are not trends unless this is a record over some period. Either say changes or say trends (which has a time element)—not both.	Thank you. This has been changed to 'changes'.
Melanie	Mayes	Figure	Executive Summary	es1	14				should explain what is an anomaly	The caption does refer to blue and red bars illustrating values below and above the average respectively, but the authors feel as though further explanation of an anomaly is probably outside of the level of detail optimal in an Executive Summary.
Nathan	Mantua	Text Region	Executive Summary		15	15	1	6	what about the potential for natural, internal variability to either amplify, reduce, or even reverse surface temperature trends for significant parts or all of the US over the next few decades? This issue is covered in some detail in Chapters 5 and 6 (see Deser et al 2012, Deser et al 2014, Deser et al 2016) Deser, C., L. Terray and A. S. Phillips, 2016: Forced and internal components of winter air temperature trends over North America during the past 50 years: Mechanisms and implications. J. Climate, 29, 2237-2258, doi: 10.1175/JCLI-D-15-0304.1. Deser, C., A. S. Phillips, M. A. Alexander, and B. V. Smoliak, 2014: Projecting North American Climate over the next 50 years: Uncertainty due to internal variability. J. Climate, 27, 2271-2296, doi: 10.1175/JCLI-D-13-00451.1. Deser, C., R. Knutti, S. Solomon, and A. S. Phillips, 2012: Communication of the role of natural variability in future North American climate. Nat. Clim. Change, 2, 775-779, doi: 10.1038/nclimate1562.	Thank you. The Core Writing Team feels as though further treatment of this in the Executive Summary is too much detail and nuance. The authors prefer this to belong in a chapter where the discussion can include more context.
Michael	MacCracken	Text Region	Executive Summary		15	15	1	4	The reason that the US (and other land areas) will warm more than the global average needs to be explained—land areas warm more than ocean due to lower thermal capacity and due to less effective evaporative cooling than the ocean. I think giving a reason for an effect helps to make the point more convincing, especially when talking to a lay audience. Otherwise, the argument is made that the result just comes from unreliable models—and this is just not true on several accounts. Statements like temps of recent record setting years will become relatively common in the near future would make great points in the overarching ES section—short, pithy and relatable by real people	Thank you. The authors have elected to leave explanation and background to the discussion in the chapters. The Core Writing Team feels as though more detail might dilute the clarity of the finding rather than the other way around.
Allison	Crimmins	Text Region	Executive Summary		15	15	3	4	Word "scenario" is used, but has yet to be explained for a lay audience. Definition/explanation is needed.	Thank you. The Core Writing Team has added a new 2-page highlights section to the Executive Summary, which includes this statement.
Michael	MacCracken	Text Region	Executive Summary		15	15	4	4	I am not a fan of two-figure precision—I'd suggest saying, for example, roughly 8-9 F instead of saying 8.7 F	Thank you. The Core Writing Team has added a box on future scenarios.
Michael	MacCracken	Text Region	Executive Summary		15	15	4	6	This graph does NOT show the expected ranges of "climate sensitivity", but the expected ranges of warming for two different emission scenarios; I'd add that why there is a range has also not been explained. Again, "scenario" has yet to be explained!	Thank you. Yes, the Core Writing Team has now made these ranges.
Michael	MacCracken	Figure	Executive Summary	ES.2	15				Change "under" to "with"—or perhaps relate to "with higher rates of emissions in the future"	Thank you. The Core Writing Team has added a box on future scenarios in the previous section and this figure and caption has been changed to clarify.
Michael	MacCracken	Text Region	Executive Summary		16	16	2	2	Added the word scenarios: "Significantly More Warming Occurs Under Higher Greenhouse Gas Concentrations Scenarios"	

First Name	Last Name	Comment Type	Chapter	Figure/Table No.	Start Page	End Page	Start Line	End Line	Comment	Response
Michael	MacCracken	Text Region	Executive Summary		16	16	2	2	While the word "greenhouse gases" has been used previously, I have yet to read an indication of which gases in this category are most important or even what greenhouse effect means (other than to say "heat-trapping"). It would be nice to have some sort of box providing an explanation of the effect itself. As one critic has actually correctly noted, adding greenhouse gases actually causes the atmosphere to emit more IR radiation (as well as absorb more)—but the former dominates as there is additional transfer of energy to the atmosphere that it must get rid of by IR, and the IR flux to space (at equilibrium) is the same as before. Getting this right would really add to credibility, if perhaps not readability.	Thank you. The authors are electing not to include significant amounts of 'primer' material or background on climate processes. There is significant additional discussion in chapter 14 regarding which GHGs are included in projections.
Michael	MacCracken	Text Region	Executive Summary		16	16	5	5	I'd suggest changing "pathways" to "emissions pathways"—indeed, you might even want to do this in terms of cumulative future emissions, given IPCC has said this is really the key factor and negotiators are talking more and more about emissions budgets.	Thank you. Strictly speaking, these are not emission pathways. The emissions are derived as one plausible route to achieving a 'Representative Concentration Pathway'. The Core Writing Team has added a box to explain more about scenarios.
Michael	MacCracken	Text Region	Executive Summary		16	16	6	7	Calling 1976-2005 "near present" rather than "recent past" will likely lead to the impression (and to criticisms) that the report is not up-to-date, which is just not true.	Thank you. The authors feel as though there is adequate indication that the report reflects data through 2016.
Allison	Crimmins	Figure	Executive Summary	Figure ES.3	16				It is very hard to distinguish between the lightest yellow color and the other light yellows, though much of the maps fall in this range. Suggest using more oranges or making the yellows darker/more gold	Thanks. Unfortunately, it doesn't really work to make the light yellows darker, since it then makes the middle and upper range harder to differentiate.
Michael	MacCracken	Figure	Executive Summary	ES.3	16				I think it would also be useful to show a figure or how actual temperatures would compare—then indicating reduced temperature gradient will obviously affect the weather. I think showing a displacement of climate for a few states might be shown (especially given one of the lead authors is known for such figures).	Thank you. The authors feel as though this is too much detail for an Executive Summary figure. And this Executive Summary doesn't address state level changes.
Allison	Crimmins	Text Region	Executive Summary		17	17	1	2	Suggest changing title to "Extreme temperature and precipitation events are becoming more common"	Since not all extreme temp and precip events are becoming more common, the authors have decided to retain 'many'.
Allison	Crimmins	Text Region	Executive Summary		17	17	12	12	detailed understanding is insufficient to do what? People could read this to mean that we have so much uncertainty that our science is insufficient to guide policy or actions. Suggest rewording to get across more research is needed.	Thank you. This has been reworded.
Michael	MacCracken	Text Region	Executive Summary		17	17	12	12	I'd change "in" to "given". Regarding the text box below, is the phrase "very high confidence" properly placed. I'd suggest the evaluation pertains primarily and is most meaningfully included if placed after the first sentence, as placed now it might be interpreted as only applying to the second sentence, and this is pretty much an obvious conclusion, so inclusion of the phrase is not very meaningful	Text on line 12 has been changed so the 'in' is no longer there. The text box has now been replaced with a different key finding.
Nathan	Mantua	Text Region	Executive Summary		17	17	17	18	It is notable, I think, that Fig. ES.5 shows that for most stations in the US extreme warm days in the 1981-2005 period are cooler than extreme warm days in the 1901-1960 period. Readers will see that figure and may wonder why that striking pattern is not mentioned in the executive summary.	Thank you. This was a challenging figure to explain adequately in the Executive Summary and ultimately best dealt with in the chapter. The Core Writing Team decided to replace this figure.
Allison	Crimmins	Text Region	Executive Summary		17	18	17	9	These bullet points jump around a lot between observed and projected impacts. Any reason why this section does not follow the same format as the previous section, which split observed and projected temp trends into two sections?	Thank you. The Core Writing Team has re-organized and added sub-headings so it is easier to follow.
Michael	MacCracken	Text Region	Executive Summary		17	17	17	18	The results of Hansen et al. with his shifting Gaussian make clear that summer (or seasonal) temperature anomalies have also occurred. Indeed, Hansen's analysis of observations shows that up to five sigma events are occurring—which is astounding. So, it is not just the number of particular days that is changing, but the nature of seasonal anomalies.	Thank you. Yes, seasonal changes are discussed in the chapter, but the authors have elected not to include in the Executive Summary, based on space.
Michael	MacCracken	Text Region	Executive Summary		17	17	18	18	"extreme cold waves" used to be referred to as Siberian express events—I would think that including that name in parentheses might be a helpful link for the public.	Thank you for helping us to be accessible. However, in this case, the authors respectfully disagree since this is not typically used anymore.
Michael	MacCracken	Text Region	Executive Summary		17	17	21	25	It would help to define "heavy precipitation events"—how much in how long a time. While this may differ by region, giving an indication would help. I also think it might be worth explaining here how a shift in the bell-shaped curve tends to lead to a proportionately larger change in what have in the past been considered heavy and extreme events.	The Core Writing Team has switched out the heavy precipitation figure so that it is clear that multiple ways of defining 'heavy precipitation' can be used and, while there are important differences, the basic key finding is true across multiple indices.
Michael	MacCracken	Text Region	Executive Summary		17	17	21	25	It would help to mention that this exact type of change is also evident in the observations over all of the Earth's other continents (at least all but Antarctica).	The increase in heavy precipitation globally is now in a green box key finding. Thank you.
Kathy	Jacobs	Text Region	Executive Summary		17	17	26	30	The concept of atmospheric rivers is not intuitive - important to provide a more accessible explanation since this is in the "new science" category	Thank you. We have attempted in the parentheses to explain this, and there is more explanation in the chapter.
Kevin	Trenberth	Text Region	Executive Summary		17	17	29	30	Mostly, statements are made with no understanding of why. Here is a nice exception in that it gives a reason for the change, except the reason here is quite wrong. The reason is the higher atmospheric moisture content. It relates more to higher temperatures than higher evaporation!	Thank you. Respectfully, the Core Writing Team contends the existing explanation is accurate, given that it indicates that higher evaporation occurs with higher temperatures.
Michael	MacCracken	Text Region	Executive Summary		17	17	29	30	This whole point is a very strong and useful conclusion—so I think it would be useful to be even more specific, saying "increasing evaporation from the oceans" and "with increasing ocean temperatures."	Thank you. In the Executive Summary, the Core Writing Team has elected to try to keep the key findings as straightforward (and short) as possible, so as to allow the take-away to be as clear as possible. So the authors decline to add this detail in this case.
Allison	Crimmins	Text Region	Executive Summary		17	17	31	34	It would be useful to note even in this short key finding in the ES that the drivers of the Dust Bowl were not just climate change. A lot of other factors at play that make this a sorta unfair comparison.	Yes. There is certainly further explanation that would be necessary for a full and complete picture of why the Dust Bowl was so prominent, however, authors have declined to add this detail in the key finding, noting that most present-day droughts also have non-climate factors that play a role.
Michael	MacCracken	Text Region	Executive Summary		17	17	33	33	I'd suggest adding a phrase here so this says "the 1930s, which was also amplified by poor land use choices, remains". This is really comparing apples and oranges unless some of the other causative factors are mentioned.	Yes. There is certainly further explanation that would be necessary for a full and complete picture of why the Dust Bowl was so prominent, however, authors have declined to add this detail in the key finding, noting that most present-day droughts also have non-climate factors that play a role.
Allison	Crimmins	Text Region	Executive Summary		18	18	3	3	Well anything is "possible". Of course you have very high confidence that it is possible. I think what you mean to say is that under these situations, long-lasting hydrological drought is projected (or expected) with very high confidence.	The authors feel as though it is not quite justified to say that it is projected to occur with very high confidence (that is stronger than the evidence allows), but have changed this to "increasingly possibly".
Keely	Brooks	Text Region	Executive Summary		18	18	8	9	We recommend not including low confidence findings when they are not making a specific point or adding important value, for example in the executive summary on page 18 lines 8-9.	Thank you. Generally, this is guidance the Core Writing Team has also adopted; however, in this case, frequency would have been a 'missing' part of this key finding and authors felt it was worth pointing out the different projected elements of hurricanes and where confidence differs.
Michael	MacCracken	Text Region	Executive Summary		18	18	13	14	I think the explanation of what the graph shows is really quite confusing. I just don't think that saying the "top 20% of the annual maximum daily precipitation values in each period for events exceeding the threshold for a 5-year return period" is really very clear—why two thresholds and which one prevails, etc.	Thank you. This figure has been changed in response to several comments.
Michael	MacCracken	Text Region	Executive Summary		18	18	14	15	I think the sentence needs to start with something like "In comparing the two periods, ..." to make clear what "greater" refers to.	Thank you. This figure has been changed in response to several comments. And AK and HI have been added.
Allison	Crimmins	Figure	Executive Summary	ES.4	18				This figure looks very similar to the extreme precip maps in NCA3 (and actually NCA2), but those maps are looking at metrics like percent change in heaviest 1% events and this maps is looking at something much more complicated—difference in the average of the top 20% of event with a 5-year return. By making the maps look very similar (same color scheme, same faded black boxes with the percents over the regions) these different graphs could be confused as showing the same thing. A reader could easily be mistaken into thinking the 12% increase in the Pacific NW shown in NCA3 has been downgraded to just 3% increase in NCA4 (so nothing to worry about!). I would suggest using the same metric, or changing the look and feel of this graphic so it doesn't confuse people. Also need to add Alaska, Hawaii, and Caribbean and note if the baseline years in those regions are different.	Thank you. This figure has been changed in response to several comments. And AK and HI have been added.

First Name	Last Name	Comment Type	Chapter	Figure/Table No.	Start Page	End Page	Start Line	End Line	Comment	Response
Michael	MacCracken	Figure	Executive Summary	ES.4	18				As a personal view, I think the word "drought" implies that the effect is of natural origin and would be expected to bounce back at some time ahead. Instead, what is occurring is a climate change in which the dry subtropics are expanding, thus altering the expectation of wintertime precipitation regimes from centralized around some norm to a situation with more and more years being dry and fewer and fewer being wet (even extremely wet such as in California this year). We don't say the Sahara is experiencing a drought, even a "chronic, long-lasting, hydrological drought" although this latter phrase is better than simply saying only "drought." Essentially a long-term shift is occurring.	Thank you. The projections don't necessarily support uninterrupted drying throughout the year. So the authors are electing to stay with this language at this time.
Kathy	Jacobs	Figure	Executive Summary	ES 4	18				The figure on Observed Change in 5 year Extreme events is problematic because it uses exactly the same color scheme as a similar graphic that was widely publicized from the NOAA but its results appear to be entirely different. To the uninitiated, it looks like the severity of rainfall events is decreasing in the northeast, when in fact it is just a different metric (5 years vs 1% events). Strongly recommend changing the color scheme and to provide some explanation that there are different ways of measuring intensity of precip	Thank you. This figure has been changed in response to several comments.
Michael	MacCracken	Text Region	Executive Summary		19	19	4	7	I'd be interested to know to what extent the daily summer maximum temperatures across the US might have been affected by the extension of irrigation. The spatial pattern of the cooling vs. warming in the Great Plains really is, it seems to me, quite suggestive that irrigation (so evaporative cooling) may be playing a role in keeping the eastern Great Plains cooler than it was. I would also note that over much of the Northeast, there has been significant reforestation, and this too would be a cooling influence. I think it might be useful to indicate that increasing the GHG concentrations would be expected to raise the nighttime minimums more than the daytime maximums (which really has more to do with moistness of the surface), etc.	Thank you. While this is too much to cover in an Executive Summary, there is greater discussion of this trend in Chapter 6.
Allison	Crimmins	Text Region	Executive Summary		19	21	10	5	I was at first surprised to see a text box in the Executive Summary since it doesn't seem the natural place for something like this. Still, I really liked this text box. Great information and written at a good reading level. I would suggest shortening it however- a three page text box is hardly a text box. I would suggest deleting the last two paragraphs (page 20 lines 8-25) and keep this just on the different circulation patterns, which fit in nicely with figure ES.6. It doesn't seem that a text box has to be this comprehensive and the cut good information could be saved and made into another text box later or added to a chapter. That way this text box has a clear focused single message.	Thank you. The Core Writing Team feels as though the last two paragraphs actually convey a couple of critical points. For example, since Arctic change is so rapid and large, and it is covered in this report, authors also wanted to make it clear that this doesn't just affect Alaska, but potentially much of the U.S. And even large scale circulation, such as the sub-tropical dry zones, may fundamentally change parts of the U.S. climate.
Michael	MacCracken	Text Region	Executive Summary		19	19	10	10	I don't understand the phrase "Halfway Across the World"--pretty clearly what is happening across the whole world is affecting the US, although some regions more than others. Why not say "Around the World"?	Thank you. This heading has been changed.
Michael	MacCracken	Text Region	Executive Summary		19	20	10	25	Why is it that this subsection is so different in style than the preceding section--this one being text focused and the preceding one being bullet focused?	Thank you. This is a text box. When the report is laid out for publication, it will be clearer that this is a bounded box.
Keely	Brooks	Text Region	Executive Summary		19	20	21	7	Please add a note about PDO.	Thank you. The Core Writing Team agrees the PDO is important, but has not added more 'modes' into this paragraph, instead focusing on the two related sets of modes that specifically affect the U.S.s in the way laid out. The Core Writing Team is trying to keep the length as tight as possible, while still making the essential points.
Allison	Crimmins	Figure	Executive Summary	ES.5	19				Consider simplifying the title and adding information about the Dust Bowl in the caption (that this was driven by more than just temperature- Poor land use practices and many years of intense drought contributed to these heat waves by depleting soil moisture and reducing the moderating effects of evaporation). Maybe also note in the caption that increases in warmest days are negative (blue) because they are subtracting out the baseline years that include the Dust Bowl, but that trends since 1950 are XYZ.	Thanks. This figure has been replaced in response to a number of comments.
Michael	MacCracken	Figure	Executive Summary	ES.5	19				To me, the scales for the top figure should be inverted so the positive anomalies are on top.	Thanks. This figure has been replaced in response to a number of comments.
Melanie	Mayer	Figure	Executive Summary	es5	19				any explanation why even though 2014, 2015, 2016 are the hottest years to date, the 1930s still remain the most extreme?	The reviewer is confusing changes globally with specific events in the continental United States. The 1930s had the worst heat waves and drought in the continental United States because of the effects of the dust bowl (which in itself had strong human related factors in their occurrence), but the 1930s were not particularly warm years worldwide.
Kathy	Jacobs	Figure	Executive Summary	ES5	19				The Dust Bowl domination title really begs the question of why climate change hasn't changed the hot day extremes...Why not explain why you think this is? also need more explanation of the curve on the left in particular which is showing a decrease in the warming of cold days...very confusing.	Thanks. This figure has been replaced in response to a number of comments.
Nathan	Mantua	Text Region	Executive Summary		20	20	1	7	I recommend adding a few sentences about interdecadal modes of natural variability important for US climate (PDO/PO, AMO), and how changes in these persistent patterns can either amplify or dampen anthropogenically forced trends.	Thank you. The Core Writing Team has been more specific and added language in several places to reflect this idea.
Melanie	Mayer	Text Region	Executive Summary		20	20	5	7	i don't think there is enough support for this statement in the summary, considering only 1.6F change. Suggest to strengthen it if it remains in the summary	Thank you. This statement has been revised to better reflect the chapter.
Michael	MacCracken	Text Region	Executive Summary		20	20	6	6	The phrase "can no longer be assumed to be ..." seems inconsistent with the proposed approach to be used in the report, namely confidence and likelihood. Indeed, this phrase seems to be more drawn from a strict, hypothesis-testing interpretation. Please check.	Thank you. This statement has been revised to better reflect the chapter and confidence guidance.
Harold	Tattershall	Text Region	Executive Summary		20	20	14	17	"The Arctic is warming at a rate approximately twice as fast as the global average and, if it continues to warm at the same rate, Septembers will be nearly ice-free in the Arctic Ocean sometime between now and the 2040s." First, this statement is not consistent throughout this report; in several areas mid-century is projected. Second, observations and the volume decline analysis of consolidated data suggest that this circumstance will occur sooner than later; it would be helpful to acknowledge this due entirely to the interconnected potential economic and societal impacts. Third, although the report states in several areas that climate models are prone to under-assessing this is missing to qualify this projection; at that in the Executive Summary!	Thank you. The Core Writing Team has looked across the places in the report to which referred and made them more consistent. Authors have not just referred to climate models in this sentence, but indicated a time frame based on the current (observed) rate of change.
Michael	MacCracken	Text Region	Executive Summary		20	20	14	14	I don't think the phrase "potentially even" is consistent with the likelihood and confidence statements being used in this report. There is actually pretty good evidence that the changes in the Pacific and Arctic are indeed influencing the weather.	Thank you. The authors are comfortable with this language since this is an active area of research and, as yet, robust conclusions are not available regarding this link.
Sarah	Zerbonne	Text Region	Executive Summary		20	20	16	16	It may not be clear to some that Septembers normally have ice in the Arctic -- it may be prudent to provide a relative reference for this statement.	Thank you. The Core Writing Team has referred the reader to Figure ES.9, which shows the sea ice decline in September.
Adam	Stein	Text Region	Executive Summary		20	20	20	25	This text reads somewhat confusing, especially to someone who is not familiar with this specific topic.	Thank you. This paragraph has been revised.
Michael	MacCracken	Text Region	Executive Summary		20	20	20	25	It seems to me that the expansion of the subtropics also should be mentioned.	Thank you. This paragraph has been revised.
Nathan	Mantua	Text Region	Executive Summary		21	21	2	3	How are ENSO and associated teleconnection patterns that influence North American climate being influenced by human activities? Why is the discussion of large-scale patterns of natural variability limited to ENSO-related teleconnections?	Thank you. The Core Writing Team has indicated that confidence is low in how humans are influencing these patterns (there is more discussion in the Chapter 5), and authors do discuss multiple modes of variability in this text box. The figure is simply illustrative of one mode: ENSO.

First Name	Last Name	Comment Type	Chapter	Figure/Table No.	Start Page	End Page	Start Line	End Line	Comment	Response
Allison	Crimmins	Text Region	Executive Summary		21	22	8	32	At this point in my reading, I have forgotten why some points are in bullets and some in green boxes. I had to scroll back up to see what the green boxes signified and then was a bit confused. The green box in this section talks about heat absorption and ocean acidification, but then are followed up by many many bullets on sea level rise before we get to info on absorption and acidification. I'm not sure how you picked what would go in the green boxes- what was your criteria? I don't find them more compelling than the titles to the sections, which are good. Perhaps splitting this section up (heat and CO2 uptake in one, sea level rise and flooding in a second) so you can include a green box on sea level rise would also be helpful, especially because this section has 50 many bullets I suggest that anywhere trends reported as "since" a start date have the statement revised to state the specific start and end years for the trend estimate.	Thank you. The Core Writing Team has reorganized the bullets so that they flow better, and provided some additional green boxes with some of the main findings the team hopes people will take away.
Nathan	Mantua	Text Region	Executive Summary		21	21	14	14	I suggest that anywhere trends reported as "since" a start date have the statement revised to state the specific start and end years for the trend estimate.	Thank you. The Core Writing Team has tried to blend specificity with contextual language accessible to the public. In some cases authors have added a specific beginning date.
Kathy	Jacobs	Text Region	Executive Summary		21	22	14	7	Given that there was a lot of pushback about including probabilities of particular ranges of SLR in the NCA3, this degree of specificity seems a bit surprising. Also, wonder if a table would work better - this is pretty complex.	Thank you. This is based on recent reports and data. And as the authors have tried to indicate, there is lower confidence in the ranges towards the end of the 21st century. The Core Writing Team has also given an indication (in the next key finding) what the potential upper end of the 'possible' rise could be, without assigned confidence.
Kathy	Jacobs	Figure	Executive Summary	E56	21				This is a great illustration of the influence of ENSO, but is there a way to use colors to illustrate sea surface temps as well? Perhaps too complicated. Also, in the caption, should explain the reason for focusing on the winter season.	Thank you. The Core Writing Team has added more explanation in the figure caption. The authors have elected not to include SSTs since that would add too much confusion to the main point, which is simply that these modes affect U.S. temperature on seasonal-to-interannual scales.
Allison	Crimmins	Text Region	Executive Summary		22	22	1	1	Suggest changing "has made a substantial contribution" to "has been a major cause of", especially since you use "contributing to" later in the same sentence	Thank you. The Core Writing Team prefers 'substantial contribution' since 'a major cause' might imply 'the majority of'.
Allison	Crimmins	Text Region	Executive Summary		22	22	4	7	You noted that you would be reporting things in American and SI units, so you may want to put SLR estimates in meters in parentheses (also so it can be better compared to IPCC estimates)	Thank you. Done.
David	Hawkins	Text Region	Executive Summary		22	22	4	7	"Relative to the year 2000, GMSL is very likely to rise by 0.3-0.6 feet by 2030; 0.5-1.2 feet by 2050; and 1-4 feet by 2100 (very high confidence in lower bounds of each of these predictions; medium confidence in upper bounds for 2030 and 2050; low confidence in upper bounds for 2100)." The full range of projections, including the extreme case of 8.2 feet by 2100 should be included in this key finding, supplementing the "very likely" ranges of sea level rise currently identified. We recommend taking the second sentence of the next key finding, which reads, "Emerging scientific results regarding ice-sheet stability suggest that, under a higher scenario, a GMSL rise exceeding 8 feet by 2100 cannot be ruled out. (Ch. 12)" and adding it to the text in Lines 4-7. The science on sea level rise has developed considerably in recent years, particularly with regard to the potential instability of the West and East Antarctic, the deterioration of which seems to be progressing faster than was previously understood (DeConto & Pollard, 2016). Providing information on the extreme case in the key finding with the "very likely" ranges of sea level rise better communicates the full range of possibilities we must prepare for. Classifying the projected 4 foot global sea level rise by 2100 as an "upper bound" is something of a misnomer. Chapter 12 states that a 4 foot rise lies midway between the Intermediate and High-Intermediate cases projected by the Interagency task force. Also, the statement that there is "low confidence" in the "upper bound" projections for 2100 is confusing and potentially misleading. The section should clarify that there is low confidence that the "upper bound" for 2100 will not be larger than 4 feet.	Thank you. The Core Writing Team has elected to leave the 8ft possibility in a separate key finding given that authors cannot reasonably ascribe confidence or likelihood in that case. The authors have re-examined the confidence and likelihood for other ranges and feel comfortable with the existing statements.
Michael	MacCracken	Text Region	Executive Summary		22	22	8	11	This may be the case if all one considers is CO2 and the other long-lived GHGs, but it not the case if one considers short-lived species. The UNEP assessment led by Drew Shindell shows that a reasonably aggressive emissions control program focused on the short-lived GHGs could cut the projected warming between now and 2050 IN HALF, which would be a very sizeable influence. Thus, I think the sentence here is simply not correct.	Thank you. Given the slower response time of ocean heat however, it is still the case that emissions trajectories have less effect on the first half of the 21st century
Sarah Keely	Zerbonne Brooks	Text Region	Executive Summary		22	22	10	10	I believe the word "rise" is missing after GMSL.	Thank you. Fixed.
Michael	MacCracken	Text Region	Executive Summary		22	22	12	12	Please add "emission" between higher scenario.	Thank you. Done.
David	Hawkins	Text Region	Executive Summary		22	22	16	16	Should not "were" be "when"? If not, a better explanation is needed.	This key finding has changed significantly and this is no longer an issue. Thank you.
David	Hawkins	Text Region	Executive Summary		22	22	19	26	"Relative sea level (RSL) rise in this century will vary along U.S. coastlines due to vertical land motion and changes in ocean circulation, as well as changes in Earth's gravitational field and rotation from melting of land ice (very high confidence)." The inclusion of information on how RSL will vary along the nation's coastline is a valuable addition to this year's report. This key finding found at lines 8-13 should also quantify the projected variations in RSL for the regions identified. NOAA's recently published Global and Regional Sea Level Rise Scenarios for the United States (January 2017) and provides the following projections for the regions identified under the Intermediate-High scenario of GMSL (see p. 29). U.S. Northeast: 0.4-0.7 m (1.3-2.3 ft) Western Gulf of Mexico: 0.2-1.0 m (0.7-3.3 ft) Pacific Northwest: 0.2-0.3 m (0.7-1.0ft) Alaska: -1.0m-0.2 m (-3.3-0.7 ft)	Thank you. There is more detail in the chapter (12), but the authors would prefer to keep the key finding more accessible. Several other comments indicate that multiple numbers and ranges make it hard to follow.
Michael	MacCracken	Text Region	Executive Summary		22	22	20	20	Thank you for capitalizing "Earth" when referring to the global system--please check this is done throughout.	Thank you. Done.
Melanie	Mayes	Text Region	Executive Summary		22	22	22	26	not clear to what scenarios you refer, temperature or sea level rise?	Thank you. The Core Writing Team has added 'sea level' to the scenarios we refer to.
Michael	MacCracken	Text Region	Executive Summary		22	22	28	28	I think the phrase "five to ten fold" needs to be change as "fold" can mean a factor of ten. How about saying something like "... is occurring five to ten times as often".	Thank you. The Core Writing Team has kept the language but included a clearer figure to ensure readers can see the scale.
Kathy	Jacobs	Text Region	Executive Summary		22	22	33	35	This point about increases in acidification could be combined with the point above on the same topic - all this adds is the detrimental impacts to marine system which have already been found to be far more than potential" in NCA3.	Thank you. This entire section has expanded and the Core Writing Team has added more key take-aways (green boxes) and provided better organization.
Melanie	Mayes	Text Region	Executive Summary		22	22	35	35	might be helpful to list a couple of impacts here	Thanks. Since this report is input to several marine-related chapters in the NCA4, the Core Writing Team hesitates to add specific impacts.
Michael	MacCracken	Text Region	Executive Summary		22	22	36	3	It seems to me it is worth mentioning that acidification is occurring most rapidly and seriously in the Arctic and regions experiencing colder ocean temperatures.	Thank you. The Core Writing Team has added a higher latitude statement.
Melanie	Mayes	Whole Page	Executive Summary		22				L17, paleo evidence says that 2C may represent 6 ft SLR or greater. But L5 says 1-4 ft is expected.	Thank you. There is more explanation in Chapter 12, but the L5 key finding represents the projections for a point in time (2100) vs the paleo evidence, which represents the ultimate SLR that might be expected over a long period of higher temperatures (equilibrium). This is why authors also note that SLR is expected to continue beyond 2100.
Keely	Brooks	Text Region	Executive Summary		23	23	11	11	Please add context to show the significance of 204% change here and in the corresponding chapter.	Thank you. There are more details in Chapter 13, but as the writing team points out, the impacts of this change, while likely significant, are not well understood.
Allison	Crimmins	Figure	Executive Summary	E5.7	23				The x-axes of these two graphs should not be aligned, as it is very confusing that one goes back 2500 years in the past and the other spans 1800-2100. Suggest making very clear where the bottom figure falls within the top figure.	Thank you. The Core Writing Team has changed this as requested.
Harold	Tattershall	Text Region	Executive Summary		24	24	6	8	"Melting trends are expected to continue with late summers becoming nearly ice-free for the Arctic Ocean by mid-century (very high confidence)." As previously discussed "between now and the 2040s" is suddenly mid-century; these are the sort of inconsistencies the so-called 'denial machine' exploits.	Thank you. The Core Writing Team has now made this consistent.

First Name	Last Name	Comment Type	Chapter	Figure/Table No.	Start Page	End Page	Start Line	End Line	Comment	Response
David	Hawkins	Text Region	Executive Summary		24	24	18	21	The summary should note the large size of the permafrost store of carbon to better communicate the significant risks associated with permafrost melting.	Thank you. The Core Writing Team has added a statement about uncertainty regarding this feedback.
Alison	Crimmins	Figure	Executive Summary	ES.8	24				Great figure, though needs to be bigger. I would suggest pointing out in the caption that some of these cities are projected to experience nuisance flooding 365 days out the year by the end of the century, even under lower emissions.	Thank you. The Core Writing Team has actually excerpted two of the graphics so the remaining panels can be larger, and also clarified the scale.
Michael	MacCracken	Text Region	Executive Summary		25	25	1	4	I'm surprised that the increasing loss of mass of ice in Antarctica is not mentioned here.	This section is about Alaska and the Arctic, but Antarctic ice sheet instability is mentioned in the sea-level rise section.
Michael	MacCracken	Text Region	Executive Summary		25	25	6	6	Need to change "predicted" to "have been projecting" so using words consistently.	Thank you. This key finding has been revised and is no longer is part of the wording.
Allison	Crimmins	Text Region	Executive Summary		25	25	9	12	Medium-high and low-medium are not confidence levels outlined in the front matter. In addition, the use of the word "may" on line 11 doesn't make sense with a low-medium confidence. I think saying something "may" influence something else could easily be given 100% confidence. The statement should be that warming influences, has influenced, will influence or is expected to influence... with low confidence.	Thank you. This has been reworded to avoid this issue.
Harold	Tattershall	Text Region	Executive Summary		26	26	3	5	"September sea ice extent and age (thickness) shown for 1984 (top) and 2016 (bottom), illustrating that significant reductions have occurred in sea ice extent and age. The bar graphs in the lower right of each panel illustrate the sea ice area covered within each age category."	The authors agree about risk of rapid sea ice decline in coming years and the concern that climate models are not able to capture that appropriate physics. The core writing team also notes the larger trends in sea ice volume as opposed with sea ice extent, which corroborate the physical explanation provided by the reviewer. This is addressed in Chapters 1 and 11.
Allison	Crimmins	Text Region	Executive Summary		26	26	7	8	I made extensive comments to the above for Chapter 1, Section 1.2.6, Page 45, Lines 28-30. Suggest "will require major reductions in emissions" rather than "a major reduction"	Thanks. Changed.
Nathan	Mantua	Text Region	Executive Summary		26	26	9	9	the statement that "human activities are now the dominant cause of the observed changes in climate" is simply too broad to be informative (or defensible). When I think about "observed changes in climate" they encompass the full spectrum of ENSO, PDO, NAO, AMO and other unnamed climate extremes like the NE Pacific ocean heat wave from 2014-2016. There is no evidence that human activities dominate the observed changes in climate associated with those patterns of interannual to interdecadal variability, is there? Please refine this lead sentence to be more specific to what is supported by published research.	Thanks. This has been edited to 'trends' rather than all changes.
Allison	Crimmins	Text Region	Executive Summary		26	27	12	2	Suggest dropping the info about the three international agreements (not sure why that is in the ES of a science report) but it WOULD be helpful to know why 2 degrees C is called out in the title of this section--let readers know why 2C is a threshold	This section has been shortened and this sentence has been omitted. Thank you.
Keely	Brooks	Figure	Executive Summary	9	26				Note if the season of the pictures are the same or not.	Thank you. The description of the figure indicates they are both September.
Kathy	Jacobs	Text Region	Executive Summary		27	27	10	16	If you are going to say that there is such a big delay, need to also say that failure to initiate mitigation efforts will have much larger impacts on the climate of the future in the same paragraph - the highlighted line above doesn't cut it. It seems like there are lots of good reasons to delay action if you only tell one side of the story.	Thank you. This key finding has been significantly reworded.
Michael	MacCracken	Text Region	Executive Summary		27	27	11	11	The sentence needs to be revised as "concentrations" should be singular.	Thank you. This key finding has been significantly reworded, and the authors have reviewed the singular vs plural use of concentration(s) across the Executive Summary.
Michael	MacCracken	Text Region	Executive Summary		27	27	12	12	The phrasing here contributes to a misconception and confusion often put forward by The Skeptic community. In particular, the lifetime of a particular CO2 molecule in the atmosphere is really only several years--not the "long lifetime" mentioned in the sentence. Instead it is the perturbation to the atmospheric CO2 concentration that has the long lifetime--and that is the case and why that needs to be explained.	Thank you. This key finding has been significantly reworded.
Michael	MacCracken	Text Region	Executive Summary		27	27	13	13	Change "in the atmosphere" to "in atmospheric composition" or something similar--be sufficiently specific.	Thank you. This key finding has been significantly reworded.
Michael	MacCracken	Text Region	Executive Summary		27	27	13	15	This would be a good place to explain that this conclusion applies for long-lived species, but not for the full situation when short-lived species are included. Indeed, roughly half of the increment to radiative forcing during the 20th century from 20th century emissions is a result of the emission of short-lived species. This just has to be explained.	Thank you. This key finding has been significantly reworded and more has been added regarding other species of GHGs
Nathan	Mantua	Text Region	Executive Summary		27	27	15	15	near-term changes in climate will also be influenced by past and present aerosol emissions, natural (volcanic, natural wildfires) and human-caused (biomass burning, and fossil fuel based aerosol emissions)	Thank you. This key finding has been significantly reworded.
Marcus	Sarofim	Text Region	Executive Summary		27	27	17	24	2 degrees was the target determined in Paris, but is not the only threshold worth analyzing: it would be useful (here, or in Chapter 14) to perhaps create a table with 1.5 degrees, 2 degrees, 2.5 degrees, and 3 degrees: total cumulative carbon allowed for each, and date that cumulative total is reached under RCP4.5 and RCP8.5.	Thank you. The Core Writing Team discussed adding a table but felt it would be too much for the Executive Summary. Chapter 14 contains much more extensive discussion however.
Allison	Crimmins	Text Region	Executive Summary		27	27	17	24	Greatly appreciate that you spell out when the 2C threshold would be reached under the two RCPs. This is helpful. If the "likely"s in the two sentences are based on the same statistical likelihood spelled out in the front matter, consider italicizing.	Thank you. This has been strengthened and reworded.
Jan Ivar	Korsbakken	Text Region	Executive Summary		27	27	17	24	This mirrors a comment to the corresponding text in Chapter 14 Key finding no. 2 and p. 483 lines 23-34: It is stated that to meet the 2C objective, approximately 400 GtC could still be emitted globally. This number is misleading, as it does not include the additional heating effect from emissions of non-CO2 greenhouse gas emissions or other non-CO2 climate forcers. There is no realistic scenario in which the effect of non-CO2 forcers is brought anywhere close to zero. Any "budget" for future CO2 emissions should therefore be based on a plausible scenario or range of scenarios for the magnitude of future non-CO2 forcings, as is done in most frequently cited CO2 budgets, including those of the IPCC 5th Assessment Report and the 450 Scenario of the IEA's World Energy Outlook [see, e.g., Table 2.2. on p. 64 of "Climate Change 2014 - Synthesis Report" from the IPCC 5th Assessment Report, and section 8.5.1 of the IEA World Energy Outlook 2016]. They find that remaining allowable CO2 emissions for a 50% chance of limiting warming to below 2C to be approximately 300 GtC (IEA) and 250 GtC (IPCC) after adjusting for non-CO2 forcers (after subtracting emissions that have already taken place after those estimates were constructed). The estimate of the remaining number of years is especially misleading, given that it compares CO2-only emissions to a future emissions budget which is meant to be adjusted for the effect of non-CO2 forcings. This is likely to cause readers to believe that we have more time than we actually have. I would urge you either to use figures that have been adjusted for a reasonable range of future non-CO2 forcings, or at the very least state very clearly and very explicitly that the numbers are actually lower due to non-CO2 effects; indicate typical non-CO2-adjusted numbers from the IPCC, IEA or others; and remove any estimate of remaining years of emissions which is not based on adjusted numbers.	Thank you. This key finding has been significantly reworded.

First Name	Last Name	Comment Type	Chapter	Figure/Table No.	Start Page	End Page	Start Line	End Line	Comment	Response
David	Hawkins	Text Region	Executive Summary		27	27	17	24	The stated budget of 1000 GtC for CO2 for a 2°C target is incorrect. As stated in this report, anthropogenic activities, primarily burning fossil fuels and deforestation, have emitted more than 600 Pg or GtC into the atmosphere since pre-industrial times. (p. 483, in 23-24) The global cumulative CO2 budget to keep warming levels below 2 degrees C is 790 GtC, after accounting for non-CO2 forcing (66% probability of success). [1] Therefore, only ~200 GtC of CO2 can be emitted, and under current policies, that remaining budget for the 2 degree target will be consumed as early as 2032. [2],[3] See calculation in file "CO2 budget consumption calcs.xlsx," submitted by email as part of these comments. [1] Stocker, T.F., D. Qin, G.K. Plattner, L.V. Alexander, S.K. Allen, N.L. Bindoff, F.M. Brion, J.A. Church, U. Cubasch, S. Emori, P. Forster, P. Friedlingstein, N. Gillett, J.M. Gregory, D.L. Hartmann, E. Jansen, B. Kirtman, R. Knutti, K. Krishna Kumar, P. Lemke, J. Marotzke, V. Masson-Delmotte, G.A. Meehl, I.I. Mokhov, S. Piao, V. Ramaswamy, D. Randall, M. Rhein, M. Rojas, C. Sabine, D. Shindell, L.D. Talley, D.G. Vaughan and S.P. Xie, 2013: Technical Summary. In: Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Stocker, T.F., D. Qin, G.K. Plattner, M. Tignor, S.K. Allen, J. Boschung, A. Nauels, Y. Xia, V. Bex and P.M. Midgley (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA. Technical Summary TFE.8 at 102-103 [2] Global energy-related CO2 emissions projections are derived from: Energy Information Administration, International Energy Outlook (IEO) 2016, May 2016, http://www.eia.gov/outlooks/ieo/ . [3] CO2 emissions from land use change and cement are derived from: Boden, T.A., G. Marland, and R.J. Andres. 2016. Global, Regional, and National Fossil-Fuel CO2 Emissions. Carbon Dioxide Information Analysis Center, Oak Ridge National Laboratory, U.S. Department of Energy, Oak Ridge, Tenn., U.S.A. doi 10.3334/CDIAC/00001_V2016. Cement emissions were held constant at 2015 levels (0.56 GtC/yr). Due to high variability in land use change emissions in recent years, emissions were held constant at 1 GtC/yr.	Thank you. This key finding has been significantly reworded.
Kathy	Jacobs	Text Region	Executive Summary		27	27	17	24	This whole paragraph is confusing - if one doesn't know about the global agenda to limit the warming to 1.5 or 2 degrees, there is no context. This is a really complicated idea in the first place - if I include it in summary, we need more explanation.	Thank you. This whole section has been reworded and the Paris goals are mentioned in a key finding.
Adam	Stein	Text Region	Executive Summary		27	27	19	20	The incorporation and summation of the GtC numbers are not quite clear and need to be presented in a more straightforward way.	Thank you. This key finding has been significantly reworded.
Allison	Crimmins	Text Region	Executive Summary		27	27	25	30	I'm not sure this bullet belongs here- especially unsure whether this belongs in the ES, but also unsure it belongs in the CSSR. The bullet point says very little ("could possibly" is so weak; saying that you have medium confidence that assessing stuff could be helpful seems odd) and yet ventures into territory the front matter said the CSSR would avoid. It is unclear why these would only be useful IF we don't remain under 2C, and also odd that you don't mention any specific mitigation actions, but you do mention specific geoengineering options (notably without saying the word geoengineering). This bullet just doesn't fit here well and doesn't help explain much.	Thank you. This key finding has been significantly reworded.
Michael	MacCracken	Text Region	Executive Summary		27	27	25	25	There is only one global average CO2 concentration--please change "concentrations" to the singular.	Thank you. The Executive Summary has been scrubbed to attend to this issue.
Michael	MacCracken	Text Region	Executive Summary		27	27	25	25	It is simply not the case that the CO2 concentration is all that matters; so do the concentrations of methane, HFCs, sulfate, black carbon --I'd suggest that there just has to be mention of the other factors that are also affecting the climate.	Thank you. The Core Writing Team has added several instances in these key findings with more on short-lived and other GHGs.
Kathy	Jacobs	Text Region	Executive Summary		27	27	25	30	Haven't checked to see what the citation on the value to decision-makers statement but since the rest of the ES doesn't comment on what is or isn't useful to them and since there is no stakeholder engagement component to this report need to be a little careful.	Thank you. This key finding has been significantly reworded and 'decision-makers' removed.
Keely	Brooks	Text Region	Executive Summary		27	27	29	29	Please include a sentence about the potential for unintended consequences.	Thank you. This key finding has been significantly reworded and the importance of 'risks' has been added.
Allison	Crimmins	Text Region	Executive Summary		27	27	31	34	This is a great bullet point, but doesn't fit here at all, under a section title that talks about limiting warming to 2C. Can it be moved elsewhere?	Thank you. This whole section has been re-organized.
Michael	MacCracken	Text Region	Executive Summary		27	27	31	31	The phrase "Atmospheric levels" is just sloppy writing--it is really critical to be more precise even when writing for the general public--perhaps even more important. The needs to say something like "The global-average atmospheric CO2 concentrations has ..." Also, "last seen" is too colloquial for a science assessment--perhaps say "last occurring" or something similar.	Thank you. This has been reworded to address these points.
Melanie	Mayes	Text Region	Executive Summary		27	27	32	34	for only 3.6-6.3F higher than today, sea level was 66 +/- 33 ft higher? This is likely to confuse an audience unfamiliar with geologic time...some explanation is necessary, or suggest remove this.	Thank you. This key finding has changed and this is no longer present in the Executive Summary.
Michael	Kolan	Whole Page	Executive Summary		27				Second bullet. Define what is considered preindustrial (so one can say preindustrial levels). Fourth bullet. Good context but not sure what it adds to the topic of "Choices made today will determine the magnitude of climate change risks beyond the next few decades."	2nd bullet: Since this is a relative temperature change, the authors don't think it would help to give the specific global temperature prior to industrial period. 4th bullet: this section has been reorganized.
Allison	Crimmins	Text Region	Executive Summary		28	28	1	1	I know this is minor, but in the green box you say observations are consistent with the higher projection scenarios. It seems better to say the higher future scenarios use emissions rates consistent with those we've seen over the past 15-20 years.	The higher scenarios are not driven by what authors understand recent emissions to have been - in fact the future scenarios are based on future 'representative concentration pathways' and emission scenarios have been backed out of those pathways. The Core Writing Team has added a new box on future emissions scenarios to say more on how these are derived.
Allison	Crimmins	Text Region	Executive Summary		28	28	1	4	Again, great bullet, but not sure it belongs under the title of remaining under 2C. Also, I would argue there is no such thing as a precise past climate analog, no matter how far back you go. Perhaps be more specific by what you mean by "past climate analog" (temp? CO2 levels? rate of emissions? en nino conditions?) or better yet, rephrase to say what you mean: that Earth has not experienced changes of this magnitude for at least the last 66 million years.	Thank you. The Core Writing Team has reorganized this section. And removed 'precise'.
Michael	MacCracken	Text Region	Executive Summary		28	28	1	1	In the box above line 1, it is essential to say this is a statement about global emissions and not US emissions--and, if fact, it is almost not even true for global emissions as the increases in developing countries and being counter-balanced by decreases in many of the developed countries.	Thank you. The Core Writing Team has added 'global'.
Michael	MacCracken	Text Region	Executive Summary		28	28	1	1	In the box above line 1, in lines 4 and 5, the goal should not be to stabilize the temperature AT 1.5 or 2 C (incidentally, why are not the values also given in F?), but to have the temperature peak at no more than these values and then decline back toward 0 C or so.	Thank you. The Core Writing Team has added Fahrenheit, and changed the wording of this key finding.
Michael	MacCracken	Text Region	Executive Summary		28	28	1	4	CO2 is not the only GHG that matters--if there had been an explanation about multiple gases much earlier, then the fact that gases (and aerosols) other than CO2 could readily be mentioned here along with CO2. But that explanation is missing in the Executive Summary.	Thank you. The Core Writing Team has discussed non-CO2 GHGs in several places.
Michael	MacCracken	Text Region	Executive Summary		28	28	1	2	I'd suggest that it might be useful to indicate that the way we know this is from geological evidence-- I really think that in communicating convincingly to the public, it can really help to include the basis for the statement rather than to just make an assertive sentence such as this.	Thank you. This would add to an already-long key finding and, while evidence is discussed in the chapter, the authors have elected not to add detail here.
Marcus	Sarofim	Text Region	Executive Summary		28	28	2	4	The sentence reads awkwardly to me: perhaps, "In addition, present-day emission rates of nearly 10 GtC per year may exceed rates seen at any time in at least the last 66 million years?" One of the issues that wasn't clear was whether the "climate analogue" was due to CO2 concentration, emissions, a combination of the two, or even climate? Moreover, a "precise" climate analogue would be impossible as continents were in different places millions of years ago, so I'm not sure that's a good term here.	Thank you. This key finding has been reworded and 'precise' has been removed.

First Name	Last Name	Comment Type	Chapter	Figure/Table No.	Start Page	End Page	Start Line	End Line	Comment	Response
Kathy	Jacobs	Text Region	Executive Summary		28	28	3	4	The idea that you have a level of precision necessary to know whether you have a precise analogue over 66 million years stretches the credibility limit.	Thank you. This key finding has been reworded and 'precise' has been removed.
David	Hawkins	Text Region	Executive Summary		28	29	5	14	This is an important section. However, the section (and associated Chapter 15) should state that the science supports a conclusion that the risks of both compound events and tipping point events increase as the temperature change from the pre-industrial baseline increases. See discussion of the Reasons for Concern approach in our comment on the whole document and the Executive Summary chapter. Such findings provide additional support for identifying temperature changes well below 2°C as scientifically needed to avoid dangerous anthropogenic interference with the climate. They also support a conclusion that not losing the capacity to limit such changes to 1.5°C is an important risk minimization objective.	Thank you. The Core Writing Team has retained a sentence that indicates that the further and faster the Earth System is changed, the greater the risk of such surprises. And there is an additional sentence saying the probability of these surprises "increases as the influence of human activities on the climate system increases".
Allison	Crimmins	Text Region	Executive Summary		28	28	6	19	This section is well done and explains what you mean by "surprises" much better than on page 7.	Thank you. Page 7 has been reworded.
Michael	MacCracken	Text Region	Executive Summary		28	28	6	8	Using the analogy "unprecedented experiment" without referring to Revelle and Suess I would suggest might be considered plagiarism (or misappropriation) that needs to be avoided.	There are no references in the Executive Summary, but all references appear in association with the chapters.
Michael	MacCracken	Text Region	Executive Summary		28	28	8	13	While there are indeed shortcomings in model representations of the entire Earth system, I think it essential (in addition to what is said in the next few paragraphs/points) to also state up front that none of the omissions can be expected to sharply reduce the climate sensitivity that makes the increase in CO2 of very serious concern. Indeed, as the next paragraphs state well, what is missing may affect aspects such as thresholds for continental ice melting and other such nonlinear types of outcomes, and what is missing may actually indicate the climate sensitivity should be a bit higher (which would help to explain how the Cretaceous worked). It really thus needs to be said that the full history of the Earth's climate cannot be explained without the climate sensitivity being a few degrees (C or F) per CO2 doubling.	Thank you. The Core Writing Team feels as though this is too much detail for an Executive Summary.
Allison	Crimmins	Text Region	Executive Summary		29	31	15	6	Strongly suggest moving this text box up to the front of the ES please! This is a really big box, so anything that can be done to shorten or turn it into an interesting infographic instead of a long bulleted list would be great. Really good information here- possibly the most important part of the ES.	Thank you. The Core Writing Team has added a new highlights section at the front of the Executive Summary. And it has been shortened here.
Kathy	Jacobs	Text Region	Executive Summary		29	31	20	5	Very helpful to have the new news in this summary fashion	Thank you!
Michael	MacCracken	Text Region	Executive Summary		29	29	21	21	Given this is a document for the public, I'd urge providing an explanation of what the phrase "detection/attribution" means--it is really jargon that needs to be explained.	Thank you. This is extensively explained in the chapters. And a bit more detail has been added to this sentence.
Allison	Crimmins	Text Region	Executive Summary		29	29	31	32	Though you say "so-called" I would suggest putting the phrase "global warming hiatus" in quotes and being clear in the first sentence that the slowdown was a reported slowdown, or at least something observed in some datasets. The last sentence does not go far enough to reassure me that the slowdown is nonexistent.	That section of the report has been reworked and is no longer part of this box.
Michael	MacCracken	Text Region	Executive Summary		29	29	31	31	I'd urge saying "possible causes"	That section of the report has been reworked and is no longer part of this box.
Kathy	Jacobs	Text Region	Executive Summary		29	29	31	33	Though it is important to explain that we now know why there was a slowdown in the rate of increase, it is also important to note that there will continue to be variability in the future - so the planet has continued to warm at a steady pace" is a little misleading.	That section of the report has been reworked and is no longer part of this box.
Allison	Crimmins	Text Region	Executive Summary		30	30	12	14	Whoa ... can you say that a slowing occurring over a few months is a key bullet point in a list of things that have changed since NCA3 titled "slowing regrowth of Arctic sea ice extent"??? I think this bullet could be re-phrased to note that new data has been added to a long term trend, and that new data includes some record breaking values, but it seems a stretch to talk about events within one year.	Thank you. The text in this bullet does indicate this is part of a longer-term trend. All indications are that these new record low values could be extremely important.
Michael	MacCracken	Text Region	Executive Summary		30	30	12	14	I'd urge replacing "regrowth" with "normal cold-season regrowth" to make clear you are not talking about some new trend in the recovery.	Thank you. The Core Writing Team has added the word 'seasonal'.
Michael	MacCracken	Text Region	Executive Summary		30	30	21	23	While greater spatial refinement of longer-term averages may have some value, my preference would be paying more attention to how the distributions of weather types and events are changing-- people and systems tend to be much more dependent on the range and array of weather events (so not just extremes) rather than to the multi-decadal averages of seasonal to interannual changes in various variables.	This section no longer appears in the Executive Summary.
Michael	Kolian	Whole Page	Executive Summary		30				Accelerated ice-sheet loss and irreversibility: New observations from many different sources confirm that ice-sheet loss is accelerating (Chapters 1, 11, 12). Suggest adding something about irreversibility (certainly not in terms of human lifetime).	Thank you. This may be too complicated to add properly in the Executive Summary.
Allison	Crimmins	Text Region	Executive Summary		31	31	1	6	Suggest dropping this last bullet completely. This is not something new in NCA4 not in NCA3, it is something new that has happened outside the NCA process. I get that talking about it for the first time in an NCA product is new, but talking about mitigation isn't. I don't think this bullet belongs here and draws unnecessary specificity to political situations.	Thank you. The Core Writing Team has reworded this bullet, but feels that this new framework and the assessment done in terms of implications for the global climate of associated national goals is certainly new information to highlight.
Keely	Brooks	Whole Chapter	Executive Summary						People have heard much about the polar vortex and RRR over the last few years. It may be useful to note these specifically in the executive summary	Thank you. The Core Writing Team has elected not include this as a specific discussion.
David	Hawkins	Whole Chapter	Executive Summary						The Executive Summary is a critical component of this report. It is generally well written and with exceptions noted in later comments, covers the key topics clearly and accurately. As stated in our comment on the entire report, the Executive Summary should contain a synthesis similar to the IPCC "reasons for concern" approach that summarizes the magnitude of the risks for key indicators as a function of global temperature increases from pre-industrial levels. Such a synthesis would demonstrate that risks for most key indicators increase significantly as temperature changes exceed 1.5°C and 2°C.	Thank you. The Core Writing Team is not planning to add such a table for the U.S. - partly because there is less confidence at the national scale, but partly for space constraints and wish to place emphasis on other aspects.
Michael	MacCracken	Whole Chapter	Executive Summary						Overall, the Executive Summary does an excellent job of summarizing current understanding about climate change in the recent past and projections of climate through the 21st century. I offer a number of comments aimed mainly at clarification for the general public/individual without expert knowledge and to promote greater specificity in the points made	Thank you. The Core Writing Team has attempted to address these very helpful comments!
Kathy	Jacobs	Whole Chapter	Executive Summary						Chapter 2 should be pared down a bit to focus on what is new and different - a primer on how the atmosphere works probably doesn't belong here. This chapter is the only one that is really accessible to non-experts, and yet it is still fairly heavy-going for some. There is a need for a variety of communications tools to focus on the information that the regional and sectoral authors will really want/need. Separate smaller products might be useful for other audiences.	The first half of this comment is really about Chapter 2, not the Executive Summary. Chapter 2 has been significantly revised since the public review, especially towards addressing the requests of other review points and the review by the National Academy of Sciences. The second half suggests the need for other communication products; those are available through the state-based reports by the NOAA NCEI and by the availability of downscaled climate products (e.g., from the LOCA statistical downscaling product described in Chapter 4).
Michael	MacCracken	Text Region	Chapter 01: Our Changing Climate		32	32	3	30	Excellent set of summary comments. I am surprised, however, to see nothing about the accelerated melting of ice sheets and thermal expansion contributing to sea level rise and nothing on how the higher CO2 concentration is contributing to ocean acidification. Both are very high confidence and important to be considering--and sea level rise is mentioned early in the next section as very clear.	The ice sheets are certainly important. This is captured in Chapters 11 and 12 so not repeated in this chapter.
Allison	Crimmins	Text Region	Chapter 01: Our Changing Climate		32	32	4	5	Holy hyphens batman	Just following the style guide. No changes.
Michael	MacCracken	Text Region	Chapter 01: Our Changing Climate		32	32	9	15	Somehow in this finding it needs to be indicated that the rate of evaporation is also going up (and the amount of precipitation in light events is going down), so that there is a greater likelihood of low soil moisture. While such periods of low soil moisture can be labeled as drought, drought is tied to variability (it gets dry and then returns to wet). What is happening in addition is an underlying aridification as the subtropics are expanding poleward--nowhere does this trend toward aridification seem to be mentioned.	That comes out in later chapters.

First Name	Last Name	Comment Type	Chapter	Figure/Table No.	Start Page	End Page	Start Line	End Line	Comment	Response
Nathan	Mantua	Text Region	Chapter 01: Our Changing Climate		32	32	17	19	The statement that "human activities ... are primarily responsible ... for the observed climate changes in the industrial era ..." is simply too broad - be more specific about the time period and which parts of the "observed climate changes in the industrial era" fit this description.	Text revised for better clarity. However, essentially all aspects of the observed changes in the climate system fit this statement.
Michael	MacCracken	Text Region	Chapter 01: Our Changing Climate		32	32	18	18	In that Skeptics do offer alternative explanations, it seems to me that this should say that there are no alternative explanations that are supported by the evidence in anywhere near as credible and quantitative a way. I just think saying no other alternative explanations will invite someone offering one--it just won't be credible.	Text revised for clarity.
Michael	MacCracken	Text Region	Chapter 01: Our Changing Climate		32	32	22	22	I'd suggest changing "depends" to "will depend"	Agreed. Text revised.
Michael	MacCracken	Text Region	Chapter 01: Our Changing Climate		32	32	23	24	I don't understand why climate sensitivity is mentioned here in a way that seems to indicate that it has not been established by the fact that the climate is already changing in response to this climate sensitivity. Thus, I'd suggest saying something like "globally to an extent consistent with the sensitivity exhibited in causing the ongoing warming over the last several decades."	Sentence is really referring to the remaining uncertainty in the sensitivity. Text revised for clarity.
Harold	Tattershall	Text Region	Chapter 01: Our Changing Climate		32	39	27	28	Overall comment: Although there is mention of the potential impact of increased aerosols in the atmosphere having a cooling impact there is no inter-coupling with the increased coal burning by both India and China in particular that contributed to this effect; i.e., SO2.	The authors are not aware of any studies showing this had a significant effect on global temperatures during this particular period.
Allison	Crimmins	Text Region	Chapter 01: Our Changing Climate		32	32	29	29	You may want to put a comma in number like 1700 on line 29, so that it doesn't look like the year 1700 but is 1,700 years.	Text revised as suggested.
Michael	MacCracken	Text Region	Chapter 01: Our Changing Climate		32	32	29	30	I would suggest saying "any time in the 1700 years or more for which we can credibly reconstruct the global distribution of land surface temperatures."	Agreed. Text revised.
Michael	MacCracken	Text Region	Chapter 01: Our Changing Climate		33	33	1	1	I'd suggest saying "for the United States"	Agreed. Text revised.
Nathan	Mantua	Text Region	Chapter 01: Our Changing Climate		33	33	10	17	lines 10-11: this statement: "human activities ... are primarily responsible for the observed climate changes over the last 15 decades" is way too broad to be supported by peer-reviewed science. line 16-17: alternative explanations ... cannot explain the majority of the observed changes in climate..." This absolutely needs more specificity with respect to which "observed changes in climate" are being discussed. The historical and paleoclimate record have a wide variety of "climate change" features in space and time, and only a subset of those features have been attributed to anthropogenic forcing, mostly in the period after 1950.	Text has been revised for clarity. Essentially all observed changes over the period, especially over the last 6 decades are attributable to human-induced forcing. The authors would agree there are more questions about attribution of the generally smaller changes before 60 years ago.
Allison	Crimmins	Text Region	Chapter 01: Our Changing Climate		33	33	11	11	"last 15 decades" sounds very funny. Why wouldn't you just 150 years?	Agreed. This text has been revised.
Allison	Crimmins	Text Region	Chapter 01: Our Changing Climate		33	33	11	12	I LOVE this line about "alternatives explanations". Clear, straightforward. I would suggest adding this to the overarching text at the beginning of the ES. This is something likely to be quoted.	Thank you.
Michael	MacCracken	Text Region	Chapter 01: Our Changing Climate		33	33	11	11	I'd suggest changing "over the last 15 decades" to ", especially since the mid-20th century" or something similar as natural influences (like volcanic eruptions) played a more important role in the late 19th /early 20th centuries.	Agreed. Text has been revised.
Michael	MacCracken	Text Region	Chapter 01: Our Changing Climate		33	33	12	12	Again, there are other suggested explanations, they are just not credible--and this really applies only since the mid 20th century; before that one does not really need human activities in nearly as convincing a way.	We have revised the text in this paragraph for further clarity.
Marcus	Sarofim	Text Region	Chapter 01: Our Changing Climate		33	33	13	16	1) It is true that the cycles I am familiar with generally redistribute heat between the ocean and the atmosphere; however, I could hypothesize internal variability that leads to, say, a shift in cloudiness that would in fact influence the heat content of the earth system (by changing the albedo). 2) Is Church et al (2011) the right reference here? It is a sea level paper. 3) This paragraph should also note that observed "external" forcing does not explain recent warming (e.g., solar changes).	Interesting speculative idea, but the authors are not aware of any such cycles that are observed or that would be expected to have a long term effect. Clouds are in fact known to be affected by the changes in climate. Church et al. 2011 reference is ok; it is also about the Earth's heat content as well as the discussion of the oceans. Sentence added on solar influences.
Michael	MacCracken	Text Region	Chapter 01: Our Changing Climate		33	33	16	16	Above you said there are no alternative explanations, but here you seem to admit that there are. What wants to say is that no other causes provide a credible explanation. The few lines here need more nuance. I also don't think this should say "unknown forcing factors"--it can be said that forcing factors other than human activities cannot explain what is happening and that known human activities quite reasonably explain what has happened without the need for other factors, and there are no suggested factors, even speculative ones, that can explain the timing or magnitude and would somehow cancel out the role of human factors.	Good point. Text revised for better clarity.
Michael	MacCracken	Text Region	Chapter 01: Our Changing Climate		33	33	21	24	One cannot forecast local weather out even near two weeks--there are some large-scale aspects that show some useful degree of predictability out to 1 or even 2 weeks, at least during some seasons. I'd also use the word "forecast" instead of "predict" here. I'd work to improve this discussion a bit.	Agreed. Text revised.
Kathy	Jacobs	Text Region	Chapter 01: Our Changing Climate		33	33	21	21	Might need to explain the term chaotic, this has a different meaning to the public	Text revised.
Michael	MacCracken	Text Region	Chapter 01: Our Changing Climate		33	33	26	28	The phrase "quite unpredictably" is very strange wording--maybe say "The statistics defining the climate are accumulated, over time, from the constantly evolving interactions of weather systems, exchange energy and water with the oceans and land surface and respond to changing regional and global influences, such as ..." I would not include the phrase "more predictable" to describe these influences--they are more slowly changing.	Agreed. Text revised.
Michael	MacCracken	Text Region	Chapter 01: Our Changing Climate		33	33	30	30	Just to sound better, I'd suggest changing "there are" to "we include"	Agreed. Text revised.
Allison	Crimmins	Text Region	Chapter 01: Our Changing Climate		34	34	1	2	This sentence should cite the EPA 2016 Indicators report	Agreed. Text revised.
Allison	Crimmins	Text Region	Chapter 01: Our Changing Climate		34	34	2	13	This whole paragraph needs citations. Almost every sentence in this needs a citation, and yet there is nothing but the Meehl reference. What papers were assessed to come to these conclusions? At the very least, the data sets in the EPA Indicators report could be cited for each of these trends. The EPA uri is not correct on line 16, and you may want to cite the actual peer-reviewed report and not the websites that may be altered. Also a little typo on line 10 (a should be as).	Additional citations have been added. Much of the text describes the figure, which is an update from NCA3 using NOAA-based and other dataset. Blunden and Arndt (2016) has a similar set of figures.
Michael	MacCracken	Text Region	Chapter 01: Our Changing Climate		34	34	9	11	I thought it was likely that the declining ozone depletion had created atmospheric circulation patterns that tended to encourage increased ice extent, but that now global (ocean) warming was growing to exceed that and Antarctic ice extent has at least stopped growing, if not reversed.	Meehl et al. supplanted earlier speculation.
Allison	Crimmins	Text Region	Chapter 01: Our Changing Climate		34	34	17	20	Indicating that multiple human influences can be involved would seem to me worth explaining. Note that most of these indicators are in the United States, not global indicators. Those do exist, though you didn't cite anything in the paragraph between lines 1-13, so not sure what sources you're using. If this is based only on EPA indicators, then you may want to note that it paints a compelling picture of a warming planet, yes, but also a warming United States.	References have been added for the global datasets. Figure 1.1 is based on global datasets.
Michael	MacCracken	Text Region	Chapter 01: Our Changing Climate		34	34	27	27	I would think it useful to somewhere be explaining how the change in global average temperature is calculated as this is not obvious and readers might wonder how this is done. Really, it is an area-weighted summation of local changes from the normal for that region--and so is an anomaly and not, for example, a direct thermometer measurement, just as MSU is not a direct measurement. I'd be pretty careful in describing what one is using here.	A reference has been added to provide that definition if needed by the reader.
Michael	MacCracken	Text Region	Chapter 01: Our Changing Climate		34	34	29	29	There is only one "global average temperature" that can increase--one can temperatures around the world increasing, but there is only one global average temperature.	Text revised.
Allison	Crimmins	Text Region	Chapter 01: Our Changing Climate		34	34	31	31	Suggest spelling out "for example", and I guess you need the tilda on the ninos throughout the chapter.	Text revised. Tildas will be added later.

First Name	Last Name	Comment Type	Chapter	Figure/Table No.	Start Page	End Page	Start Line	End Line	Comment	Response
Allison	Crimmins	Text Region	Chapter 01: Our Changing Climate		34	34	32	37	This is an unnecessarily long sentence when it should be stated boldly. 15 of the last 16 warmest years happened between 2001 and 2015. period. Then put all the detail in the next sentence. That will help make quoting this simpler. This is a really bad run-on that is hard to parse. This will also need updating to include 2016. Plus a little grammar error on line 34 (an should be a). I do like the last line about 3 of the 4 warmest have occurred since NCA3.	Agreed. Text revised.
Michael	MacCracken	Text Region	Chapter 01: Our Changing Climate		34	34	32	37	A quite long sentence.	Agreed. Text revised.
Michael	MacCracken	Text Region	Chapter 01: Our Changing Climate		34	35	37	2	Presumably, this will all be updated in the final version.	Indeed. This text has been updated.
Kathy	Jacobs	Text Region	Chapter 01: Our Changing Climate		34	34	38	38	Need to update now that 2016 is over	Text revised and updated.
Allison	Crimmins	Text Region	Chapter 01: Our Changing Climate		35	35	3	5	The sentence starting with "its instructive" is very hard to understand and poorly written. Can you just say "Though an even more powerful El Nino occurred in 1998, the global temperature in that year was much lower than that in 2015". The following sentence is also a little odd, not least with the "per se" phrase-- is it more accurate to say that human warming has more of an influence than El Nino on record temperatures than to just say human warming is THE dominant factor? Perhaps "This suggests that human caused warming has a stronger influence on the occurrence of record temperatures than El Nino events". Also, error on line 7- I think you mean "also" instead of "only, though I would suggest for clearer writing purposes you remove unnecessary and weakening phrases like "Its instructive to note" and "It must also be added". Just state what you want to state. You can just go with "In fact" here if you really need to.	Excellent points. Text revised.
Allison	Crimmins	Text Region	Chapter 01: Our Changing Climate		35	35	9	9	Delete "we must assume that". It is not needed and weakens the statement. This is a scientific assessment- we don't need to assume. We have citations.	Agreed. Text revised.
Michael	MacCracken	Text Region	Chapter 01: Our Changing Climate		35	35	10	12	This is a bit confusing as it says natural variability is contributing to "shaping the Earth's weather and climate"--natural variability is not really shaping the climate, which is, as defined earlier in the section, the three-decade average. Natural variability can influence each year's conditions, but not really the climate, for which human influence is dominant.	Good point. Text revised.
Michael	MacCracken	Text Region	Chapter 01: Our Changing Climate		35	35	13	13	I would suggest saying that it is the warming and its persistence that far exceeds--not the trend.	Agreed. Text revised.
Michael	MacCracken	Text Region	Chapter 01: Our Changing Climate		35	35	16	16	Need to say "exert influences"	Text revised.
Allison	Crimmins	Text Region	Chapter 01: Our Changing Climate		35	35	17	21	As much as 'should be 'as long as'. The phrase "and, perhaps short to medium term changes in relation between..." does not make sense. This last sentence is hard to follow.	Agreed. Text revised.
Michael	MacCracken	Text Region	Chapter 01: Our Changing Climate		35	35	20	20	No, the variability did not slow "the average pace of warming"--it led to a rate of warming that was a bit less than the average pace of warming for several years--given what we know now, it did not alter the "average pace of warming".	That sentence was replaced.
Michael	MacCracken	Text Region	Chapter 01: Our Changing Climate		35	35	25	25	Why is the baseline for this figure not the period 1901-60 (I think it is) that this report sets as the general baseline to be used? Setting the baseline as 1880-2015 really diminishes the perception of warming that has occurred, sort of implying that the baseline is the sort of unaffected normal from which changes should be calculated. Using the normal that the report indicated would be used, namely 1901-60,would seem to be a much more appropriate baseline to be using for consistency and so that it becomes much clearer the amount of stress that is being put on systems by the warming over the time since the mid-20th century. I would also suggest having a box that would explain that different types environmental and societal systems likely have different baselines. For example, the forests of the western mountains in the US really grew up based on something like the climate of the first half of the 20th century and before, and so the changes in climate to date should be shown relative to that baseline, not to the longer baseline. As another example, significant siting and design of infrastructure in the cities in the eastern US was developed with the sea level of the early 19th century, so what matters is the rise since then, and many of the older buildings and homes in eastern US cities were likely designed based on the climate norms from the first half of the 20th century, so the changes affecting them are a good bit more than just the part of the warming that is shown in red. The international negotiations are based on the change in conditions since preindustrial times and I would suggest that that is the baseline that should be used in the major graphics.	The first sentence now explains the effect relative to 1901-1960. This figure appears this way on the NOAA website and in other documents, so the authors decided to not revise it. However, the authors *are* trying to see if TSU can redraw it. The second part of the comment does not apply to this report. The NCA4 will use analyses appropriate to various impacts.
Michael	MacCracken	Text Region	Chapter 01: Our Changing Climate		35	35	34	37	There seems to be a huge gap between these sentences--what happened to the second half of the 20th century?	Text revised. Simple edit made to avoid a longer discussion.
Michael	MacCracken	Text Region	Chapter 01: Our Changing Climate		35	35	36	36	What is really happening over the Arctic is the loss of the mechanism for the temperatures to get really cold--that is, sea ice is needed to insulate the air from the ocean waters below the ice, and this allows great cooling. Losing sea ice means this does not happen. It is a bit strange to compare and account for this lack of ability to get really cold with the warming that is going on over most of the world. Yes, there are impacts to not getting so cold, so this is certainly part of climate change, but the two types of changes are a bit different conceptually.	While the authors agree, they don't see the need to further edit the text to add in such discussion.
Michael	MacCracken	Text Region	Chapter 01: Our Changing Climate		36	36	3	11	There is an awful lot in this paragraph for a normal reader to comprehend--it seems to me that a bit more description and explanation is needed, a more central them to the paragraph.	The authors don't see the problem. The paragraph progresses logically.
Michael	MacCracken	Text Region	Chapter 01: Our Changing Climate		36	36	13	17	Why is a different baseline used for this figure, I'd like to see them all be something more like what is used here, but why should there be a different baseline for figure 1.3 versus 1.2--all it will create is confusion. I favor something like 1880-1950 baseline for all figures.	Figures 1.2 and 1.3 do use the same baseline. The baseline approach and why 1850-1900 is not used (data not good enough) is explained in the Guide to the Report in the Front Matter.
Michael	MacCracken	Text Region	Chapter 01: Our Changing Climate		36	36	25	25	Here it is suggested that the 1850-1900 baseline is known--if so, why did the report indicate it would use 1901-60 because earlier data were inadequate. I would urge that all plots use the baseline as close to preindustrial is possible.	The authors state in the Guide to the Report that the period before 1901 is less trustworthy, so most of the graphics drawn for this report use the period 1901-1960 as a baseline. Figure 1.4, from IPCC, used a different baseline using only model results.
Michael	MacCracken	Text Region	Chapter 01: Our Changing Climate		36	36	29	29	Why is the 1986-2005 baseline used--this makes the results/numbers inconsistent with the other figures that are using other baselines. This plot should be relative to 1901-60 if that is the baseline that is to be used in lieu of preindustrial. Given negotiations are with respect to preindustrial, the preindustrial baseline should be used throughout so amount of change is comparable.	As much as possible, all projections are relative to 1986-2005, as stated in the Guide to the Report.
Michael	MacCracken	Text Region	Chapter 01: Our Changing Climate		36	36	32	33	It would really be useful to have a box somewhere that explained statistics and what phrases such as the words in the brackets means as far as the climate change issue is concerned, so indicating that there is a 1 in 20 chance that the Earth could warm by the highest amount (a quite large risk compared to the risk that we would accept in boarding an aircraft)--so this upper limit is not really even high enough for the stress and due diligence tests that companies are usually subjected to, etc. And is this averaging across models done across the ensemble mean of the models or is it calculated based on the total set of individual runs, so accounting for the spread within each model as well?	The reviewer is referred to IPCC 2013 where all that info is presented. The spread in each model is accounted for as it states in IPCC 2013. The highs in the spreads do not represent absolute highs or absolute lows. No change to the text.

First Name	Last Name	Comment Type	Chapter	Figure/Table No.	Start Page	End Page	Start Line	End Line	Comment	Response
Allison	Crimmins	Text Region	Chapter 01: Our Changing Climate		37	39	1	27	1) You use "slowdown" previously but here you introduce "hiatus" and "pause". May want to pick one thing and stick with it, only mentioning the other two terms once at the beginning like "assertions about a slowdown (often also called "hiatus" or "pause")..." 2) This text box is WAY too long. 3 pages before the figures are even inserted? The second sentence can be deleted. Most of the second paragraph can be deleted (see next point), maybe only leaving the last point that records do not support assertions that warming ceased. The paragraph on p38 lines 4-10 can be deleted (it just sounds defensive and doesn't add anything). Not sure you need p38 lines 28-31 for the same reason--suggest cutting. Also suggest cutting p 39 lines 7-10. Doesn't fit in the paragraph, language is weak ("appears to"), and doesn't add anything the previous paragraph already covered. 3) The second paragraph (p37 lines 5-13) spend a lot of time repeating denier language and not clearly refuting it. No where in this paragraph does it say that this practice of choosing short time periods is an inappropriate scientific method. 4) If you characterize speed-ups as "temporary" you should also characterize the slowdowns as such, early on in this section and throughout. 5) p38 lines 2-3: Make a new complete sentence without the weakening language "Thus the recent temporary slowdown is not surprising." The next sentence covers the statistical part. 6) On p28 lines 24, the "measurement/model discrepancy" could be explained better with the gist of the paragraph on p38 lines 4-10, something like "Some of the discrepancy between modeled temperature projections (such as those from CMIP5 models) and measured warming have been attributed to natural fluctuations..." Now you really don't need that earlier paragraph (lines 4-10). Ditch the "other studies said" language--that's what the citations are for. 7) Minor error on p38 line 34 (delete in)	The box has been revised and provides better clarity relative to the choice of terms.
Michael	MacCracken	Text Region	Chapter 01: Our Changing Climate		37	37	5	13	The text needs to distinguish between the claim that the rate of warming due to greenhouse gases was reduced (for which there is no evidence) and the finding that natural variability and some negative forcing from small volcanic eruptions led to the net change in global average temperature being low/stalled--and while simultaneously indicating that there can be/have been times when the apparent rate of warming got quite large, but this was due to natural variability adding to the human-caused warming rate, and so analyses should be looking more at longer term rates to get at the GHG warming rate.	That is exactly what this paragraph is setting up so that the rest of the box can discuss what the actual findings are. No change to text.
Marcus	Sarofim	Text Region	Chapter 01: Our Changing Climate		37	37	10	13	Is it also worth noting that no "hiatus" was observed in ocean-heat-content or sea level rise datasets?	Text added to make this point.
Michael	MacCracken	Text Region	Chapter 01: Our Changing Climate		37	37	15	15	Why is another baseline used here--how can one really do much intergraph comparing when baselines keep being changed?	As it says in the Guide to the Report, the authors are dependent on baselines from the literature unless new graphics can be created. In this particular case, the figure has been redrawn with the 1901-1960 baseline.
Marcus	Sarofim	Text Region	Chapter 01: Our Changing Climate		37	37	20	21	Sentence could be clarified by stating: During the recent slowdown period, of all the existing datasets reflecting some measure of global temperature, warming only ceased for atmospheric temperatures measured by satellites, and even there for only two out of (three? four?) datasets and for a very narrow range of time periods.	Not relevant. The figure caption is referring to the satellite data shown in the figure.
Nathan	Mantua	Text Region	Chapter 01: Our Changing Climate		37	37	34	35	See Meehl et al 2016 for an alternative view pointing to a role for the extended cool phase of the PDO/IPO in the big hiatus.	Good point. Text revised to account for this.
Michael	MacCracken	Text Region	Chapter 01: Our Changing Climate		37	37	34	34	Meehl et al. 2016: Contribution of the Interdecadal Pacific Oscillation to twentieth-century global surface temperature trends. Nature Climate Change. DOI: 10.1038/NCLIMATE3107	Text has been revised.
Kathy	Jacobs	Text Region	Chapter 01: Our Changing Climate		37	37	34	34	Drop the second "occurred" in the sentence.	Agreed. Text rewritten.
Nathan	Mantua	Text Region	Chapter 01: Our Changing Climate		38	38	13	13	Grammar problems in this sentence	Agreed. Text revised.
Kathy	Jacobs	Text Region	Chapter 01: Our Changing Climate		38	38	20	20	add reference to Meehl et al. (2016): Nature Climate Change. DOI: 10.1038/NCLIMATE3107	Agreed. Text revised
Michael	MacCracken	Text Region	Chapter 01: Our Changing Climate		38	38	24	27	an excess amount of heat seems like an odd way to phrase this	Agreed. Text revised
Michael	MacCracken	Text Region	Chapter 01: Our Changing Climate		38	38	26	26	My understanding is that the effects of small volcanic eruptions was a more important factor than is indicated by how it just seems to have been thrown in at the end. I'd suggest its likely contribution be given greater prominence in the discussion here.	Order changed in the sentence.
Michael	MacCracken	Text Region	Chapter 01: Our Changing Climate		38	38	26	26	There is an extra "I"	Agreed. Text revised.
Michael	MacCracken	Text Region	Chapter 01: Our Changing Climate		38	38	28	29	The model simulations being compared to were not "predictions"--they were "projections" that assumed that there would be no influence from changing natural factors, so they were conditional predictions, which we call projections. Thus, the root word "predict" is not appropriate in either of the two lines.	Text has been revised.
Michael	MacCracken	Text Region	Chapter 01: Our Changing Climate		38	38	31	31	It was not "spurious" warming--this was a projection, not a prediction--it was basically considering the case that only the GHG concentrations changed, and not accounting for other forcings.	Not exactly true because the models do account for natural variations but they are not on the same time line of ocean variations as the real climate system is. There is no attempt to line those up.
Kathy	Jacobs	Text Region	Chapter 01: Our Changing Climate		38	38	31	31	Avoid terms like spurious warming	Nonetheless, text is revised to get rid of spurious.
Michael	MacCracken	Text Region	Chapter 01: Our Changing Climate		38	38	32	33	What "these" refers to is just not clear. And is the Trenberth paper a single viewpoint or a consensus view--phrasing could be adjusted here to indicate studies are still going on to subdivide the responsibility for what happened.	Agreed. Text revised.
Michael	MacCracken	Text Region	Chapter 01: Our Changing Climate		38	38	34	34	You mean "new high"--overall phrasing not smooth	Typo corrected.
Michael	MacCracken	Text Region	Chapter 01: Our Changing Climate		39	39	5	5	The model results being referred to here are not really predictions--are they not hindcasts as what is being done is analysis of how well models simulate changes in the past. I think this needs clarification, perhaps instead say "simulations" or something.	Agreed. Text revised.
Michael	MacCracken	Text Region	Chapter 01: Our Changing Climate		39	39	19	19	And here again another baseline--this is really confusing. Again the 1901-60 baseline needs to be used.	Figure has been redrawn.
Allison	Crimmins	Text Region	Chapter 01: Our Changing Climate		39	39	33	34	Delete part of sentence after semi-colon. Not sure why this is in here. If people really felt strongly it could just go in the figure caption.	Agreed. Text revised.
Michael	MacCracken	Text Region	Chapter 01: Our Changing Climate		39	39	33	33	To really help the reader, I think it needs to be explicitly said again that these totals are for over land areas and not globally, as could easily be inferred here.	Agreed. Text revised.
Michael	MacCracken	Text Region	Chapter 01: Our Changing Climate		39	39	33	33	Given that the word "reconstruction" usually refers to making estimates from paleoclimatic sources of information and here what is being done is to assemble observations from around the world, I do not think it appropriate to use the word "reconstructions"--say "compilations and assembly of observations" or something similar	That phrase was eliminated.
Michael	MacCracken	Text Region	Chapter 01: Our Changing Climate		39	39	36	37	Why not instead have Figure 1.7 show the decade by decade sequence? Using the period 1985-2015 means that the graph is really centered on 2000, so 16 years ago, and so misses a very important set of years. Yes, there will be more noise, but it allows greater currency. Indeed, maybe show the running 5-year average or something similar.	Not readily redone without making it much more complex, so decided not to pursue this. The figure shown is an update of that in NCA3.
Allison	Crimmins	Text Region	Chapter 01: Our Changing Climate		40	40	4	4	Specify what energy budgets considerations you're talking about. This phrase sounds like you're talking about electricity generation or something. I know you're not, but it is still a bit vague.	Text revised.

First Name	Last Name	Comment Type	Chapter	Figure/Table No.	Start Page	End Page	Start Line	End Line	Comment	Response
Michael	MacCracken	Text Region	Chapter 01: Our Changing Climate		40	40	6	7	I know an Australian Skeptic who will be delighted to see that the text correctly says that increasing the CO2 leads to increased loss of IR radiation by the troposphere. I would just note on his behalf that the prevailing wisdom and public understanding is that adding CO2 traps more energy in the atmosphere, so adds energy rather than increases atmospheric loss. Of course, resolution of this is to say that increasing CO2 leads to greater energy absorbed by the atmosphere and re-emitted to the surface, with the additional transport to the atmosphere coming by convection. So, this wording might need to be adjusted given the simplified way that the greenhouse effect is explained in the IPCC report (something that the Skeptic considers as an indication that nothing said by the IPCC can then be considered correct).	Point taken. Text revised to further explain the processes.
Michael	MacCracken	Text Region	Chapter 01: Our Changing Climate		40	40	10	11	The last phrase rather hangs there, not really attached to the phrase about the change in atmospheric water vapor	Good point. Text revised.
Michael	MacCracken	Text Region	Chapter 01: Our Changing Climate		40	40	15	20	First, on line 16, you mean "drier". This discussion of changes in climatic normals really misses the major point that for regions like California and other locations along the polar side of the subtropics what is expected to happen is more generally dry years and fewer years that might well be much wetter than before (California being an example). I would not be surprised if average decadal precipitation in California will turn out to be average, but this average hides that they have experienced 5+ very dry years and then a drenching year. Such a shift can be very problematic in many ways. Thus, I think it essential to be saying more here than just about changes in the decadal (or even multi-decadal) trends, at least making clear that the averages have to be considered in the context of variability or something—but just giving broad trends is not adequate. Also, it needs to be mentioned here that evaporation is also going up, so even with increased precipitation, the resulting soil moisture and suitability for agriculture could be a good bit worse (especially in that there is this tendency of a greater fraction of the precipitation coming in heavier events and with other remaining events becoming lighter and so of generally little use. Also, there is no mention here of how the subtropics are tending to expand, causing spreading aridification—this is sometimes incorrectly described as drought (which means that it gets dry and then will come back)—yes, the greater heat and evaporation is causing a faster transition to very dry conditions that one could call drought, but this is occurring in addition to an underlying aridification that needs to be pointed out. Overall, then, this paragraph is simply inadequate.	Text revised. However, you are asking for more detail in what is already too long a chapter.
Kathy	Jacobs	Text Region	Chapter 01: Our Changing Climate		40	40	18	18	What does zonal mean sense mean?	Text revised.
Allison	Crimmins	Text Region	Chapter 01: Our Changing Climate		40	40	24	24	To be consistent with earlier sections, you may want to call this "Trends in Global Extreme Weather Events"	Good point. Text revised.
Allison	Crimmins	Text Region	Chapter 01: Our Changing Climate		40	40	25	37	May be worth mentioning here the point that we've seen advances in attribution of extreme weather events to human causes since NCA3	Good point. Sentence added.
Allison	Crimmins	Text Region	Chapter 01: Our Changing Climate		40	40	26	29	This point is so much easier to see/understand in a simple figure. If there isn't room maybe you can just refer them to NCA3 figures or something like https://www.epa.gov/sites/production/files/2016-07/bell_curve.swf	Reference to NCA3 added.
Michael	MacCracken	Text Region	Chapter 01: Our Changing Climate		41	41	3	3	Change "much" to "many" for grammatical reasons	Agreed. Text revised.
Michael	MacCracken	Text Region	Chapter 01: Our Changing Climate		41	41	9	14	The phrasing here makes it seem as if the changing circulation is somehow separate from being induced by human activities—so, yes, some occurs through the radiation process and then some indirectly as the circulation adjusts to the changed distribution of heating. The statement on lines 12 and 13 suggests that there might be some other cause, but there is no other comparable forcing to human activities and suggesting it is natural variability ignores its persistence—while the sequence is harder to document, implying that there is some other possibility with human influence playing no role makes no sense at all.	Sentence has been revised.
Michael	MacCracken	Text Region	Chapter 01: Our Changing Climate		41	41	11	11	What does "increasing" mean—number or intensity or persistence or what?	Text revised for clarity.
Allison	Crimmins	Text Region	Chapter 01: Our Changing Climate		41	41	13	13	Very awkward grammar. Maybe "Observed changes in circulation may also be the result of human influences on climate, though this is still an area of active research"	Agreed. Text revised.
Michael	MacCracken	Text Region	Chapter 01: Our Changing Climate		41	41	18	19	Really, it would be better to say that "what have in the past been considered extreme precipitation events" are increasing, for more is yet to come, and with the informal updating of climatic norms to cover three decades, what is considered extreme will be changing to catch up with the shifting of actual occurrence over a time closer to the present.	Agreed. Text revised.
Allison	Crimmins	Text Region	Chapter 01: Our Changing Climate		41	42	29	18	Suggest not introducing acronyms like TC and ETC that aren't used frequently enough in these sections to require acronym-ing, plus aren't well known.	Agreed. Text revised as suggested.
Michael	MacCracken	Text Region	Chapter 01: Our Changing Climate		41	41	32	32	This should perhaps also indicate that changes in snowfall and rapid melting can also confuse the record.	Too much detail. Text ok as is.
Michael	MacCracken	Text Region	Chapter 01: Our Changing Climate		42	42	6	7	What about trends in general location of tornados and trends in the time of year? We seem to be having more tornados in months when this was very unusual—is the time of year during which they are seen broadening?	Text revised to reference Chapter 9 where there is a more extensive discussion of tornadoes in the United States. Data inconclusive at this point on lengthening of tornado season.
Michael	MacCracken	Text Region	Chapter 01: Our Changing Climate		42	42	9	22	Why no mention that the temperature seems to be changing faster than the storms are moving, so more precipitation is coming as rain and less as snow, at least in terms of winter storm activity. Thus, the amount and duration of snow cover is receding.	The authors did not add this discussion; it is covered in later chapters.
Kathy	Jacobs	Text Region	Chapter 01: Our Changing Climate		42	42	16	16	might need to explain the term meridional temperature gradients	Should be ok as is for the intended audience.
Michael	MacCracken	Text Region	Chapter 01: Our Changing Climate		42	42	20	20	To read more appropriately, change "both" to "the"	Agreed. Text revised.
Allison	Crimmins	Text Region	Chapter 01: Our Changing Climate		42	42	24	35	Suggest starting with what you do know and including caveats, like the first sentence, where appropriate. But talking over and over of hampering will give the impression we know nothing and nothing has advanced. The caveats in the first sentence are already covered by the caveats at the beginning of this section on p40, so you can save some space by cutting repetitive sentences.	Text revised.
Kathy	Jacobs	Text Region	Chapter 01: Our Changing Climate		42	43	24	9	This section seems more like a literature summary than an assessment of the state of knowledge.	This section and been shortened and reader is referred to Chapter 9 for more detail.
Allison	Crimmins	Text Region	Chapter 01: Our Changing Climate		43	43	1	9	This paragraph has a lot of "thus study said, but then this study found that, and then other studies found other things" This whole paragraph seems like it could be condensed into a sentence, like "Whether global trends in high-intensity tropical cyclones are already observable is a topic of active debate; some research suggest positive trends (cites), some insignificant trends (cites), and others no detectable trends (cites.)"	Text revised and simplified.
Allison	Crimmins	Text Region	Chapter 01: Our Changing Climate		43	43	20	25	This is rather a long rambling paragraph that was adequately covered by the first sentence and by the rest of the section. This chapter is so long already- suggest cutting.	This paragraph sets up the rest of the section. We will look for other ways to cut text.
Michael	MacCracken	Text Region	Chapter 01: Our Changing Climate		43	43	20	21	I think it needs to be made clear here that the effects of changes in land cover on climate have largely been regional rather than global. On the other hand, the changes in climate are having effects on land cover around the world. On line 21, also change "case" to "cases"	Text revised as suggested.
Michael	MacCracken	Text Region	Chapter 01: Our Changing Climate		43	43	22	22	Changes in sea ice cover are not usually considered changes in "land" cover, but changes in "surface" cover. Might it be that the titles of section need adjustment?	Good point. Text revised.

First Name	Last Name	Comment Type	Chapter	Figure/Table No.	Start Page	End Page	Start Line	End Line	Comment	Response
Harold	Tattershall	Text Region	Chapter 01: Our Changing Climate		43	43	23	25	Section 1.2.5.: "Other changes are currently mainly causes of climate change but in the future could become consequences (e.g., deforestation), while other changes are mainly consequences of climate change (e.g., effects of drought)." I fundamentally disagree with this statement. The progressive infestation of Bark Beetles into the Boreal and other forests, and the associated damage to the natural tree sink, is a consequence of climate change. The reality that temperatures have increased disproportionately in northern latitudes due entirely to climate change has diminished the natural barrier of long periods of sub-zero temperatures.	Text revised to clarify this concern.
Kathy	Jacobs	Text Region	Chapter 01: Our Changing Climate		43	43	23	25	This sentence is awkward	Sentence has been eliminated.
Michael	MacCracken	Text Region	Chapter 01: Our Changing Climate		43	43	25	25	This should really say "drought and aridification"--drought being temporary, and aridification being more permanent.	Revised as suggested.
Kathy	Jacobs	Text Region	Chapter 01: Our Changing Climate		43	43	30	34	Drought obviously causes changes in land cover but it is not usually viewed as a land process per se. If this topic stays in this section the intersection between aridity and land cover and land use might need to be clearer.	Good point. Text revised for further clarity.
Allison	Crimmins	Text Region	Chapter 01: Our Changing Climate		44	44	3	11	Just a note to check these numbers against the SOCCR-2 report values	Agreed. But this would not be possible until a draft of SOCCR-2 has been released for Public Review, which had not happened by the time CSSR was in the final clearance process.
Kathy	Jacobs	Text Region	Chapter 01: Our Changing Climate		44	44	17	17	Defining growing season as "non-frozen" does not work	Agreed. Text revised.
Allison	Crimmins	Text Region	Chapter 01: Our Changing Climate		45	47	3	38	This entire section was painfully long and I would recommend shortening. It seems much of this information is covered in Chapter 11, so why is there so much detail here? I think you could drop the section on snow cover at least, but I think this would be improved by shortening by half or more. The entire SLR section is only three paragraphs long, so this can be done.	Section has been extensively rewritten and shortened.
Michael	MacCracken	Text Region	Chapter 01: Our Changing Climate		45	45	15	15	Regarding "since 1979", it might instead be said that "since comprehensive satellite observations began in 1979"--or was there earlier evidence of an increase (other than in the quite variable Gobi Desert)?	Adjusted the statement to read "since comprehensive satellite observations began in 1979".
Allison	Crimmins	Text Region	Chapter 01: Our Changing Climate		45	45	20	22	Can this 1979-2014 value be updated with 2015 and 2016 values? The data is available.	Text revised. The data have been updated.
Michael	MacCracken	Text Region	Chapter 01: Our Changing Climate		45	45	24	26	The period over which these results needs to be stated	Text has been revised to do this.
Harold	Tattershall	Text Region	Chapter 01: Our Changing Climate		45	45	28	30	The Arctic sea ice volume is a critical aspect of prospective changes that could have extremely deleterious atmospheric and societal impacts on both the US and the rest of the world. The almost total reliance on predicting the timing of a "blue ocean" event (for area extent less than 106 km ² or approximately 3.9x10 ⁵ mi ²) by models, has the potential of severely under-assessing the associated risks leading directly to flawed essential policy decisions to minimize or avert these identifiable risks. The characteristics of ice melting can be observed in a laboratory and confirmed in the field. If an ice cube is placed in a glass of water it will melt disproportionately as a ratio of its depth to the area of its surface. The area of the surface will remain relatively large, relative to the depth, until the final moments when quite suddenly the remainder of the cube will melt. This implies that at a certain point in time there could be a rapid melt out of the remaining Arctic sea ice; one that is not considered in the models projecting for instance near or at mid-century for a "blue ocean" event. Consider this mathematical analysis of the exponential decline of the Arctic sea volume: https://sites.google.com/site/arctischepenguin/home/piomas/ That analysis is based on PIOMAS data: http://psc.apl.uw.edu/research/projects/arctic-sea-ice-volume-anomaly/ And, the PIOMAS data has been confirmed by data from CryoSat-2: http://neven1.typepad.com/blog/2016/04/cryosat-2-confirms-sea-ice-volume-is-low.html#more http://www.esa.int/Our_Activities/Observing_the_Earth/The_Living_Planet_Programme/Earth_Explorers/CryoSat-2/ESA_s_ice_mission Added to this situation is that as the Arctic sea ice recedes, thereby exposing progressively more of the Arctic Ocean earlier each season, solar irradiance will progressively increase the temperature of the ocean. At the onset of winter the surface of the ocean will cool sufficiently to allow sea ice to reform but the reforming sea ice will act as thermal blanket. It thereby retains some of the added heat under the reforming ice and as the ice reforms, or when cracks appear, a considerable amount of latent heat is released, potentially altering weather patterns in the Northern Hemisphere. Added to this situation is that the heat trapped under the thermal blanket will continue to attack the underside of the Arctic sea ice throughout the winter months.	This is more for Chapter 11. And too long for what can be included here. The authors agree with the reviewer about the risk of rapid sea ice decline in the coming years and the concern that climate models are not able to capture that appropriate physics. The authors also note the larger trends in sea ice volume as opposed with sea ice extent, which corroborate the physical explanation provided by the reviewer. However, we are unable to insert a detailed description into this document but have added text drawing attention to the fact that this limits our ability to make projections.
Allison	Crimmins	Text Region	Chapter 01: Our Changing Climate		45	45	34	12	May be worth mentioning somewhere in this paragraph that increases in Antarctic sea ice extent were expected. The whole "stymied" thing and the list of possible influences gives the impression that you are befuddled.	This section has been rewritten, shortened, and revised for better clarity.
Allison	Crimmins	Text Region	Chapter 01: Our Changing Climate		45	46	34	26	There are a lot of ice sheets here that are given acronyms, but then the acronyms are only used maybe once more in this chapter. May want to cut down on the barrage of acronyms when not needed	Agreed. The authors have removed detail from this section and the names for most glaciers and ice sheets will be removed. The acronyms for ice sheets are only kept if they are used more than twice.
Kathy	Jacobs	Text Region	Chapter 01: Our Changing Climate		45	46	34	12	This paragraph seems a little defensive, and needs to be in the context of the overall net loss of ice mass. The whole section should be revisited to make sure it hangs together well.	The entire section has been revised and we think that it "hangs together" much better. The authors have also contrasted Antarctic sea ice gain relative to Arctic sea ice loss.
Michael	MacCracken	Text Region	Chapter 01: Our Changing Climate		46	46	2	4	I thought the effect of ozone depletion on winds was thought to be a significant contributing factor, but not mentioned here.	There was some suggestion of that in an earlier paper but not backed by other data. Ozone depletion can certainly influence the atmospheric circulation around Antarctica. However, the authors feel that this detail is unnecessary in the current discussion in light of more recent papers.

First Name	Last Name	Comment Type	Chapter	Figure/Table No.	Start Page	End Page	Start Line	End Line	Comment	Response
Harold	Tattershall	Text Region	Chapter 01: Our Changing Climate		46	46	4	7	"Scientific progress on understanding the observed changes in Antarctic sea ice extent is stymied by the short observational record; complex interactions between the sea ice, ocean, atmosphere, and Antarctic Ice Sheet; and large interannual variability." Irrespective of the "short observational record", a failure to acknowledge the potential risk of considerable sea level rise emanating from the Antarctic would seem to be highly questionable. The constantly increasing discharge rate, particularly from West Antarctica, must be adjusting the salinity of the surrounding ocean water. Common sense dictates that as the salinity reduces then the ocean water affected will freeze more easily, thereby progressively increasing the associated area. If there is no associated scientific analysis to confirm this hypothesis, it should not stand in the way of the risk being identified particularly because this situation has potentially interconnected consequences relative to the major ocean currents of the world. One should also note that there is now strong evidence that East Antarctica has engaged and thus the projections for sea level rise by 2100 could be grossly understated: http://www.canberetimes.com.au/world/scientists-confirm-that-warm-ocean-water-is-melting-the-biggest-glacier-in-east-antarctica-20161218-gtdgeg.html This would potentially completely change the current observations that gains in East Antarctic ice mass are partially off-setting losses emanating from West Antarctica; particularly the WAIS. In both cases of the Arctic sea ice, and discharge from the Antarctic, it would appear that the entire focus is linear extrapolations based on regression line analysis of data. The collapse of Larsen B was non-linear, and Goren Ekstrim identified considerable non-linear activity in the Greenland ice sheet relative to ice-quakes. Ice melts but it also disintegrates and the identifiable risk is that disintegration is sudden thereby exposing the US to forward and considerable under-assessed and thus under-stated risks.	Thank you for the details. The sentences referenced are about Antarctic sea ice, not land ice, which is covered in the next subsection. Also the risk analysis upper limit for SLR that then follows is largely based on the uncertainty of the West Antarctic ice sheet. The authors have rewritten the text on Antarctic land ice.
Kathy	Jacobs	Text Region	Chapter 01: Our Changing Climate		46	47	13	20	The section on Continental Ice Sheets is too detailed, need to give an assessment of the state of knowledge, not a summary of all the recent papers	This section has been rewritten and shortened by more than a page.
Michael	MacCracken	Text Region	Chapter 01: Our Changing Climate		46	46	25	25	This needs to indicate where the ocean transport is coming from. I think this means warming of the oceans and increased contact between the ice shelves and the warmer ocean as they retreat.	Text has been revised and we have removed these details.
Michael	MacCracken	Text Region	Chapter 01: Our Changing Climate		46	46	34	34	"additional" to what--need to give an indication	Text revised. This sentence is revised to include "on top of current projections".
Allison	Crimmins	Text Region	Chapter 01: Our Changing Climate		47	47	10	10	Sorry to nitpick but, but unprecedented means it never happened before, so no matter how much time has passed since 2012, that event would have been unprecedented. Suggest saying it was unprecedented, not remains unprecedented, and if necessary just say it also hasn't happened since.	Text revised as suggested.
Marcus	Sarofim	Text Region	Chapter 01: Our Changing Climate		48	48	2	8	Would the authors be able/willing to make some kind of stronger statement regarding acceleration in the sea level rise dataset? (I'll also comment on Chapter 12, where maybe more detail would be relevant). But something about whether we've now had a long enough time period to be confident that: a) the rate of sea level rise since 1990 is unprecedented in the instrumental record (AR5 was unable to make this claim, but we've had an additional 4 years of data that has actually lead to even faster sea level rise, and part of the problem for AR5 was the Jevrejeva study which I think is not as good as the Hays et al. 2015 reconstruction) b) that it is also the fastest that's been seen in X hundred years c) that the higher rate of rise is not explained by natural variation would be relevant, if we have sufficient confidence in the above statements.	This is under consideration for Chapter 12, but too much detail for Chapter 1.
Michael	MacCracken	Text Region	Chapter 01: Our Changing Climate		48	48	6	6	Why change from inches per decade, as previously, to inches per year--keep things consistent, and I favor per decade.	Good point. Text revised.
Michael	MacCracken	Text Region	Chapter 01: Our Changing Climate		48	48	14	14	I think the phrase "to date" needs to be added here when saying the effects are "minor", as this is going to change.	Agreed. Text revised.
Keely	Brooks	Text Region	Chapter 01: Our Changing Climate		48	49	30	31	The Paleoclimate section in Chapter 1 has some components that are inconsistent with the paleoclimate section in Chapter 4, p. 158 line 14-p. 159, line 22. We recommend you add additional detail on paleoclimate analogues, to describe if climate change on the geologic time scale, which presents temperature and CO2 conditions similar to those projected in the future, is considered natural variability? Some differences include geologic changes in climate occurred when land masses were in a different configuration so the atmospheric and ocean processes that stabilize our climate today did not exist, or there was an external driver such as increase in incoming solar radiation that prompted the change. Another notable difference is that the rate of change is unprecedented in the geologic record, so the magnitude of impacts is uncertain and this occurs at a time when the majority of our populations are situated along coastlines. A final cautionary note would be to point out that geologic climate change frequently coincided with mass extinction events.	The authors have revised the section, and made sure the discussion is consistent with Chapter 4.
Allison	Crimmins	Text Region	Chapter 01: Our Changing Climate		48	48	31	33	This first sentence is really hard to follow. It sounds like the paleoclimate records are only covering 2000 years. And "overprint" is a strange term. Why not just say "Paleoclimate records demonstrate long-term natural variability in the climate and overlap the records of the last two millennia, referred to here as the "Common Era"."	Agreed. Text revised.
Michael	MacCracken	Text Region	Chapter 01: Our Changing Climate		48	48	31	36	Come now, volcanic eruptions have caused fluctuations in climate, but not changes, and GHGs are now larger than land cover change. So, this sentence buries the GHG effect last, which is not correct. Why not, as this is revised, separate off the preindustrial period--so before and after fossil fuels, or separate off before the last century, etc.	Sentence revised. However, the reviewer is incorrect about volcanic eruptions not possibly have a longer term impact. The recent analyses of the little ice age indicate it was due to ocean responses following a series of large eruptions. And was not due to the Maunder Minimum in sunspots.
Michael	MacCracken	Text Region	Chapter 01: Our Changing Climate		49	49	9	10	Why use an unconventional baseline period? It is really key to work harder to use a common baseline, perhaps 1901-60.	This figure is based on a published paper and figure. However, we have added a sentence to the caption to explain the difference if used the 1901-1960 baseline.
Michael	MacCracken	Text Region	Chapter 01: Our Changing Climate		49	49	15	15	Why use an unconventional baseline period? It is really key to work harder to use a common baseline, perhaps 1901-60.	This figure is from an existing published paper, so not possible to change the time period.
Allison	Crimmins	Text Region	Chapter 01: Our Changing Climate		49	49	20	31	Consider adding a caveat sentence in this paragraph- you are not trying to say that the Pliocene is the exact model of what we expect today based on GHG levels, but you may give that impression. Maybe something along the lines of the time periods you mention being partial analogs but not exactly what you'd expect to see in modern times due to all the other things that influence climate besides Milankovitch cycles and GHG concentrations. Besides for being careful, it may head off some important questions.	Good point. Text added for clarity.
Michael	MacCracken	Text Region	Chapter 01: Our Changing Climate		49	49	26	28	The explanation is not adequate here as changes in orbital forcing summed over the Earth and through the year are roughly zero. What happened during the Eemian was an increase in NH summertime solar radiation at the expense of a reduction in the SH--the latter had less effect than in the NH due to the buffering effect of the ocean and that in the NH the extra solar must go into melting as there is no ocean layer in which to store it. Also change "as the Earth travels around the Sun" to "as a result of cyclic changes in the shape of the Earth's orbit around the Sun." And then I would incorporate the next sentence saying "even though the CO2 concentrations was only near preindustrial levels."	Agreed. Text revised.
Michael	MacCracken	Text Region	Chapter 01: Our Changing Climate		49	49	28	31	I think it important to make the last two sentences of the paragraph a separate paragraph as the subject is very different from the earlier sentences.	Agreed. Text revised.

First Name	Last Name	Comment Type	Chapter	Figure/Table No.	Start Page	End Page	Start Line	End Line	Comment	Response
Allison	Crimmins	Text Region	Chapter 01: Our Changing Climate		49	51	32	31	While I really really like this text box, and even feel it should go up at the front of the Executive Summary, I don't feel it needs to be repeated here. This is three pages you could drop. The executive summary is summarizing the findings of the entire report, so it makes sense to have that section there. But this is a chapter on Global Changes, so why is there a sudden break from the chapter topic to talk about the report itself? I think this is much more powerful and relevant in the ES and does not add anything but length here.	By definition, the Executive Summary can only discuss what is in the report itself. Chapter 1 sets up the report while also providing a summary of global findings. So it makes sense to provide a summary of major findings in one place in the report itself. Other reviewers also expressed positively for this section. We have decided to keep the section.
Kathy	Jacobs	Text Region	Chapter 01: Our Changing Climate		49	51	32	31	This box is very helpful, but to distinguish it from other news boxes you might want to call this "Changes in Assessment Methodologies" or something	What's New is not just changes in methodologies. It is also new understanding of the science. The authors don't think this requires a change to the text.
Michael	MacCracken	Text Region	Chapter 01: Our Changing Climate		49	49	33	33	I am confused as to why Box 1.2 is here as opposed to being in the Executive Summary—it goes well beyond summarizing what is discussed in Chapter 1, and really is a summary of the whole report. Were there a section 1.3 of the report that explained the general topics and rationale for the rest of the chapters in the report, then presenting a summary of what lies ahead would make good sense. I would thus suggest that such an overall summary of how the report is now broken down needs to be added.	That rationale is in the Guide to the Report. This will be a box to separate it from the rest of the discussion. The Executive Summary needs to reflect material already in the report itself, so it makes sense to summarize what is new in this report where authors both set up the rest of the report, along with providing a summary of global findings.
Michael	MacCracken	Text Region	Chapter 01: Our Changing Climate		50	51	1	30	This is a really excellent summary of what I think has been learned and where we stand today. Great job.	Thank you.
Michael	MacCracken	Text Region	Chapter 01: Our Changing Climate		50	50	22	22	This sentence sort of implies a shorter overall tornado season although I don't think that is what is meant. It would be helpful to clarify that while there may be greater concentration over fewer days, the spread of the days through the year could be greater.	The authors have revised the sentence for better clarity.
Allison	Crimmins	Text Region	Chapter 01: Our Changing Climate		50	51	34	3	Though you say "so-called" I would suggest putting the phrase "global warming hiatus" in quotes and being clear in the first sentence that the slowdown was a reported slowdown, or at least something observed in some datasets. The last sentence does not go far enough to reassure me that the slowdown is non-existent.	Text revised as suggested.
Kevin	Trenberth	Text Region	Chapter 01: Our Changing Climate		51	51	8	8	The statements about AMOC are quite wrong. Many recent studies are not cited and what they have in common using the RAPID array data is the emphasis on huge natural variability that makes any trend not at all significant. Frajka-Williams, E. (2015), Estimating the Atlantic overturning at 26°EAN using satellite altimetry and cable measurements, <i>Geophys. Res. Lett.</i> , 42, 3458a0f3464, doi:10.1002/2015GL063220. Srokosz, M. A., and H. J. Bryden (2015), Observing the Atlantic Meridional Overturning Circulation yields a decade of inevitable surprises, <i>Science</i> , 348 (6241), 1255575, doi: 10.1126/science.1255575. Stepanov, V. N., D. Iovino, S. Masina, A. Storto, and A. Cipollone (2016), Methods of calculation of the Atlantic meridional heat and volume transports from ocean models at 26.5°EAN, <i>J. Geophys. Res. Oceans</i> , 121, doi:10.1002/2015JC011007. This carries over to p 452 l 8 and p 456.	Statement has been revised to weaken it. This section on What's New has no references; those should be in the associated chapter(s). Chapter 13 provides further discussion.
Allison	Crimmins	Text Region	Chapter 01: Our Changing Climate		51	51	13	16	Whoa... can you say that a slowing occurring over a few months is a key bullet point in a list of things that have changed since NCA3 titled "slowing regrowth of Arctic sea ice extent"? I think this bullet could be re-phrased to note that new data has been added to a long term trend, and that new data includes some record breaking values, but it seems a stretch to talk about events within one year.	Good point. Updated to more recent data and lead statement made only for 2016-2017.
Marcus	Sarofim	Text Region	Chapter 01: Our Changing Climate		51	51	17	17	"Slowing in Arctic sea-ice area extent regrowth" seems very out of place in this list: it appears to refer to the regrowth of Arctic sea ice in the 2016-2017 winter season, which is more of a "weather" observation than a climate trend. Suggest deleting. (Additionally, chapter 11 doesn't seem to highlight the 2016-2017 regrowth at all) (Alternatively, maybe this is meant to reflect better understanding of the longer term Arctic sea ice retreat: in which case it needs to be totally reworded)	The statement has been revised. Even though this is one year, the ice regrowth is much lower than any previous year, so this is a new finding warranting discussion. Chapter 11 will add discussion.
Michael	MacCracken	Text Region	Chapter 01: Our Changing Climate		51	51	22	22	Need to capitalize "Earth" as you are talking about the planet and not the soils.	Change has been made.
Allison	Crimmins	Text Region	Chapter 01: Our Changing Climate		51	51	25	30	Suggest dropping this last bullet completely. This is not something new in NCA4 not in NCA3, it is something new that has happened outside the NCA process. I get that talking about it for the first time in an NCA product is new, but talking about mitigation isn't. I don't think this bullet belongs here and draws unnecessary specificity to political situations	This section is What's New in this report, and science implications of the Paris Agreement is new info. Statement has been revised to better reflect the science basis of the discussion.
Michael	MacCracken	Text Region	Chapter 01: Our Changing Climate		52	52	1	1	I very much like the approach used here of providing information on how the various findings were developed and on what information they are based. Well done	Thank you.
Harold	Tattershall	Text Region	Chapter 01: Our Changing Climate		52	52	13	14	Box 1.2: "Accelerated ice-sheet loss and irreversibility: New observations from many different sources confirm that ice-sheet loss is accelerating." As stated earlier, the focus of the majority of commentary appears to be based on linear extrapolations and yet acceleration is non-linear by its very nature. The identifiable risk is that acceleration will pass through the saddle point of a given plot and thus become potentially so severe that it cannot be countered; or in lay terms enter a mode of unstoppable change.	Reviewer meant page 51. While the authors don't disagree with the reviewer, no change is need to the statement in the text.
Nathan	Mantua	Text Region	Chapter 01: Our Changing Climate		54	54	11	12	this is too broad, needs to be more specific about time period and types of "climate change" that "many lines of evidence... demonstrate that human activities are primarily responsible for the observed climate changes in the industrial era."	This is intended to be a short statement summarizing a key finding from the chapter. It would not be a short key finding if it were greatly expanded upon. The reader should see the rest of the chapter to get more detailed info.
Nathan	Mantua	Text Region	Chapter 01: Our Changing Climate		56	56	3	4	this is simply not true; ENSO has profound influences on tropical climate at interannual time scales, and basin-scale variations in North Atlantic and Pacific climate (e.g. AMO, PDO/IPO) are known to have profound signatures on climate trends and variations at multi-year to multi-decade time scales at continental scales in mid-latitudes	No change. Text revised to eliminate the word limited.
Marcus	Sarofim	Figure	Chapter 01: Our Changing Climate	1.1	58				I recognize that there is already a lot of data on this plot, but I feel like it would be useful to add annual snow cover and annual sea ice in addition to Mar-Apr snow and Sep sea ice.	Figure revised to include the additional information requested.
Michael	MacCracken	Text Region	Chapter 01: Our Changing Climate		59	59	4	4	The baseline here should be the one proposed for the overall report, namely 1901-1960, which is about as close as can be estimated reliably to preindustrial. Using the longer baseline that shows so much blue really diminishes the impression of the warming that human activities have caused—this really needs to be changed.	The authors did not say every graph would follow that approach. Overall temperature trend relative to 1901-1960 addressed in the caption. There are historical reasons from prior references for keeping the figure as is.
Michael	MacCracken	Text Region	Chapter 01: Our Changing Climate		60	60	3	3	This is not correct way to describe the plot—it is NOT showing a trend but instead a change in temperature over a given interval unless you want to call the plot the rate of warming over 30 years (so not per year or per decade as a trend would normally be given)	Good point. Caption revised.
Keely	Brooks	Figure	Chapter 01: Our Changing Climate	1.3	60				One important aspect of the foundational physical science of climate change is the that for impact assessments higher resolution location specific climate information is needed. Therefore, it would be most useful when showing anomaly maps for key variables such as temperature and precipitation that the figures be at the very least at the scale of the United States, rather than globe. For example, why use Vose et al. 2012 to show surface temperature trends for the entire globe when audience is particularly interested in U.S. (Figure 1.3)? Walsh et al 2014 provides figures that are appropriate to the U.S. scale and highlights the main point -- spatial distribution of changes in temperature. This is relevant for all figures & studies that focus at a global scale. (same as Fig 1.7)	The U.S. temperature change is covered in Chapter 6. This chapter specifically says it is covering the global changes.

First Name	Last Name	Comment Type	Chapter	Figure/Table No.	Start Page	End Page	Start Line	End Line	Comment	Response
Michael	MacCracken	Text Region	Chapter 01: Our Changing Climate		61	61	3	3	This plot is NOT relative to 1986-2005 (those years are all above the zero line) but looks to be more appropriately about a preindustrial estimate. Whatever it is, this needs to be fixed, preferably making sure that it is relative to preindustrial or to the period 1901-60 that is the preferred reference period for this report.	Good catch. Figure 1.4 has been revised to fix this. Projections are relative to 1976-2005.
Allison	Crimmins	Figure	Chapter 01: Our Changing Climate	1.4	61				Consider showing the other RCP lines, at least 4.5. If it doesn't clutter the graphic too much, it could be helpful for the rest of the CSSR but also NCA4, which will include a lot of modeling at RCP4.5 and RCP6.0	Figure 1.4 has been revised to also include RCP4.5.
Michael	MacCracken	Text Region	Chapter 01: Our Changing Climate		62	62	2	2	This plot should be replotted so it is relative to the 1901-1960 baseline proposed for this report--having all these different baselines is just very confusing and unnecessary.	Done. Figure has been redrawn.
Allison	Crimmins	Figure	Chapter 01: Our Changing Climate	1.5	62				The citation text is rather confusing (the maximum number of years historically for less than positive trends???) Can you say this is a smoothed data set instead? And if warming only ceased in two datasets for a narrow range of time, then why are you calling it a slowdown?	Caption has been revised.
Michael	MacCracken	Figure	Chapter 01: Our Changing Climate	1.5	62				I do not see why this plot is in here--when the climate is described as a three-decade average what should be shown is the time history of trends for the running 30 year average. Just because the Skeptics do something inappropriate like look at short-term trends is no reason to give in to their flawed reasoning and show a 17-year plot (and contending that only 2 curves give negative trends when all are close to zero is really a too fine a distinction). Of course there will be fluctuations in the trend using 30-year running average. so that is fine, but shoing 17-year trends should be saved for the particular literature papers explaining the issue--not in the overall report where this is really inside baseball talk.	The authors redid the plot to make the short-term trends versus long-term trends clearer.
Michael	MacCracken	Text Region	Chapter 01: Our Changing Climate		63	63	3	4	Again, the baseline should be 1901-60 and not altered here--it is just confusing to keep changing the baseline.	Agreed. Figure has been redrawn relative to the 1901-1960 baseline.
Allison	Crimmins	Figure	Chapter 01: Our Changing Climate	1.6	63				Very hard to see the green NOAA line	Figure has been redrawn to emphasize the NOAA dataset.
Michael	MacCracken	Text Region	Chapter 01: Our Changing Climate		64	64	4	4	If you are showing a trend instead of a difference, then the color bar needs to have units of amount of precipitation per time period, not just be "inches"--really need to be precise on language.	Caption revised.
Michael	MacCracken	Text Region	Chapter 01: Our Changing Climate		64	64	5	5	HOORAY AND CONGRATULATIONS--THIS FIGURE USES THE BASELINE THE FRONT MATERIAL INDICATED WAS BEST TO BE USING	Thank you.
Michael	MacCracken	Text Region	Chapter 01: Our Changing Climate		65	65	2	6	Now back to using another baseline--very confusing. The plots need to be made relative to the 1901-60 baseline (the human influence is). It might also be said in the caption that over this relatively long period there was an underlying change in forcing go on due to the orbital elements--namely a change in precession (so time of year the Earth is closest to the Sun) from fall into winter, I think it is, so that may well be explanation of the underlying slow cooling going on that began about 6000 years ago, and around which various fluctuations have taken place for reasons still being explored (like deforestation of Europe, etc.).	Sentence added to the figure caption about the difference from using the two different baselines.
Michael	MacCracken	Text Region	Chapter 01: Our Changing Climate		66	66	3	3	In that hard to change the baseline on this plot, how about at least indicating the difference in the value of the bseline (in the temperature record) between 1961-90 and 1901-60.	Added a sentence to the caption to provide the difference in using the two different baselines.
Allison	Crimmins	Figure	Chapter 01: Our Changing Climate	1.9	66				It is unclear what the neon teal lines represent	sentence added to the figure caption to show this is the HADCRUT4 observation record.
Allison	Crimmins	Whole Chapter	Chapter 01: Our Changing Climate						This entire chapter could be greatly strengthened by shortening it by half. It is painfully long, and each section seems to have been given different instruction on how much detail to go into, so that it results in a mish-mash of level-of-details. Restricting this chapter to a specific page length (like 10-12 pages tops, instead of more than 20 with the figures included) would greatly improve the chapter, distill the information, prevent so many redundancies (much of this information is already in other chapters), and help the chapter feel like a coherent narrative instead of disparate voices. Dropping the redundant section on what is new from NCA3 already saves 3 pages, but there is a lot of text in other sections, especially the cyrosphere section, that can be dropped with simple references to the more detailed chapters. So cutting in half seems very reasonable. Upon reading it, it felt like the authors did not make thoughtful choices about the most important things to get across in this chapter and what could be reserved for the following chapters, which, rather than being what I assume the authors thought of as comprehensive, actually served to obscure the findings by not helping the reader understand what the most important high-level points are, and where to find the more detailed points elsewhere.	The authors have made an attempt to shorten the chapter. But half is not possible. The What's New in this Report was specifically requested (in agency reviews), and needs to be in the main report if included in the Executive Summary.
Allison	Crimmins	Whole Chapter	Chapter 01: Our Changing Climate						I was surprised in reading this chapter how much the text used the language of climate deniers and presupposed the "slowdown" was a given phenomenon, particularly after last year's NOAA paper, where adjustments to the record actually resulted in no or little slowdown. For instance, in Figure 1.5, why do you demarcate the slow down, but not the "speed up" of other eras? Why fall into that trap of highlighting the slowdown? I get being responsive to frequently asked questions, but the emphasis here seems wrongly placed.	The hiatus received a lot of press, warranting discussion. The authors have tried to edit to revise the discussion to account for your concern. On the other hand, the "slowdown" was real but not surprising as said in the text.
Michael	Kolian	Whole Chapter	Chapter 01: Our Changing Climate						Indicators of a Globally Changing Climate. Pg. 34 Updated url to EPA's Climate Change Indicators in the United States: https://www.epa.gov/climate-indicators Full citation: U.S. Environmental Protection Agency. 2016. Climate change indicators in the United States, 2016. Fourth Edition. EPA 430-R-16-004. This reference provides several of the Global indicators mentioned later in the chapter and well as U.S. specific indicators (growing season, ragweed pollen season). Note: Meehi et al 2009 has been updated (Meehi et al 2016) http://www.pnas.org/content/113/49/13977.full.pdf the observational record is expanded back to 1930 and simulations are used to 2100.	Thank you. Text revised.
Roger	Griffis	Whole Chapter	Chapter 01: Our Changing Climate						This Chapter includes extensive information on climate-related changes in ocean temperatures on global to regional scales which is outstanding and appropriate given the state of the science. But this strong foundation in Chapter 1 is not supported throughout the rest of the document especially not in Chapter 13 on Ocean Warming etc which has almost no information on past and projected future changes in ocean temperatures for US ocean basins. This is a complete mismatch and glaring whole in the document since there is available data and assessments of climate impacts on US ocean temperatures that should be the lead content of Chapter 13 and a key message from that chapter but appears almost completely lacking from Chapter 13. This appears to be a major omission in the report.	Passed comment to the authors of Chapter 13 and have asked them to account for this in the revisions to their chapter.

First Name	Last Name	Comment Type	Chapter	Figure/Table No.	Start Page	End Page	Start Line	End Line	Comment	Response
Andrew	Pershing	Whole Chapter	Chapter 01: Our Changing Climate						<p>pg 36, l 3-11. This paragraph is confusing. I appreciate trying to foreshadow the discussion of AMOC in the oceans, but I think a more general discussion of ocean warming would be more appropriate here. The oceans are warming and store a significant proportion of the extra heat that we've been accumulating. It would also be worth mentioning the oceans' role in redistributing heat in the climate system. This would support the box on the alleged hiatus.</p> <p>pg 40, L15-17. Given that oceans are 100% wet, the idea of a dry area over the ocean will be confusing to a lay reader. I would talk about high/low rainfall.</p> <p>pg 60, L3-7. When I think of temperature trends, I think of the rate of temperature change (i.e. degrees per year). I think it is more appropriate to call these temperature anomalies or just the change in temperature.</p> <p>pg 64. This figure makes it seem like it never rains over the ocean. I presume that this is from station data, therefore, there is limited data available over the ocean. If it isn't possible to truly show the global patterns, I would mention in the caption that data is from long-term stations, so precipitation changes over the ocean and Antarctica could not be computed.</p>	Good points. Text has been revised in all of these sections as requested.
Scott	Weaver	Whole Chapter	Chapter 01: Our Changing Climate						<p>The discussion in chapter 1 regarding the global warming hiatus spends a fair amount of time and space explaining the physical mechanisms for the hiatus after presenting the more recent evidence that the hiatus does not exist, but was instead an artifact of some aspects of post processing the long term temperature data (i.e., the Karl et al. 2015 study). I suppose it depends on the precise definition of a hiatus (i.e., whether it is a slow down or a complete leveling off of the temperature trend), but a report such as this would be much more useful for science based policy makers if it included an explicit and scientifically backed discussion regarding a potential reconciliation for these seemingly opposing conclusions. I imagine that this may also be something that the IPCC will have to confront in AR6.</p>	The slowdown did exist, there just was no hiatus in climate change suggesting climate change had stopped as was appearing in the press over recent years. Thus the reason for a box. The authors have revised the text in that box, both shortening it while also trying to add further clarity.
Allison	Crimmins	Text Region	Chapter 02: Scientific Basis		85	85	3	23	<p>While I like these key findings, you make it known in the front matter that this is a technical report written for a more technical audience. Thus I wonder if you need to put the definitions of things like "feedbacks" or note the importance of aerosols in the key findings here. These are not findings in themselves, they are rather already known and understood by the technical experts you suggest is your audience. You may be able to shorten these then, making the last one for instance just say "While there are large uncertainties associated with feedback processes, the net feedback effect over the industrial era has been positive (amplifying warming) and will continue to be positive in coming decades"</p>	This chapter's content is well established and hence familiar to a technical audience in many respects. The authors prefer to leave the additional sentences for completeness.
Michael	MacCracken	Text Region	Chapter 02: Scientific Basis		85	85	21	22	<p>It seems to me a bit more should be said because the positive feedbacks, including especially water vapor and snow/ice albedo combine to be very strong, essentially tripling the direct radiative response. Yes, clouds can go a bit either way, but overall, the net effect is very strongly positive.</p>	Key finding has been edited for a stronger statement about the fact that net effect of feedbacks is positive and triples the effect of the original forcing.
Marcus	Sarofim	Text Region	Chapter 02: Scientific Basis		85	85	28	28	<p>"accurately" means different things to different people: perhaps note the accuracy in terms of W/m²?</p>	Observational uncertainty ranges are given in Figure 2.1 caption, and now point to Figure 2.1.
Michael	MacCracken	Text Region	Chapter 02: Scientific Basis		85	85	29	29	<p>Saying "about one-third" is unhelpfully loose; per your Figure 1, the number is 29.4%, so say "just less than 30%" rather than "about one-third"</p>	The text has been revised to incorporate this suggestion. The sentence now reads: "About a third (29.4%) of incoming, short-wavelength energy..."
Michael	MacCracken	Text Region	Chapter 02: Scientific Basis		85	85	30	32	<p>In that clouds are responsible for something like 3/4 of the Earth's albedo, it would seem that they should receive much more prominence in this sentence as compared to the land and ocean surface, which is likely most of the rest. The next sentence makes this point, but I would still suggest reordering the points in this sentence.</p>	The text has been revised to incorporate this suggestion; "clouds" are now first in the list.
Michael	MacCracken	Text Region	Chapter 02: Scientific Basis		86	86	2	3	<p>Regarding "some of this radiation", the number is about 90% and saying just "some" is misleading and validates a criticism of some deniers. This needs to be changed to say something like "most of this radiation"</p>	The text has been revised to incorporate this suggestion; the text now reads "most of this radiation"
Marcus	Sarofim	Text Region	Chapter 02: Scientific Basis		86	86	6	6	<p>Add "holding albedo constant" as a modifier to this sentence.</p>	The text has been revised to incorporate this suggestion; the following qualified has been added to the end of the sentence: ", when albedo is held constant."
Michael	MacCracken	Text Region	Chapter 02: Scientific Basis		86	86	23	27	<p>Actually there are other important factors, a key one being the distribution by season and latitude. Indeed, changes in this distribution by changes in orbital parameters are the driving force of ice ages, causing, with the help of internal feedbacks (natural carbon cycle feedback, ice sheet albedo, isotatic adjustments, etc.), a change in the global average temperature by 6 C. Based on the Cretaceous climate and its likely causes, the position of the continents and positions and extent of mountains can also affect the global average temperature. Thus, the text needs to have a qualification indicating that these factors dominate for the present geographic and orographic configuration and orbital parameters.</p>	The authors have modified the sentence to read "Thus, Earth's equilibrium temperature in the modern era is controlled by a short list of factors..." (added "in the modern era" to be clear that not including factors such as continental position and orbital changes).
Harold	Tattershall	Text Region	Chapter 02: Scientific Basis		86	86	27	29	<p>Section 2.1: "Anthropogenic activities have changed the Earth's radiative balance and its albedo by adding greenhouse gases, particles (aerosols), and aircraft contrails to the atmosphere, and through land-use changes." Unmentioned is the fact that due to the change in radiative balance, and the consequential increase in temperature, is the release of carbonaceous materials from the Arctic, which may have already (or at a minimum is an identifiable risk), have entered a positive feedback loop.</p>	What is described by the reviewer in this comment is one of many feedbacks to anthropogenic radiative forcing, which are discussed later in the chapter. The authors have now added a sentence here pointing out that forcing triggers feedbacks and refer to the later sections that discuss this in detail.
Michael	MacCracken	Text Region	Chapter 02: Scientific Basis		86	86	27	29	<p>While the statement is true, not making clear that the GHG influence is the largest of te factors, by a good deal.</p>	This fact becomes evident later in the text.
Michael	MacCracken	Text Region	Chapter 02: Scientific Basis		87	87	13	13	<p>I'd suggest changing "led to" to "contributed to" or something similar as the former seems to indicate that the natural variability is leading in what is happening, whereas that is just not the case, as the second part of the sentence indicates. Similar wording should be used for the two types of contributions.</p>	The text has been revised to incorporate this suggestion; "led to" is now "contributed to" in the text that discussed natural variability.
Michael	MacCracken	Text Region	Chapter 02: Scientific Basis		87	87	21	26	<p>As a metric, radiative forcing does have its limits. For example, the changing orbital elements have essentially a zero radiative forcing when one integrates over the Earth and seasons, and yet it leads to the largest climate change the Earth has known over the last several million years—namely the glacial/interglacial cycling with a range of 6 C. We are also learning that the responsiveness of the climate to forcings varies a bit by the altitude at which the radiation is absorbed. "Nuclear winter" studies made this most clear—in that case, it was suggested that the incoming solar radiation would be absorbed by dark smoke at an altitude above virtually all of the greenhouse gases. When that happens, there is no greenhouse effect and the surface temperature would quickly plummet were it not for residual heat in the ocean. So, the metric works okay for minor changes as GHG concentrations change a little and if aerosols are generally near the surface or mainly scatter radiation. Otherwise (and also for orbital element redistributions of incoming solar energy), the metric approach IPCC used by the IPCC does not work at all. So, I'd be careful and more specific in the statements that are made, perhaps making the few statements that are there a separate paragraph augmented by a qualifying sentence. Then make the rest of the present paragraph a new paragraph.</p>	The authors understand the reviewer's comment. The team has clarified the text by adding a qualifier to the first sentence, as applying "over the industrial era" when factors such as seasonal and orbital changes don't apply. Further, the team disagrees that the radiative forcing concept doesn't apply when forcings are above the tropopause. In this case, TOA radiative forcing would be a valid metric.
Michael	MacCracken	Text Region	Chapter 02: Scientific Basis		88	88	1	3	<p>Just to repeat a comment at the start of this paragraph, the metric works assuming that the incoming solar radiation is not absorbed in the troposphere at an altitude above all or most of the amplifying effects of the greenhouse effect.</p>	See response to comment on pg 87, lines 21-26.

First Name	Last Name	Comment Type	Chapter	Figure/Table No.	Start Page	End Page	Start Line	End Line	Comment	Response
Michael	MacCracken	Text Region	Chapter 02: Scientific Basis		88	88	3	5	With respect to a change in the upward flux amount, this generally refers to visible radiation (such as due to an change in surface albedo) as the IR changes generally represent feedbacks, and so the flux changes resulting from feedbacks and adjustments do not count as radiative forcings. This should be noted, indicated that the change in upward flux needs to be counted assuming no other change has occurred in the troposphere.	Per IPCC, the definition the authors have given is correct. The authors have added clarification that "flux" in both and the preceding sentence refers to longwave plus shortwave.
Michael	MacCracken	Text Region	Chapter 02: Scientific Basis		88	88	6	27	This paragraph is quite murky, and it is not at all clear yet why this quite long paragraph even needs to be here.	It's important to define ERF here because of it's use in other parts of this chapter (i.e. Figure 2.3, Figure 2.6 and Section 2.3.2 Aerosols discussion.) The authors have edited the text for better clarity. The text has been revised to incorporate this correction. The authors thank this reviewer for noting this editorial error.
Michael	MacCracken	Text Region	Chapter 02: Scientific Basis		88	88	7	7	Change to "defined as"	The text has been revised to incorporate this suggestion. The first sentence now reads (per suggestion from another reviewer): "Climate drivers of significance over the industrial era include both those associated with anthropogenic activity and, to a lesser extent, those of natural origin."
Michael	MacCracken	Text Region	Chapter 02: Scientific Basis		88	88	14	15	How can it be that the tropospheric temperature can change without a change in surface atmospheric temperature given that convection couples all levels of the troposphere? The explanation does not seem very complete.	The text does not state that tropospheric temperature changes will not cause surface temperature changes. It is simply that this response is not included in what is defined (e.g. in IPCC AR5) as RF. Here the authors are simply stating the technical definition of ERF.
Nathan	Mantua	Text Region	Chapter 02: Scientific Basis		88	88	29	30	Please ensure that key findings in Chapter 1 are consistent with the correct statement made here: "Climate drivers of significance over the industrial era include both those associated with anthropogenic activity and those of natural origin."	The text has been revised to incorporate this suggestion. The first sentence now reads (per suggestion from another reviewer): "Climate drivers of significance over the industrial era include both those associated with anthropogenic activity and, to a lesser extent, those of natural origin."
Michael	MacCracken	Text Region	Chapter 02: Scientific Basis		88	88	30	30	I'd suggest changing to say "and, to a lesser extent, those of natural origin."	The text has been revised to incorporate this suggestion.
Michael	MacCracken	Text Region	Chapter 02: Scientific Basis		88	88	33	35	This is a really strange list to include here, somehow suggesting they could have a significant effect over the time scales of interest--why include, or at least indicate that there is no indication they will have such effects on the time scales of interest. And you left off nova events that would affect the ozone layer, etc.	The authors now separately address cosmic rays and have re-written the sentence on natural drivers that operate on longer timescales. It now reads: "There are other known drivers of natural origin that operate on longer timescales (e.g. changes in Earth's orbit in the Milankovich cycles, and changes in atmospheric CO2 via chemical weathering of rock)."
Michael	MacCracken	Text Region	Chapter 02: Scientific Basis		88	88	34	34	Change "asteroids" to "asteroid impacts"--they have to hit to have an effect.	The text has been revised to incorporate this suggestion.
Michael	MacCracken	Text Region	Chapter 02: Scientific Basis		89	89	7	8	You might also add that volcanic eruption effects are also intermittent and exert effects mainly over only a few years.	The text has been revised to incorporate this suggestion.
Michael	MacCracken	Text Region	Chapter 02: Scientific Basis		89	89	17	17	Please say "percentage changes in variance" as the absolute changes do not amount to more than the 0.1% of 1360 W/m2.	The text has been revised to incorporate this suggestion. The sentence now reads: "Although these (TSI) variations amount to only 0.1% of the sun's total output of about 1360 W/m2 (Kopp and Lean 2011), relative variations in irradiance at specific wavelengths can be much larger (tens of percent)."
Michael	MacCracken	Text Region	Chapter 02: Scientific Basis		89	89	20	20	I'd suggest changing "important" to "detectable" or "discernible" or something similar. How do we know this will be "important", which would seem to imply that there are clearly sizeable impacts on the environment, society or weather and I don't think this is at all proven.	The text has been revised to incorporate this suggestion; "important" is now "discernible"
Michael	MacCracken	Text Region	Chapter 02: Scientific Basis		90	90	11	11	Given what is said later in the paragraph, it should also be noted that volcanic aerosols scatter about ten times as much radiation forward as backward, whitening the sky and allowing more radiation to reach into the canopy of forests and so help to pull a bit of CO2 out of the atmosphere.	This level of detail is beyond the scope of this chapter.
Michael	MacCracken	Text Region	Chapter 02: Scientific Basis		90	90	32	32	It needs to be said that these perturbations tend to last for only a year or two--and is not constant over long periods of time.	The figure (Figure 2.6) caption now points this out explicitly. The text and figure combined now make this point clearly.
Barbara-Ann	Lewis	Text Region	Chapter 02: Scientific Basis		92	92	1	3	The production of carbon dioxide gas from cement manufacturing and use reported here does not appear to include subsequent sequestration of the emitted gas by carbonation (reabsorption of atmospheric carbon dioxide by cement hydration products). It has been estimated that 43% of carbon dioxide gas emissions by the cement industry, from 1930 to 2013, has been sequestered in carbonating cement materials (Xi, F. et al, Nature Geoscience 9:880-883 [2016]). In China alone, the cement carbon sink was about 0.14 GtC in 2013 (ibid.). Lumping cement and fossil fuel together in the sentence, and particularly in Figure 2.7, is misleading with regard to the relative magnitude of cement vs fossil fuels, or land use, as a specific source of this atmospheric gas.	The text has been revised to incorporate this suggestion.
Michael	MacCracken	Text Region	Chapter 02: Scientific Basis		92	92	1	19	This is a long paragraph covering a lot of material--it needs to be split up.	The text has been revised to incorporate this suggestion. The paragraph has been split in two, with the second paragraph now starting at: "In the industrial era, the CO2 atmospheric growth rate has been exponential"
Michael	MacCracken	Text Region	Chapter 02: Scientific Basis		92	92	3	3	Unbalanced parenthesis	Thank you for catching this editorial error; the needed parenthesis has been added.
Michael	MacCracken	Text Region	Chapter 02: Scientific Basis		92	92	5	5	The explanation here needs to be much more nuanced. There are quite a number of instances where Skeptics (and some uninformed business leaders) point out that the lifetime (or residence time) of a particular atmospheric CO2 molecule is really only a few years. The long lifetime applies to the net CO2 perturbation--and it should be noted that the persistence of the CO2 perturbation extends for, to some extent, many millennia.	This sentence has been revised to include the word 'effective', to make it clear this is the "effective lifetime", not the lifetime of a particular CO2 molecule.
Michael	MacCracken	Text Region	Chapter 02: Scientific Basis		92	92	21	31	The caption does not explain the land use source, indicating that this term is largely, but not only, deforestation.	The text has been revised to incorporate this suggestion.
Michael	MacCracken	Text Region	Chapter 02: Scientific Basis		92	92	23	24	Suggesting that the land and ocean are "true sinks" is really not the case. As emissions are brought down, especially to negative emissions, the CO2 that went into the land and ocean will come back out, making clear that they are not sinks forever.	The word 'true' has been deleted.
Michael	MacCracken	Text Region	Chapter 02: Scientific Basis		92	92	33	34	It needs to be said that the comparison is on a per unit weight basis. It also needs to be said that the effectiveness is at early times--over the full persistence time of CO2, this is not case.	The GWP sentence has been revised. The GWP details account for the 'early time' aspect.
Marcus	Sarofim	Text Region	Chapter 02: Scientific Basis		92	92	34	36	This is an incorrect characterization as written: "Methane also has indirect climate effects through induced changes in CO2, stratospheric water vapor and ozone (Lelieveld and Crutzen 1992). The 100-year GWP of methane is high (28, direct; 34 including indirect)" I would rewrite: "Methane also has indirect climate effects through induced changes in CO2, stratospheric water vapor, and ozone (L&C, 1992). The 100-year GWP of methane is 28-36, depending on whether oxidation into CO2 is included, and whether climate-carbon feedbacks are accounted for." (the key is that the indirect effects of methane on ozone & stratospheric water vapor are already accounted for in the value of 28, which the original wording does not make clear. Additionally, neither 28 nor 34 take into account the CO2 oxidation product: 30 and 36 do that).	The text has been revised to incorporate this suggestion. Sentence now reads: "The 100-year GWP of methane is 28-36, depending on whether oxidation into CO2 is included, and whether climate-carbon feedbacks are accounted for, and its 20-year GWP is even higher (84; 86) (Myhre et al. 2013 Table 8.7)."

First Name	Last Name	Comment Type	Chapter	Figure/Table No.	Start Page	End Page	Start Line	End Line	Comment	Response
Antonio	Sarmiento G	Whole Page	Chapter 02: Scientific Basis		92				I would like to recommend the inclusion of a very, very important point that follows directly from a fact you clearly mention on page 92 of the report : Processes that remove emitted CO2 from the atmosphere include uptake in the oceans, residual land uptake, and ultimately rock weathering, thereby yielding an atmospheric lifetime of many decades to millennia, far greater than any other major GHG. The consequence of this fact, which is the point I think you should include, is that CO2 in the atmosphere has a very distinct and different behaviour to that of all known greenhouse gases (GHGs), that is, CO2 emissions accumulate in the atmosphere and do exacerbate the greenhouse effect for a much longer period of time than any other greenhouse gas. This problem is clearly shown in Figure SPM.10 in the Summary for Policymakers of the Fifth Assessment Report of the IPCC (p. 28, also attached as a figure). In this figure, the increase of global mean surface temperature due to cumulative CO2 emissions is separately plotted in order to differentiate its effect from the effect caused by all the other GHGs; it thus clearly shows the important, very relevant role that CO2 plays in the warming of the planet and the fact that, even if the emissions of all other GHGs were stopped/halted, the planet would go on warming due to the cumulated CO2 still present in the atmosphere (for centuries or even longer). This figure also shows the fact that in order to avoid crossing the accorded limit to the increase in global mean surface temperature of 2°C, the highest emissions path that we could follow is the RCP2.6 (any other path with a stronger reduction in emissions would be a safer way to avoid crossing the limit); it is also clear that this is due to the bending of the RCP2.6 path from 2040-2049 onwards, a bending which in turn is due to the fact that from this decade onwards, there are not any further CO2 emissions along this particular RCP. This also implies that if any efforts are made to reduce the limit to 1.5°C, as stated in the Paris Agreement, then the CO2 emissions should vanish long before the 40s decade (in the 2020-2029 decade, according to the figure). I do believe that this particular point should be clearly stated in the CSSR Report you are about to finish since it may be of critical relevance to the way we need to deal with GHGs emissions – specially CO2 emissions – in order to avoid catastrophic warming of the planet. Also, on page 88, line 7 (2nd line of second paragraph), there is a small typo:	The role of CO2 as suggested is accounted for in multiple ways in this chapter's text and figures. The relationship to temperature response is outside the scope of this chapter and is addressed in Chapter 14.
Antonio	Sarmiento G	Figure	Chapter 02: Scientific Basis	2.7	92				The figure I am asking to be included should go in page 92, right before figure 2.7 Unfortunately I am not able to upload the required figure, but it is figure SPM.10 in the Summary for Policymakers of the Fifth Assessment Report of the IPCC (mentioned in the note uploaded before in the WHOLE PAGE option for Comment Type.	The figure SPM.10 is Figure 14.2 (in Chapter 14 of the report).
Michael	MacCracken	Text Region	Chapter 02: Scientific Basis		93	93	3	3	The precision of the emissions total and uncertainty seem unrealistically high.	This range is based on top-down estimates specifically. We now make this clear. Revised text reads: "Methane has a variety of natural and anthropogenic sources, which totaled 556 ± 56 Tg CH4 in 2011 based on top-down estimates, with the anthropogenic fraction estimated to be about 60% (Ciais et al. 2013)."
Marcus	Sarofim	Text Region	Chapter 02: Scientific Basis		93	93	10	11	Suggest modifying to note recent increase in methane concentration - e.g.: "The remaining uncertainty in the cause(s) of the approximately 20-year negative trend in the methane annual growth rate starting in the mid-1980s, and the recent resumption of methane concentration growth in the past few years, reflects the budget complexity (IPCC 2013)."	The text has been revised to incorporate this suggestion.
Michael	MacCracken	Text Region	Chapter 02: Scientific Basis		93	93	19	19	Again, precision in emissions estimates and uncertainty seems unrealistically high.	These number are cited directly from IPCC AR5. This is now made clear: "Anthropogenic sources account for approximately 40% of the estimated annual N2O emissions of 17.9 (8.1 to 30.7) TgN (Ciais et al., 2013)."
Marcus	Sarofim	Text Region	Chapter 02: Scientific Basis		93	93	32	36	Maybe a parenthetical noting that there are small natural sources of CF4 and SF6 would be appropriate, since as written the implication is that all fluorocarbons are entirely synthetic.	The text has been revised to incorporate this suggestion.
Michael	MacCracken	Text Region	Chapter 02: Scientific Basis		93	93	37	37	In that the role of tropospheric ozone as a GHG influence needs to be explained, this line needs to indicate that it is stratospheric ozone that is depleted.	The text has been revised to incorporate this suggestion. Sentence now reads: "The rapid growth of CFCs declined beginning in the 1990s with their regulation under the United Nations Montreal Protocol as substances that deplete stratospheric ozone (Figure 2.4)."
Marcus	Sarofim	Text Region	Chapter 02: Scientific Basis		94	94	13	22	The authors may want to note that anthropogenic additions of water vapor have minimal effect on global temperatures. (irrigation is also mentioned briefly on page 96)	Sentence added to clarify this aspect.
Michael	MacCracken	Text Region	Chapter 02: Scientific Basis		94	94	20	22	I'd make these lines a separate paragraph and then add a sentence that the atmospheric circulation, especially convection, limit the buildup of water vapor in the atmosphere, such that the water vapor given off by combustion of fossil fuels or by large powerplant cooling towers does not accumulate in the atmosphere, but actually offsets water vapor that would otherwise evaporate from the surface. And this control by atmospheric circulation limits the atmospheric lifetime of an H2O molecule is roughly 8 to 10 days (I can't recall which), also meaning the buildup can't occur. As a result, the amount of water vapor in the troposphere ends up being determined by the changing temperature of the troposphere, and so is considered a feedback and not a forcing. This is worth really explaining as there is sometimes confusion about emitted water vapor is not also considered a human influence on the climate.	The text has been revised to incorporate this suggestion.
Keely	Brooks	Text Region	Chapter 02: Scientific Basis		94	94	22	22	Please add information about how much more water the atmosphere will hold per degree warmed.	This information is given in Section 2.6, which is referenced here.
Michael	MacCracken	Text Region	Chapter 02: Scientific Basis		94	94	24	35	IMPORTANT: I would really suggest having separate paragraphs for tropospheric and stratospheric ozone. Also, in model runs I did with the MAGICC model, the RF of tropospheric ozone due to precursor emissions during the 21st century is roughly equal to the methane forcing due to 21st century emissions and the total of these is about equal to the CO2 forcing through the century caused by the 21st century of emissions--so tropospheric ozone forcing is really important and merits much more attention. Admittedly, the CO2 emissions during the 21st century have a very long tail and so will exert emissions for many later centuries whereas this will not be the case for the emissions of methane or tropospheric ozone (really its precursors) during the 21st century. So, if one really wants to limit radiative forcing and the temperature increase during the 21st century, one has to address the precursor emissions of tropospheric ozone, and this very minimal mention is simply inadequate. It would be worthwhile here referencing to the UNEP 2011 and the Shindell et al. 2012 papers so as to get everything right.	Expanding the text to address 21st century RF terms and limiting anthropogenic RF is beyond the scope of this report.
Michael	MacCracken	Text Region	Chapter 02: Scientific Basis		95	95	31	33	This needs to be more quantitative, for the land surface effect is pretty small, First, the global surface as a whole (so land and ocean) only reflect back to space about 5% of incoming solar radiation due both to the presence of clouds so the solar radiation does not reach the surface and because much of the surface is not very reflective. In that a CO2 doubling creates a radiative forcing of equivalent to about a 2% change in solar radiation, the changes in land cover are not near to creating or potentially creating anything like as large a change in radiative forcing. Overall, while changes in surface characteristics can have local to regional influences, such as, along with the waste heat of energy consumption, cause urban areas and megalopolises to be somewhat warmer than rural areas, but those areas only cover a very small area of the planet. Agricultural areas are larger, but not changing very much, and it is the ongoing change in land cover and land use that matter, not the total change since 8000 years ago.	This sentence now reads "There is strong evidence that these changes have increased Earth's surface albedo, creating a globally averaged net-negative RF of -0.15±/0.10 W/m2 (Myhre et al. 2013).", providing the requested quantification. We also, however, point out that land use change contributes to forcing through more than just albedo change. This is discussed more extensively in Chapter 10.
Michael	MacCracken	Text Region	Chapter 02: Scientific Basis		96	96	11	12	Contrails form only under some weather conditions, and this needs to be mentioned. The conditions are generally in the hours before the region would become cloudy in any case because if the air is dry the contrails evaporate. And is this really the case in the mid-troposphere.	The text has been revised to incorporate this suggestion.

First Name	Last Name	Comment Type	Chapter	Figure/Table No.	Start Page	End Page	Start Line	End Line	Comment	Response
Michael	MacCracken	Text Region	Chapter 02: Scientific Basis		96	96	11	18	It needs to be said that this term has been estimated and is relatively small overall. You could even mention that when planes were grounded after 9/11 and so an indication of how modest this effect is was illustrated.	The text has been revised to incorporate this suggestion in a following section (Section 2.4).
Michael	MacCracken	Text Region	Chapter 02: Scientific Basis		96	96	34	34	It needs to be made clearer that this is a large relative uncertainty to a very small term—not something that could grow to overwhelm the GHG forcing term that is of order 20-50 times larger, etc.	The text has been revised to incorporate this suggestion. Wording has been revised to read: "Radiative forcing due to changes in solar irradiance is estimated to be 0.05 (0.0 - 0.1) W/m ² between 1745 and 2005 (Myhre et al. 2013), a very small fraction of total anthropogenic forcing in 2011. The large relative uncertainty derives from inconsistencies among solar models, which all rely on proxies of solar irradiance to fit the industrial era."
Michael	MacCracken	Text Region	Chapter 02: Scientific Basis		97	97	19	19	Instead of just saying aerosols, this needs to separately say sulfates and black carbon because they have different sources and different potential for reducing these emissions (and reducing emissions is really a key issue for consideration)—lumping them together is just not at all helpful. This also needs to say "tropospheric ozone" as this is clearly most important. Also, there is really not much that can be done about contrails or LCC, so these are really a distraction here and in any case have pretty small and mainly local to regional influences (e.g., contrails over relatively cloudy areas really don't do much, and LCC can be of either sign).	This section is about the relationship between forcing and climate response. It is beyond the scope of this section to get into the feasibility of mitigating specific forcings, nor how doing so would specifically affect climate. Further, it would overly complicate the text. It is accurate to say that all aerosols are heterogeneously distributed; there is no need to specify how the different types of aerosols are differently distributed. The word "tropospheric" was added in front of ozone, as suggested.
Michael	MacCracken	Text Region	Chapter 02: Scientific Basis		97	97	25	26	I really don't think the radiative forcing (at the tropopause) has strong latitudinal variations—this should be rechecked. And I am not sure what is meant by the humidity comment.	There are significant latitudinal variations, and variations with both humidity and cloud cover; e.g. see (now cited): Ramanathan, V., M. S. Lian, and R. D. Cess, Increased atmospheric CO ₂ : Zonal and seasonal estimates of the effect on the radiation energy balance and surface temperature, J. Geophys. Res., 84, 4949-4958, 1979.
Michael	MacCracken	Text Region	Chapter 02: Scientific Basis		97	97	27	30	Actually, the RF caused by time varying orbital forcing has strong seasonal and latitudinal patterns shows that there can be a very large influence—namely cause glacial-interglacial cycling.	The authors have edited to make clear that referring to changes within the industrial era. The text now reads: "Quantifying the relationship between spatial RF patterns and regional and global responses in the industrial era difficult because it requires distinguishing forcing responses from the inherent internal variability of the climate system, which acts on a range of time scales."
Michael	MacCracken	Text Region	Chapter 02: Scientific Basis		97	97	36	37	This seems unduly pessimistic. The sulfate forcing has a strong interhemispheric imbalance, and we see a relatively modest difference between hemispheric responses, so we do have some sense (there is also experience from the experience with the patterns of ozone forcing. So, there is some influence, but limited, etc.	The authors have added the word "generally" ("there is generally very low confidence") to be clear this is not universally true. The team also notes the sentence that follows makes the point that this for some features there is a robust signal/response relationship.
Marcus	Sarofim	Text Region	Chapter 02: Scientific Basis		98	102	3	29	While this section does an admirable job of walking through feedbacks, it seems to fail to ever sum them up into a total net feedback. And if it does so, it would be useful to also discuss the alternate methods of calculating total feedbacks (e.g., estimating based on emergent behavior in climate models, using paleoclimate temperature and forcing estimates, and using simple climate models with 20th century temperatures to estimate feedbacks, among others).	Sections 2.5 and 2.6 now includes discussion of relationship between forcings and climate response, Transient Climate sensitivity, Equilibrium Climate Sensitivity, and the climate sensitivity factor -- including a mean +/- 90% CI for climate sensitivity (which reflects the net effect of all feedbacks). Section 2.5 also now mentions other methods of determining TCR and ECS.
Marcus	Sarofim	Text Region	Chapter 02: Scientific Basis		98	98	24	35	There is a discrepancy between 1.6 W/m ² (line 24) and 1.7 W/m ² (line 35): I recognize that this is because the estimates are from different sources, but I'd prefer 1.6-1.7 W/m ² in both places, citing both sources, then confuse people about which one is preferred. (unless one is preferred, then use only that one)	The text has been revised to incorporate this suggestion.
Michael	MacCracken	Text Region	Chapter 02: Scientific Basis		101	101	15	15	Here and elsewhere, when talking about the global CO ₂ concentration, it needs to be in the singular, not as plural.	The text has been revised to incorporate this suggestion, with the text now specifying 'global mean concentration' when that is what was meant. Edits were made as follows: (with pg/line numbers referencing locations in the TOD of CSSR): pg 92, line 32: "Methane concentrations and RF..." -> "The global mean methane concentration and RF..." pg 92, line 38: "With a current global value near 1840 parts per billion by volume (ppb), methane concentrations have increased..." -> "With a current global mean value near 1840 parts per billion by volume (ppb), the methane concentration has increased..." pg 93, line 12: "Growth in nitrous oxide concentrations and RF..." -> "Growth in the global mean nitrous oxide concentration and RF..." pg 101, line 15: "Atmospheric CO ₂ concentrations are determined by..." -> "The global mean atmospheric CO ₂ concentration is determined by..." pg 102, line 15: "...that increased atmospheric CO ₂ concentrations provide..." -> "...that an increased atmospheric CO ₂ concentration provides..."
Michael	MacCracken	Text Region	Chapter 02: Scientific Basis		101	101	18	18	My understanding is that two-thirds is substantially too high. The 2016 report of the Global Carbon Budget gives a value of 57% over the past decade. This number thus needs to be corrected.	The sentence has been edited to reflect the numbers in the latest Global Carbon Budget, as given in Le Quere et al. (2016). It now reads: "During the past decade just less than a third of anthropogenic CO ₂ has been taken up by the terrestrial environment, and another quarter by the oceans (Le Quere et al., 2016 Table 8), through photosynthesis and through direct diffusion into ocean waters."
Harold	Tattershall	Text Region	Chapter 02: Scientific Basis		101	101	22	24	Altered uptake rates will affect atmospheric CO ₂ abundances, forcing, and rates of climate change. Such changes are expected to evolve on the decadal and longer time-scale, though abrupt changes are possible. There is no mention that the natural tree sink is currently declining at an ever-increasing rate based on considerable changes in the Amazon, Boreal, and Taiga forests plus the rampant spread of bark beetles to areas where they were formerly not present. In other areas where bark beetles did exist their reproductive cycle has been observed as increasing to two, or more, times per annum. Additionally, the extensive fires in the Boreal and Taiga forests result in black carbon, which due to the wind patterns is driven into the Arctic thereby altering albedo, with implications as discussed in prior sections. This situation is progressively altering the basic parameters of the calculations used to quantify many aspects of climate change. Added to this is no mention of the report by the IUFRO (International Union of Forest Research Organizations) presented to the UN in 2009, which stated a risk of a complete flip of the natural tree sink at an increase of 2.5°C above the preindustrial benchmark. http://www.nature.com/news/2009/090416/full/news.2009.369.html The identifiable risk is that even if the Paris Accord was implemented perfectly, as it stands, it is very likely that the consequential temperature increase would be greater than 2.7°C. An additional identifiable risk is that even an increase of 2°C could have a considerable impact on the natural tree sink, due to the 80/20 statistical law, and thereby lead directly to the possibility of the inability to stabilize the increase at 2°C.	The level of detail discussed here is beyond the scope of this chapter. In particular, the issue of black carbon from forest fires being transported to the Arctic is very specific; discussing this in detail without also discussing other such detailed processes would be unbalanced. Given the remit of this chapter and report, it is sufficient to note more generally that there are land/climate and atmospheric composition/climate feedbacks.

First Name	Last Name	Comment Type	Chapter	Figure/Table No.	Start Page	End Page	Start Line	End Line	Comment	Response
Barbara-Ann	Lewis	Text Region	Chapter 02: Scientific Basis		101	102	34	2	This comment is with regard to responses of plant-herbivore relationships to elevated carbon dioxide concentrations in the atmosphere. Carbon fertilization above normal has resulted in vegetation of lower quality for insectivores in terms of water, nitrogen (10-30% reduction, leading to an increase in C:N), and allelochemicals in the host-plant leaves, as well as the toughness, starch and fiber content of leaf tissue (D. Lincoln et al., Trends in Ecology and Evolution 1993, 8 (2):64-68). Some studies have shown that herbivorous insects consistently responded to enriched carbon dioxide-grown foliage by increasing their consumption (20-80%) compared to feeding on foliage grown under ambient conditions (references cited by D. Lincoln et al., <i>ibid.</i>). Responses of development of gypsy moths and tent caterpillar moths to enriched foliage are also discussed in this reference, among other plant-insect interactions. Inclusion of some mention of observed effects of carbon fertilization of foliage on growth and development of lepidoptera and orthoptera is needed at the end of line 2, page 102, or elsewhere as appropriate. The current text mentions only the effect of carbon fertilization on plant growth. There can also be effects on life that feeds on those plants, with implications for human herbivores.	The authors appreciate the detailed information provided here, but consider it beyond the scope of this chapter.
Harold	Tattershall	Text Region	Chapter 02: Scientific Basis		102	102	15	16	In contrast, other analyses suggest that phytoplankton NPP has decreased by about 1% per year over the last 100 years. Although the above statement correlates with recent research it is an average over a century. Researchers at Canada's Dalhousie University say the global population of phytoplankton has fallen about 40 percent since 1950, and it may be more, which brings focus to the possibility that the majority of this decline may have occurred within the last few decades. https://www.scientificamerican.com/article/phytoplankton-population/	The study pointed to by the reviewer(s) is Boyce et al. (2010), which is already cited in support of the "1% per year over the last 100 years" text -- because that is the main concluding message of that paper. Boyce et al (2010) does state: "Regional trends were also estimated using data since 1950 only, but the direction of all trends remained unchanged and the magnitude of changes was minimal (Fig. 3b). Post-1950 trends were amplified in some regions, resulting in a greater but more variable global rate of decline (20.008 ± 0.0068 mg m ²³ yr ²¹ ; P, 0.0001)." The authors don't consider the finding regarding trends over the recent few decades to be sufficiently robust to highlight in this assessment.
Nathan	Mantua	Text Region	Chapter 02: Scientific Basis		103	103	10	11	ENSO is typically considered to be a global source for interannual climate variability, though it does have some contribution at decadal and longer time scales. But as noted later in this document, decadal to interdecadal modes of climate variability are important at basin-scales and continental scales (PDO/IPO and AMO).	The authors consider this comment to reflect agreement with how ENSO is discussed in the context of impacts on ocean climate feedbacks. No change made.
Marcus	Sarofim	Text Region	Chapter 02: Scientific Basis		104	104	30	32	Be specific that this permafrost release estimate is for RCP8.5, and for context, note that the central estimate is about 6% the size of total human emissions over that time frame. Alternatively, since for RCP8.5 the increase is 1.7 to 9.7% of emissions, and for RCP4.5 the increase is 3-11% of emissions, you could generalize and state that the permafrost release is likely to amount to a 2 to 11% increase in total emissions. (but better worded). Also, Schaefer et al. abstract states an expected warming of 0.29 degrees C - why is this different from the 0.52 in the chapter?	Thank you for catching this error. The 0.52 C value in these lines was a mistake because the 0.29 C value from Schaefer et al. (2014) was accidentally converted to Fahrenheit twice. Second, the text in lines 30-32 on page 104 have been revised to contextualize and improve the precision of this statement. Text was also added to generalize the potential impact of the permafrost-carbon feedback given the broader range of forcing scenarios.
Marcus	Sarofim	Figure	Chapter 02: Scientific Basis	2.1	113				Could the net imbalance (bottom left) possibly be highlighted more? I missed it my first time looking at the figure, and it doesn't appear to be noted in the caption or the text. And this is clearly an important number.	A sentence was added to the figure caption to point this out.
James	Butler	Figure	Chapter 02: Scientific Basis	2.5	117				The y-axis for Figure 2.5(d) should read W/m ² /yr-1, as it is an annual rate, not an accumulated amount as shown in the other panels.	This is now clarified in the caption.
Barbara-Ann	Lewis	Figure	Chapter 02: Scientific Basis	2.7	119				This comment is with regard to the second figure in 2.7, i.e., emissions partitioning. The data and graph for fossil fuel and cement from energy statistics should not use combined data for the two sources. As currently portrayed to a casual viewer, the smaller contribution from cement may be construed to be of the same order of magnitude as the much larger contribution of fossil fuels. In other words, the figure is misleading. (Please see my comment on page 92 of the text).	This figure has been updated to include data up through 2015 and now only shows what was the bottom panel. This figure now groups together "Fossil fuel and industry" more generically, so cement production is not called out specifically.
Allison	Crimmins	Text Region	Chapter 03: Detection and Attribution		139	139	3	8	1.1-1.3 is not close to 1.2; 1.2 falls within the range of 1.1-1.3. This could be a very confusing sentence for some readers. Though this is meant for a technical audience, it could still be made more clear. For instance, it is not clear that the second sentence is a "ergo" statement, following the first sentence. I would also consider just dropping the first sentence from the key finding completely, as it can be explained at length in the text and traceable account. The last two sentences are clear and punchy on their own. You may also want to consider making two key findings- one a detection KF and one an attribution KF.	The authors have modified the first sentence to note that the central estimate of the observed warming lies within the likely range of the anthropogenic contribution. The authors have not adopted the suggestion of using just the last two sentences as the Key Finding, since the NAS review encouraged the authors to try to increase the use of quantitative information in the Key Findings.
Allison	Crimmins	Text Region	Chapter 03: Detection and Attribution		139	139	15	15	Not sure why this says "again". It doesn't seem you've said this before.	The text has been revised to incorporate this suggestion. The word "again" has been deleted.
Allison	Crimmins	Text Region	Chapter 03: Detection and Attribution		139	139	19	19	More confident than what? Do you mean statements with high confidence?	The entire section has been rewritten, and the authors no longer use the term "more confident statements".
Michael	MacCracken	Text Region	Chapter 03: Detection and Attribution		139	139	28	28	Do you really want "approaches" or just "approach"--awkward as is.	This was changed to "approach".
Allison	Crimmins	Text Region	Chapter 03: Detection and Attribution		139	139	30	32	It is kinda confusing to jump around from attribution to detection back to attribution. Im not sure why that Detection sentence is stuck in the middle there- maybe it could be moved or incorporated into the first paragraph (lines 10-18) instead? It is also a little unclear whether you are saying multi-step is the same as attribution-without-detection, or whether these are two distinct methods (you don't talk about the latter)	The entire section of various attribution methodologies has been restructured, and moved into a new appendix C on methodologies. The entire text of this section has been restructured to improve the logical flow of the text, which had too much "jumping around" between topics as pointed out by the reviewer.
Allison	Crimmins	Text Region	Chapter 03: Detection and Attribution		140	140	7	12	This is a long sentence already, but it could help to say WHY this experiment was done (to see how likely Sandy was under past climate conditions as a way to see if current human influences on climate altered the likelihood of the event)	A sentence was added to clarify why such experiments are done. The material on Hurricane Sandy has been moved into box C.2. in Appendix C.
Kevin	Trenberth	Text Region	Chapter 03: Detection and Attribution		140	140	12	14	In any storm the result is always the combination of the natural variability and climate change. In the case of super storm Sandy, SSTs were 1 to 3°C above normal over major regions of the eastern Atlantic and hence up to 2°C above global warming, but these anomalies were not included in the Lackmann study. Much more definitive is the Magnusson et al 2013 MWR study which showed huge impacts of the anomalous SSTs. The Lackmann study is grossly misinterpreted here.	The authors have responded to this comment in a revised discussion of the Hurricane Sandy case study, which is now contained in Box C.2 within Appendix C. The team improved the characterization of the Lackmann study by noting that the hurricane was 5hPa more intense under present day than preindustrial conditions, though this change was not significant at the 95% confidence level according to Lackmann. The authors disagree with the reviewer that the Magnusson et al. study was more definitive than the Lackmann in terms of identifying the anthropogenic component to the storm. In fact, Magnusson et al. (MWR, 2014) compare runs with the full observed SST anomalies vs. climatological anomalies, which is not an adequate experimental design for addressing the issue of anthropogenic contribution to Hurricane Sandy. First, the relevant anthropogenic climate change signal includes not just the sea surface temperature but also the atmospheric temperatures above the sea surface and throughout the troposphere and stratosphere. By modifying only sea surface temperature, additional moist instability is specified into the simulation, creating an exaggerated response compared to a greenhouse gas warming signal. Also the pattern of SSTs is important, and there is no evidence that the pattern of SST anomalies imposed in the Magnusson et al. experiments matches the pattern or magnitude of SSTs forced by anthropogenic forcing agents. For these reasons, Magnusson et al. avoid making any claims in their article that it has any bearing on the issue of anthropogenic climate change impacts on Sandy, which, given the arguments above, is entirely appropriate on their part.

First Name	Last Name	Comment Type	Chapter	Figure/Table No.	Start Page	End Page	Start Line	End Line	Comment	Response
Michael	MacCracken	Text Region	Chapter 03: Detection and Attribution		140	140	12	14	IMPORTANT: This sentence seems rather isolated--how could 5 C higher SSTs off the coast not have an effect; are there other studies. This quote, I'd suspect, will get taken out of context unless qualified or joined to other statements about studies that found a relationship. Presumably, the hypothesis to be proven wrong is that there is no influence and so they sought proof beyond two-sigma that there was an effect--had the hypothesis been to prove that climate change had no influence, my guess would be that that test would also fail. So, the result may well be based on the choice of hypothesis and the framing used ("statistically significant"--this is the very wording/jargon, which was used in the IPCC chapter, that caused confusion over the detection-attribution situation in the second assessment and led to all the problems Ben Santer had when the SPM, which generally is framed in a relative likelihood framing, ended up being phrased as "discernible human influence") the wording there now is statistical jargon and just has to be explained as meaning essentially beyond all doubt in a report for the public; the words do not at all mean that there is no possibility of a human influence. Had a risk-based type analysis been done, seeking to get a result aimed at use by those who do stress tests/due diligence tests and so need to look at plausible worst case situations, I rather doubt that the conclusion would have come out as it did (the result might well have been that there is a high likelihood that the warmer world had a strong influence on the storm--that statement is actually consistent with the phrasing here; it is just that the analysis does not give two-sigma confidence, which I imagine is hard to get with such a naturally variable situation. One type of qualifier that should thus be added to this sentence would be to explain the framing (i.e., two sigma proof, or beyond reasonable doubt), and then also what other framings might show (i.e., preponderance of evidence, or more likely than not--or even a small chance as is used to decide when considering the possibility of serious consequences (e.g., the health effects of various toxics, etc.).	The Hurricane Sandy case is discussed in more detail now as an example of the "ingredients-based" approach to event attribution in Box C.2 in the new Appendix C on detection and attribution methodologies. In addressing the question of whether Hurricane Sandy was influenced by anthropogenic climate change, the issue is not whether the observed SST anomalies off the coast had an effect in isolation (they did, as shown by Magnusson et al. for example). The issue is whether the net change in the various large-scale environmental fields (SSTs, atmospheric temperatures, moisture, and circulation) that are attributable to anthropogenic forcing had any significant effect on Sandy. (More discussion on "significant effect" later.) The Lackmann study is the only one we are aware of that has at least partially addressed this question, by simulating the effect on Sandy's intensity of SST, atmospheric temperature, and atmospheric moisture changes since 1900 that are attributable to anthropogenic forcing. The authors have updated the statement to clarify that the anthropogenic changes in large-scale environment since 1900 had caused Hurricane Sandy to be about 5 hPa more intense, but that this modeled change was not statistically significant at the 95% confidence level. The team has added a separate box (C.1) to discuss the issue of significance levels in the context of detection/attribution and extreme events.
Allison	Crimmins	Text Region	Chapter 03: Detection and Attribution		140	140	15	24	Can you provide your expert judgment on whether the tradeoff of less false negative to more false positives is worth it, or more accurate?	This issue is one of the questions addressed in the new Box C.1. In the new appendix C on methodologies for detection and attribution. There, as discussed, there are different types of errors or scenarios that we would ideally like to avoid in detection/attribution. However, the decision of what type of analysis to do may involve a tradeoff where one decides that it is more important to avoid either falsely concluding that anthropogenic forcing has contributed, or to avoid falsely concluding that anthropogenic forcing had not made a detectable contribution to the event. Since there is no correct answer that can apply in all cases, it would be helpful if, in requesting scientific assessments, policymakers provide some guidance about which type of error or scenario they would most desire be avoided in the analyses and assessments in question. A new Box C.1 in appendix C on detection/attribution methodologies was added primarily to address this question.
Michael	MacCracken	Text Region	Chapter 03: Detection and Attribution		140	140	20	24	IMPORTANT: More needs to be said about this issue of framing. Based on long tradition, we scientists want to avoid being wrong as we are building the pyramid of knowledge and want it rock solid. This is fine, but it is a standard that we do based on our perspectives about decision-making. Much of society makes other choices, perhaps relative likelihood--and this report is talking to the public so it needs to be forthright in making explanations about what our choice of framing means. In the AIDS crisis, the medical community was using the hypothesis-testing framing with medicines, not wanting to approve any medicine until they had very high confidence that the medicine would be effective and not have adverse side effects. The AIDS activists objected, saying that choice would mean many would die before the definitive proof was available, and their view that they should have access to the drugs that showed even a hint of helpfulness--after all, they were going to die anyway, so let them try the drugs even before full sequence of animal and human testing was completed. They did win this right and many were saved--that is, their framing was seen as more ethical and appropriate than the scientific framing. Well, with climate change we are also facing an existential threat to the only planet that we have and the projections are for disastrous outcomes, and so again the framing becomes important--at the very least is has to be carefully explained, and also providing an indication in other framings more typically used by policymakers, industry, and the public is needed as well. The way we scientists want the results is something like having 20 to 1 odds in one's favor PLUS 20 to 1 odds in one's favor that there is no other possible explanation. Using a standard like this is making an ethical choice with respect to situation today and the risks of severe climate change being faced by society--fine for some esoteric theoretical situation, but applying it in the situation we face requires being totally open about what we are doing--and that all needs to be explained here to the public instead of using jargon. The audience for this report is the public and decision makers, and there just has to be a translation of the findings to their relative likelihood framing (and to risk framings) as the IPCC Sims should be doing, but have too often had problems with.	
Allison	Crimmins	Text Region	Chapter 03: Detection and Attribution		140	140	28	31	The only key finding of this chapter seems to be based solely on the IPCC report (ok) and solely on this one sentence. I could use a little spelling out here-- maybe another sentence or two that helps me understand why you say it is extremely like that more than half the temp is anthropogenic. I'd even like it spelled out like detection was 1.2 and attribution was 1.1-1.3 or something-- something that really drives home this point.	The text has been rewritten and expanded to address the point of the reviewer. Also some material was moved from the old Fig. 3.1 figure caption (now Fig. 3.2) to the main text (with slight wording modification). There is now a second key finding in the chapter dealing with extreme event attribution science.
Michael	MacCracken	Text Region	Chapter 03: Detection and Attribution		141	141	3	3	I think you want "due to"	That is correct, although the sentence in question has been moved to main text and completely rewritten.
Michael	MacCracken	Text Region	Chapter 03: Detection and Attribution		141	141	6	6	Do you really want "or" or should this be "and for"?	This was changed to "and for".
Michael	MacCracken	Text Region	Chapter 03: Detection and Attribution		141	141	11	11	I think it would help to say "globally, for changes"	The text has been revised to incorporate this suggestion.
Allison	Crimmins	Text Region	Chapter 03: Detection and Attribution		141	142	35	4	I don't find these NAS bullet points compelling in any way. They are nothing burgers. They don't tell me anything about detection or attribution of US extreme weather events-- they are more general nice guidelines for any attribution process. You just left us hanging about the Texas and California events and took us on a tangent	The NAS report main finding has been encapsulated in a new Key Finding. However, a decision was made by the author team to locate most of the attribution results for individual phenomena out into the chapters for the phenomena. In Chapter 3, we therefore discuss mostly the process of attribution in general, with just a few illustrative examples, along with global attribution. That is why we focus in Chapter 3 the overarching "nice guidelines" from the NAS report in Chapter 3, leaving most of the detailed assessments of individual events to the other chapters. The reviewer states that we left readers hanging about the Texas and California events and took readers on a tangent. The Texas event is discussed in detail on the following page and an assessment conclusion is given. Some revision to the text on the Texas event is done in response to other reviewer comments. Attribution of California drought is discussed in detail in Chapter 8, and is not included here as that would be repetitive.
Allison	Crimmins	Text Region	Chapter 03: Detection and Attribution		142	142	13	15	This is a well stated sentence. Can we add that projected extreme weather events, or weather events in the future, may at some point have a zero possibility? Or that as the signal pulls away from the noise, we expect to see extreme weather events in the future that were not possible in pre-industrial times?	We added some text that addresses this issue. This material now appears in revised Section 3.4.

First Name	Last Name	Comment Type	Chapter	Figure/Table No.	Start Page	End Page	Start Line	End Line	Comment	Response
Michael	MacCracken	Text Region	Chapter 03: Detection and Attribution		142	142	19	23	Did the analysis consider the effect of the increased downward IR due to the higher CO2 concentration leading to more rapid evaporation and transition to soil dryness/drought conditions? Fine to say the meteorological condition was mainly set up by the El Nino, but the higher downward IR and so higher nighttime temperatures leads to greater evaporation and faster soil moisture dryness. And then with reduced soil moisture, there is reduced evaporative cooling and so temperatures increase, more readily leading to heat waves. There are quite a number of pathways by which human activities can worsen the situation, and seldom are all the pathways tested.	From Hoerling et al. (2013) model discussion: "A second configuration employs a global atmospheric model in which SSTs, sea ice, and carbon dioxide concentrations (but no other external forcings) are specified to vary as observed during the period 1950ߚ. This uses the atmospheric component [Global Forecast System (GFS)] of the second version of NOAA's Climate Forecast System (CFSv2) ... The fourth configuration is based on the externally forced CMIP5 simulations. We analyze monthly output from 20 different models that were subjected to variations in greenhouse gases (GHGs), aerosols, solar irradiance, and the radiative effects of volcanic activity for 1880-2005 (Taylor et al. 2012)." So the authors believe the answer to the reviewer's question is "yes". They used CMIP5 models to estimate that the effect of anthropogenic forcing on temperatures--in this case it was 0.6 C. These models would be including the processes mentioned by the reviewer. Therefore it appears that the processes hypothesized by the reviewer, while operating to some degree, apparently are not producing the bulk of anomalies seen in the observed extreme event of 2011.
Michael	MacCracken	Text Region	Chapter 03: Detection and Attribution		142	142	23	25	The choice of baseline here is interesting and meaningful. Choosing the baseline as the most recent NOAA normal when in fact the baseline is increasing over time tends to minimize the finding of the actual significance of the change. While some systems maybe adapting so fast that the most recent normal is indicative of their capabilities, for at least some systems like forest and infrastructure and hydrogeography, the baseline might perhaps better be the baseline proposed for the report as a whole namely 1901-60. As the Hansen et al. paper with the sliding Gaussian shaped curves, when he used his first period as the baseline, three decades later he was finding that four and even five-sigma events were occurring for summer average NH land surface temperatures--so what were 1 in 1000 probabilities in the mid 20th century are now occurring 10% of the time. It seems to me that something needs to be said about this issue of baselines when talking about the changing occurrence of extremes. Young people may only remember the most recent NOAA three-decade normal, but older folk and older infrastructure and ecosystems recall (and are really sort of tuned to) how different the situation is than an earlier normal. That the choice of normal makes a difference, and if one wants to be consistent with the negotiators and Paris Agreement, the question at hand is the departure from preindustrial conditions.	The authors added some text to the discussion of this case to address the issue of different baseline reference periods.
Michael	MacCracken	Text Region	Chapter 03: Detection and Attribution		142	142	23	27	So one sentence says doubles and one says 20 times as many hot conditions. The casual reader might think that this means that scientists disagree, but both statements are right and the difference is likely due to the use of different normals. To help the reader, this issue of what is being used as the normal needs to be explained, and the reasons and situations that make one choice right in some situations and another in other situations needs to be explained. I'd suggest making this all into one sort of thought saying current conditions are twice as bad as just 15 years ago, but 20 times as often as 50 years ago, or something similar so it is clearer that one is reporting on studies with different baselines, and then explain what this means with respect to various types of systems and what they are adapted to.	The authors don't have enough information to conclude that the differences in findings are just due to use of different baseline, though it appears that the baseline selection contributes to the differences. The team added the following sentence: "For example, the studies used different baseline reference periods to determine the magnitude of anomalies, which can also affect quantitative conclusions, since using an earlier baseline period typically results in larger magnitude anomalies (in a generally warming climate)."
Michael	MacCracken	Text Region	Chapter 03: Detection and Attribution		142	142	27	34	How can there be no mention here that the two studies used different baselines and so would of course get different degrees of change? It is not so much their methods as the different baselines used. This is why many of my comments urge being more careful about using the same baseline, and then explain what it means where there is a difference and why this may be of use.	The authors added the following text: "For example, the studies used different baseline reference periods to determine the magnitude of anomalies, which can also affect quantitative conclusions, since using an earlier baseline period typically results in larger magnitude anomalies (in a generally warming climate)."
Michael	MacCracken	Text Region	Chapter 03: Detection and Attribution		143	143	5	6	This needs to be explained more clearly to the public--right now it is mostly statistician jargon that I rather doubt many in the public could explain.	This paragraph was rewritten to make it clearer for the public and to establish its relevance to the rest of the report.
Michael	MacCracken	Text Region	Chapter 03: Detection and Attribution		143	143	9	9	If you wanted to be generous, you could include a citation to work by Roger Pielke, Sr, as this is a point he keeps making and seems to feel no one listens to--which in turn seems to lead to even more forceful objecting on his part.	The authors added a recent relevant Pielke Sr. reference. Pielke, Sr., R. A. R. Mahmood, and C. McAlpine, 2016: Land's complex role in climate change. Physics Today, 69(11), 40 (2016). Doi:10.1063/PT.3.3364.
Michael Marcus	MacCracken Sarofim	Text Region	Chapter 03: Detection and Attribution		144	144	23	23	Need to say "showing the unusual nature"	The text has been revised to incorporate this suggestion.
		Text Region	Chapter 03: Detection and Attribution		144	144	29	32	It might be appropriate to cite, e.g., Marvel et al. 2016 (http://www.nature.com/nclimate/journal/6/14/full/nclimate2888.html) which indicates that these two assessments might underestimate TCR and ECS. (I think Drew Shindell and/or Steve Smith may also have published papers to this effect).	This reference has been added, and there is expanded discussion of some recent studies that estimate the TCR.
Michael	MacCracken	Text Region	Chapter 03: Detection and Attribution		144	144	30	30	The phrase "remains uncertain" seems not the way to say it--virtually everything has some uncertainty and so in some framing or other could be said to be "uncertain." What needs to be said in a report for the public is probably what the range is and whether this range has any important effect on the overall findings--and what this effect might be. In the case at hand, the main potential influence may well be exactly how warm it will be when all emissions are cut to zero or something else pretty far off. Is there any effect of the uncertainty at all in the matters at hand except perhaps to differentiate between very likely and extremely likely or something like that. When one says something is uncertain, there is a responsibility to give an indication of what this uncertainty means--without context, the phrase can be taken out of context and cause all sorts of misconceptions.	The paragraph has been reworded to emphasize ranges of estimates rather than the vague language of "remains uncertain".
Michael	MacCracken	Text Region	Chapter 03: Detection and Attribution		144	144	33	33	And now something is "highly uncertain"--well, what does this mean and what sort of effects does it have. Provide context--and here there are some effects of the uncertainty and range of estimate, so provide a bit of explanation.	The paragraph has been reworded to emphasize ranges of estimates rather than the vague language of "highly uncertain".
Michael	MacCracken	Text Region	Chapter 03: Detection and Attribution		144	144	35	35	And now "considerable uncertainty"--okay, but does it have any effect on whether there is a problem with CO2 emissions or how fast we need to act? Not much. This paragraph is written as if one is seeking funds for research as opposed to explaining to the public about the overall state of the situation being faced--is it any wonder there has been so little understanding and action by the public. What we have are ranges of estimates for various parameters, etc--yes, the details matter, but on the grander scale these uncertainties are really not all that important. Context please.	The paragraph has been reworded to emphasize ranges of estimates rather than the vague language of "considerable uncertainty".
Michael	MacCracken	Text Region	Chapter 03: Detection and Attribution		144	144	38	38	Last word needs to be "of"	The text has been revised to incorporate this suggestion.
Michael	MacCracken	Text Region	Chapter 03: Detection and Attribution		145	145	1	1	Thank you for explaining the significance of the uncertainty, but it seems to me the factor two to three is on the low end of what would be needed--is it not more than that?	The text has been modified to rationalize the statement, at least with regards to the observed global temperature increase over 1951-2010. However, the IPCC AR5 assessment and original statement are based on comparison of observed trends with a CMIP5 multi-model sample of internal variability. A recent study focusing on the most variable of the AR5 models (GFDL CM3) indicates that there is less than factor of three margin of error if one looks at a model with the strongest multidecadal variability within CMIP5. We've included some language that discusses the case of GFDL CM3 internal variability in particular, based on the recent study of Knutson et al. (2016).
Michael	MacCracken	Text Region	Chapter 03: Detection and Attribution		145	145	24	24	Need it to be "more than half"	The text has been revised to incorporate this suggestion.
Michael	MacCracken	Text Region	Chapter 03: Detection and Attribution		146	146	10	10	Need "due to" instead of "due on"	The sentence was moved and completely rewritten.
Michael	MacCracken	Text Region	Chapter 03: Detection and Attribution		146	146	13	13	Change "or" to "and for"--at least this would make it clearer for me.	The text has been revised to incorporate this suggestion.
Michael	MacCracken	Text Region	Chapter 04: Projections		152	152	3	5	Because there is widespread misunderstanding about what would be required, I think the statement needs to add that this would require a reduction in global emissions of CO2 and some other species by of order 90%. So, this would be a huge step--I'd cut the word "merely" as much more is needed than keeping emissions constant, which is how some people interpret statements like this.	The word "merely" has been removed and the KF completely revised to make it clear -- as recommended by the reviewer -- that even if emissions ceased immediately, a commitment to a specific amount of global warming could continue. The revised KF now reads: "Even if humans immediately ceased emitting greenhouse gases into the atmosphere, existing concentrations would commit the world to at least an additional 1.1°F (0.6°C) of warming over this century relative to the last few decades"

First Name	Last Name	Comment Type	Chapter	Figure/Table No.	Start Page	End Page	Start Line	End Line	Comment	Response
Michael	MacCracken	Text Region	Chapter 04: Projections		152	152	5	6	This sentence needs revision for a couple of reasons. First, it is not clear if it is tied to the previous sentence's provision of keeping the atmospheric concentration level. Because it is different, I think this sentence and the next really need to be a separate main finding, not linked to the above, which should be about what happens if one can keep the concentration constant and what it would take to do this. Second, in addition to saying that this statement assumes ongoing emissions, this statement needs to be quantitative--so saying something like "Assuming ongoing emissions of CO2 and other climate-changing substances and only minor natural influences, projections of warming over the next few decades range from about 0.15 to 0.25 C/decade [OR WHATEVER THE NUMBERS ARE], with slowing of this rate only possible if emissions of methane, black carbon and other short-lived species are sharply and rapidly reduced." It really is essential to be both quantitative, and to indicate that cutting emissions of short-lived species could make a difference (see Shindell et al., 2012 and UNEP, 2011). Getting a bit more nuanced, what really needs to happen is to cut the emissions of short-lived warming forcings by at least as much as the declining emissions of SO2 from coal-fired power plants will reduce the sulfate cooling influence. Thus, perhaps the revision should be "Assuming ongoing emissions of CO2 at or near current levels and only minor natural influences, projections of warming over the next few decades range from about 0.15 to 0.25 C/decade [OR WHATEVER THE NUMBERS ARE], with some amplification (moderation) of the rates depending on whether SO2 emissions (and so sulfate cooling) are reduced faster (more slowly) than the emissions of methane, black carbon and other short-lived species." In any case, the sentence that is here is too limited and needs revision.	The authors have taken the reviewer's advice and separated this KF into three separate KFs. The authors have also added quantitative information to the subsequent statements, as suggested. Regarding discussion of other forcing agents in the KFs, the values cited from IPCC do account for the variation in short-lived forcing agents as represented in the RCP scenarios. The authors have added a statement in the text specifically mentioning the dependence of these numbers on other emissions and pointing the reader to chapter 14, where the role of other gases and aerosols is discussed in more detail.
Michael	MacCracken	Text Region	Chapter 04: Projections		152	152	7	8	It seems to me that it needs to be said in this sentence that CO2 emissions are very likely to be the ones that will matter most as it is just unlikely that other emissions (well, maybe except some halocarbons) will be big enough during that period to be much of an influence--they will just likely be controlled by then. The second problem with the sentence is using the word "future", sort of implying in this sentence that it will be emissions after mid-century that matter. Actually, it is emissions of CO2 over coming decades that will be critical, so I'd suggest changing "future" to "ongoing" or something to indicate that all future emissions of CO2 matter. Indeed, to avoid going over 2 C, global emissions need to end in only a couple of decades. I would also rephrase to provide a quantitative emission, basically saying "Past mid-century, the further increase in the global average temperature will depend primarily on total emissions beyond the present, with the global average temperature in 2100 reaching roughly 3-5 C over preindustrial unless emissions are declining rapidly by mid-century; failing to cut emissions even earlier will mean that the rise in global average temperature cannot be kept to less than 2 C." Not having at least some quantification in the second and third sentences of the present point is simply not adequate.	This KF has been completely re-written in response to the reviewer's comments. It now reads: "Beyond the next few decades, the magnitude of climate change depends primarily on cumulative emissions and the sensitivity of the climate system to those emissions (high confidence). Projected changes range from 2.6-4.8°C under the higher RCP 8.5 scenario to 0.3-1.7°C under the lower RCP 2.6 scenario, for 2081-2100 relative to 1986-2005 (medium confidence)."
Michael	MacCracken	Text Region	Chapter 04: Projections		152	152	9	9	There are not atmospheric levels (plural). Be precise and say that "The global average CO2 concentration has now passed"	KF has been revised to read: "4. Global mean atmospheric carbon dioxide (CO2) concentrations have now passed 400 ppm..."
Michael	MacCracken	Text Region	Chapter 04: Projections		152	152	9	10	Strictly, no one saw this--so about just say "last occurring" instead of "last seen". And say "the global average temperature" or "temperatures around the world"	KF has been revised to read: "...a level that last occurred about 3 million years ago, when global average temperature and sea level..."
Michael	MacCracken	Text Region	Chapter 04: Projections		152	152	11	13	A phrase needs to be added indicating that during these earlier times the world was considerably warmer than at present	The fact that global average temperature was higher is already made clear in the preceding sentence.
Michael	MacCracken	Text Region	Chapter 04: Projections		152	152	14	15	While experts will know why the year 66 million was chosen, most in the public won't, so explain that this was when dinosaurs roamed the Earth and it was warm enough around the Arctic for near tropical vegetation to be growing. You might even indicate that this all ended when a massive asteroid (10 km diameter, is the estimate that I recall) struck the Earth. Do a bit of educating.	This KF has been revised to use a round number instead ("more than 50 million"). Commenting on dinosaurs and asteroids is far beyond the scope of this chapter, let alone that of a KF.
Michael	MacCracken	Text Region	Chapter 04: Projections		152	152	16	17	Was there really an acceleration, or only an increase? I'd suggest using just "increase" and also change "is" to "has been" as the next sentence makes clear that the increase in emissions has actually virtually stopped (and so is that a sudden deceleration?). I'm not sure that "scenarios" has really been defined--actually these were more different possibilities for projected emissions and not really tied to the societal changes that might be expected (as was done for earlier scenarios). Was 1.5 C really set as a "target" or an "aspirational goal"?	The growth rate was increasing, so that is an acceleration. The following reference has been added to the evidence base for this KF: https://www.esrl.noaa.gov/gmd/ccgg/trends/gr.html "is" has been changed to "has been". The chapter defines both RCPs and SSPs, the latter of which provide the societal changes consistent with RCPs. The generally accepted wording in both this report as well as the peer-review and gray literature is "target".
Michael	MacCracken	Text Region	Chapter 04: Projections		152	152	21	21	How about changing "impacts" to "changes and impacts" or "changes in climatic conditions and associated impacts" to better indicate the information provided and applied.	KF has been revised to say, "changes and impacts".
Michael	MacCracken	Text Region	Chapter 04: Projections		152	152	29	30	Putting info about both past and future in present tense reads a bit strangely.	After consideration of this point, we still feel the existing text is clear.
Nathan	Mantua	Text Region	Chapter 04: Projections		152	152	30	30	Delete "Since the industrial era,"	Phrase has been deleted.
Michael	MacCracken	Text Region	Chapter 04: Projections		152	152	30	32	Presumably this means "Since the start of the Industrial Era, the climatic effects of human emissions ..." and then say "gases have risen to overwhelm the influences of ..."	The first clause of the sentence has been removed. It now reads: "Today, human emissions ... now overwhelm"
Michael	MacCracken	Text Region	Chapter 04: Projections		152	152	34	34	"particulates" is an adjective, either say "particles" or "particulate matter"	According to Google's dictionary, "particulate" is a noun.
Michael	MacCracken	Text Region	Chapter 04: Projections		153	153	3	4	It should be noted here that doing this would require going to, essentially, zero emissions of CO2 while maintaining the emissions of SO2, which come mainly from the coal-fired plants that put out the CO2 whose emissions are to be cut to zero; I think it essential to give a sense of how impossible and idealized a case this sentence is referring to. It would also seem to be useful to explain that this is the amount of warming that would occur as equilibrium is approached.	This has been noted in the revised KF1, which now reads: "1. Even if humans immediately ceased emitting greenhouse gases into the atmosphere, existing concentrations would commit the world to at least an additional 1.1°F (0.6°C) of warming over this century relative to the last few decades (high confidence)." A brief mention of the role of other forcing agents in determining near-term warming has been added, along with a reference to chapter 14 where this topic is discussed in more detail.
Michael	MacCracken	Text Region	Chapter 04: Projections		153	153	7	10	This is what scenarios were--the RCP scenarios are not similarly based on population, etc.	This is a generic sentence that lists the many terms in which scenarios can be expressed, including radiative forcing which corresponds to RCPs. After consideration of this point, we feel the existing text is clear and accurate.
Michael	MacCracken	Text Region	Chapter 04: Projections		153	153	12	13	Climate sensitivity refers to the global, not the regional response.	"and regional" has been removed.
Harold	Tattershall	Text Region	Chapter 04: Projections		153	153	19	21	Carbon emissions and economic growth may be beginning to decouple, as global economies led by China and the United States phase out coal and begin the transition to renewable, non-carbon energy. There is no mention that as the burning of coal declines that the former SO2 shield also declines and therefore the temperature is more than likely to increase accordingly. This is a key understanding for policy making.	The focus of this section is on carbon; the radiative forcing effects of short-lived sulphate aerosols and other anthropogenic agents are discussed at length in Chapter 14.
Michael	MacCracken	Text Region	Chapter 04: Projections		153	153	22	22	I'd suggest changing "agree" to "committed"	changed to "committed"
Michael	MacCracken	Text Region	Chapter 04: Projections		153	153	29	29	This should be retitled to "Scenarios of Future Emissions" rather than what it is, which could be interpreted to mean scenarios that will be created in the future.	The reviewer echoes a common misconception, that all scenarios are emission scenarios. They are not, and this section makes that clear.
Michael	MacCracken	Text Region	Chapter 04: Projections		153	153	32	32	I'd suggest changing "possible" to "plausible"	"plausible" is more commonly used, but implies a likelihood judgement that we would prefer to avoid. "possible" is more neutral, defined simply as whether or not it is possible.
Michael	MacCracken	Text Region	Chapter 04: Projections		154	154	1	1	Change "lays" to "laid"--and rest of sentence should be in past tense. Also, somehow it needs to be said that these extended through the 21st century.	Changed "began" to "begin" to keep tense consistent. Figure 1 makes it clear that these scenarios extend through 2100.

First Name	Last Name	Comment Type	Chapter	Figure/Table No.	Start Page	End Page	Start Line	End Line	Comment	Response
Nathan	Mantua	Text Region	Chapter 04: Projections		154	154	3	26	I recommend adding a 5th key finding that highlights the existence of an irreducible uncertainty for regional-scale US climate trends and variations over the next 50 years due to natural, internal variability (Deser et al. 2012, 2014). Deser, C., A. S. Phillips, M. A. Alexander, and B. V. Smoliak, 2014: Projecting North American Climate over the next 50 years: Uncertainty due to internal variability. J. Climate, 27, 2271-2296, doi: 10.1175/JCLI-D-13-00451.1. Deser, C., R. Knutti, S. Solomon, and A. S. Phillips, 2012: Communication of the role of natural variability in future North American climate. Nat. Clim. Change, 2, 775-779, doi: 10.1038/nclimate1562.	The authors have divided KF 1 into two parts, and added the following phrase to the new KF2: "2. Over the next two decades ... In some regions, this means that the trend may not be distinguishable from natural variability." We have also added the two recommended citations to the chapter references and the evidence base for KF2.
Michael	MacCracken	Text Region	Chapter 04: Projections		154	154	4	4	Capitalize Earth, and "or" should be "and"	Earth is only capitalized when referring to the planet (as in, "the Earth") and ESMs include carbon cycle models, that is the actual definition of an ESM -- so "or" is correct.
Michael	MacCracken	Text Region	Chapter 04: Projections		154	154	5	5	Need again to go to past tense.	"were" has been changed to "are" for consistency.
Michael	MacCracken	Text Region	Chapter 04: Projections		156	156	3	3	Were the new scenarios created for this assessment or by someone else?	The references that are already cited in this section make it clear that the SSPs were created well before the CSSR was written.
Harold	Tattershall	Text Region	Chapter 04: Projections		157	157	30	32	In order to meet the ambitious 1.5°C (2.7°F) target in the Paris Agreement, only 150 GtC more of carbon can be emitted globally. To meet the higher 2°C (3.6°F) target, approximately 400 GtC more can be emitted. This is a very misleading statement because it is based on transient and not equilibrium temperature increase. Firstly, climate sensitivity has not been agreed but the trend has been for the basic value to increase. Secondly, when climate sensitivity is ignored then the implication is that some form of atmospheric carbon draw-down will be developed and deployed if the temperatures are to be maintained.	These numbers have been modified for consistency with Chapter 14, which incorporates the effects of non-CO2 greenhouse gases into the calculation. However, these calculations are based on estimated equilibrium, not transient, sensitivity. For more information, the reviewer is referred to the 2011 National Academy of Sciences report, "Climate Stabilization Targets: Emissions, Concentrations, and Impacts over Decades to Millennia".
Michael	MacCracken	Text Region	Chapter 04: Projections		157	158	30	4	Generally, plaudits for a clear and quantitative statement of the serious situation that is faced. My only comment is on page 158, line 4 where I would suggest that this the range of possibilities becomes somewhat broader rather than say "even more uncertain". Given that the ranges given were to precise years (and are likely too precise), what does "becomes even more uncertain" actually mean?	Thank you! The authors have revised the sentence referenced, so it is more precise. The team has also ensured that it is coordinated with chapter 14, where this topic is discussed in more detail.
Michael	MacCracken	Text Region	Chapter 04: Projections		158	158	6	6	Who is "their" referring to?	"their" referred to "fossil fuel reserves," but has been removed for clarity.
Michael	MacCracken	Text Region	Chapter 04: Projections		158	158	26	26	Again, there was one CO2 concentration--not "levels".	"levels" has been changed to "concentration"
Michael	MacCracken	Text Region	Chapter 04: Projections		158	159	37	2	The text needs to be redone recognizing that concentration needs to be singular--doing plural is confusing.	Text has been revised accordingly.
Michael	MacCracken	Text Region	Chapter 04: Projections		159	159	8	9	I would think that the text would translate the rises in meters to also show these amounts in feet	Values are now given in both feet and metres.
Michael	MacCracken	Text Region	Chapter 04: Projections		162	162	4	5	"coarser" and "finer" than what--not at all clear.	Specific examples of the typical ranges in global and regional model spatial resolutions have been added to the figure caption.
Michael	MacCracken	Text Region	Chapter 04: Projections		163	163	19	19	I would suggest saying "specific natural variations" as the models to predict natural variations, the different ones just generate different ones, etc.	"specific" has been added
Harold	Tattershall	Text Region	Chapter 04: Projections		164			18	Why are the models not sub-divided into categories based on how accurate their projections track with actual or historic events? If the sub-sets were then analyzed a range of projections could be derived.	The authors have added a short paragraph and several references to this chapter, describing past studies that demonstrated how weighting models based on past performance did necessarily not narrow the range of uncertainty or improve the quality of future forecasts.
Michael	MacCracken	Text Region	Chapter 04: Projections		164	164	20	21	"natural variability" is very likely to be a small and even net zero effect--why give it so much prominence? And what happens in the future does not depend on scientific uncertainties--only our attempts to project what the changes will be depend on scientific uncertainties.	After consideration of this point, the authors still feel the existing text regarding natural variability is clear and accurate. However, the team has corrected the statement to make it clear that the actual future does not depend on scientific uncertainty, but rather our projections of the future.
Michael	MacCracken	Text Region	Chapter 04: Projections		164	164	20	38	While it is true uncertainties exist, it needs to be made clearer that these uncertainties will not make the problem go away, and indeed are as likely to make the situation worse as would make the situation less bad.	A reference to chapter 15 has been added here, which addresses this topic in more detail, including in its KFs.
Michael	MacCracken	Text Region	Chapter 04: Projections		165	165	5	5	The wording is not very clear--of course the amount of warming will increase in the future, but the rate is estimated to be roughly what it is now, so why say "particularly past mid-century"--by then we will be over 2 C at the current rate and all sorts of things will happen before then, so why imply the situation will not be serious until then	This sentence has been rewritten to make it clear that scenario-based uncertainty does not dominate over scientific uncertainty and natural variability until past mid-century.
Michael	MacCracken	Text Region	Chapter 04: Projections		166	166	3	8	There are earlier comments on this key finding that I hope would be considered here.	Earlier comments have been considered and the KFs revised accordingly.
Michael	MacCracken	Text Region	Chapter 04: Projections		168	168	31	31	The numbers in this table are in general far too precisely expressed--having more than 2 or 3 figure precision is just not justified.	The authors agree; all numbers have now been rounded to three significant digits.
Allison	Crimmins	Whole Chapter	Chapter 04: Projections						Strongly recommend removing chapter 4. It falls at a very odd place in the outline of the report, breaking up the science with a sudden about turn to details about methodology. A large portion of this chapter seems more suitable to an appendix than to a full chapter. Particularly the very lengthy explanations of what RCPs, SSPs, and pattern scaling are. I find almost all of section 4.2 to be either better suited in the appendix or else completely redundant to other parts of the report. I think I've read about the Pliocene being an analog in three different chapters now (particularly in chapter 15). There seems no reason to repeat it at length here. The paragraphs on page 157 are almost exactly copy and pasted in the Mitigation chapter 14. My strong recommendation would be to take a few pieces of this chapter (the part directly pertaining to the key findings, which are good) and move those to another chapter (e.g. Ch 2 or 3), then I would delete all the redundant text, and move any remaining pieces about the nitty gritty of how models work into an appendix about models. In this way, chapter 4 would no longer exist as a free-standing chapter, but all the parts of it would be in more appropriate places and you could save a lot of un-needed pages	This concern was raised with the lead authors and, after consideration of this point, it was concluded that the existing chapter is necessary and appropriate. However, the team is able to address the reviewer's concerns in part, by moving the figure on paleoclimate sea level rise to chapter 12 to decrease redundancy, and significantly shortening the paragraphs on p. 157 to eliminate redundancy with chapter 14.
Nathan	Mantua	Text Region	Chapter 05: Circulation and Variability		186	186	11	14	century-scale trends in NE Pacific circulation have contributed to century-long temperature trends on the Pacific coast (and for West Coast states) (Johnstone and Mantua 2014); for the 1963-2012 period, internal variability in circulation made substantial contributions to observed DJF surface temperature trends over North America (Deser et al 2016). Johnstone, J. A., and N. J. Mantua, 2014: Atmospheric controls on northeast Pacific temperature variability and change, 1900-2012. Proc. Natl. Acad. Sci. USA, 111, 14 360-14 365, doi:10.1073/pnas.1318371111. Deser, C., L. Terray and A. S. Phillips, 2016: Forced and internal components of winter air temperature trends over North America during the past 50 years: Mechanisms and implications. J. Climate, 29, 2237-2258, doi: 10.1175/JCLI-D-15-0304.1.	The text has been revised to incorporate this suggestion in the chapter. Both papers are already cited. We added a more detailed assessment of the Johnstone and Mantua 2014 paper in section 5.3. We also added to the subsection on INTERNALLY-GENERATED VERSUS EXTERNALLY-FORCED DECADEAL CLIMATE VARIABILITY the Deser et al 2016 reference and pointing out the impact of internal atmospheric variability on trends.
Michael	MacCracken	Text Region	Chapter 05: Circulation and Variability		187	187	6	6	Need to capitalize "Earth"	The text has been revised to incorporate this suggestion.
Nathan	Mantua	Text Region	Chapter 05: Circulation and Variability		187	187	35	35	add "and regional" after "local" (Deser et al 2016) Deser, C., L. Terray and A. S. Phillips, 2016: Forced and internal components of winter air temperature trends over North America during the past 50 years: Mechanisms and implications. J. Climate, 29, 2237-2258, doi: 10.1175/JCLI-D-15-0304.1.	The text has been revised to incorporate this suggestion. The reference is already listed.
Harold	Tattershall	Text Region	Chapter 05: Circulation and Variability		190			9	There is no mention in this section of the potential impact of the increasing fresh water discharge from Greenland on this entire situation. For instance there has been a quantified reduction in the flow rate of the Gulf Stream, by scientific research, which could eventually result (possibly within the next decade) in extremely deleterious impacts on Europe and the North East of the US in winter months.	The text has been revised to incorporate this suggestion. Specifically, the authors modified the last paragraph in 5.2.3 (subsection NORTH ATLANTIC OSCILLATION AND NORTHERN ANNUAL MODE) to discuss the two directions of the atmosphere-ocean-cryosphere interactions impact on recent trends.

First Name	Last Name	Comment Type	Chapter	Figure/Table No.	Start Page	End Page	Start Line	End Line	Comment	Response
Nathan	Mantua	Text Region	Chapter 05: Circulation and Variability		191	191	11	11	NPO is the 2nd mode of SLP variability over the North Pacific sector (Linkin and Nigam 2008), not the leading mode as stated here (the PNA/Aleutian Low pattern is the leading mode, and over the North Pacific the SLP varies as a monopole centered over the Aleutians Island chain)	The text has been revised to incorporate this suggestion.
Nathan	Mantua	Text Region	Chapter 05: Circulation and Variability		191	191	21	23	note the PNA signature is expressed as variations in the wintertime Aleutian Low over the North Pacific, and that low-frequency variations in the PNA/AL are associated with the PDO (Mantua et al. 1997) Mantua, N.J. and S.R. Hare, Y. Zhang, J.M. Wallace, and R.C. Francis. 1997: A Pacific interdecadal climate oscillation with impacts on salmon production. <i>Bulletin of the American Meteorological Society</i> , 78, pp. 1069-1070.	We have added the suggested citations in our chapter assessment. Specifically, we added text and the reference in 5.2.4 (subsection Pacific Decadal Oscillation (PDO)/Interdecadal Pacific Oscillation (IPO)).
Nathan	Mantua	Text Region	Chapter 05: Circulation and Variability		194	194	23	23	add citation to Meehl et al. 2016 Meehl et al. 2016: Contribution of the Interdecadal Pacific Oscillation to twentieth-century global surface temperature trends. <i>Nature Climate Change</i> . doi:10.1038/NCLIMATE3107	The authors have added the suggested citations in the chapter assessment.
Nathan	Mantua	Text Region	Chapter 05: Circulation and Variability		195	195	8	8	the IPO pattern was identified with an EOF analysis of 13-year running-averaged SST fields	The text has been revised to incorporate this suggestion to be more accurate and also refer to Mantua et al. 1997 who first introduced the PDO. Specifically we mention that the PDO is the leading EOF of North Pacific monthly averaged sea surface temperatures. The 13-year running average is mainly used to display the PDO time series with more clarity, and thus is not mentioned in the description of the diagnostics approach of the PDF.
Nathan	Mantua	Text Region	Chapter 05: Circulation and Variability		197	197	26	26	revise "year-to-year" to "year-to-year, decade-to-decade, and multi-decadal"	After consideration of this point, the team still feels the existing text of this key finding is clear and accurate. In this Key Finding the authors specifically refer to modes of variability that affect U.S. temperatures and precipitation on interannual time scale (with high confidence). The authors also refer to changes in these modes and their impact on longer time scale (with medium confidence).
Michael	MacCracken	Text Region	Chapter 05: Circulation and Variability		199	199	25	31	Excellent to see this was of expressing likelihood rather than the way the approach was expressed in the Front Material, which make divisions using two significant figures.	We thank the reviewer for this comment. The likelihood of impacts was removed from the traceable account to be consistent with the Front Material.
Charlie	Luce	Whole Chapter	Chapter 05: Circulation and Variability						There is no mention in the chapter of changing wind fields associated with the decrease in meridional temperature gradients. There are a couple of sentences on midlatitude jet shifts. The slowing wind field (observed and projected) in the Pacific Northwest is partially related to that and partially related to changing land-ocean temperature contrasts. This has important consequences for orographic precipitation enhancement in mountains in the northwestern U.S. (Luce et al., 2013). Luce, C. H., J. T. Abatzoglou, and Z. A. Holden (2013), The Missing Mountain Water: Slower Westerlies Decrease Orographic Enhancement in the Pacific Northwest USA, <i>Science</i> , 342(6164), 1360-1364, DOI: 10.1126/science.1242335.	The authors have not chosen to include this citation and a discussion on observed and projected slowing wind fields in the Pacific Northwest due to lack of literature on this topic. The uncertainties related to meridional wind change in the North Pacific are already assessed.
Scott	Weaver	Whole Chapter	Chapter 05: Circulation and Variability						The notion that natural climate variability modes, such as ENSO, NAO, AO, PNA, etc. are being affected by human caused climate change is potentially overstated in comparison to the scientific literature on this topic. Additionally, there is an internal inconsistency in the CSSR as the Executive Summary appears to over inflate the confidence that natural climate variability modes have been affected by human-caused climate change when compared to the more uncertain language of chapter 5. There is a fair amount of back and forth on whether anthropogenic influences are causing these modes to change, especially in the introductory paragraphs to chapter 5. Please state more clearly the consensus view with respect to the certainty, or lack thereof, regarding the human influence on natural climate variability modes to maintain consistency between the Executive Summary and chapter 5.	The executive summary has been revised to incorporate this suggestion. Furthermore, the chapter has been modified to provide more clearly an assessment of current knowledge the role of anthropogenic influences on modes of variability. The introductory paragraph is also modified to be more consistent with the main chapter text.
Adam	Stein	Text Region	Chapter 06: Temperature Change		217	217	8	8	There is a grammatical error: change the "is" after "rise" to "in".	The text has been revised to incorporate this suggestion.
Nathan	Mantua	Text Region	Chapter 06: Temperature Change		217	217	11	12	Fig ES.5 shows that the temperature of extreme warm days peaked in the 30s for much of the US, and that recent trends in the index for the US (say from the 1950s to early 2000s) are much weaker than the interannual to interdecadal variability over the full record. This key finding must be consistent with what is shown in Fig. 6.3 (and Fig ES.5, and what is stated in the executive summary).	This figure has been removed from the Executive Summary, as has the statement about the temperature of the coldest and warmest days of the year in the Key Finding. The figure itself remains in Chapter 6 because it documents observed changes in extremes that are of interest to some user communities. However, the text has been revised considerably to clarify the nature of the changes, to elaborate on the importance of the Dust Bowl, and to ensure consistency with Fig. 6.3 (e.g., the chapter now explicitly points out that there has been only a very small increase in the hottest daily temperature of the year since the 1960s, and that this increase took place amidst large interannual variability).
Astrid	Caldas	Text Region	Chapter 06: Temperature Change		217	217	32	32	This is the first mention to NCA3 in the chapter, therefore the spelled-out text should be here and not on line 6 of page 218	The text has been revised to incorporate this suggestion.
Astrid	Caldas	Text Region	Chapter 06: Temperature Change		218	218	5	6	This is the second mention of NCA, so the spelled-out name should be on the first mention, on page 217 line 32	The text has been revised to incorporate this suggestion.
Astrid	Caldas	Text Region	Chapter 06: Temperature Change		218	218	10	11	references	We have added the suggested citations in our chapter assessment.
Astrid	Caldas	Text Region	Chapter 06: Temperature Change		218	218	12	12	Annual average near-surface temperature	The text has been revised to incorporate this suggestion.
Astrid	Caldas	Text Region	Chapter 06: Temperature Change		218	218	28	29	what was the average?	The text has been revised to incorporate this suggestion ("average annual sea surface temperature").
Michael	MacCracken	Text Region	Chapter 06: Temperature Change		218	218	33	33	Is this referring to contiguous US?	The text has been revised to incorporate this suggestion. (Yes, this refers to the contiguous United States.)
Astrid	Caldas	Text Region	Chapter 06: Temperature Change		219	219	4	5	Repeated sentence on caption	The text has been revised to incorporate this suggestion.
Marcus	Sarofim	Text Region	Chapter 06: Temperature Change		219	219	9	26	1) Can this paragraph discuss the comparison with the new Climate Reference Network (recognizing that the time period would be limited) 2) Over this 36 year period, it appears that the US surface temperatures have warmed faster than the troposphere according to the 3 satellite measurements: what do models say about the relative rates of warming above the US, and is this time period long enough for a comparison between observations & models to be meaningful?	1) As noted by the reviewer, the time period for the U.S. Climate Reference Network is limited (national coverage only being achieved in the mid-2000s), thus these data are not useful in documenting the rate of warming over the past several decades, which is the focus of this paragraph. 2) This section addresses observed changes in temperature, not the agreement between observations and models.
Astrid	Caldas	Text Region	Chapter 06: Temperature Change		219	219	18	19	This can be updated now that 2016 data are out?	The text has been revised to incorporate this suggestion.
Michael	MacCracken	Text Region	Chapter 06: Temperature Change		219	219	22	22	I thought the US standard was 6 feet?	After consideration of this point, the authors still feel the existing text is clear and accurate. According to the Office of the Federal Coordinator for Meteorological Services and Supporting Research Federal Standard for Siting Meteorological Sensors at Airports (revised 2016), the recommended height for the temperature sensor is 1.5 meters. Guidelines for the U.S. Cooperative Observer Network are comparable.
Astrid	Caldas	Text Region	Chapter 06: Temperature Change		219	219	35	35	PAGES 2k or PAGES 2k (consistency in spelling, check line 31)	The text has been revised to incorporate this suggestion (the correct abbreviation is PAGES 2k).
Astrid	Caldas	Text Region	Chapter 06: Temperature Change		220	220	23	23	plant and animal phenology	The text has been revised to incorporate this suggestion.
Astrid	Caldas	Text Region	Chapter 06: Temperature Change		220	220	32	34	this sentence seems out of place here, since the next paragraph is the one talking about warmest daily temps and extremely warm days.	The phrase "extremely warm days" was an error. It should have said "extremely cold days." The text has been revised accordingly.
Astrid	Caldas	Text Region	Chapter 06: Temperature Change		221	221	11	17	why are there no numerical values for warmest daily temps? they were listed for coldest daily temps. Table 6.2 shows increase in warmest daily temp only in the Southwest, not "throughout the west" (northwest shows decrease).	The text has been revised to incorporate this suggestion.
Nathan	Mantua	Text Region	Chapter 06: Temperature Change		221	221	20	21	While there may be a "slight increase" in the US average index for warmest daily temperature of the year, Figure 6.3 shows that any trend in that period is very small compared with the yearly to interdecadal variations in that time series. It is important to refrain from confusing a clear climate change signal from random variations (noise).	The text has been revised to incorporate this suggestion.

First Name	Last Name	Comment Type	Chapter	Figure/Table No.	Start Page	End Page	Start Line	End Line	Comment	Response
Michael	MacCracken	Text Region	Chapter 06: Temperature Change		223	223	15	15	Regarding "were mostly due", I'd assume because the hypothesis was to be proved was that there was a human influence and this could not be done to two standard deviations. This does not mean that there was not a human influence but that it could not be fully proven. In that the world is facing a very challenging situation, and so the question really needs to be whether there is convincing evidence that human influences are not having an effect—I rather doubt that it can be proven human influences are not having an effect. I'll ask here, as I have asked elsewhere, for the framing of the evaluation (i.e., two sigma) to be explained and for results also to be presented considering relative likelihood and even to reverse the hypothesis and whether it can be said that there is convincing evidence human activities were not a factor.	After consideration of this point, the authors still feel the existing text is clear and accurate.
Astrid	Caldas	Text Region	Chapter 06: Temperature Change		224	224	6	7	the language here is misleading: one assumes that "increased intensity of a cold wave" means a COLDER cold wave, not a warmer cold wave.	These projected changes (2.5 and 2.9F) are for the "near term" -- i.e., very roughly 2030. The text has been revised to clarify this point.
Astrid	Caldas	Text Region	Chapter 06: Temperature Change		225	225	33	33	need to expand on this point to reflect the national picture and importance of 1930's extreme hot days - table 6.2 shows DECLINES in 6 or 7 regions; Fig 6.3 shows declines at most stations in West Coast states and almost all stations east of the Rockies. Note that the character of the "warm spells" days and Heat Wave index shown in Figure 6.4 is not a simple linear increasing trend, as opposed to the more linear decline in cold spells.	The text has been revised to incorporate this suggestion.
Nathan	Mantua	Text Region	Chapter 06: Temperature Change		228	228	5	7	"such as the intermountain West in the early 20th century" is not stated under uncertainties for key finding 1 - not relevant there?	The text has been revised to incorporate this suggestion.
Astrid	Caldas	Text Region	Chapter 06: Temperature Change		228	228	25	27	I recommend adding Deser et al's (2016) Figure 9b as a nice example showing "dynamically adjusted" forced trends versus dynamically-adjusted observed trends.	The authors thank the reviewer for the helpful suggestion. In this case, the original figure is being retained in the chapter because its focus (i.e., annual temperature since 1901) is more comprehensive than the focus of the recommended figure (i.e., winter temperature since 1963).
Nathan	Mantua	Text Region	Chapter 06: Temperature Change		240	240	1	8	Deser, C., L. Terray and A. S. Phillips, 2016: Forced and internal components of winter air temperature trends over North America during the past 50 years: Mechanisms and implications. J. Climate, 29, 2237-2258, doi: 10.1175/JCLI-D-15-0304.1.	
Astrid	Caldas	Whole Chapter	Chapter 06: Temperature Change						No tables mention Alaska, however through the text there seems to be references to Alaska calling on tables, not just figures?	The text has been revised to incorporate this suggestion. (Alaska is now included in tables to the extent possible.)
Andrew	Pershing	Whole Chapter	Chapter 06: Temperature Change						pg 231. The table columns should be labeled as temperature change or temperature difference. The average annual temperature in the US is not 13.8F.	After consideration of this point, the authors still feel the existing tables and figures are clear and accurate.
									pg 234-235. Seems weird to not have Alaska, especially since it is a region in the NCA.	pp. 231 - The caption states that the table depicts changes in average temperature.
									pg 236. I think you need to add another color to the color scale in order to allow for some discrimination between regions, especially during the winter. While an all-red map conveys a point, it is not especially useful.	pp. 234 - Alaska is discussed in the text.
									pg. 241. The labels on the rows in the figure are not clear at all (tox??). I question whether this figure is needed. It speaks to differences between the models. While this is of technical importance, I don't think it adds much to our understanding of climate impacts on the US.	pp. 236 - This is a standard NCA color palette.
									Chapter 6 would be stronger if it included a more thorough explanation for the large area of cooling over portions of the central and Eastern U.S. during summer -- which coincides with the region that has the largest summertime mean and standard deviation of precipitation -- and is likely related to natural multidecadal climate variability mode interference with the anthropogenic climate change signal in that region.	pp. 241 - The figure has been moved to an appendix.
Scott	Weaver	Whole Chapter	Chapter 06: Temperature Change						I would have thought that this set of findings would have included some finding related to topical cyclones/hurricanes.	The text has been revised to incorporate this suggestion.
Michael	MacCracken	Text Region	Chapter 07: Precipitation Change		252	252	3	21	There are grammatical errors: remove the two periods after "United States".	Projected changes in TC precipitation are discussed in Chapt. 9 in the context of overall changes in TC intensity and precipitation. The authors do also include a section on projected changes, but not in the KMs since we don't want to duplicate a KM that is already in another chapter.
Adam	Stein	Text Region	Chapter 07: Precipitation Change		252	252	17	18	It would be nice to be able to update the results to include this year, given the downpours in occurring in California.	The text has been revised to incorporate this suggestion.
Michael	MacCracken	Text Region	Chapter 07: Precipitation Change		253	253	7	8	Regarding the lake effect snows, a key issue is whether the lakes are ice covered or not. If they were frozen all year, there would be no lake effects snows, and so with warming one can, until it gets too warm, get more snow (this all happened to one of our colleagues at USGCRP who had family in Buffalo). While the lake was free of ice, they got lots of snow, when it froze over, this did not happen. This rather counter-intuitive relationship needs to be explained here instead of just giving the results and having them seem contradictory.	The authors are updating the observed maps to include 2016, however it likely will not result in large changes. But the team will modify the text to indicate that the drought is largely over for now.
Michael	MacCracken	Text Region	Chapter 07: Precipitation Change		254	254	12	17	I'd like to see some synoptic discussion of what is happening. My hypothesis is that what is happening in the summer is less cold air is being generated in Canada and the cold (cool) fronts coming out of Canada into US are a lot less strong, so not adequate to really get convective systems going as often. On the Atlantic coastal plain I sense a reduction in mid- to late- summer convective activity because these fronts that can trigger systems are not strong enough to get cold air up and over the Appalachians—we have plenty of warm moist air—the cold air that has to slip under them to get convection started is just not as cold and there is not that much of it. So, we get fewer extratropical storm systems. Having text that just gives out changes without explaining what is happening just seems to be not as helpful as this report should be.	The authors have included a couple of sentences and two references to briefly explain this.
Michael	MacCracken	Text Region	Chapter 07: Precipitation Change		255	255	25	38	It seems to me that more needs to be done than just doing statistics on the data—there need to be synoptic analyses thinking about mechanisms and then searching to see if that is how the system is working. This all reminds me of Pat Michaels saying that ENSO did not cause changes in precipitation across the US because he was averaging across storm track locations and not really looking at the phenomena themselves. That to me seems the problem here—there should be more looking at how the system works than giving changes in US or even regional totals. As just an example, assume Jennifer Francis' hypothesis is correct—that would lead to more precipitation in some regions and not others—this might have a clear attribution to a weaker equator-pole gradient but it would not be causing the same sign or character of changes everywhere. I think a good bit deeper analysis is needed.	The authors appreciate the suggestion, however this is an assessment of the relevant literature and the team is not aware of literature that backs up the hypothesis in the comment.
Michael	MacCracken	Text Region	Chapter 07: Precipitation Change		256	256	26	36	While it is somewhat useful to indicate that there is more precipitation, more information is really needed. For example, with precipitation tending to come more often in extreme events, it would be useful to have information on the spread of the rainfall over the season, so perhaps a pdf of the frequency of precipitation events of various magnitudes, intervals between rain events, etc. Indeed, what would really be useful to have is changes in soil moisture as with warmer temperatures there will also be increased evaporation. It seems essential to me that this paragraph, indeed, the chapter, be better framed in terms of what is likely to matter to various types of water managers and water users. Just saying that precipitation over a region went up over a season is not particularly helpful for farmer and others—they want information on changes in useful water availability; and for water and ecosystem managers, they might want to have information on variations in the amounts in particular storms or snow onto frozen ground. While the types of information different groups want will vary and not everything can be provided to everyone, at the very least context needs to be added so that just changes in seasonal total precipitation is considered an indication of whether or not changes will matter for ecosystems or society.	The authors appreciate the suggestion, however this is an assessment of the relevant literature and the team is not aware of literature that backs up the hypothesis in the comment.
Michael	MacCracken	Text Region	Chapter 07: Precipitation Change		259	259	12	27		The authors appreciate the comment. However for projected changes in water availability, which is what the comment appears to be asking for, Chapter 8 covers drought, floods and hydrology. This includes soil moisture as well as drought and snowpack. Also, much of what is asked for will be covered in the water resources chapters of the NCA.

First Name	Last Name	Comment Type	Chapter	Figure/Table No.	Start Page	End Page	Start Line	End Line	Comment	Response
Michael	MacCracken	Text Region	Chapter 07: Precipitation Change		259	259	31	32	Regarding this comparison to natural variation, this is just the change in total seasonal precipitation--this is only one aspect of considering whether the changes will be small or large compared to natural variation--all the changes could be in one storm, the distribution of magnitudes and number of rainfall events could dramatically change, and on and on. Without evaporation and lots of other types of changes being considered, suggesting that this is an assessment makes this finding seem much more significant than it may be--a lot of caveating on the significance of this finding is needed.	These maps show projected multi-model mean average seasonal changes for the last 30 years of the 21st century. The maps show whether the average changes are large compared to internal variability or small compared to internal variability. It is highly doubtful that large 30 year average changes could be due to one or a few storms. While the authors agree the distribution and magnitudes of precipitation events may change, this is addressed, somewhat, in looking at projected changes in extremes.
Michael	MacCracken	Text Region	Chapter 07: Precipitation Change		260	260	4	4	I think the text needs to explain where the subtropics are--and that increasingly this designation will be applying to the US Southwest and South-central, and maybe even Southeast--and then add Hawaii and the Caribbean islands as appropriate. I would guess that most people think the subtropics do not and will not include the US, and this is simply wrong. While this is sort of implied in the next sentence, I don't think it is clearly enough indicated, etc.	The authors have added a phrase defining the subtropics.
Astrid	Caldas	Text Region	Chapter 07: Precipitation Change		260	260	19	19	Mention atmospheric rivers in this section?	The authors have added some text about projected changes in ARs stating that extreme AR statistics are expected to increase (Dettinger 2011) and west coast ARs are expected to occur at lower latitudes (Shields and Kiehl 2016).
Michael	MacCracken	Text Region	Chapter 07: Precipitation Change		260	260	20	30	There is no discussion here (is it elsewhere) of how having more rain in heavy events generally ends up meaning fewer days of moderate and modest precipitation--and this can be a strong corollary of having more extreme rainfall, and needs to be mentioned, etc.	This is a good point and one worth illustrating. The team is developing a figure that shows the distribution by percentile bins to show that the heavy events increase at the expense of the lighter events.
Michael	MacCracken	Text Region	Chapter 07: Precipitation Change		260	260	22	23	Exactly--that more precipitation is going up means that the increases in precipitation talked about earlier may not be at all beneficial, emphasizing the need for more context. I would suggest adding a subsection or box early in the chapter that explains the water balance (including evaporation, distribution of rainfall amounts, etc.) and how it matters and the many ways in which changes can occur, some of which may be beneficial and some clearly not--that a lot will depend on the needs of particular users of the moisture.	Thank you for the suggestion, however due to space limitations and the fact that diagrams of the hydrologic cycle are readily available on the web, the authors decline to add a box on the basics of the water cycle.
Andreas	Prein	Text Region	Chapter 07: Precipitation Change		261			4	Chapter 7 provides a well-thought out summary of precipitation changes in the U.S. I would suggest to add the following paragraph on changes in hourly precipitation extremes to subsection 7.2.2. Hourly precipitation extremes that cause extremes such as flash floods have high societal relevance since they cause the highest rates of weather-related fatalities in the U.S. after heat waves. Projected changes in summertime hourly precipitation that were simulated by a weather forecast resolution climate model show a distinctive shift to fewer but more intense rainfall events in the central U.S. (Prein et al. 2017). Annual hourly maximum precipitation is increasing Nationwide in all seasons by 20%-70%. The rate of increases depends on water vapor availability and is highest along the Coastlines and high latitudes. Also, the frequency of seasonal hourly precipitation extremes is expected to increase in all regions by up to 5 times in the same areas that show the highest increases in extreme precipitation rates. Prein, A.F., R.M. Rasmussen, K. Ikeda, C. Liu, M.P. Clark, G.J. Holland, 2016. The future intensification of hourly precipitation extremes. Nature Climate Change, 7, 483-492 (2017), doi:10.1038/nclimate3168	The authors have added text on the Prein work that states the more intense (99.9 percentile) events are increasing at the expense of lesser intense (97.5 percentile) hour events.
Michael	MacCracken	Text Region	Chapter 07: Precipitation Change		262	264	1	28	There is no finding related to increased evaporation or to issues of changes in soil moisture--and in the findings no qualification about these items--at least add some qualifying phrases.	Evaporation and soil moisture are covered in Chapter 8. Due to space limitations the authors are not including mention here.
Michael	MacCracken	Text Region	Chapter 07: Precipitation Change		263	263	11	14	I would like to understand what is meant here by "wetter" and "drier"--this chapter seems to be about the amounts of precipitation, where fore me saying wetter and drier would mean that evaporation is also being considered and so the changes mean that there is more of less soil moisture, but I see no evidence that this has been considered. Also, given the precipitation intensity is up, do these words indicate that there is more time raining or less time raining, or are they just about precipitation amounts [in this regard, I'd note that Trenberth gave a talk at the AMS meeting in Seattle indicating that models do a very poor job in simulating the actual times it is precipitating (although with such large grid sizes, I was not clear if the models would be right it was raining in some fraction of the grid cell or not)]. If what is meant by the analyses is that there is more or less rainfall, say that--don't use terms wetter and drier as substitutes as I do not think the user of water would agree the terms are synonymous.	The authors have changed the text in KM 3 to say "receiving more precipitation" and "less precipitation" rather than wetter or drier.
Michael	MacCracken	Text Region	Chapter 07: Precipitation Change		264	264	4	4	Remove extra period	Corrected; both extraneous periods removed.
Michael	MacCracken	Text Region	Chapter 07: Precipitation Change		264	264	12	12	This should say "climate model results"	yes, "results" added.
Michael	MacCracken	Text Region	Chapter 07: Precipitation Change		264	264	24	24	Needs a comma after "uncertainties" and remove the one after "medium"	Yes, thanks, corrected.
Michael	MacCracken	Figure	Chapter 07: Precipitation Change	Figure 7.1	266				The indication of a strong increase in summertime precipitation in California makes absolutely no sense at all. There is basically no rainfall during the summer in the areas of California that are colored dark green--any is perhaps from deposition of coastal fog. Where the amounts are so small that unrepresentative amounts lead to misleading results, no coloring should be used. The labels on the rows in the figure are not clear at all. I question whether this figure is needed. It speaks to differences between the models. While this is of technical importance, I don't think it adds much to our understanding of climate impacts on the US.	The maps show percentage differences between the two time periods, not absolute amounts. Even though it rains very little in the JJA season in California, even a small absolute change can show up as a large percentage change.
Andrew	Pershing	Whole Page	Chapter 07: Precipitation Change		270					The authors agree and have dropped the figure from the chapter.
Michael	MacCracken	Figure	Chapter 07: Precipitation Change	Figure 7.5	270				There needs to be some sort of explanation for the large red block showing in the lower right hand part of the figure. Are the models all related? What does the "Distance from obs" mean and what is the significance--that is, what does this term mean in terms of physics? What is the nature of the problem?	This figure has been removed.
Astrid	Caldas	Whole Chapter	Chapter 07: Precipitation Change						Resources: Xiang Gao1*, C. Adam Schlosser1, Paul O'ao-Gorman2, Erwan Monier1, and Dara Entekhabi3 21st Century Changes in U.S. Regional Heavy Precipitation Frequency Based on Resolved Atmospheric Patterns. DOI: http://dx.doi.org/10.1175/JCLI-D-16-0544.1 Published Online: 21 December 2016 Shields, C. A., and J. T. Kiehl (2016). Simulating the Pineapple Express in the half degree Community Climate System Model, CCSM4, Geophys. Res. Lett., 43, 7767-7773, doi:10.1002/2016GL069476. The future intensification of hourly precipitation extremes-Andreas F. Prein*, Roy M. Rasmussen, Kyoko Ikeda, Changhai Liu, Martyn P. Clark and Greg J. Holland NATURE CLIMATE CHANGE VOL 7 JANUARY 2017 HYPERLINK "	Thank you for the list of references. The authors will be including the Prein et al. and Xiang et al. and possibly the Shields references in the chapter.
Erica	Brown	Whole Chapter	Chapter 07: Precipitation Change						Did the committee consider the recent NAS study on attribution and its relevance for inclusion in this chapter and others (https://www.nap.edu/catalog/21852/attribution-of-extreme-weather-events-in-the-context-of-climate-change) ?	The concepts of the NAS report were considered in the attribution section of the report. In particular the authors have a section on event attribution that assesses a number of extreme event attribution studies.
Erica	Brown	Whole Chapter	Chapter 07: Precipitation Change						The Traceable Accounts section is very useful. Having a succinct description of the evidence base, the new information since the last report, remaining uncertainties and assessment of confidence based on evidence is helpful for utility water resources planners and decision makers.	Thank you for your comment. The traceable accounts are useful in documenting the assessment process for individual key messages.
Erica	Brown	Whole Chapter	Chapter 07: Precipitation Change						The figures identified as to be added to the section will be useful illustrations to demonstrate the trends and findings.	Thank you for the compliment. Hopefully all figures are useful in this way.

First Name	Last Name	Comment Type	Chapter	Figure/Table No.	Start Page	End Page	Start Line	End Line	Comment	Response
Charlie	Luce	Whole Chapter	Chapter 07: Precipitation Change						No mention is made of the decline in orographic precipitation enhancement in the Northwest as noted in Luce et al., (2013). Considering that other mentions of regional changes are scattered throughout the chapter (starting as early as the first paragraph in section 7.1) it looks like a potentially important oversight. It also suggests a need for a comment maybe a section or paragraph on the sampling behind measurements of historical trends, which are largely low elevation long-duration gages. By setting particular limits on the timing, hydrologically important locations (e.g. mountains) may be excluded from sampling. Some mention should be made about difference that might exist between GCM scale projections and finer scale assessments due to changes in orographic enhancement in some regions as well.	The authors included a sentence on the reduction in streamflow as related to reduced orographic enhancement of precipitation and cited Luce et al.
Keya	Chatterjee	Text Region	Chapter 08: Droughts, Floods, and Hydrology		281	281	11	12	This should be connected to food production difficulties that will be associated with agricultural drought.	Indeed, there are serious implications for food production. However, such impacts of climate change are deferred to the actual 4th National Climate Assessment and are out of the scope of this report.
Keya	Chatterjee	Text Region	Chapter 08: Droughts, Floods, and Hydrology		281			16	This should be connected to related difficulties with food production and agricultural drought	Indeed, there are serious implications for food production. However, such impacts of climate change are deferred to the actual 4th National Climate Assessment and are out of the scope of this report.
Astrid	Caldas	Text Region	Chapter 08: Droughts, Floods, and Hydrology		281	281	19	19	but the science is improving and for some events we can say anthropogenic climate change is playing a significant role.	Our review of the extreme event literature finds no formal attribution studies of anthropogenic climate change influence on actually flooding during specific events. There is literature finding a human amplification on specific extreme precipitation events. However, the extension to hydrological analyses has not been made for these events. The authors will hold these key findings to a very high standard of evidence and will not make the formal attribution statement despite our feeling that such could be made when such hydrological analyses are eventually performed.
Astrid	Caldas	Text Region	Chapter 08: Droughts, Floods, and Hydrology		281	281	20	20	increased "riverine" flooding	This Key Finding was rewritten. The adjective "riverine" is now used.
Keya	Chatterjee	Text Region	Chapter 08: Droughts, Floods, and Hydrology		281	281	20	20	Specific examples of heavy downpours should be included, spell out states.	The authors have been instructed to keep Key Messages general.
Erica	Brown	Text Region	Chapter 08: Droughts, Floods, and Hydrology		281	282	23	7	Just as it's pointed out that different characterizations of drought apply to different kinds/classes of decision makers, it would be helpful to note that decision makers at a local water resources management (e.g., water utility managers) also need more localized scale. Regional projections do not always represent the situation of all utilities within the region. In this instance, an increased resolution in defining drought would facilitate more localized water management.	Reference the revised KF6 in chapter 4
Michael	MacCracken	Text Region	Chapter 08: Droughts, Floods, and Hydrology		281	281	23	23	Drought also brings to mind to me that this is a limited time departure rather than a permanent changes. After all, we do not say the Sahara is having a 6000-year drought, and Australia saying that a region is having a 40-year drought is, in my view, misleading. What is happening is both aridification as a result of the tendency for an expanding subtropics, and then on top of that getting an increased incidence of intense dry periods due in part to faster evaporation and then also more of the precipitation occurring in extreme events, leaving less for events between such extreme precipitation events, etc. Thus, what I would like to encourage is some elaboration of this sentence that indicates both that the baseline change needs to be called aridification, and then on top of this there is the additional effect of altering the pdfs of precipitation and dry periods.	6. Combining output from global climate models and dynamical and statistical downscaling models using advanced averaging, weighting, and pattern scaling approaches can result in more relevant and robust future projections. For some regions, sectors, and impacts, these techniques are increasing the ability of the scientific community to provide guidance on the use of climate projections for quantifying regional-scale impacts (medium to high confidence). The authors agree with the comment, although there is little literature to assess on changing reference conditions. However, the team added the following sentence: "As the climate changes, conditions currently considered "abnormally" dry may become relatively "normal" in those regions undergoing aridification or extremely unlikely in those regions become wetter. Hence, the reference conditions defining drought may need to be modified from those currently used in practice."
Erica	Brown	Whole Page	Chapter 08: Droughts, Floods, and Hydrology		281				Defining drought at the outset according to the NOAA definition (i.e., three classes of drought) is helpful and important. It may also be important to characterize drought and other phenomena impacted by climate in the context of multiple indices, particularly when considering the locally affected areas when compared with regional or state-wide drought assessment.	The authors have added extensive discussion of the changes in hydrological drought in the Western US as this has the most complete literature. Other regions can be discussed in NCA4 if those lead authors so choose.
David	Hawkins	Whole Page	Chapter 08: Droughts, Floods, and Hydrology		281				Statement on flood frequencies and attribution to human influences, p. 281, lines 17-21: Detectable increases in seasonal flood frequency have occurred in parts of the central United States. This is to be expected in the presence of the increase in extreme downpours known with high confidence to be linked to a warming atmosphere, but formal attribution approaches have not identified the connection of increased flooding to human influences. The statement about attributing a connection between increased incidents of flooding and human influences is only strictly true for riverine flooding events and that clarification should be included in the statement. Certain types of flooding are known to have increased as a result of sea level rise, which is attributable to climate change, like tidal flooding, as discussed in detail in Chapter 12. Other types of flooding, like urban flooding, may also be more easily attributable to human influences and climate, change due to their stronger direct correlation to severe precipitation events, as discussed in Chapter 7. Urban flooding results from heavy precipitation events that overwhelm the existing infrastructure's ability to convey the resulting stormwater. A recent study of urban flooding was conducted by the Illinois Department of Natural Resources (available at https://www.dnr.illinois.gov/WaterResources/Documents/Final_UFAA_Report.pdf) found the problem to be fairly common in urban areas and resulted from increasingly frequent severe precipitation events. Reference should be made in the key findings to these other types of flooding events, so as not to leave readers to erroneously conclude that there is no attributable connection between climate change and all types of flooding.	The revised key finding is as follows: "5. Detectable changes in some classes of flood frequency have occurred in parts of the United States and are a mix of increases and decreases. Extreme precipitation, one of the controlling factors in flood statistics, is observed to have generally increased and is projected to continue to do so across the United States in a warming atmosphere. However, formal attribution approaches have not established a significant connection of increased riverine flooding to human-induced climate change and the timing of any emergence of a future detectable anthropogenic change in flooding is unclear. (Medium confidence)" The authors have added a paragraph about urban flooding and this reference in response to a similar comment. Regarding the second half of the comment, literature on the detection and attribution of observed changes in precipitation variability relative to its average is non-existent. Hence, there is nothing to say in this key finding about such.
Michael	MacCracken	Text Region	Chapter 08: Droughts, Floods, and Hydrology		282	282	3	4	It seems to me there needs to be elaboration of "runoff", in that it can occur in a concentrated way (i.e., floods) or spread out, and so the characteristics of runoff can also matter—just indicating the change in total runoff is not really as much information as may be useful. California's time history is likely a good example—with this year's rain and runoff, I'd suggest that the decadal average values may be near normal whereas California is tending to have now rain come more and more heavily in perhaps fewer and fewer events/years. Thus, time averages can be very problematic in conveying the nature of changes.	The commentator is missing the context. Here the authors are discussing drought. The team has changed "Runoff" to "Seasonal total runoff" to clarify. And the authors note the expanded discussion on flooding, which is more to the point of the comment.
Michael	MacCracken	Text Region	Chapter 08: Droughts, Floods, and Hydrology		282	282	11	11	I would suggest changing "these" to "what have in the past been called" or something similar as what will now be happening are pretty clearly mixed types of events.	The authors do not see how this change helps clarify the statement at hand.
Michael	MacCracken	Text Region	Chapter 08: Droughts, Floods, and Hydrology		282	282	16	17	Regarding use of the word "periodic" seems to me to apply a regularity that could only exist if there is some very clear causal factor. That has not, as far as I know, been established, although there have been suggestions such as lunar nodal cycles, etc. I would think it would be more appropriate to say something like that such events have occurred occasionally over the past. If there are conditions that are controlling these cycles, mention needs to be made of them.	Agreed. The authors changed "periodically" to "occasionally" as suggested.
Michael	MacCracken	Text Region	Chapter 08: Droughts, Floods, and Hydrology		282	282	19	32	On a global basis, in that climate zones are shifted, would one not expect some regions to have more (e.g., where subtropical edge is shifting poleward) and some regions to have fewer (e.g., as the tropics expand a bit, etc.) extreme droughts—so making a statement about trends in the total number would seem inappropriate to be making. I would suggest providing a bit more context in what is being said.	Here the authors are repeating the IPCC AR5 revision of the IPCC AR4 statements for context. Regarding the appropriateness of total number, climate change is much more than just shifts in climate zones. Changes in the hydrological cycle due in part to increases in atmospheric water vapor could lead to all manner of changes in drought statistics, including total number. The authors elect to leave the discussion intact.
Astrid	Caldas	Text Region	Chapter 08: Droughts, Floods, and Hydrology		282	282	35	35	Additional Source for this section: U.S. Environmental Protection Agency. 2016. Climate change indicators in the United States, 2016. Fourth edition. EPA 430-R-16-004. www.epa.gov/climate-indicators .	The drought indicators in this report are overly spatially aggregated in the long term trends and without much climate change context. However, the authors have elected to cite this in the flood section.

First Name	Last Name	Comment Type	Chapter	Figure/Table No.	Start Page	End Page	Start Line	End Line	Comment	Response
Michael	MacCracken	Text Region	Chapter 08: Droughts, Floods, and Hydrology		282	282	37	38	Saying "mostly" is a rather strong assertion for the "very severe" droughts (recall Hansen et al. paper showing shifting Gaussian distributions of observed summer average temperature, where over just a few-decade shift led to what had been 1 in 1000 occurrences now occurring 100 times as often, so even a little shift of human activities can lead to a huge increase in the very severe conditions--and the Hansen et al. curve shifts even seem to show a 5-sigma event--it very much seems to me this statement is ignoring how small changes in the mean can greatly increase the occurrence of the worst extremes). Even if there has not yet been two-figure sigma proof that climate change has had some influence, this does not in any way mean that climate change has not been having an influence. I'd venture that there is also not a two-sigma proof that climate change has not had an effect. This sentence is thus based on the premise--and it is a premise and framing that is based on scientific tradition, but is not the type of analysis that is done in public and government decision-making. Thus, I'd suggest a more nuanced statement (the statement on the next page, lines 2-3 starts to do this, but not at all enough of how small shifts can greatly change what is happening in the tail of the distribution--again, some elaboration is needed).	First, the Hansen paper mentioned suffers from serious statistical methodological errors. There are at least two rebuttals to this paper that point out errors, one of which was written by a lead author of this chapter. The paper is not assessable in our opinion. Second, our statement is "large-scale meteorological patterns of mostly natural origins". This is not a statement about temperature changes but rather circulation changes. The literature does not support detection of statistically significant changes in observed patterns that are associated with meteorological drought. Obviously then, there can be no attribution to human causes of undetected trends. Third, our "premise" is that the burden of proof on an assessment is that anthropogenic climate change has a detectable and attributable effect, not that it did not have an effect. The authors consider the latter to be the null hypothesis and it is not disproven.
Erica	Brown	Text Region	Chapter 08: Droughts, Floods, and Hydrology		284	284	1	6	Where does the "ridiculously resilient ridge" of high pressure quote come from (which reference?) Is this a scientific term that helps define the context? For a non-meteorologist, this phrase is confusion. Suggest simplifying to read "... deficit from 2011 to 2014 resulted from a ridge of high-pressure that remained in place for an extended period of time."	Admittedly it is a nickname, but actually targeted towards non-meteorologists. It even has its own wikipedia page, https://en.wikipedia.org/wiki/Ridiculously_Resilient_Ridge . The authors elect to retain this terminology as it is less confusing not more.
Michael	MacCracken	Text Region	Chapter 08: Droughts, Floods, and Hydrology		284	284	1	15	I think it needs to be stated clearly (meaning to two-sigma, or basically roughly 20 to 1 odds) that if the cause of an unusual event cannot be related in a clear causal way to human factors, then it is presumed to be natural. This does not mean it is sure to be natural, but that we have not yet figured out how to prove a human influence to a very high standard. This is done by scientists for a reason, but this is not the decision-making frame generally used by society, which is relative likelihood or even related to there being a small risk--so I'd suggest that context is needed here. Yes, there have been intense droughts in California before and there are also said to be natural because no proof of cause has been adequately proven, and that such events are not yet associated with a causal event, this expands what is considered to be natural variability even though there could have been some other cause (e.g., unrealized intensity of a poorly documented volcanic eruption, etc. So, I would just suggest that better framing is needed, explaining the assumptions made in coming to conclusions, etc.	The authors have elaborated on this in chapter 3, box 3.1: "...In this box, the team responds to several such questions received in the public review period. - Why is such a high degree of confidence (e.g., statistical significance at level of 0.05) typically required before concluding that an attributable anthropogenic component to a climate change or event has been detected? For example, could attribution studies be reframed to ask whether there is a 5% or more chance that anthropogenic climate change contributed to the event? This question is partly related to the issue of risk avoidance. For example, if there is a particular climate change outcome that we wish to avoid (e.g., global warming of 3oC, or 10oC, or a runaway greenhouse) then one can use the upper ranges of confidence intervals of climate model projections as guidance, based on available science, for avoiding such outcomes. Detection/attribution studies typically deal with smaller changes than climate projections over the next century or more. For detection/attribution studies, researchers are confronting models with historical data to explore whether observed climate change signals are emerging from the background of natural variability or not. Typically the emergent signal is just a small fraction of what is predicted by the models for the coming century under continued strong greenhouse gas emission scenarios. Detecting that a change has emerged from natural variability is not the same as approaching a threshold to be avoided, unless the goal is to ensure no detectable anthropogenic influence on climate. Consequently, use of a relative strong confidence level (or p-value of 0.05) for determining climate change detection seems justified."
Erica	Brown	Text Region	Chapter 08: Droughts, Floods, and Hydrology		284	284	16	38	The sentence beginning on line 16 suggests that anthropogenic climate change increased the risk of high temperatures in CA, yet the sentence on line 38 suggests there hasn't been a formal identification of anthropogenic effects on drought. Suggest modifying the sentence at the beginning on line 16 to, "As with the studies conducted for the 2012-2014 timeframe, other studies suggested that anthropogenic climate change did increase the risk of high temperatures in California... (Seager et al. 2015, Diefenbaugh et al. 2015)"	The authors refer to the very beginning of the drought discussion distinguishing the various definitions of drought. The paragraph starting at line 16 discusses the connections between high temperatures and agricultural drought and the associated human influence. The sentence starting at line 38 refers to meteorological drought, which is at the top of this hierarchy of drought definitions. The human influence on temperature has not been connected to changes in seasonal average precipitation. Hence, there is no meteorological drought trends identifiable by seasonal average precipitation trends.
Michael	MacCracken	Text Region	Chapter 08: Droughts, Floods, and Hydrology		284	284	27	30	The wording of sentence is a bit confusing--adding a comma or two would help	The text has been revised to incorporate this suggestion.
Keya	Chatterjee	Text Region	Chapter 08: Droughts, Floods, and Hydrology		284	284	34	35	Cite this in bullet #4 at top of chapter.	Key messages do not have citations.
Michael	MacCracken	Text Region	Chapter 08: Droughts, Floods, and Hydrology		284	284	38	39	Needs to be rewritten in active voice.	Why? The statement is true as it stands.
Michael	MacCracken	Text Region	Chapter 08: Droughts, Floods, and Hydrology		285	286	14	2	This is a quite long paragraph--would likely be able to convey main messages more clearly by breaking it up.	The authors have made the suggested revision
Michael	MacCracken	Text Region	Chapter 08: Droughts, Floods, and Hydrology		285	285	15	15	The word "would" is not needed. Also, at least for the first national assessment, we worked to scrub the word "may" from the text. Can this word be replaced by one of the selected likelihood words to be used in this assessment?	This section has been rewritten.
Michael	MacCracken	Text Region	Chapter 08: Droughts, Floods, and Hydrology		285	285	16	16	Given their Mediterranean climate, there is not much summer precipitation in most cases. It might better be said that what is happening is a shortening of the season when precipitation can occur (evident particularly in the spring) and even that this is happening as a result of the expansion of the subtropics, in turn occurring due to a strengthening and broadening of tropical regions. I'd like to see a bit more comprehensive explanation based on the global scale shifts in the circulation regimes to give a bit more coherence to the discussion.	The authors added these sentences: "In much warmer climates, expansion of the tropics and subtropics, traceable to changes in the Hadley Circulation, cause shifts in seasonal precipitation that are particularly evident in such arid and semi-arid regions and increase the risk of meteorological drought. However, uncertainty in the magnitude and timing of future southwestern drying is high."
Keya	Chatterjee	Text Region	Chapter 08: Droughts, Floods, and Hydrology		285	285	17	19	Full out and cite at top of chapter.	This statement is essentially the same as key finding #2. There is no need to have two key findings on future agricultural drought.
Michael	MacCracken	Text Region	Chapter 08: Droughts, Floods, and Hydrology		285	285	18	19	And an additional reason is that more and more precipitation is occurring in the relatively rare extreme precipitation events.	The statement is about agricultural drought, not meteorological drought. The authors do not see this comment as relevant.
Keya	Chatterjee	Text Region	Chapter 08: Droughts, Floods, and Hydrology		286	286	26	30	Spell out which states are 'western' here.	The authors are adhering to the use of regions defined in Figure 1 of the Report.
Charlie	Luce	Text Region	Chapter 08: Droughts, Floods, and Hydrology		286	287	26	11	This section of text demonstrates decreases in snowpack across the west, but does not point out the spatial heterogeneity in response, focusing rather on stating how dire changes might be. Some discussion of the spatial heterogeneity of snowpack response would be important as would citations to studies that are not just model-chain-applications. Specifically, Luce et al., (2014) demonstrate differences in snowpack sensitivity (including spatial distributed projections at SNOTEL stations where observations were made. Luce et al. (2014) also show projections for the mean residence time of snow, which is a new metric that contrasts with the traditional April 1 SWE. While April 1 SWE shows the change on a specific date near the end of the snowpack season, the mean snow residence time is the average life span of snow that falls. It is a more direct measure of how long water is stored as snow and consequently the change in hydrologic regime (e.g. streamflow timing). Note that the citation to Rhoades et al., 2016 already in the CSSR (Figure 8.3) shows changes that are heterogeneous, but the units are unclear. Based on the caption, it sounds more like snowfall equivalent, in which case it is all the more important to include papers with other metrics such as Luce et al., 2014 and some citations therein with projections. Also, the Rhoades citation is not available online anywhere, and the author is probably Alan Rhoades (who works with CESM), not Chuck Rhoades (who works more on Biogeochemistry). Luce, C. H., Lopez-Burgos, V., Holden, Z., 2014, Sensitivity of snowpack storage to precipitation and temperature using spatial and temporal analog models, Water Resour. Res., 50, 9447-9462, 10.1002/2013WR014844.	It was not pointed out, but spatial heterogeneity is shown in Table 8.2. The authors take the point and mention it directly as well as note the change in Snow Residence time with the following new text: "Table 8.2 reveals that the reductions in snow water equivalent accelerate in the latter half of this century under this emissions scenario and substantial variations across the western United States. Changes in snow residence time, an alternative measure of snowpack relevant to the timing of runoff, is also shown to be sensitive to elevation with widespread reductions across this regions (Luce et al 2014)."
Michael	MacCracken	Text Region	Chapter 08: Droughts, Floods, and Hydrology		286	287	26	11	Another very long paragraph containing a number of points that would normally merit coverage in a separate paragraph.	This discussion has been lengthened and existing paragraphs somewhat reworked.
Keya	Chatterjee	Text Region	Chapter 08: Droughts, Floods, and Hydrology		287			5	Which ones? Please add detail.	Added rcp8.5 as example. But A1B or A2 would also fit.

First Name	Last Name	Comment Type	Chapter	Figure/Table No.	Start Page	End Page	Start Line	End Line	Comment	Response
Keya	Chatterjee	Text Region	Chapter 08: Droughts, Floods, and Hydrology		287		6		Pull out to top line of chapter.	Although the authors feel that this is an important finding, the team elected not to highlight it as a Key Finding.
Keya	Chatterjee	Text Region	Chapter 08: Droughts, Floods, and Hydrology		287		9		Please add states.	The authors are adhering to the use of regions defined in Figure 1 of the Report.
Astrid	Caldas	Text Region	Chapter 08: Droughts, Floods, and Hydrology		287	287	29	29	Additional resources for section 8.2: Archfield, S.A., R.M. Hirsch, A. Viglione, and G. Blisch. 2016. Fragmented patterns of flood change across the United States. American Geophysical Union. Accepted for publication. OCT 10, 2016 Hurricane Sandy's flood frequency increasing from year 1800 to 2100 by Ning Lin, Robert E. Kopp, Benjamin P. Horton, Jeffrey P. Donnelly, Proceedings of the National Academy of Sciences AECOM. 2013. The Impact of Climate Change and Population Growth on the National Flood Insurance Program Through 2100.	Archfield et al. is now cited. The hurricane Sandy paper has been referred to chapter 9 authors. This statement has been added: "In a report prepared for the Federal Insurance and Mitigation Administration of the Federal Emergency Management Agency, a regression based approach of scaling river gauge data based on seven commonly used climate change indices from the CMIP3 database (Tebaldi et al. 2006) found that at the end of the 21st century the 1% annual chance floodplain area would increase in area by about 30% with larger changes in the Northeast and Great Lakes regions and smaller changes in central part of the country and the Gulf Coast (AECOM 2013)."
Astrid	Caldas	Text Region	Chapter 08: Droughts, Floods, and Hydrology		287	287	31	31	coastal flooding from storm surge *and sea level rise*	The authors added sea level rise as a separate coastal flooding phenomena.
Michael	MacCracken	Text Region	Chapter 08: Droughts, Floods, and Hydrology		287	287	32	35	During the first US national assessment, there was strong disagreement between NOAA and USGS authors on this question. Closer examination identified two causes, and I would suggest that these may be the cause for some of the variation in findings. The first issue was that there are different relationships in the eastern two thirds of the US from the rest--namely that flooding in rivers in the eastern and southeastern US usually results from heavy rainfall in the days before the flooding, whereas in the northern Great Plains and mountainous US, except for flash floods, most floods are due to massive snowmelt that occurs well after the snow has occurred. Thus, one has to be very careful of doing US wide analyses that will tend to weaken the collective findings even though the regional findings can be robust (so in eastern US, more intense precipitation events might lead to more flooding situations, whereas in west less snowpack may mean less flooding--and so on average these two findings get muddled. The second issue was how trends in excess rainfall was identified: As I recall, the USGS looked at trends in the annually determined 95% rainfall event (which led to a rather noisy record as the actual amounts each year varied a lot and so a trend was hard to see) whereas NOAA determined the 95% level based on a 30-year average (so it was more robust) and looked for trends in the number of occurrences of events larger than the 95% level). Each agency argued its approach was better or more traditional than the other, and so that there were differences was not surprising. In citing just the Hirsch and Ryberg results, it seems to me that this assessment may well not be representing the full range of views--so where are the Groisman (from NOAA) findings on this issue?	The flooding section has been extensively rewritten with a more regional perspective. The Groisman et al paper, although dated, is now cited, along with more recent regional and national literature.
David	Hawkins	Whole Page	Chapter 08: Droughts, Floods, and Hydrology		287				The introductory lines of this section states that flood events fall into one of three categories: flash floods along smaller waterbodies, prolonged flooding on major rivers, and storm surge in coastal areas. But flash floods also occur in urban areas (so-called urban flooding) and are unassociated with proximity to a waterway (see comment above). These floods result from excessive rainfall that overwhelms stormwater systems. Urban flooding results from heavy precipitation events that overwhelm the existing infrastructure's ability to convey the resulting stormwater. A recent study of urban flooding was conducted by the Illinois Department of Natural Resources (available at https://www.dnr.illinois.gov/WaterResources/Documents/Final_UFAA_Report.pdf) found the problem to be fairly common in urban areas and resulted from increasingly frequent severe precipitation events. Also tidal flooding needs to be recognized here, with reference to Ch. 12. Urban flooding and tidal flooding are two distinct phenomena from the flooding events described here and should be recognized.	This is a good point. The authors have modified the introduction to read: "Flooding damage in the United States can come from flash floods of smaller rivers and creeks, prolonged flooding along major rivers, urban flooding unassociated with proximity to a riverway, coastal flooding from storm surge which may be exacerbated by sea level rise, and the confluence of coastal storms and inland riverine flooding from the same precipitation event (Ch. 12: Sea Level Rise)." and added the following paragraph and an additional citation. "Urban flooding results from heavy precipitation events that overwhelm the existing sewer infrastructure's ability to convey the resulting stormwater. Future increases in daily and sub-daily extreme precipitation rates will require significant upgrades to many communities' storm sewer systems (SFPUC, UFAA)."
Astrid	Caldas	Text Region	Chapter 08: Droughts, Floods, and Hydrology		288	288	1	1	See EPA 2016 at p. 27 "Besides climate change, several other types of human influences could affect the frequency and magnitude of floods--for example, dams, floodwater management activities, agricultural practices, and changes in land use." U.S. Environmental Protection Agency. 2016. Climate change indicators in the United States, 2016. Fourth edition. EPA 430-R-16-004. www.epa.gov/climate-indicators .	Citation added. Thank you
Astrid	Caldas	Text Region	Chapter 08: Droughts, Floods, and Hydrology		288	288	3	3	Additional source for this section: U.S. Environmental Protection Agency. 2016. Climate change indicators in the United States, 2016. Fourth edition. EPA 430-R-16-004. www.epa.gov/climate-indicators .	Citation added. Thank you
Astrid	Caldas	Text Region	Chapter 08: Droughts, Floods, and Hydrology		288	288	4	26	Additional source for whole paragraph: Slater, L., and G. Villarini. 2016 update and expansion to data originally published in: Mallakpour, L., G. Villarini. 2015. The changing nature of flooding across the central United States. Nature Climate Change 5:250-254.	This does not appear to be a citable reference. It is not listed in Prof Villarini's web pages.
David	Hawkins	Text Region	Chapter 08: Droughts, Floods, and Hydrology		288	288	5	7	The report should say that there ARE trends in flooding, it's just not clear yet what role climate change is playing. The statement on lines 5-7 that, "Recent analysis of maximum streamflow shows statistically significant trends only in the Upper Mississippi River Valley (increasing) and in the Northwest (decreasing) (McCabe and Warlock)," is incorrect and at odds with the later statement on lines 35-38, citing the work of University of Iowa researchers Mallakpour and Villarini. That study found increased frequency of flooding in their analysis of stream gauges in river basins throughout the Midwest from North Dakota across to Ohio and in states throughout the entirety of the Upper Mississippi River basin. The statement on lines 5-7 should be changed to reflect that flooding is happening more frequently throughout the Midwest, although it is still not clear yet the role climate change is playing in the frequency of flooding.	Agreed. The key problem is with the word "only" on line 6 of page 288. Also, the discussion was a bit of order and has been rearranged as follows "The IPCC WG1 AR5 (Bindoff et al. 2013) did not attribute changes in flooding to anthropogenic influence nor report detectable changes in flooding magnitude or frequency. Trends in extreme high values of streamflow are mixed across the United States, as reported in the Third National Climate Assessment (Walsh et al. 2014). Analysis of 200 U.S. stream gauges indicates both areas of increasing and decreasing flooding magnitude (Hirsch and Ryberg 2012) but does not provide robust evidence that these trends are detectable or attributable to human influences. Significant increases in flood frequency have been detected in about one-third of stream gauge stations examined for the central United States, with a much stronger signal of frequency change than is found for changes in flood magnitude in these gauges (Mallakpour and Villarini 2015). Recent analysis of annual maximum streamflow also shows statistically significant trends in the upper Mississippi River valley (increasing) and in the Northwest (decreasing) (McCabe and Wolock 2014). Although both temperature and precipitation increases influence the flooding change, no formal attribution of these changes to anthropogenic forcing has been claimed (Mallakpour and Villarini 2015)."

First Name	Last Name	Comment Type	Chapter	Figure/Table No.	Start Page	End Page	Start Line	End Line	Comment	Response
Michael	MacCracken	Text Region	Chapter 08: Droughts, Floods, and Hydrology		288	288	10	13	If "clearly attributed" means detection with two-sigma significance, then this needs to be clearly stated without using jargon such as this. Basically, one could have attribution with one-sigma significance, meaning very clearly the balance of evidence suggests a human influence, and the text would be right but very misleading in terms of providing information for the public. It is simply essential that the framing for various statements be given and if the hypothesis testing framing is being done then the results need to also be given in a balance of evidence framing as well, and even in a risk-based framing too. Thus, the finding could here be by stating something to the effect "While no studies have found that long-term changes in riverflow of major rivers can be attributed to human-induced climate change with greater than 95% confidence, it does appear that climate change is tending to lead to lower flows in generally arid regions (e.g., the Colorado and Rio Grande basins) and to higher flows in rivers in ..." Presuming this is the case, this would be much more useful information than obscuring what the tendencies are behind jargony phrases like "clearly attributed". This is a problem throughout the document that needs fixing. The following sentence helps, but without greater explanation it reads as in conflict with the preceding sentence and so sounds like a reach whereas both are correct if one carefully understands the applicable framing.	This line has been deleted in the revised text. However, the authors refer here to our answer to comment 134016 (from the same commentator) about attribution.
Keya	Chatterjee	Text Region	Chapter 08: Droughts, Floods, and Hydrology		288	288	13	14	Add specific states.	The authors are adhering to the use of regions defined in Figure 1 of the Report.
Astrid	Caldas	Text Region	Chapter 08: Droughts, Floods, and Hydrology		288	288	17	17	See Archfield, S.A., R.M. Hirsch, A. Viglione, and G. Blischl. 2016. Fragmented patterns of flood change across the United States. American Geophysical Union. Accepted for publication.	Thank you for this citation. The authors have added this to the extensive revision about flooding.
Astrid	Caldas	Text Region	Chapter 08: Droughts, Floods, and Hydrology		288	288	27	30	Besides climate change, several other types of human influences could affect the frequency and magnitude of floods—for example, dams, floodwater management activities, agricultural practices, and changes in land use.	The authors added "dams and floodwater management" to existing statement at the beginning of section 8.2 "Deforestation, urbanization, dams, floodwater management activities, and changes in agricultural practices can all play a role in past and future changes in flood statistics. Projection of future changes is thus a multivariate problem (Walsh et al. 2014)."
Astrid	Caldas	Text Region	Chapter 08: Droughts, Floods, and Hydrology		288	288	28	28	affect *the magnitude, duration, and frequency of* flooding	The authors think the comment refers to line 32 on this page. "Duration" has been added.
John	Posey	Whole Page	Chapter 08: Droughts, Floods, and Hydrology		288	288			I am writing to comment on chapter 8 of the Climate Science Special Report, particularly pp. 287-289 regarding flood risk. I applaud the authors for their caution in attributing flood trends to anthropogenic climate change. Flooding is a complex phenomenon. The risk of flash floods on small streams is influenced not only by precipitation levels, but also by the amount of pavement and other impervious material in a watershed. Flooding on large rivers is affected by land cover and constriction of channels, most notably through levee construction. As a result, much work remains to be done in order to determine, first, how much of a change in flood risk in a given location is the result of changing precipitation patterns, and secondly, how much of the change in precipitation patterns may be attributed to anthropogenic climate change. Along with the need for caution, however, it is also important to take into account the growing body of research showing that in the Midwest, changes in precipitation are leading to changes in hydrology generally, and to changes in flood risk in particular. As in the previous assessment, a great deal of emphasis is placed on the 2012 article by Hirsch and Ryberg. This is a perfectly fine article, but there has been a lot of work done since then that should also be taken into account. Moreover, Hirsch & Ryberg use only a bivariate correlation between CO2 levels and peak annual streamflow. Again, there is nothing wrong with this approach. But there is quite a bit of research that uses other methods, including approaches that attempt to take both land use/land cover as well as climatic variables into account. All of these works should be weighed, rather than relying so heavily upon a single study. Based on recent research, I argue that there is at least a medium level of confidence that climate change is exacerbating flood risk in the Midwest. In what follows, I will use long quotes from the articles cited in order to minimize the risk of misinterpretation on my part. 1) Mallakpour, Iman, and Gabriele Villani. "The changing nature of flooding across the central United States." Nature Climate Change 5.3 (2015): 250-254. The Special Report characterizes this article as follows: "Although both temperature and precipitation increases were influencing the flooding changes, no attribution of these changes to	Thank you for the extensive comment and literature review about Midwestern flooding. In general, we agree with your interpretation of the literature. The connection of increased flooding in the region is certainly attributable to the observed local increases in the seasonal average and/or extreme precipitation shown in chapter 6 of this assessment report. We have added an extensive discussion of this literature in line with your three propositions. However, there is a critical missing element in the literature which causes us to keep our final assessment statement essentially the same. And that is although the connection between flooding and precipitation changes is quite clear, there is no evidence that the observed change in seasonal precipitation in the Midwest is of anthropogenic origins. The connection of increases in Midwestern extreme precipitation to anthropogenic forcing changes is tenuous but at least not inconsistent with larger scales studies. The affirmative results from attribution study of global extreme precipitation by Min et al. is actually dominated by the CONUS and Western European regions as observations are limited elsewhere. However, it is not enough to make an attribution statement about CONUS or US regional extreme precipitation. Hence, indirect attribution of flooding changes to anthropogenic forcing changes is not possible. Language is critical in this regard and we find the cited literature to often be imprecise. Some of the literature do make attribution claims by the noted connection between floods and extreme precipitation, but this is only an attribution to climate and not anthropogenic climate change itself. Our revised attribution statement is slightly reworded to be clearer on this point and is as follows: No studies have formally attributed (see chapter 3) long-term changes in observed flooding of major rivers in the United States to anthropogenic forcing. We conclude that there is medium confidence that detectable, though not attributable in response to anthropogenic forcing changes, increases in flood statistics have occurred in parts of the central United States. Min, S.K., X. Zhang, F.W. Zwiers, and G.C. Hegerl, 2011: Human contribution to more-intense precipitation extremes. Nature, 470, 378-381. http://dx.doi.org/10.1038/nature09763
Michael	MacCracken	Text Region	Chapter 08: Droughts, Floods, and Hydrology		289	289	10	13	In my full set of comments, I mistakenly listed this comment as being about lines on page 288 when I meant to have it be 289. Here is the comment regarding these lines on page 289: If "clearly attributed" means detection with two-sigma significance, then this needs to be clearly stated without using jargon such as this. Basically, one could have attribution with one-sigma significance, meaning very clearly the balance of evidence suggests a human influence, and the text would be right but very misleading in terms of providing information for the public. It is simply essential that the framing for various statements be given and if the hypothesis testing framing is being done then the results need to also be given in a balance of evidence framing as well, and even in a risk-based framing too. Thus, the finding could here be by stating something to the effect "While no studies have found that long-term changes in riverflow of major rivers can be attributed to human-induced climate change with greater than 95% confidence, it does appear that climate change is tending to lead to lower flows in generally arid regions (e.g., the Colorado and Rio Grande basins) and to higher flows in rivers in ..." Presuming this is the case, this would be much more useful information than obscuring what the tendencies are behind jargony phrases like "clearly attributed". This is a problem throughout the document that needs fixing. The following sentence helps, but without greater explanation it reads as in conflict with the preceding sentence and so sounds like a reach whereas both are correct if one carefully understands the applicable framing.	The authors recognized the line mixup. See reply to the original comment.
Keya	Chatterjee	Text Region	Chapter 08: Droughts, Floods, and Hydrology		289			13	Describe states included in this region.	The authors are adhering to the use of regions defined in Figure 1 of the Report.

First Name	Last Name	Comment Type	Chapter	Figure/Table No.	Start Page	End Page	Start Line	End Line	Comment	Response
Astrid	Caldas	Text Region	Chapter 08: Droughts, Floods, and Hydrology		289	289	24	24	This section should be significantly improved by drawing on a larger, more representative sample of the scientific literature. The weak conclusions are not supported by the literature, which actually shows a strong connection between human caused climate change and the increasing risk of western wildfires, and a lengthening of the western wildfires season. Some suggestions for additional citations: Dennison, P.E., S.C. Brewer, J.D. Arnold, and M.A. Moritz. 2014. Large wildfire trends in the western United States, 1984-2011. <i>Geophysical Research Letters</i> 41:2928-2933. doi:10.1002/2014GL059576. Brian J. Harvey. 2016. Human-caused climate change is now a key driver of forest fire activity in the western United States. <i>PNAS</i> 2016.113 (42) 11649 - 11650 ; published ahead of print October 10, 2016, doi:10.1073/pnas.1612926113 Liang, Shuang; Hurteau, Matthew; Westerling, Anthony L. 2016. Response of Sierra Nevada forests to projected climate-wildfire interactions. <i>Global Change Biology</i> . Early view version: Accepted manuscript published online November 1, 2016. Westerling A.L., H.G. Hidalgo, D.R. Cayan, and T.W. Swetnam. 2006. Warming and earlier spring increase western U.S. forest wildfire activity. <i>Science</i> 313:940-943. Online at http://www.sciencemag.org/content/313/5789/940.full . A. LeRoy Westerling, Timothy J. Brown, Tania Schoennagel, Thomas W. Swetnam, Monica G. Turner, and Thomas T. Veblen. 2016. Climate and Wildfire in Western US Forests. Chapter 3 in <i>Forest Conservation in the Anthropocene: Science, Policy, and Practice</i> . Edited by V. Alaric Sample, R. Patrick Bixler, and Char Miller. University Press of Colorado. August, 2016. pp 43 - 56. Adam M. Young et al. Climatic thresholds shape northern high-latitude fire regimes and imply vulnerability to future climate change. <i>Ecography</i> (2016). DOI: 10.1111/ecog.02205	Thank you for this comment and the useful list of references. The authors have extensively rewritten this section and cited all of these references except Westerling et 2016 due to lack of availability to us. The authors have also added figure 8.4 about Western US fire trends. The team has restated the assessment statements but probably not as strongly as the commentator would desire. The authors feel that a formal detection and attribution analysis incorporating consideration of internal variability has not been performed since Gillett et al (2004). For this reason, the likelihood and confidence statements are less than they might be with a formal D&A study. The new assessment statements and rationale are: "We conclude that there is medium confidence for a human-caused climate change contribution to increased forest fire activity in Alaska in recent decades with a likely further increase as the climate continues to warm, and low to medium confidence for a detectable human climate change contribution in the western United States based on existing studies. Recent literature does not contain a complete detection and attribution analysis of forest fires including estimates of natural decadal and multi-decadal variability as described in chapter 3. These assessment statements about attribution to human induced climate are instead based on a plausible anthropogenic contribution to observed trends based on model calculations and very likely changes to relevant climate variables, principally surface air temperature, soil moisture and snow melt timing." A general projection also does not appear to have been made for the Western US (or the CONUS) and prohibits an assessment statement about future CONUS forest fire activity. Gillett NP, Weaver AJ, Zwiers FW, Flannigan MD (2004) Detecting the effect of climate change on Canadian forest fires. <i>Geophys Res Lett</i> 31(18):1-4.
Erica	Brown	Whole Page	Chapter 08: Droughts, Floods, and Hydrology		289				This section appears to accurately describe how the studies cited demonstrate (or do not demonstrate) a human-caused climate change contribution to wildfires, yet the only studies mentioned are ones that suggested a human correlation. Are there any studies that found that human caused climate change had not increased the risk of severe seasons?	After considering all the comments about the fire section, the authors have merged it with the discussion of Arctic wildfire and rewritten it with a more complete review of the literature and have revisited the assessment statement. See the response to comment #133270 for the details. We do note that attribution is incomplete in this field. However, our assessment is that the significant increase in forest fire activity since 1980 is due to anthropogenic warming with "medium" confidence in Alaska and "low to medium" confidence in the Western US. This is based in part on the timing of the increase in fire activity which is not coincident with changes in fire management policies. If a full analysis of natural variability were to be in agreement with the existing literature, confidence and likelihood statements would be stronger. The authors have significantly modified the attribution statement about fire. See the response to comment #133270. The authors have also added a strong statement about future fire risk. Regarding bark beetles, the authors note this statement from the commentary by Harvey (2016). "For example, outbreaks of native bark beetles (which are also triggered by warm/dry climate conditions) are routinely blamed for many recent forest fires, although scientific evidence has found weak to nonexistent links between beetle outbreaks and subsequent fire occurrence, area burned and burn severity." The team leaves further details to the appropriate NCA4 authors.
Harold	Tattershall	Text Region	Chapter 08: Droughts, Floods, and Hydrology		290	290	2	5	We conclude that there is medium confidence for a human-caused climate change contribution to increased forest fire activity in Alaska in recent decades, but low confidence for a detectable human climate change contribution in the western United States based on existing studies. There is no mention in this section about the spread of Bark Beetles and the associated consequences. In other sections it has been made very clear that temperatures are more than likely to increase disproportionately in northern latitudes which in effect will reduce the natural barrier, i.e., sustained freezing temperatures, to this insect. There is considerable evidence of the increasing damage by Bark Beetles to the Canadian Boreal Forest (this may also be true across the entire forest regions of the northern hemisphere), and as the infestation spreads, and kills trees, more and more fuel is produced for forest fires. This is a very serious issue relative to under-assessment of forward risks. The basis; if indeed the natural tree sink declines at a rate that has not been included in basic calculations used to quantify the CO2 consequences of burning more fossil fuel, then by default policies will have been considered on a flawed premise. This statement needs to be re-evaluated based on additional literature. For example: Dennison et al (2014) which points to climate change as a dominant driver of changing fire activity in the western United States. Littell et al 2009 finds that from 1977 through 2003, roughly 64 percent of the fire area burned by wildfires on public lands in the western United States can be related directly to such climate variables as temperature, precipitation, and drought. Moreover, evidence strongly indicates that the western wildfire season is lengthening, and has grown from five months on average in the 1970s to seven months today (Climate Central 2012; Westerling et al. 2006; Brown, Hall, and Westerling 2004). Steve Running and colleagues have found more large fires in the west. Please include that literature.	
Astrid	Caldas	Text Region	Chapter 08: Droughts, Floods, and Hydrology		290	290	3	5	This statement needs to be re-evaluated based on additional literature. For example: Dennison et al (2014) which points to climate change as a dominant driver of changing fire activity in the western United States. Littell et al 2009 finds that from 1977 through 2003, roughly 64 percent of the fire area burned by wildfires on public lands in the western United States can be related directly to such climate variables as temperature, precipitation, and drought. Moreover, evidence strongly indicates that the western wildfire season is lengthening, and has grown from five months on average in the 1970s to seven months today (Climate Central 2012; Westerling et al. 2006; Brown, Hall, and Westerling 2004). Steve Running and colleagues have found more large fires in the west. Please include that literature.	The authors have rewritten the forest fire section with a more complete review of the literature and have revisited the assessment statement. See the response to comment #133270 for the details.
Keya	Chatterjee	Text Region	Chapter 08: Droughts, Floods, and Hydrology		290			5	Running, S. <i>Science</i> 2006 313:927 is a commentary about the Westerling paper. The authors cite it, but it is the Westerling et al study that defines the research.	Check boxes are now eliminated.
Erica	Brown	Whole Page	Chapter 08: Droughts, Floods, and Hydrology		291				The Traceable Accounts section has check boxes to indicate the confidence level in each key finding. The boxes should be eliminated so that the reader can proceed immediately to the narrative explanation of confidence.	
Keya	Chatterjee	Text Region	Chapter 08: Droughts, Floods, and Hydrology		292			23	Link to food production.	This climate change impact topic will be covered in the appropriate chapter of NCA4.
Keya	Chatterjee	Text Region	Chapter 08: Droughts, Floods, and Hydrology		293			28	Discuss CA reliance on snow pack. Discuss food production links.	This climate change impact topic will be covered in the appropriate chapter of NCA4.
Keya	Chatterjee	Text Region	Chapter 08: Droughts, Floods, and Hydrology		294			20	Spell out states	The authors are adhering to the use of regions defined in Figure 1 of the Report.
Keya	Chatterjee	Text Region	Chapter 08: Droughts, Floods, and Hydrology		295			6	Needs a map	Space limitations prohibit another graphic.
Michael	MacCracken	Text Region	Chapter 08: Droughts, Floods, and Hydrology		295	295	7	13	For the attribution column, the framing for using the evaluation needs to be indicated (this is true for other similar tables in the report as well). That is, if a two-sigma framing is being used, this is a very strong test requirement; were a one-sigma test requirement used, then one might be able to say that the event is more likely than not being affected by human-induced climate change and give a sense of what is happening even if not as high a confidence level. For public decision-making that tends to use a framing of more likely than not or relative likelihood, it is important in this report to be conveying information in that framing as well as in the traditional scientific framing. Please make a map or graphic of this chart	The authors do not feel that the details of attribution should be repeated in chapters 6, 7, and 8. The authors have very deliberately chosen a conservative interpretation in constructing assessments about attribution of observed changes to human activities. Chapter 3 and the appendix describe the methodology and its rationale and the authors cite that chapter in the relevant attribution sections. The authors have, however, added the notion of projection without attribution to enable assessments of future changes that have not emerged from the climate noise.
Keya	Chatterjee	Table	Chapter 08: Droughts, Floods, and Hydrology	8.1	296				Please make a map or graphic of this chart	Space limitations prohibit another graphic.
Michael	MacCracken	Text Region	Chapter 08: Droughts, Floods, and Hydrology		298	298	5	5	What "nrnsos" mean? The letters do not match those of the preceding words?	This is the CMIP5 standard name for this variable. Originally included for completeness, it has been removed as jargon.
Michael	MacCracken	Text Region	Chapter 08: Droughts, Floods, and Hydrology		303	303	21	22	Why are there no references to the papers of Groisman on this topic--his work for NOAA covers a number of the topics in the chapter?	The flooding section has been extensively rewritten with a more regional perspective. The Groisman et al paper, although dated, is now cited, along with more recent regional and national literature.

First Name	Last Name	Comment Type	Chapter	Figure/Table No.	Start Page	End Page	Start Line	End Line	Comment	Response
Keely	Brooks	Whole Chapter	Chapter 08: Droughts, Floods, and Hydrology						We appreciate that the authors describe the difference in drought types (meteorologic, agricultural, and hydrological drought), and attempt to organize the science summary accordingly. However, the title of the Chapter is misleading because the chapter, (Droughts, Floods and Hydrology) for the most part, only summarizes meteorologic and agricultural drought and floods, with a short summary of wildfire appended at the end. In the subsection meant to summarize past hydrologic drought, the authors describe research related to meteorologic and agricultural drought (e.g. precipitation deficits, PDSI and soil moisture results). While there is a limited summary of projected future runoff (p. 286 line 16 -p. 287 line 11), a more in depth synthesis of the latest hydrology research (observed and projected) is needed and should be a fundamental component of this chapter.	The authors have changed the title removing the word hydrology and replacing with wildfire to be more descriptive of the chapter contents. The authors have removed the seasonal runoff projections as they are inconclusive, especially after model weighting. However, have added significantly more discussion of midwestern and western US hydrology.
Keely	Brooks	Whole Chapter	Chapter 08: Droughts, Floods, and Hydrology						Recent literature evaluating the influence of rising temperatures on streamflow and surface water supplies in the absence of changes in precipitation is noticeably absent. Given that there is far more certainty regarding rising temperatures compared to precipitation for a given location in the future, this topic should be addressed.	The revision of the snowmelt section, in response to the NAS comments, addresses the concerns stated in this comment.
Keely	Brooks	Whole Chapter	Chapter 08: Droughts, Floods, and Hydrology						The drought section (and to some degree the flood subsection) focuses heavily on human attribution component of recent droughts, rather than providing information about observed and projected droughts (meteorologic, ag, and hydro). Perhaps this summary would be more appropriate in the attribution chapter? It may be more useful to decision makers if this section focused more on paleo, observed and projected drought magnitudes and frequencies (of various types), and a discussion of the limitations in the predictive capabilities of these events.	The authors have extensively rewritten the drought and flood sections. Attention was paid to documenting that past drought and flood trends (except in the western US) have not been attributed to climate change and in some cases are at odds with the expected anthropogenic responses. In particular, the authors added the notion of "projection with attribution" in chapter 4, to be used in chapters 7 and 8.
Erica	Brown	Whole Chapter	Chapter 08: Droughts, Floods, and Hydrology						Providing historical context upon which to compare the recent major US droughts is also helpful.	Much of the historical context was already there, but the authors added the following sentences in response to a more specific NAS comment: "Drought is, of course, directly connected to seasonal precipitation totals. Figure 7.2 shows detectible observed recent changes in seasonal precipitation that are not convincingly attributable to anthropogenic climate change (Knutson et al. 2014). In fact, the increases in observed summer and fall precipitation are at odds with the projections in figure 7.6. As a consequence of this increased precipitation, drought statistics over the entire CONUS have declined (Andreadis and Lettenmaier 2006; Mo and Lettenmaier 2015). Furthermore, there is no detectible change in meteorological drought at the global scale (Sheffield et al., 2012). However, a number of individual event attribution studies suggest that if a drought occurs, anthropogenic temperature increases can exacerbate soil moisture deficits (for instance Seager et al. 2015)."
Erica	Brown	Whole Chapter	Chapter 08: Droughts, Floods, and Hydrology						It would be useful to include more observational data as the information presented appears to be primarily derived from CMIP5.	The context of this comment is unclear. The authors do discuss the observational record, as incomplete as it may be, for the topics in this chapter. For drought and floods, the spatial incompleteness of the observational literature does not make for compelling graphics. The authors have, however, added a figure with observed Western US wildfire trends.
Charlie	Luce	Whole Chapter	Chapter 08: Droughts, Floods, and Hydrology						Recent uncited work should be incorporated into this chapter as it tells a bit different of a story for the Northwest with respect to drought. Specifically, long term trends in streamflow have seen trends in annual streamflow, with the strongest trends in drought years (Luce and Holden, 2000). Further examination of these trends along with other data has attributed these changes to decline in precipitation (Luce et al., 2013). Specifically the precipitation reductions have resulted from decreased westerly windspeeds in winter over the region, and these trends in westerlies are consistent with CMIP-5 projected windspeed changes linked to a decreasing meridional temperature and pressure gradient. We further demonstrate that the observed changes are not just a result of low-frequency climate variability modes. I believe these two items are the primary components for formal attribution. Furthermore, the precipitation changes have been linked to statistically significant trends in 7Q10 (a hydrologic drought metric) as the primary source of change in hydrologic drought in NW Mountain rivers over the last 60 years (Kormos et al., 2016). This chain of connections for drought is important. It does not counter anything about how declining snowpacks are likely to further decrease drought severity in the future, but clarifies causes of existing changes and highlights an additional source of change that has not been considered. It is all from journals with rigorous peer-review. Luce, C. H., J. T. Abatzoglou, and Z. A. Holden (2013). The Missing Mountain Water: Slower Westerlies Decrease Orographic Enhancement in the Pacific Northwest USA, <i>Science</i> , 342(6164), 1360-1364, DOI: 10.1126/science.1242335. Luce, C. H., and Z. A. Holden (2009). Declining annual streamflow distributions in the Pacific Northwest United States, 1948-2006, <i>Geophys. Res. Lett.</i> , 36, L16401, doi:10.1029/2009GL039407. Kormos, P., C. Luce, S. J. Wenger, and W. R. Berghuijs (2016). Trends and Sensitivities of Low Streamflow Extremes to discharge Timing and Magnitude in Pacific Northwest Mountain Streams, <i>Water Resour. Res.</i> 52(7), 4990-5007, 10.1002/2015WR018125.	Thank you for the comment. The authors have revised the western water discussion substantially in reply to other public and NAS comments. In response to this comment, we have also added the following text: "In the Northwest U.S., long term trends in streamflow have seen declines, with the strongest trends in drought years (Luce and Holden, 2000) that are attributed to a decline in winter precipitation (Luce et al., 2013). These reductions in precipitation are linked to decreased westerly wind speeds in winter over the region. Furthermore, the trends in westerlies are consistent with CMIP-5 projected wind speed changes due to a decreasing meridional temperature and pressure gradient rather than low-frequency climate variability modes. Such precipitation changes have been a primary source of change in hydrologic drought in the Northwest over the last 60 years (Kormos et al., 2016) and are in addition to changes in snowpack properties. "
Charlie	Luce	Whole Chapter	Chapter 08: Droughts, Floods, and Hydrology						Section 8.3 should be expanded to include other drought effects on forests. The current discussion on forest fires is limited, and many may not agree with its interpretation. It would not be untoward to title a section titled "ecological drought" in parallel with meteorological, agricultural, and hydrologic drought as detailed in the first portion of the chapter. Extensive reviews of effects of drought on forests were published in 2016. Large Synthesis Document: Vose, J. M., J. S. Clark, C. H. Luce, and T. Patel-Weynand (Eds.) (2016). <i>Effects of Drought on Forests and Rangelands in the United States: A Comprehensive Science Synthesis</i> . Gen. Tech. Rep. WO-93b., 289 pp., U.S. Department of Agriculture, Forest Service, Washington Office, Washington, D.C. Some Resultant Publications in Global Change Biology: Clark, J. S., Iverson, L., Woodall, C. W., Allen, C. D., Bell, D. M., Bragg, D. C., D'Amato, A. W., Davis, F. W., Hersh, M. H., Ibanez, J., Jackson, S. T., Matthews, S., Pederson, N., Peters, M., Schwartz, M. W., Waring, K. M., Zimmermann, N. E., 2016. The impacts of increasing drought on forest dynamics, structure, and biodiversity in the United States, <i>Global Change Biology</i> , 22, 2359-2352, 10.1111/gcb.13160. Clark, J. S., Vose, J. M., Luce, C. H., 2016. Forest drought as an emerging research priority, <i>Global Change Biology</i> , 22, 2317-2317. Littell, J. S., D. L. Peterson, K. L. Riley, Y. Liu, and C. H. Luce (2016). A review of the relationships between drought and forest fire in the United States, <i>Global Change Biology</i> , 22(7), 2353-2369, 10.1111/gcb.13275. Schlesinger, W. H., Dietze, M. C., Jackson, R. B., Phillips, R. P., Rhoades, C. C., Rustad, L. E., Vose, J. M., 2016. Forest biogeochemistry in response to drought, <i>Global Change Biology</i> , 22, 2318-2328, 10.1111/gcb.13105. Some Resultant Publications in Forest Ecology and Management: Kolb, T. E., Fettig, C. J., Ayres, M. P., Bentz, B. J., Hicke, J. A., Mathiasen, R., Stewart, J. E., Weed, A. S., 2016. Observed and anticipated impacts of drought on forest insects and diseases in the United States, <i>Forest Ecology and Management</i> , 380, 321-334.	The authors have extensively rewritten the wildfire section and have merged with what was previously in chapter 10. See the reply to comment #133270. The impacts of drought on forests is better left to the appropriate NCA4 chapter.

First Name	Last Name	Comment Type	Chapter	Figure/Table No.	Start Page	End Page	Start Line	End Line	Comment	Response
Scott	Weaver	Whole Chapter	Chapter 08: Droughts, Floods, and Hydrology						The statement in Chapter 8 that the western U.S. is projected to experience chronic precipitation deficits is not entirely consistent with the projections of increased land falling atmospheric river events over the western U.S. proposed in chapter 9. Please reconcile this apparent contradiction.	The statement has been revised to "the southwestern United States may experience chronic future precipitation deficits, particularly in the spring," with "south" being the word missing that reflected our original intent. The authors refer to details in chapter 9, but our interpretation is that future storms tend to track farther north due to circulation changes. Hence the two statements are not inconsistent (with the clarification about southwest).
Michael	MacCracken	Whole Chapter	Chapter 08: Droughts, Floods, and Hydrology						I did not get the sense that the message conveyed in the text of the chapter, or even in just the findings, gave anywhere near the environmental and societal significance of the changes as in conveyed in the figures of the chapter--the chapter just seems to hide a sense of what is happening by focusing on whether there is two-sigma significance of the magnitude and seriousness of the changes and types of changes that, in a relative likelihood framing, would be described as already starting to occur. It seems to me a bit more discussion of the framing being used and what it means for coming to conclusions needs to be given.	Key findings have been restructured to more clearly state the assessment. The issue about the detection and attribution of changes in drought and flood versus confidence in projections is clarified by the new language of "projection without attribution" introduced in Chapter 4.
Michael	MacCracken	Text Region	Chapter 09: Extreme Storms		308	308	3	32	Well written set of findings. I particularly like how the changing synoptic situations and regional analyses across the US are brought into the findings instead of simply taking contiguous averages. I did not see, however, any mention in the findings of possible changes to those in the Caribbean Islands megaregion to be covered in the Assessment.	Thanks for your comment, although it's not clear that this comment was intended for the page and line numbers specified. Perhaps this was intended for another chapter's Key Findings? Still, the authors can at least partially address the comment regarding the Caribbean, and will attempt to add this regional specificity to the tropical cyclone sections.
Michael	MacCracken	Text Region	Chapter 09: Extreme Storms		309	309	19	19	Please change "certainty" to "confidence"--there can be degrees of confidence and uncertainty, but not of certainty. What is certain is certain or it is not certain.	Thank you. The authors agree that this should be modified. The team has changed the text from "This is not meant to imply that no such increases have occurred, but rather that the data are not of a high enough quality to determine this with much certainty," to "This is not meant to imply that no such increases have occurred, but rather that the data are not of a high enough quality to determine this with much confidence."
Michael	MacCracken	Text Region	Chapter 09: Extreme Storms		311	311	17	20	There should also be confidence in the finding of greater rainfall rates because the radiative forcing of increased CO2 is felt most in the upper troposphere, thus exerting a slight stabilizing tendency on the atmosphere. To overcome this, as the storm gets going it can process additional water vapor--this also becomes clear because with a constant flow of air, that the air holds more moisture will lead to more condensation, and so more rainfall and energy to drive the storm. So, getting more rainfall is a pretty robust result.	The authors agree that in addition to model consensus, the team also has a physical framework that aligns with the model projections. The authors have modified the text from "Confidence in projected global increases of intensity and tropical cyclone precipitation rates is medium and high, respectively, as there is some consistency among studies and at least a fair degree of model consensus." to "Confidence in projected global increases of intensity and tropical cyclone precipitation rates is medium and high, respectively, as there is some consistency among studies and at least a fair degree of model consensus. Confidence is further heightened, particularly for projected increases in precipitation rates, by a robust physical understanding of the processes that lead to these increases."
Michael	MacCracken	Text Region	Chapter 09: Extreme Storms		312	312	16	16	I'd suspect that those affected by Superstorm Sandy might think that this is a very theoretical distinction, in that the storm certainly packed a tremendous punch even though its hurricane category had officially fallen as it was coming onshore and the waves and storm surge it piled up while it was a hurricane out at sea. It might be helpful to add a caveat here, perhaps making clear that tropical cyclones just below hurricane wind levels can do very devastating damage. In fact, it might be that since rainfall does so much damage it might be useful to be categorizing storms in terms of the amount of rainfall they dump on land or the amount of storm surge that they create even if offshore, etc. At the least, I would think a sentence referring to tropical cyclones, precipitation and storm surge damage and the damage they can do is owed to the reader (and American public) or scientists will be seen as rather standing aloof based on quite fine distinctions.	Thank you for the comment. The authors do make this distinction clear a few lines below: "Furthermore, the 11-year absence of U.S. landfalling major hurricanes is not a particularly relevant metric in terms of coastal hazard exposure and risk. For example, Hurricanes Ike (2008), Irene (2011), and Sandy (2012), and most recently Hurricane Matthew (2016) brought severe impacts to the U.S. coast despite not making landfall in the United States as major hurricanes. In the case of Hurricane Matthew, the center came within about 40 miles of the Florida coast while Matthew was a major hurricane, which is close enough to significantly impact the coast but not close enough to break the 'drought' as it's defined." To address your comment and further emphasize this distinction, the authors have expanded that section to state "Furthermore, the 11-year absence of U.S. landfalling major hurricanes is not a particularly relevant metric in terms of coastal hazard exposure and risk. For example, Hurricanes Ike (2008), Irene (2011), and Sandy (2012), and most recently Hurricane Matthew (2016) brought severe impacts to the U.S. coast despite not making landfall in the United States as major hurricanes. In the case of Hurricane Sandy, extreme rainfall and storm surge during landfall caused extensive destruction in and around the New York City area, despite Sandy's designation as a minimal (Category 1) hurricane at the time. In the case of Hurricane Matthew, the center came within about 40 miles of the Florida coast while Matthew was a major hurricane, which is close enough to significantly impact the coast but not close enough to break the 'drought' as it's defined."
Michael	MacCracken	Text Region	Chapter 09: Extreme Storms		313	313	5	8	In that hurricanes and tropical cyclones are a means of carrying substantial amounts of energy poleward and the continents are leading the oceans in warming in response to human-induced effects, might it be that the storms are favoring taking paths over the ocean that are at least slightly cooler than potential paths over the continents (perhaps due to geopotential gradients)--or perhaps the major waves just set up to deflect storms from passing over the continents in the summer.	Thanks, this is an interesting question. The authors are fairly tightly constrained here though, in that our general purview is to assess the extant literature and form a likelihood or confidence statement about some process/phenomenon. So the authors don't have much room for speculation without specific references to cite, and will have to leave this as an interesting question for now.
Michael	MacCracken	Text Region	Chapter 09: Extreme Storms		313	313	16	16	Are there studies of changes in just ordinary thunderstorm days, by region and season? For many regions, just normal thunderstorms are responsible for a regularness in the arrival of rainfall through the summer season, etc. My impression (not confirmed in any way) is that the number of mid to late summer thunderstorms on the Atlantic coastal plain from New England to Georgia has been decreasing, not for lack of atmospheric moisture, but from weakening and even the lack of the remnants of Canadian summer cold fronts carrying their cold air up and over the Appalachian mountains. With out masses of cold dense air slipping under the warm moist air, thunderstorms just do not get started on the coastal plain and summer dryness and even drought occurs unless overwhelmed by TC induced rains. On the other hand, on the northwestern side of the Appalachians, might there be more thunderstorms as more often the warm moist Atlantic/Caribbean air is getting inland over the mountains and there are at least remnants of the cool fronts coming out of Canada to trigger thunderstorms. I think much could thus be learned by also looking at regional trends in just the number of thunderstorms occurring, or perhaps in the cumulative amount of rain from thunderstorms by region and season.	Thank you for your comment. Although the authors appreciate the value in including information on ordinary thunderstorm days, the focus of this chapter is on extreme storms, and accordingly, ordinary thunderstorms fall outside the scope of the chapter. Moreover, the credible studies in the refereed literature have focused on severe thunderstorms rather than ordinary thunderstorms.
Michael	MacCracken	Text Region	Chapter 09: Extreme Storms		313	313	28	29	Are these days spread over longer or shorter periods of the year? That is, is the tornado season getting longer or shorter as a result.	This is a valid question, which the authors in fact have addressed on line 32: "The extent of the season over which such tornado activity occurs is increasing as well!"
Keya	Chatterjee	Text Region	Chapter 09: Extreme Storms		314			31	Specify states	Here, we should be adhering to the use of regions defined in Figure 1 of the Report. We have modified "Central United States" to "Midwest and Southern Great Plains".
Keya	Chatterjee	Text Region	Chapter 09: Extreme Storms		315			4	Specify states	Here, we are adhering to the use of regions defined in Figure 1 of the Report.
Keya	Chatterjee	Text Region	Chapter 09: Extreme Storms		315			7	Specify states	Here, we are adhering to the use of regions defined in Figure 1 of the Report.
Michael	MacCracken	Text Region	Chapter 09: Extreme Storms		317	317	14	15	Is the increase in frequency spread over a number of years, or is the increased number concentrated in the few years that such situations develop. That is, due the wet years get even wetter (which seems to be happening in California this year), or is the a spreading out of such situations so that such intense drought as California has been experiencing will not be as long or prolonged?	This is an excellent question and one that deserves more study. At this point though, there has not been an examination that we are aware of that looks at the year to year variability and that would yield an answer to this question. Typically, the examination is simply over a block of time in the future and in the present and a comparison made between the total number of ARs (thus yielding a avg frequency for the period).

First Name	Last Name	Comment Type	Chapter	Figure/Table No.	Start Page	End Page	Start Line	End Line	Comment	Response
Erica	Brown	Whole Page	Chapter 09: Extreme Storms		319				The Traceable Accounts section has checkboxes to indicate the confidence level in each key finding. In some chapters, multiple boxes (two or three) have been checked for certain key findings. While this is explained in the subsequent narrative as the confidence levels in multiple factors contributing to the key finding, it is unnecessarily confusing and initially appears contradictory. The boxes should be eliminated so that the reader can proceed immediately to the narrative explanation.	Thank you for this suggestion. We agree that the boxes are not helpful in some situations and we have modified our procedures so that they can be eliminated in those cases.
Michael	MacCracken	Text Region	Chapter 09: Extreme Storms		326	326	2	7	It would be nice if there could also be a plot of the locations of tornadoes by decade to get a sense if there is a shifting in their average location. Such information could potentially be useful in planning for shelters, etc.	Thank you for your comment. Unfortunately, the authors do not know of a credible paper in the published literature that shows this for the historical tornado record. Moreover, there is no evidence in the environment-based modelling studies of significant geographical shifts in the combined hazards of hail, wind, and tornado.
Erica Scott	Brown Weaver	Whole Chapter Whole Chapter	Chapter 09: Extreme Storms Chapter 09: Extreme Storms						The draft figures are effective in illustrating the information presented. The statement in Chapter 8 that the western U.S. is projected to experience chronic precipitation deficits is not entirely consistent with the projections of increased land falling atmospheric river events over the western U.S. proposed in chapter 9. Please reconcile this apparent contradiction.	Thank you for your feedback. Thank you for this comment. The text in Chapter 8 that this comment refers to deals with "hydrological drought", which differs from "meteorological drought". This is fully described/defined in section 8.1. So in this case, there is no contradiction, but rather two distinct metrics being addressed.
Michael	MacCracken	Text Region	Chapter 10: Land Cover		337	337	24	25	This statement makes it seem as if they could generally be small, whereas this is simply not the case. There are all sorts of concerns, such as how stresses on ecosystems could cause loss of keystone species and collapse, how shifts may disrupt ecosystems, that timing of flowering could change to times when pollinators are not available, that all sorts of things could happen. It seems to me that this statement should acknowledge that there are lots of complexities, so risks could be high even if understanding now is not good enough to provide statistically significant projections of what will happen.	Thank you for your comment regarding the disruptive consequences of changes to the growing season on plant community structure and function. In previous assessment reports (e.g., NCA3) many chapters referred only to the beneficial effects of a lengthened growing season on plant growth, but neglected to consider how water and nutrient availability as well as land use/land cover change and phenological asynchrony could have detrimental effects, as you mention. The authors have added a sentence about timing mismatch between spring onset and pollinator activity with appropriate references to recent research. Our charge in this report is to describe the land cover and associated biogeochemical responses to climate change that have physical feedbacks to the climate system. Future uncertainties in terrestrial feedbacks to climate will be determined by human-caused land use/land cover change and ecosystem responses to a changing climate. By describing the observed and projected changes in frost-free period and growing season length induced by climate change, the authors expect to provide an opportunity for NCA4 to assess how those changes are impacting and will impact terrestrial ecosystem structure and function, including the potentially significant effects of interacting phenologies across plant and animal species. In this report, the authors highlight both the positive and negative consequences of growing season length on plant productivity.
Michael	MacCracken	Text Region	Chapter 10: Land Cover		337	337	31	31	At the Bornstein symposium at the 2017 AMS meeting in Seattle, his talk indicated that it was not population so much that was the cause but population density, and that this had been an important insight in the field. I'd suggest checking on this statement.	Thank you for this suggestion. It is true that not only areal extent of urban settlements, but population density as well as the associated layout of infrastructure (building height/density), aerosols and carbon cycle dynamics are important. The authors have updated the Key Finding to reflect this point. In addition, the discussion in Section 10.4 now states that the strength of the UHI effect is correlated with the spatial extent and population density of urban areas, citing Imhoff et al. (2011). The authors also indicate that Imhoff et al. (2011) concluded that impervious surface area (ISA) is a more objective estimator of extent and intensity of urbanization.
Michael	MacCracken	Text Region	Chapter 10: Land Cover		337	337	32	32	On projections into the future, given the increases in efficiency of appliances and lightbulbs and hopefully electrifying transportation, it might be that the consequences of human-release of energy might be reduced, etc. Again, the science on urban effects, apparently indicates that population density is most important.	While energy production, consumption, storage and transmission are not within the scope of this chapter or report, it is true that variable population density structures (densely settled urban, and to a lesser extent, dense peri-urban and rural community structures) have variable efficiency with regards to where and how energy and plumbing lines are planned. It is true that not only areal extent of urban settlements, but population density as well as the associated layout of infrastructure (building height/density), aerosols and carbon cycle dynamics are important. The authors have updated the Key Finding to reflect this point. In addition, the discussion in Section 10.4 now states that the strength of the UHI effect is correlated with the spatial extent and population density of urban areas, citing Imhoff et al. (2011). The authors also indicate that Imhoff et al. (2011) concluded that impervious surface area (ISA) is a more objective estimator of extent and intensity of urbanization.
Jhoset	Burgos Rodriguez	Text Region	Chapter 10: Land Cover		342	343	27	38	We appreciate the reference to drought and its relation to plant invasions and in some systems alterations in local fire regimes. More generally, it's important to note that disturbance can increase an ecosystem's susceptibility to invasion by invasive species already present in the area or by invasive species newly introduced in association with the extreme event. Flooding, storm surges, and high winds can all serve as mechanisms for the introduction and/or spread of invasive species. It's also useful to note that in some cases emergency response activities can also introduce or spread invasive species (e.g., movement of vehicles carrying invasive plant seeds, movement and disposal of infested materials). (Gutowski et al. 2008, Hellman et al. 2008, Bradley et al. 2009, Heller and Zavaleta 2009, Burgiel and Muir 2010, Diez et al. 2012) General References ANSTF and NISC Ad Hoc Working Group on Invasive Species and Climate Change. 2014. Bioinvasions in a Changing World: A Resource on Invasive Species-Climate Change Interactions for Conservation and Natural Resource Management. Washington, DC. Burgiel, S.W. and A.A. Muir. 2010. Invasive Species, Climate Change and Ecosystem-Based Adaptation: Addressing Multiple Drivers of Change. Global Invasive Species Programme, Washington, DC and Nairobi, Kenya. 55 pp. Specific References Bellard, C., W. Thuiller, B. Leroy, P. Genovesi, M. Bakkenes and F. Courchamp. 2013. Will climate change promote future invasions? Global Change Biology 19(12):3740-3748. Bradley, B.A. 2009. Regional analysis of the impacts of climate change on cheatgrass invasion shows potential risk and opportunity. Global Change Biology 15:196-209. Bradley, B.A., M. Oppenheimer and D.S. Wilcove. 2009. Climate change and plant invasions: restoration opportunities ahead? Global Change Biology, 103(6):1511-1521. Burgiel, S.W. and A.A. Muir. 2010. Invasive Species, Climate Change and Ecosystem-Based Adaptation: Addressing Multiple Drivers of Change. Global Invasive Species Programme, Washington, DC and Nairobi, Kenya. 55 pp.	Thank you for the suggestion and the many associated references. The authors have added a sentence to Section 10.2.4 stating that extreme climate events can increase the susceptibility of ecosystems to invasive plants, and we cite Diez et al. (2012) and list the three mechanisms by which invasives can become established as described in their paper. Our charge in this report is to describe the land cover and associated biogeochemical responses to climate change that have physical feedbacks to the climate system. Future uncertainties in terrestrial feedbacks to climate will be determined by human-caused land use/land cover change and ecosystem responses to a changing climate. Thus, assessing the impacts of invasive species encroachment on biodiversity and ecosystem function are outside the scope of this report, but should be addressed in NCA4.

First Name	Last Name	Comment Type	Chapter	Figure/Table No.	Start Page	End Page	Start Line	End Line	Comment	Response
Jhoset	Burgos Rodriguez	Text Region	Chapter 10: Land Cover		344	347	18	7	In the context of longer growing seasons, it is also important to note that there may be similar effects on invasive plants as well as invasive plant pests. Invasive species may shift their ranges of invasive species due to changes in temperature and precipitation. Invasive insects may be able to increase the number of reproductive cycles in a season. Additionally, milder winter temperatures may not be sufficient to suppress or kill off populations of invasive species that are susceptible to the cold. (Richardson et al. 2000, Hellman et al. 2008, Bradley 2009, Bradley et al. 2009, Bellard et al. 2013) General References ANSSTF and NISC Ad Hoc Working Group on Invasive Species and Climate Change. 2014. Bioinvasions in a Changing World: A Resource on Invasive Species-Climate Change Interactions for Conservation and Natural Resource Management. Washington, DC. Burgiel, S.W. and A.A. Muir. 2010. Invasive Species, Climate Change and Ecosystem-Based Adaptation: Addressing Multiple Drivers of Change. Global Invasive Species Programme, Washington, DC and Nairobi, Kenya. 55 pp. Specific References Bellard, C., W. Thuiller, B. Leroy, P. Genovesi, M. Bakkenes and F. Courchamp. 2013. Will climate change promote future invasions? Global Change Biology 19(12):3740-3748. Bradley, B.A. 2009. Regional analysis of the impacts of climate change on cheatgrass invasion shows potential risk and opportunity. Global Change Biology 15:196-208. Bradley, B.A., M. Oppenheimer and D.S. Wilcove. 2009. Climate change and plant invasions: restoration opportunities ahead? Global Change Biology. 103(6):1511-1521. Hellmann, J.J., J.E. Byers, B.G. Bierwagen and J.S. Dukes. 2008. Five potential consequences of climate change for invasive species. Conservation Biology 22(3):534-543. Richardson, D.M., P. Pyšek, M. Rejmánek, M.G. Barbour, F.D. Panetta, and C.J. West. 2000b. Naturalization and invasion of alien plants: Concepts and definitions. Diversity and Distributions 6:93-107.	Thank you for the suggestion and the many associated references. The authors have added mention in Section 10.3.1 of invasive plants and plant pests responses to temperature changes associated with changes in plant hardiness zones, and we cite Hellmann et al. (2008). Our change in this report is to describe the land cover and associated biogeochemical responses to climate change that have physical feedbacks to the climate system. Thus, assessing the impacts of climate change on invasive species encroachment and ecosystem function are outside the scope of this report, but should be addressed in NCA4.
Harold	Tattershall	Text Region	Chapter 10: Land Cover		347	347	26	28	Section 10.3.3: (for example, as given in proposals for Reduced Emissions from Deforestation and forest Degradation, or REDD+ (https://www.forestcarbonpartnership.org/what-is-redd) There is a mistake in the application of parentheses in this sentence which makes it difficult to read. Well written chapter with useful charts! I do not understand why there is not a major box/discussion about the death of the forests of the Northwest due to climate change and pine bark beetle. This is a huge change in which climate change is implicated and the result of which (via fires) may in turn impact back to the atmosphere and there should be a box on this or chapter subsection and there should be a figure illustrating it--the change is just so striking it cannot be ignored/deserves to be featured. I would also there should be mention of the how the changing climate has been significant enough to cause the shifting of plant zones--a figure on this could help to bring home a real connection of this issue to readers. Also, I might of missed it, but I did not see anything about the shifting conditions and how fauna may be affected birds, wildlife, etc. (including the disruption of locations along migration paths). I realize that some of this will be covered in the assessment report itself, but that climate change is causing such substantial changes could useful be included in this report as well even though this chapter has to do more with feedbacks, etc.	Thank you for the editorial suggestion. The authors have rearranged the parentheses in this sentence for clarity.
Keya Michael	Chatterjee MacCracken	Whole Chapter Whole Chapter	Chapter 10: Land Cover Chapter 10: Land Cover						Submission on behalf of Adrien C. Finzi, Boston University Thank you for preparing this report. It is an excellent start to what I believe will be an important contribution to NCA 4. Thanks to people like you, the US and its citizenry can become better informed about the effect of climate change on managed and unmanaged ecosystems. While I found many positive aspects to the report, I also believe the report needs fairly substantial revision. Below are a variety of comments that I hope will be of assistance in refining the chapter. Thanks again for your time and efforts. General Comments 1. The chapter lacks congruent structure and concrete take-home messages. The åökey findingsåö are useful but the text that follows often veers from those key findings. The text often repeats itself. Many paragraphs do not have a clear thesis sentence. 2. The report tacitly blends global-scale data with US data. If this document is to serve the US NCA the chapter needs to be far more explicit about US contributions/forcings vs. those that are globally relevant. 3. The chapter does not articulate how forcings and feedbacks vary across the countries major biomes. From deserts to forests and grasslands to the arctic tundra these effects will vary substantially. Nowhere in this chapter are these differences articulated. For example, the effect of drought in the northeastern US is very different from the effect of drought in the southwest or agricultural regions for that matter. In order to understand the national climate picture, these details need to be resolved and synthesized. 4. The report appears to consistently inflate the effect of atmospheric N deposition and rising concentrations of atmospheric CO2 on the C sink in the US. These effects are highly variable in space and time. At a minimum the text should reflect current understanding. åöve made suggestions to that end in the section on specific comments. 5. A simple conceptual figure of the chapter structure and key findings would be really helpful. Figure 1 does not achieve this goal. Specific Comments I'd suggest changing "predict" to "simulate"	Many thanks! The authors thank the reviewer for this comment. For this very reason, this chapter has been difficult to construct and assess. That is, the EFFECT of drought on NE versus NW forests are indeed, as commented, significant and significantly different. However, the scope of this chapter is to provide an assessment of the effect of changes in land cover/land use on radiative forcing and feedbacks to the climate system. The authors appreciate this comment and will be forwarding many similar comments to the NCA4 community who will be able to improve their assessment of climate impacts on regional land cover, through disturbance, migration and biological inertia.
Gyami	Shrestha	Whole Chapter	Chapter 10: Land Cover						Submission on behalf of Adrien C. Finzi, Boston University Thank you for preparing this report. It is an excellent start to what I believe will be an important contribution to NCA 4. Thanks to people like you, the US and its citizenry can become better informed about the effect of climate change on managed and unmanaged ecosystems. While I found many positive aspects to the report, I also believe the report needs fairly substantial revision. Below are a variety of comments that I hope will be of assistance in refining the chapter. Thanks again for your time and efforts. General Comments 1. The chapter lacks congruent structure and concrete take-home messages. The åökey findingsåö are useful but the text that follows often veers from those key findings. The text often repeats itself. Many paragraphs do not have a clear thesis sentence. 2. The report tacitly blends global-scale data with US data. If this document is to serve the US NCA the chapter needs to be far more explicit about US contributions/forcings vs. those that are globally relevant. 3. The chapter does not articulate how forcings and feedbacks vary across the countries major biomes. From deserts to forests and grasslands to the arctic tundra these effects will vary substantially. Nowhere in this chapter are these differences articulated. For example, the effect of drought in the northeastern US is very different from the effect of drought in the southwest or agricultural regions for that matter. In order to understand the national climate picture, these details need to be resolved and synthesized. 4. The report appears to consistently inflate the effect of atmospheric N deposition and rising concentrations of atmospheric CO2 on the C sink in the US. These effects are highly variable in space and time. At a minimum the text should reflect current understanding. åöve made suggestions to that end in the section on specific comments. 5. A simple conceptual figure of the chapter structure and key findings would be really helpful. Figure 1 does not achieve this goal. Specific Comments I'd suggest changing "predict" to "simulate"	Thank you for the encouragement and the comments, which will serve to improve this chapter and inform the development of NCA4. 1) This chapter has been significantly revised and clarified, thanks to both public and NAS comments. 2) Accounting for land cover/land use change in modeling and observational frameworks at regional or continental scales with regard to climate forcing/feedbacks requires models and observations that are scaled to those domains. At this time, the most robust literature for this assessment is derived from the global, CMIP analyses. This chapter represents advances in an assessment of the contribution of the terrestrial system to climate change. In AR5, Myhre et al. (2013) provided the first assessment that articulated land cover changes in the context of albedo, aerosols, etc. Few studies highlight the observed and/or modeled radiative forcing and/or feedbacks (as outlined in revised Key Finding #2) of land cover/land use change on the climate system. We address some modeling studies (e.g., Anav, Friedlingstein, Brovkin) that have initiated these activities, again, from either continental or global perspectives. 3) Thank you for this comment. For this very reason, this chapter has been difficult to construct and assess. That is, the EFFECT of drought on NE versus NW forests is indeed, as commented, significant. The scope, however, of this chapter is to provide an assessment of the effect of changes in land cover/land use on radiative forcing and feedbacks to the climate system. We appreciate this comment and will be forwarding many similar comments to the NCA4 community who will be able to improve their assessment of climate impacts on regional land cover. 4) This section has been significantly revised. Similarly, response to this comment is that this is inherently useful for an impact of climate change on C and N, which is out of the scope of this report. We hope to pass these messages on to NCA4, where these important biogeochemistry consequences on climate can be addressed to specific comments. See also additional responses below to specific comments. 5) The Intent of Figure 10.1 is not necessarily to provide a conceptual figure of the chapter structure or summarize the key findings. Rather, intent of Figure 10.1 is to convey the importance of changes in land cover on radiative forcing, from Key Finding 1, as noted in the revised text. Additionally, in
Michael Harold	MacCracken Tattershall	Text Region Text Region	Chapter 11: Arctic Changes Chapter 11: Arctic Changes		370 370	370 370	13 31	13 33	I'd suggest changing "predict" to "simulate" These changes in Arctic sea ice, land ice, surface temperature, and permafrost influence global climate by affecting sea level, the carbon cycle, and potentially atmospheric and oceanic circulation patterns. The changes are also altering the salinity of the North Atlantic and the Arctic Ocean. The risk associated with salinity changes in the North Atlantic is potential impacts on the AMOC; there are already two scientific papers that have identified that the AMOC is slowing. If these changes continue at some point the risk is changes in winter weather patterns for both Europe and the North East Coast of the US that could impart deleterious economic impacts. Barrow recently voted to change its name - https://www.adn.com/alaska-news/rural-alaska/2016/10/13/barrow-voters-support-name-change-to-utqiaġvik/ (Najafi et al. 2015). According to this study - are you referring to the Najafi report?	Thank you for the suggestion. The text has been revised to incorporate this suggestion. The authors agree with the reviewer that changes in North Atlantic salinity has influenced the AMOC. The text has been revised to incorporate this suggestion by including 'ocean salinity'.
Carl	Markon	Text Region	Chapter 11: Arctic Changes		371		31		Barrow recently voted to change its name - https://www.adn.com/alaska-news/rural-alaska/2016/10/13/barrow-voters-support-name-change-to-utqiaġvik/ (Najafi et al. 2015). According to this study - are you referring to the Najafi report?	Thank you for your comment, the name change of Barrow, AK to Utqiaġvik has been noted in the chapter. Thank you for your comment. This citation refers to the Najafi et al. 2015 article published in Nature climate change. Najafi, M.R., F.W. Zwiers, and N.P. Gillett, 2015: Attribution of Arctic temperature change to greenhouse-gas and aerosol influences. Nature Climate Change, 5, 246-249. http://dx.doi.org/10.1038/nclimate2524
Carl	Markon	Text Region	Chapter 11: Arctic Changes		372		7		Barrow recently voted to change its name - https://www.adn.com/alaska-news/rural-alaska/2016/10/13/barrow-voters-support-name-change-to-utqiaġvik/ (Najafi et al. 2015). According to this study - are you referring to the Najafi report?	Thank you for your comment, the name change of Barrow, AK to Utqiaġvik has been noted in the chapter. Thank you for your comment. This citation refers to the Najafi et al. 2015 article published in Nature climate change. Najafi, M.R., F.W. Zwiers, and N.P. Gillett, 2015: Attribution of Arctic temperature change to greenhouse-gas and aerosol influences. Nature Climate Change, 5, 246-249. http://dx.doi.org/10.1038/nclimate2524

First Name	Last Name	Comment Type	Chapter	Figure/Table No.	Start Page	End Page	Start Line	End Line	Comment	Response
Carl	Markon	Text Region	Chapter 11: Arctic Changes		372	372	8	9	It is virtually certain that Arctic surface temperatures will continue to increase....	The text has been revised to incorporate this suggestion and now reads 'will continue'.
Michael	MacCracken	Text Region	Chapter 11: Arctic Changes		373	373	29	29	How can this retreat of sea ice only be "very likely" instead of "extremely likely"--the statement says only that there is a contribution, not that the whole meltback is due to human activities. The next sentence says internal variability could not have done it--that is very definitive. I think the first sentence needs to say "It is extremely likely that human activities have been the primary cause of the observed reduction in the Alaska and Arctic sea ice cover since 1979." The present statement just seems far too weak.	The authors agree with the reviewer's comment and have adjusted the statement to read "extremely likely" instead of "very likely".
Michael	MacCracken	Text Region	Chapter 11: Arctic Changes		373	374	29	2	There should also be mention here of the thinning of the ice (affects climate and then also habitats for species, etc.) and the longer season with surface melt leads to greater overall thawing of the ice.	Thank you for your comment. However, this comment does not seem to fit with the specified text, discussing the anthropogenic contributions to sea ice loss. Above we have highlighted the fact that, as the reviewer comment notes, the longer melt season leads to an overall thinning of sea ice.
Harold	Tattershall	Text Region	Chapter 11: Arctic Changes		373	373	32	34	Additional sea ice loss across the Arctic is virtually certain to result in late summers very likely becoming nearly ice-free (areal extent less than 106 km2 or approximately 3.9x105 mi2) by mid-century. First, a repeat of my earlier comments made for Section 1.2.6.: The Arctic sea ice volume is a critical aspect of prospective changes that could have extremely deleterious economic and societal impacts on both the US and the rest of the world. The almost total reliance on predicting the timing of a 'blue ocean' event (or areal extent less than 106 km2 or approximately 3.9x105 mi2) by models, has the potential of severely under-assessing the associated risks leading directly to flawed essential policy decisions to minimize or avert these identifiable risks. The characteristics of ice melting can be observed in a laboratory and confirmed in the field. If an ice cube is placed in a glass of water it will melt disproportionately as a ratio of its depth to surface area. The surface area will remain relatively large, relative to the depth, until the final moments when quite suddenly the entire cube will melt. This implies that at a certain point in time there could be a rapid melt out of the remaining Arctic sea ice; one that is not considered in the models projecting for instance near or at mid-century for a 'blue ocean' event. Consider this mathematical analysis of the exponential decline of the Arctic sea volume: https://sites.google.com/site/arcticshepinguin/home/piomas/ That analysis is based on PIOMAS data: http://psc.apl.uw.edu/research/projects/arctic-sea-ice-volume-anomaly/ And, the PIOMAS data has been confirmed by data from CryoSat-2: http://neven1.typepad.com/blog/2016/04/cryosat-2-confirms-sea-ice-volume-is-low.html#more http://www.esa.int/Our_Activities/Observing_the_Earth/The_Living_Planet_Programme/Earth_Explorers/CryoSat-2/ESA_s_Ice_mission Added to this situation is that as the Arctic sea ice recedes, thereby exposing progressively more of the Arctic Ocean earlier each season, solar irradiance will progressively increase the temperature of the ocean. At the onset of winter the surface of the ocean will cool sufficiently to allow sea ice to reform but the reforming sea ice will act as thermal blanket. It thereby retains much of the added	Thank you for your comment. The authors agree with the reviewer about the risk of rapid sea ice decline in come years and the concern that climate models are not able to adequately capture observed trends. As such, the authors devoted quite a bit of text to discussing observed trends in Arctic sea ice characteristics and model projected trends. The authors also note the larger trends in sea ice volume as opposed with sea ice extent, which corroborate the physical explanation provided by the reviewer. Also, the authors do referent Jennifer Francis's work and devote an entire section of this chapter to discussing the possible implications of sea ice loss to the atmospheric circulation and extreme weather events. However, the authors are unable to insert a more detailed description into this document due to space limitations. Lastly, the authors agree that there is a significant potential for far-reaching impacts to socioeconomic systems, however discussion of these are outside of the scope of this scientific assessment and are the subject of the upcoming 4th National Climate Assessment.
Michael	MacCracken	Text Region	Chapter 11: Arctic Changes		373	373	32	32	I do not understand why there are two likelihood components of the statement. I'd suggest dropping "very likely" as simply not needed. We are virtually already there--how can there be much question on this?	The text has been revised to incorporate this suggestion and "very likely" has been removed.
Michael	MacCracken	Text Region	Chapter 11: Arctic Changes		374	374	5	5	It would be helpful to revise to say "since comprehensive records started becoming available in 1982."	The text has been revised to incorporate this suggestion adding "since comprehensive records began in 1982".
Michael	MacCracken	Text Region	Chapter 11: Arctic Changes		374	374	17	18	This needs to say something like "in at least the 1150 years for which proxy indicators have provided records."	The text has been revised to incorporate this suggestion by adding "for which proxy indicators provide records".
Michael	MacCracken	Text Region	Chapter 11: Arctic Changes		374	374	18	19	This sentence is really absurd to include if there are no indications what this is about. There is no chance sea ice is going to somehow return, etc. Given that model simulations are lagging observations may well make it so one should not rely on the results of models, but there is no reason to think that further retreat will not occur. I would suggest deleting the sentence or much more thorough explaining of the situation they raise.	Thank you for your comment. The point of this sentence was to indicate that the effect of the warming of Atlantic Ocean water entering the Arctic Ocean at depth on future trajectories of Arctic sea ice is unclear. This statement does not change expectation of significant future sea ice loss as stated in section 11.2.2.
Michael	MacCracken	Text Region	Chapter 11: Arctic Changes		374	374	29	30	It would be helpful to have presentation of metric and English units in a parallel fashion	This sentence is revised to make the two mentions of sea level rise projections in metric and english units consistent.
Michael	MacCracken	Text Region	Chapter 11: Arctic Changes		375	375	19	19	I think one has to come up with a word other than "renew". The habitat there likely arose under climatic conditions that are different than what would be faced were a fire to occur in the future, so it is generally unlikely that the same habitat would again occur, so renew is not the right word to be using.	The text has been revised to incorporate this suggestion. The phrase "that renews terrestrial habitats" has been removed.
Harold	Tattershall	Text Region	Chapter 11: Arctic Changes		376	377	13	2	There is no mention in this section of the release of carbonaceous materials (CO2 and CH4) as the land based and offshore permafrost thaws (for offshore review the SWERUS3 expeditions and their findings), and that the observed increase in the Arctic atmosphere of these gases appears to be accelerating. Additionally there are several situations occurring due to large pockets of CH4, increasingly observed as the tundra melts, which could potentially lead to vicious cycles forming and thus the identifiable risk of runaway climate change. Given what would be the consequence of runaway climate change a risk of even one percent should be unacceptable but how will policy makers even know of such a risk unless science brings it to their attention?	Thank you for your comment. The authors agree that discussion of carbon dioxide and methane release from thawing permafrost on land and under that ocean serves as a significant uncertainty to future radiative forcing. This discussion is provided in section. 11.3.3 on permafrost-carbon feedbacks.
Carl	Markon	Text Region	Chapter 11: Arctic Changes		377	377	15	16	...glaciers in Alaska are out of "balance with current climate conditions"... I am not sure just what this means.	The text has been revised to incorporate this suggestion by specifying "mass balance".
Michael	MacCracken	Text Region	Chapter 11: Arctic Changes		377	377	16	16	I would say are "rapidly losing mass"--some of the changes are really dramatic, having stood on some of the melting glaciers. Providing some additional quantitative indication if seems to me is needed (and having a photo comparison would be a good visual indicator). On line 19, the word "dramatic" is used and some sort of similar word is justified for Alaska as well..	This sentence is revised to include the word "rapidly". The authors had also included pictures of mountain glacier mass loss in Alaska to illustrate glacial mass loss. Fig. 11.4 shows photos of Muir Glacier located in southeastern Alaska taken from a Glacier Bay Photo station in (a) 1941 and (b) 2004.
Michael	MacCracken	Text Region	Chapter 11: Arctic Changes		377	377	20	20	Somewhere around here, I'd include a conversion from the Gt/year to sea level rise per decade, or something similar (so, if I did the conversion correctly--and needs to be checked, 1000 Gt/yr for a decade is about an inch per decade of sea level rise)	The text has been revised to incorporate this suggestion by adding the sea level rise equivalent in inches per decade.
Michael	MacCracken	Text Region	Chapter 11: Arctic Changes		377	377	23	26	I think it needs to be made clear that not all ice on Greenland is above sea level--the ice above sea level is generally a bit less vulnerable. But much of Greenland's ice rests below sea level and water can get in via passages through several fjords, making large portions of the ice subject to more rapid loss. As this can be an important factor, I think that it does need to be mentioned.	Thank you for your comment. The authors agree the processes that drive Greenland mass loss are important, however significant discussion of these details cannot be included in chapter 11 due to space limitations. However, chapter 12 (Sea level rise) include a thorough discussion of ice sheet processes.
Carl	Markon	Text Region	Chapter 11: Arctic Changes		378	378	4	5	Re: statement of Alaska glaciers are losing mass. I assume you mean ice mass. Wondering why no references are supplied (e.g., http://onlinelibrary.wiley.com/doi/10.1002/2015GL064349/abstract)	The authors have added the suggested reference to the chapter.
Carl	Markon	Text Region	Chapter 11: Arctic Changes		378	378	25		What are Rossby waves?	Rosby waves are covered in Chapter 5.
Michael	MacCracken	Text Region	Chapter 11: Arctic Changes		379	379	11	12	I think there needs to be clarification that this means large-scale atmospheric variability and is not referring to the natural variability of the sea ice cover.	The text has been revised to incorporate this suggestion by including the phrase "large-scale atmospheric variability".

First Name	Last Name	Comment Type	Chapter	Figure/Table No.	Start Page	End Page	Start Line	End Line	Comment	Response
Michael	MacCracken	Text Region	Chapter 11: Arctic Changes		379	379	13	13	I would suggest a very slight modification that revises this to say "sea ice loss extent alone is the". I was at the recent workshop on this and was disappointed that the studies seem to be based only on area and not also on thickness. What would really be preferable is to be investigating the amount of heat transfer that is occurring—thinner ice (and the much greater presence of leads) could well be leading to much greater heat transport without the sea ice extent changing much at all.	The text has been revised to incorporate this suggestion by including the phrase "sea ice loss alone".
Harold	Tattershall	Text Region	Chapter 11: Arctic Changes		380			18	As CH4 is more than 20 times stronger a greenhouse gas than CO2. This statement could mislead policy makers since it is founded on the 100 year GWP. AR5 specifies a range of GWP's which is probably more appropriate for policy makers since that brings attention to potential short term risks. Added to the risk profile is the limit of the OH radical so that as more CH4 becomes resident in the atmosphere, particularly the Arctic, then GWP's may alter rather considerably. It is not out of the question that Arctic based CH4 could lead directly to runaway climate change and thus it is essential that policy makers comprehend the nature of the associated risks of a continuance of widespread melting of both land based and offshore permafrost.	After consideration of this point, the authors have added additional text to specify that this statistic is the Global Warming Potential and is consistent with the Ch. 2 and Ch. 15 in the report. The authors agree with the reviewer that the risks of methane as a climate forcing must be communicated effectively. The authors consider the use of this statistic (35 times stronger than CO2) appropriate for communicating that point. Additional discussion of the global warming potential definition is given in Ch. 2.
Michael	MacCracken	Text Region	Chapter 11: Arctic Changes		381	381	3	9	My understanding is that Russian scientists are looking at this quite closely and have found significant amounts of methane bubbling up from the ocean floors. Is this literature being considered?	Thank you for your comment. This literature is being considered. Further, a recent field experiment has found that the increased release of methane from the Arctic Ocean sea floor is not reaching the atmospheres, but is impeded by ocean stratification, sea bed characteristics, and bacteria. Myhre, C. L., et al. (2016). Extensive release of methane from Arctic seabed west of Svalbard during summer 2014 does not influence the atmosphere, <i>Geophys. Res. Lett.</i> , 43, 4624-4631, doi:10.1002/2016GL068999.
Harold	Tattershall	Text Region	Chapter 11: Arctic Changes		381	381	5	7	It is likely that most of the methane hydrate deposits will remain stable for the foreseeable future (the next few thousand years). I feel that this statement is based on a complete misunderstanding of the stability zone throughout the Arctic for methane hydrates. David Archer and Gavin Schmidt in particular have made many comments relative to this situation and their basis appears to be the characteristics of the ocean stability zone, i.e., approximately at a depth 250 meters. The stability of methane hydrate throughout the Arctic is more than likely governed by the combination gas law. Thus a slight increase in temperature can result in the methane being released. Applying the combination gas law to the hydrates was enclosed in sufficient detail to be stable on the surface of the Arctic Ocean if the surface temperature was 28°F or slightly below. The above in part explains the existence, and venting of CH4, from the ESAS. Key points may want to consider adding snow cover. North American snow cover is mentioned later in chapter but there is good data on snow cover for AK and Arctic. Relationship to spring phenomenon and wildfire among others. Though this may be covered elsewhere. "Green up" LAI is another topic worth mentioning here coincident to permafrost thawing and source of negative feedback. http://www.nature.com/nclimate/journal/v6/n10/full/nclimate3056.html The most recent Arctic Report Card is now available too.	Thank you for your comment. It has been taken under advisement and the authors have decided to keep the current text. This assessment of the current status and stability of methane hydrate deposits is based upon the available body of literature. Additional, references have been added in the section to support our assessment. As with most scientific research topics, the literature is likely incomplete and requires future research to improve our understanding. While this statement is made base upon currently available literature, we hope future research, as the comments suggest, sheds light on this topic.
Michael	Kolian	Whole Chapter	Chapter 11: Arctic Changes							Thank you for your comment. The suggested references have been considered. This material is covered in chapter 10: Land Cover.
Scott	Weaver	Whole Chapter	Chapter 11: Arctic Changes						The link between Arctic climate change and its influence on mid latitude atmospheric circulation variability is potentially overstated in the CSR. The research presented at the recent US CLIVAR workshop on Arctic climate change and its influence on mid latitude weather held in Washington, DC from Feb. 3-5 2017 expressed a large amount of scientific disagreement on this linkage. This controversy is similarly supported by the literature. Please adequately express the current lack of consensus on this topic in the CSR.	Thank you for your comment. After consideration of this point, we still feel the existing text is clear and (based on the designated low to medium confidence statement) accurately expresses the lack of consensus on Arctic Mid-Latitude connections.
Michael	MacCracken	Whole Chapter	Chapter 11: Arctic Changes						What seems to me to be missing here is making a strong point at the start about how dependent the whole region is on the freezing point of water—and having warming going across this value can cause huge changes, so much more than raising temperatures by a similar amount elsewhere. There is a tremendous fragility to this area of the world and conditions are right near this value, such that a relatively modest warming has the potential to radically transform the region, and we are near that point. Thus, I would urge addition to the opening material to better explain the special vulnerability of the region and why even what might elsewhere seem like relatively small changes could, over time, completely transform the region. Basically, what is being lost is the ability for the region to really get exceptionally cold in the winter—and this loss will be critical for the region.	Thank you for your comment suggestion. The authors agree that the fragility of the Arctic region should be displayed in the chapter introduction. The text has been revised to incorporate this suggestion.
Michael	MacCracken	Text Region	Chapter 12: Sea-Level Rise		411	411	2	34	There is no mention here of salt water intrusion into coastal aquifers or up into river estuaries further impacting river supplies of water (think Delaware River, St. Lawrence River, etc.)—that this type of change is occurring needs to be mentioned.	The text has been revised to incorporate this suggestion. The authors mention that coastal intrusion into coastal aquifers as an impact.
Michael	MacCracken	Text Region	Chapter 12: Sea-Level Rise		411	411	8	8	This issue of a baseline is really important. Most of the world's major cities, at least, were founded at the edge of the ocean when its level was at its preindustrial level, so using a reference to 2000 really is not referencing to the level of their infrastructure. Yes, wetlands have been adjusting, at least to some extent, as time goes along so what the baseline for calculating the rise might be other than preindustrial, but it seems to me that, for infrastructure purposes, the baseline should be preindustrial and not updated to 2000. Consider southern Florida, its infrastructure is based on a level that goes decades back before 2000. Given the meteorological information in the report is referenced to 1901-60, I would suggest that sea level rise also be adjusted to that time period.	Thanks for this suggestion. However, by doing such would make the results in this report incommensurate with the rest of the literature. The authors already discuss sea-level change over the 20th century, and (although this report is not about impacts) localities already have to manage the sea-level change that has already occurred.
Michael	MacCracken	Text Region	Chapter 12: Sea-Level Rise		411	411	13	14	There really needs to be an additional sentence added here indicating that, almost independent of emissions scenario, the rate of rise in the next century will be roughly comparable to the upper levels being indicated for the 21st century. I think that not indicating that sea level will continue to rise would really be misleading to the public, etc. Indeed, this point should be made in each of the additional points in the chapter.	The authors have included the 22nd century extensions of the new NOAA scenarios in here and state that regardless of emissions pathway, it is extremely likely that GMSL rise will continue beyond 2100 (high confidence).
David	Hawkins	Text Region	Chapter 12: Sea-Level Rise		411	411	15	22	As stated in an earlier comment on the Key Findings in the Executive Summary, the inclusion of information on how RSL will vary along the nation's coastline is a valuable addition to this year's report. This key finding should also provide the numerical values for projected variations in RSL for the regions identified and found in NOAA's recently published Global and Regional Sea Level Rise Scenarios for the United States (January 2017). That report provides the following projections for the regions identified under the Intermediate-High scenario of GMSL (see p. 29). U.S. Northeast: 0.4-0.7 m (1.3-2.3 ft) Western Gulf of Mexico: 0.2-1.0 m (0.7-3.3 ft) Pacific Northwest: 0.2-0.3 m (0.7-1.0ft) Alaska: -1.0m-0.2 m (-3.3-0.7 ft)	The authors agree, but instead provide broad regional qualitative interpretation of the Sweet et al. (2017) interagency scenarios as to not necessarily focus on one particular scenario since that would over emphasize the scenario and the lower and higher scenario regional characteristics are not necessarily the same percentage increase/decrease relative to the global mean rise amount.
Astrid	Caldas	Text Region	Chapter 12: Sea-Level Rise		411	411	27	28	In addition to increasing in depth and frequency, tidal flooding will increase in extent (see the Union of Concerned Scientists' Encroaching Tides and The US Military on the Front Lines of Rising Seas) http://www.ucsusa.org/global_warming/impacts/effects-of-tidal-flooding-and-sea-level-rise-east-coast-gulf-of-mexico#.WH_KdPkrITI http://www.ucsusa.org/global-warming/global-warming-impacts/sea-level-rise-flooding-us-military-bases#.WH_KGfkrITI	The text has been revised to incorporate this suggestion.

First Name	Last Name	Comment Type	Chapter	Figure/Table No.	Start Page	End Page	Start Line	End Line	Comment	Response
Astrid	Caldas	Text Region	Chapter 12: Sea-Level Rise		411	411	30	30	Even without an increase in intensity, hurricanes will have a greater impact as sea level rises by flooding areas to greater depths and greater extents. This conclusion is borne out by a number of studies. See, for example, Kleinosky et al. 2007; Frazier et al. 2010; Shepard et al. 2012; Maloney and Preston 2014; and Spanger-Siegrfried et al. 2016. Links: http://link.springer.com/article/10.1007/s11069-006-0004-z http://www.sciencedirect.com/science/article/pii/S0143622810000573 http://link.springer.com/article/10.1007/s11069-011-0046-8 http://www.sciencedirect.com/science/article/pii/S2212096314000060 http://www.ucusa.org/global-warming/global-warming-impacts/sea-level-rise-flooding-us-military-bases#_WH_XGfkrTI	The authors agree and the text has been revised to more clearly articulate your comment.
Keya Michael	Chatterjee MacCracken	Text Region	Chapter 12: Sea-Level Rise		411		31		List states	The text has been revised to incorporate this suggestion.
		Text Region	Chapter 12: Sea-Level Rise		412	412	2	2	For clarity of the attribution, I'd suggest changing this to "linked to the ongoing increase in the global average temperature, and to the Arctic amplification that is occurring."	The authors have left mention to global temperature and provide additional dynamical discussion within the text.
Michael	MacCracken	Text Region	Chapter 12: Sea-Level Rise		412	412	2	9	This paragraph seems to have a very short-term outlook, giving no real sense of the commitment to future sea level rise and its impacts, which are going to inundate and force evacuation of major coastal regions over the coming century and more. Given planning horizons for trying to deal this will need to be very long, I'd suggest material needs to be added here giving a better qualitative projection of what is going to happen--inundation of southern Florida, the Mississippi River delta, the Sacramento-San-Joaquin delta and lots more.	The authors feel that this is region specific and would be better handled by the regional chapters of NCA4.
Michael	MacCracken	Text Region	Chapter 12: Sea-Level Rise		412	412	4	6	It is not just flooding during storms that is going to be occurring--there is going to be increasing inundation that creates erosion of the coastline. The word "geomorphological" needs to be explained--this report is for the benefit of the public and the Congress. In addition, there will be important impacts on to coastal aquifers, etc.	The text has been revised to incorporate this suggestion.
Astrid O'Neil	Caldas Ramsay	Text Region Whole Page	Chapter 12: Sea-Level Rise Chapter 12: Sea-Level Rise		412 412	412	29	29	May also want to cite Ezer et al. 2013 (http://onlinelibrary.wiley.com/doi/10.1002/jgrc.20091/full) I AM BARBADIAN A STUDENT OF ADVANCED GEOGRAPHY 1984/87 BARBADOS COMMUNITY COLLEGE ...MY QUESTIONS ARE: WILL THERE BE A COMPLETE SHIFT IN THE EARTH FROM THE PRESENT 65.5 DEGREES AXIS, AND HOW MUCH MORE EFFORT WILL BE MADE TO WAKEUP MANKIND FROM DENIAL TO HOPEFULLY REVERSE THIS IMMINENT PROBABILITY?THE TROPIC ZONE REGION WHERE THE WEST INDIES EAST INDIES ETC HAVE PEOPLES LIVING ON LANDS THAT ARE NOT ALL ABOVE SEA LEVEL BUT HOW MUCH WILL THIS WORK REACH OUT TO THESE PEOPLES TOO? I BELIEVE THE CHURCH CAN HELP ,FOR IF MANKIND IS CAUGHT UP WITH PETTY THINGS LIKE RACISM PREJUDICE THE MAN POWER NEEDED TO SAVE OUR HOME EARTH IS NOT THERE,THE CHURCH NEEDS TO DO MORE TO HELP HEAL THE MINDS OF THOSE WHO OBSESS BY TEACHING HIGHER MINDED VALUES OF LOVE EVERYWHERE BY CONFRONTING THE MISNOMER OF RACE WHEN IS ONLY ONE. CLIMATE CHANGE PROGRAM CLASSES OUGHT BE COMPULSORY AT PRIMARY AND SECONDARY LEVELS TOO TO DRIVE HOME AWARENESS AND RESPONSIBILITY AMONGST EVERY MEMBER OF THE HUMAN RACE EG THE DANGERS OF EG PLASTIC AND SERIOUS FEDERAL GLOBAL PENALTIES TO ANY INDUSTRY THAT USES PLASTICS TO HARM HUMAN INTERNALLY,EXTERNALLY AND BY EXTENSION THE EARTH. THE EARTH IS SPHERICAL,AND AS THE POLAR CAP IN THE ARCTIC ZONE CONTINUES TO THAW EVIDENT BY THE THAWED REGIONS IN SIBERIA ETC THINK OR USE A MODEL THE ICE ONCE LIQUID HELPS MAINTAIN THE ANGLE OF TILT AXIAL WHILE THE EARTH REVOLVES AROUND THE SUN NOW THIS BALANCING FACTOR IS RAPIDLY LESSENING AND WATER BEING VISCUOS AND INFLUENCED BY THE LAW OF LEASE RESISTANCE/GRAVITY TOO,ALSO TECTONIC FORCES EFFECTS EG CHILE EARTHQUAKE WHICH SCIENTIFIC DEDUCTION THAT THE EARTH ROTATION WAS AFFECTED,VOLCANIC ERUPTIONS LEADING TO RELEASE OF LONG SUBMERGED DANGEROUS GASES ETC PROBABLY AS IMPACTFUL TO THE OZONE LAYER AS IS THE GAS FROM THE FACCES OF COWS,AND ALSO THE COLLECTIVE WEIGHT OF THE POPULATIONS OF THE GROUPS THAT ARE MIGRATING REMINDS ME OF A FERRY OVERLOADED IT KEEPS AFLOAT UNTIL BY HUMAN ERROR EVERYONE SUDDENLY MOVES TO ONE SIDE DISPLACES THE BALANCE AND CAPSIZES.	The text has been revised to incorporate this suggestion. Thank you for your comments, but your suggestions and recommendations are outside the scope of this report.
Michael	MacCracken	Text Region	Chapter 12: Sea-Level Rise		413	413	3	7	"Tectonics" is really a bit too jargony, how about saying that coastal land can also move up and down due to earthquakes driven by the ongoing movement of the tectonic plates and perhaps give an example such as the Alaska earthquake back in the 1960s caused a major effect).	The text has been revised to incorporate this suggestion.
Astrid	Caldas	Text Region	Chapter 12: Sea-Level Rise		413	413	7	7	While Kopp 2014 uses data on these different factors, this doesn't seem the place to cite the paper.	The text has been revised to incorporate this suggestion.
Astrid	Caldas	Text Region	Chapter 12: Sea-Level Rise		413	413	10	11	Tidal cycles also cause interannual variability in sea level. The 18.6 year nodal tidal cycle and the ~8.8 year cycle of lunar perige, for example, both influence sea level on US coasts. See, for example, Haigh et al 2011 (http://onlinelibrary.wiley.com/doi/10.1029/2010JC006645/full)	The authors disagree. As noted by Haigh et al., though tidal cycles affect regional high tides (and high water probabilities), they do not affect local, regional or global mean sea level.
Michael	MacCracken	Text Region	Chapter 12: Sea-Level Rise		413	413	28	28	I think it would help the reader to not just say "past warm periods" but to add something like "through the last 100 million years" or "over the Earth's history" to make clear you are not talking about short periods, or even the Holocene Maximum which was mainly warmer in the NH--it takes global warming to do this.	The text has been revised to incorporate this suggestion.
Marcus	Sarofim	Text Region	Chapter 12: Sea-Level Rise		414	414	1	14	We note that the rate of rise is faster than any since at least 800 BCE: can we say anything about how long it has been since the absolute height of sea level has been this high?	Providing such information is not possible because the GMSL record is indeterminate to within a linear trend of ± 0.1 mm/yr.
Jay	Peterson	Text Region	Chapter 12: Sea-Level Rise		415	416	32	14	Nearly all of this text on heat uptake should be in Chapter 13, with the exception of lines 7-9 that discuss SLR.	The text has been revised to incorporate this suggestion.
Astrid	Caldas	Text Region	Chapter 12: Sea-Level Rise		416	416	9	11	Also look at and potentially cite Balmaseda et al. 2013 (https://www.researchgate.net/publication/257656435_Distinctive_climate_signals_in_reanalysis_of_global_ocean_heat_content)	Thank you for your suggestion. The authors have moved the ocean heat discussion out of our chapter and into Chapter 13. The authors have passed this reference on to Ch. 13.
Keely	Brooks	Text Region	Chapter 12: Sea-Level Rise		417	417	14	16	The statement that the highest scenario of 250 cm is "consistent" with Pfeffer 2008 is inaccurate. Pfeffer found that the upper end of SLR physically possible is 2 meters, which is significantly less than 250 cm. Adoption of 250 cm as an upper physical end of what is possible for SLR supplants Pfeffer's conclusion, as well as that of subsequent work that came to the same conclusion.	The authors have edited the discussion to better articulate. As discussed in Miller et al., 2013, this is consistent with Pfeffer et al 2008, which focused on the Greenland contribution, when combined with additional analysis in Sriver et al. 2012 (regarding thermal expansion) and Bamber & Aspinall (2013)'s expert assessment regarding Antarctica.
David	Hawkins	Table	Chapter 12: Sea-Level Rise	12.1	418				These tables, while informative, could be more user friendly for purposes of interpretation. We recommend that this information be presented in manner similar to Table 4 from NOAA Technical Report NOS CO-OPS 083, Global and Regional Sea Level Rise Scenarios for the United States (January 2017). Table 4 of that publication more succinctly summarizes the scenarios and relative probabilities of the six SLR scenarios and in an easier to understand fashion.	The authors note that former) Table 12.3 is identical to Table 4 of NOAA CO-OPS Tech Report 83 of Sweet et al. (2017).
Astrid	Caldas	Text Region	Chapter 12: Sea-Level Rise		419	419	16	19	Earlier in this section, the data are presented in the order of RCP2.6, RCP4.5, then RCP8.5. Would be good to be consistent here.	The text has been revised to incorporate this suggestion.
Astrid	Caldas	Text Region	Chapter 12: Sea-Level Rise		420	420	7	7	Change "will rise" to "will have risen"	The text has been revised to incorporate this suggestion.

First Name	Last Name	Comment Type	Chapter	Figure/Table No.	Start Page	End Page	Start Line	End Line	Comment	Response
Michael	MacCracken	Text Region	Chapter 12: Sea-Level Rise		420	420	13	18	It seems to me it needs to be pointed out that the sea level sensitivity for the time since the Last Glacial Maximum is something like 20 m per degree, and it is not at all clear that the lag time was more than 2,000 years. And if you look to warmer times in Earth history, virtually all of the ice on land was apparently gone when the global average temperature was of order 4 C above present, giving a sensitivity of something like 15 m per degree—so far above this estimate of Levermann. In that so much of the ice of Greenland and Antarctica is resting below sea level, I am surprised that the indicated sensitivity is so low—yes, if one has to transfer heat from the atmosphere to the ice can be slow (although the increased CO2 does the transfer directly, so it is much more efficient than sensible heat transport). It seems to me that, at the least, the paleo derived value needs mention—and that sea level rise rate over the 12,000 year loss of the ice sheets was of order a meter per century when the global warming rate was only 6 C/120 centuries, so 0.05 C/century, whereas the projected warming rate is of order 50 times as rapid.	The authors suggest less focus on the Last Glacial Maximum due to the very different ice configuration and now expand our discussion regarding historic/future temperature-sea level sensitivities and include a figure (historic proxy sea level, temp, CO2 of Dutton et al.)
Michael	MacCracken	Text Region	Chapter 12: Sea-Level Rise		421	421	1	1	Going to 3-figure precision in this table is just not justified—there needs to be some rounding done, or convert to meters and feet and limit to 2 figure precision at best.	The authors have rounded the significant digits accordingly.
David	Hawkins	Text Region	Chapter 12: Sea-Level Rise		421	422	3	8	As stated in an earlier comment, the inclusion of information on how RSL will vary along the nation's coastline is a valuable addition to this year's report. This key finding should also provide the numerical values for projected variations in RSL for the regions identified and found in NOAA's recently published Global and Regional Sea Level Rise Scenarios for the United States (January 2017). That report provides the following projections for the regions identified under the Intermediate-High scenario of GMSL (see p. 29). U.S. Northeast: 0.4-0.7 m (1.3-2.3 ft) Western Gulf of Mexico: 0.2-1.0 m (0.7-3.3 ft) Pacific Northwest: 0.2-0.3 m (0.7-1.0ft) Alaska: -1.0m-0.2 m (-3.3-0.7 ft)	Though the authors agree, the team prefers to provide broad regional qualitative interpretation of the Sweet et al. (2017) Interagency scenarios as to not necessarily focus on one particular scenario since that would over emphasize the scenario and the lower and higher scenario regional characteristics are not necessarily the same percentage increase/decrease relative to the global mean rise amount.
David	Hawkins	Text Region	Chapter 12: Sea-Level Rise		423	423	12	30	The information provided in this section should be summarized and provided as a Key Finding of this Chapter and in the Executive Summary. All too often the threat of sea level rise is perceived to be limited to the direct inundation that will result. Less recognition is given to the effect of sea level rise on the potential for increased flooding attributable to storms large and small. This section provides important information that should be highlighted in the key findings, namely that there will be an "8-fold increase (range of 1.1-430-fold increase) is expected by 2050 in the number of floods exceeding the elevation of the current 100-year flood," (lines 15-18) and that the number of flood warnings issued as a result of local RSL rise will increase 25-fold (lines 25-27).	Though the authors agree, the regional chapters of NCA4 might be the better avenue to examine regionally projected changes.
Astrid	Caldas	Text Region	Chapter 12: Sea-Level Rise		423	423	13	14	See also Dahl et al. 2017, submitted as a technical input to NCA (manuscript has been accepted for publication at PLOS-ONE).	The authors have added the suggested citation in our chapter assessment.
Michael	MacCracken	Text Region	Chapter 12: Sea-Level Rise		424	424	34	6	I would think this paragraph might be included earlier in the chapter, even indicating that these issue will be treated in the upcoming assessment, as thoughts came up on all of these points and more along the way to this point in the chapter.	The authors have moved it into the introduction.
Michael	MacCracken	Text Region	Chapter 12: Sea-Level Rise		426	427	28	8	I'd suggest that two figure precision here is likely not justified.	The text here accurately reflects what is reported in the referenced study.
Erica	Brown	Whole Page	Chapter 12: Sea-Level Rise		426				The Traceable Accounts section has checkboxes to indicate the confidence level in each key finding. In some chapters, multiple boxes (two or three) have been checked for certain key findings. While this is explained in the subsequent narrative as the confidence levels in multiple factors contributing to the key finding, it is unnecessarily confusing and initially appears contradictory. The boxes should be eliminated so that the reader can proceed immediately to the narrative explanation.	The text has been revised to incorporate this suggestion.
Erica	Brown	Whole Page	Chapter 12: Sea-Level Rise		426				The Traceable Accounts section in this chapter includes an area for a summary sentence or paragraph for each key finding. The sentences provided do not summarize the key findings but instead explain what data was used. Delivering these summaries would be useful for readers with non-technical backgrounds and a need to understand the conclusions. The summaries will also aid utility water resources planners in communicating the conclusions of the report to their stakeholders.	The text has been revised to some extent to incorporate this suggestion.
Erica	Brown	Text Region	Chapter 12: Sea-Level Rise		430	430	35	36	Please clarify the statement "Sea level rise projections in this report are developed by an Interagency Task Force." Is this statement relevant to the whole SLR chapter? Is it only for key finding 3 (SLR in the U.S.)? This should be clarified, and the statement should not only appear in the Key finding section, but in the text related to the relevant discussion(s) as well.	It is now clearly stated in the text that the sea level rise scenarios were developed by the Interagency Task Force (Sweet et al., 2017).
Michael	MacCracken	Figure	Chapter 12: Sea-Level Rise	Figure 12.1	434				Having the colors relating to a sea level factor cover the continents will seem a bit strange to the reader. It would help to improve the caption or change the figures so as not to unduly scare people as the land surface height changes.	The authors have edited accordingly.
Keya	Chatterjee	Whole Chapter	Chapter 12: Sea-Level Rise						Well written chapter with useful charts. Increased resolution on the Gulf South needed in maps.	The authors thank the reviewer for the helpful suggestion, which has been considered in during revisions.
Keely	Brooks	Whole Chapter	Chapter 12: Sea-Level Rise						Extensive citation and use of "emerging science" is made in this chapter, in particular DeConto et al 2016. We agree that this new research is valuable and should be considered. The context for these recommendations should also be considered: decision makers are investing today in robust planning processes based on the work of the IPCC, the NCA, and - in the case of California, Washington, and Oregon - the NRC's 2012 report on sea level rise in those states. The "emerging science" cited, though not described, in the CSSR could lead to a near doubling of the worse case scenarios using the "extreme" figures in the CSSR. The implications of such a change are profound for planning, including substantial cost for adaptation measures and the elimination of some adaptation options, including potentially many "natural infrastructure" options. We continue to advocate for best available science, and if this new work is borne out in subsequent studies, we will be the first to adopt it as such. Our point here is that we must be certain this work has risen to the "best available" standard, meets criteria described for "actionable science" and merits the kind of sea change, if you will, that will follow its adoption as such by societal leaders responding to sea level rise. We agree with the characterization of this research as "emerging science" and to this end believe the CSSR should be more clear that this work must be replicated by other scientists, methodologies improved, modeling tools broadened, and outcomes reproduced by others in order for it to be considered "actionable science." In particular, we urge greater caution be recommended to readers until additional research validates and strengthens the conclusions in DeConto regarding hydrofracturing, calving, and ice shelf collapse. We are concerned that if the conclusions of DeConto's land ice model, his GCM or RCM choices, or his assumptions about Antarctic ice are mitigated or undermined, either by his next stage of work or the work of other scientists, the "whiplash" effect on decision makers will weaken confidence in science for decision making. We urge a reconsideration of how this work is presented in the CSSR to be clearer as to its experimental, new nature. Perhaps the right place to do this is in the "traceable accounts" section, which doesn't touch on this work in any substantial way, despite the appearance of language in this chapter indicating that this work should be incorporated into planning. We would suggest at least that greater caution be exercised in explaining the new approaches used in the paper and mention that	The authors agree with the comment that the 'emerging science' should be considered and mentioned, especially in context the Extreme Scenario of the new inter-agency sea level rise scenarios (Sweet et al., 2017). This Extreme Scenario (2.5 m global sea level rise by 2100) outcome is found to be very unlikely but is a possible outcome under high emission scenarios even without incorporating the results of DeConto and Pollard (2016). We provide some additional discussion regarding the topic in the traceable accounts as recommended. In the chapter, we have attempted to make clear the rapidly evolving nature of the science of extreme SLR this century, and the correspondingly high level of uncertainty in general and specifically about the pace of Antarctic melt.

First Name	Last Name	Comment Type	Chapter	Figure/Table No.	Start Page	End Page	Start Line	End Line	Comment	Response
Keely	Brooks	Whole Chapter	Chapter 12: Sea-Level Rise						In regards to the probabilities language and tables in this chapter, we believe assigning "probabilities" to outputs of this work - particularly but not exclusively the "emerging science" presented - is highly problematic. The sea level rise chapter, directly in sections in which probabilities are presented, should be revised to include clear explanation of the difference between historical statistics-based probabilities and model-based probabilities. Without this clarification, decision makers may believe the CSSR is presenting the former, when in fact it is the latter. This distinction is particularly important in the engineering and planning community, which routinely uses probabilities in risk assessment but which will not have the experience in climate science to discern the different kind of probabilities that are presented in this chapter. Using model-based probabilities in risk assessment itself presents risk of maladaptation and therefore the consumer of this information should be given the full background and caveats regarding the nature of this information.	As it reads now, the chapter is relatively transparent that these future scenarios are subjective/Bayesian probabilities (that are contingent on a particular RCP) - and that furthermore the highest end of the probability distribution (i.e., 99.9%; 2.5 m) does not rely on the "emerging science" like DeConto and Pollard. Our usage of probabilistic terminology is consistent with current scientific practice and is consistent with the likelihood language used throughout the report and discussed in the Guide to the Report.
Allison	Crimmins	Text Region	Chapter 13: Ocean Acidification		452	452	4	35	These key findings are very well written. My only suggestion would be that you don't really need to define what a Sverdrup is in the 5th KF for the technical audience (in the text sure, but not needed in the Key Finding). However, it would be nice to have a confidence ranking for the AMOC decline, since you have ones for the acidity and oxygen levels. There is also a stray parentheses in that 5th KF.	Given approach to AMOC now - that decline is ambiguous, the authors have removed all mention of Sverdrups.
Michael	MacCracken	Text Region	Chapter 13: Ocean Acidification		452	452	12	19	It might be useful to indicate that the largest/most immediate changes due to ocean acidification are in the world's colder waters, so this would include Alaska and the Arctic; and effect is slowest in the Caribbean.	As suggested by the reviewer, a sentence has been added reiterating the latitudinal differences explained in the chapter.
Harold	Tattershall	Text Region	Chapter 13: Ocean Acidification		452	452	29	30	Under a high future scenario (RCP8.5), the AMOC is projected to decline by 6 Sverdrups (1 x 10 ⁶ m ³ /sec), global average ocean acidity is projected to increase by 100% to 150%.. There is a mistake in the parentheses in the above extraction.	The text has been revised to remove stray parentheses.
Michael	MacCracken	Text Region	Chapter 13: Ocean Acidification		452	452	29	30	It would help to give a percentage change for the change in circulation—not just the change in Sverdrups.	As suggested by the reviewer, the authors removed all mention of Sverdrups and concluded changes in circulation in percentages.
Adam	Stein	Text Region	Chapter 13: Ocean Acidification		452	452	30	30	There is a grammatical error: remove the parenthesis after "150%".	The text has been revised to remove stray parenthesis.
Marcus	Sarofim	Text Region	Chapter 13: Ocean Acidification		452	452	30	30	There is a stray parenthesis here.	The text has been revised to remove stray parenthesis.
Allison	Crimmins	Text Region	Chapter 13: Ocean Acidification		453	453	3	6	While this is a great detection statement, it is a little vague to just say "changes" that those changes will break the signal from the noise. Can you give an example or two?	The text has been revised to incorporate this suggestion. The sentence now reads "Anthropogenic perturbations to the global Earth's system have included important alterations in the nutrient composition, temperature, and circulation of the oceans." The correction has been made.
Michael	MacCracken	Text Region	Chapter 13: Ocean Acidification		453	453	3	3	Need to capitalize Earth	The correction has been made.
Allison	Crimmins	Text Region	Chapter 13: Ocean Acidification		453	453	11	11	Describe your acronyms (PDO and AMOC) here rather than on line 21	The text has been revised to incorporate this suggestion.
Nathan	Mantua	Text Region	Chapter 13: Ocean Acidification		454	454	8	10	I recommend text be added to summarize Rykaczewski et al. (2015) GRL study; as a consequence of a poleward migration of major atmospheric high-pressure cells (in CMIP5 simulations), summertime winds near poleward boundaries of climatological upwelling zones are projected to intensify, while winds near equatorward boundaries are projected to weaken.	The text has been revised to incorporate this suggestion. As suggested, the sentence now reads "The intensification is attributed to the strengthening of regional coastal winds as observations already show (Sydeaman et al. 2014a) and model projections estimate for the 21st Century (Rykaczewski et al. 2015; Wang et al. 2015).
Allison	Crimmins	Text Region	Chapter 13: Ocean Acidification		454	454	18	18	Rykaczewski, R.R., Dunne, J.P., Sydeaman, W.J., Garci_a-Reyes, M.,Black, B.A.,and Bograd, S.J.(2015). Poleward intensification of coastal upwelling in response to global warming. Geophys. Res. Lett. 42,6424-6431. doi:10.1002/2015GL064694	The authors have gathered updated 2016 values.
Jay	Peterson	Text Region	Chapter 13: Ocean Acidification		454	454	19	20	Remove the sentence "Warming in 20 tropical seas is leading to increased rates of stress in biological systems like coral reefs."	The sentence has been removed from the text.
Allison	Crimmins	Text Region	Chapter 13: Ocean Acidification		454	454	35	36	This is a biological effect that will be covered in the NCA4, not a physical science finding.	A new section has been rewritten entirely about upwelling.
Harold	Tattershall	Text Region	Chapter 13: Ocean Acidification		455	455	1	3	Maybe just "There is still much uncertainty in the direction of impact climate change will have on the strength of upwelling systems in different locations"	
									Dust transported from continental desert regions to the marine environment deposits nutrients such as iron, nitrogen and phosphorus, and trace metals that stimulate growth of phytoplankton and increase marine productivity.	Biological impacts are not the purview of the CSSR. The authors did not mean to imply that phytoplankton was untouched. The text has been revised to incorporate the impact of environmental changes to primary productivity.
									The implication of this sentence is that all is well with phytoplankton when the contrary is the reality. It is estimated that a 40% drop has occurred in the population since 1950; this has considerable interconnected implications to the marine food chain and the world's carbon cycle. https://www.scientificamerican.com/article/phytoplankton-population/	
Allison	Crimmins	Text Region	Chapter 13: Ocean Acidification		456	456	11	11	"secular"?	The word secular has been removed.
Michael	MacCracken	Text Region	Chapter 13: Ocean Acidification		456	457	36	11	I'd suggest making the general points here in the findings--that is giving some sense of relative regional influence.	As suggested by the reviewer, a sentence has been added to the findings, reiterating the latitudinal differences explained in the chapter.
Michael	MacCracken	Text Region	Chapter 13: Ocean Acidification		457	457	12	16	It would likely be useful to the reader to indicate that 66M years ago is when a very large asteroid hit the Earth in a very unique event--otherwise lots of readers will not know why this date is here.	Short description about K-T boundary added.
Marcus	Sarofim	Text Region	Chapter 13: Ocean Acidification		457	457	13	14	Given how often 66 million years is mentioned in the text, it would be useful to note that this is the K-T boundary.	The text has been revised to incorporate this suggestion. Short description about K-T boundary and sediment data/first calcifying organism added.
									Specifically for this statement, is there reason to think that CO2 concentrations may have changed as fast as present 66 million years ago? Or is it that our measurement methods aren't as good past that date?	
									And similarly, it would be useful to note why 300 million years is also an important date (e.g., my understanding is that evolution of a lignin-consuming fungus contributed to an important change in the carbon cycle at that date)	
Allison	Crimmins	Text Region	Chapter 13: Ocean Acidification		457	457	16	19	One could argue that the Pliocene is the closest analog to the present CO2 levels, though maybe you are more focused on the rate here.	Thank you for your comment. It is the rate of change (which is much higher now than any of those eras) that is the issue. Also the CO2 levels were much higher at the PETM but because the rate of change was more gradual, the saturation state of the oceans was actually higher than one would expect.
Harold	Tattershall	Text Region	Chapter 13: Ocean Acidification		457	457	23	26	However, others have argued that the PETM may have resulted from an abrupt pulse of CO2, perhaps even faster than current emission rates, albeit with a lesser total emission volume. It has also been argued that the abrupt pulse that led directly to the PETM was from methane clathrate.	The authors added a reference to Wright and Shaller which notes the potential abrupt pulse of CO2. The Zeebe paper already says that it is likely caused by Methane clathrate. As the document is meant for non-oceanographers and non-scientists alike, this information is not relevant here.

First Name	Last Name	Comment Type	Chapter	Figure/Table No.	Start Page	End Page	Start Line	End Line	Comment	Response
Jhoset	Burgos Rodriguez	Text Region	Chapter 13: Ocean Acidification		457	458	26	13	Discussions are ongoing regarding the relation between ocean acidification and invasive species. Specifically, the concern is that ecological niches could be opened where coral reefs and other species reliant on calcium carbonate shells or skeletons are lost and where non-calcareous non-native species could spread or become dominate (e.g., invasive seaweeds and grasses). (ISAC 2011, Fabricius et al. 2013, Sanford et al. 2014) General References ANSTF and NISC Ad Hoc Working Group on Invasive Species and Climate Change. 2014. Bioinvasions in a Changing World: A Resource on Invasive Species-Climate Change Interactions for Conservation and Natural Resource Management. Washington, DC. Burgiel, S.W. and A.A. Muir. 2010. Invasive Species, Climate Change and Ecosystem-Based Adaptation. Addressing Multiple Drivers of Change. Global Invasive Species Programme, Washington, DC and Nairobi, Kenya. 55 pp. Specific References Fabricius, K.E., G. Deáóath, S. Noonan and S. Uthicke. 2013. Ecological effects of ocean acidification and habitat complexity on reef-associated macroinvertebrate communities. Proceedings of the Royal Society B. 281(1775). Invasive Species Advisory Council (ISAC). 2011. Marine Bioinvasions and Climate Change. Approved by ISAC on 16 June 2011 for the National Invasive Species Council. Sanford, E., B. Gaylord, A. Hettinger, E.A. Lenz, K. Meyer and T.M. Hill. 2014. Ocean acidification increases the vulnerability of native oysters to predation by invasive snails. Proceedings of the Royal Society B. 281(1778):1471-2954	Thank you for your comment, but your suggestion is outside the scope of this report. Because the CSSR is focused on physical and chemical changes, the authors did not cover how ocean acidification might lead to the spread invasive species. This will likely be covered in the National Climate Assessment.
Michael	MacCracken	Text Region	Chapter 13: Ocean Acidification		457	457	27	27	I wonder how many people will remember the definition of pH from their high school science class. Is there a way to make this clearer to people by giving example of substances with different pH values?	A definition of ocean acidification, ocean acidity, and buffering capacity were added to the section.
Harold	Tattershall	Text Region	Chapter 13: Ocean Acidification		457	458	36	27	This undersaturation will put tremendous pressure on the diverse ecosystems that support some of the largest commercial and subsistence fisheries in the world. In conjunction with the above, and certain of the proceeding comments, why is there no mention of the potential for harvestable fish by 2048? http://news.nationalgeographic.com/news/2006/11/061102-seafood-threat.html Deoxygenation can be attributed to anthropogenic nutrient input as well as CO2 emissions. This sentence has all the appearance of science- speak for the sake of science-speak. If this statement is related to fertilizer runoff ultimately being discharged at river estuaries and the associated dead-zones that occur due almost entirely too induced hypoxia from the fertilizer runoff, then why not say so? If not then why is this subject not covered as there were 405 dead-zones in 2008; how many are now? https://www.scientificamerican.com/article/oceanic-dead-zones-spread/ Bakun's 1990 hypothesis that anthropogenic warming will enhance the land-sea temperature differential and intensify alongshore winds is not consistent with observations or CMIP5 future projections (see Rykaczewski et al 2015, GRL) Rykaczewski, R.R., Dunne, J.P., Sydeman, W.J., Garcí_a-Reyes, M., Black, B.A., and Bograd, S.J. (2015). Poleward intensification of coastal upwelling in response to global warming. Geophys. Res. Lett. 42,6424-6431. doi: 10.1002/2015GL064694	This sentence was deleted because this report is supposed to focus on the physical/ chemical changes rather than the effect these have on the biological species such as fish. Information on subsistence fisheries response to environmental changes will be incorporated into the national climate assessment.
Harold	Tattershall	Text Region	Chapter 13: Ocean Acidification		458	458	20	21	Deoxygenation can be attributed to anthropogenic nutrient input as well as CO2 emissions. This sentence has all the appearance of science- speak for the sake of science-speak. If this statement is related to fertilizer runoff ultimately being discharged at river estuaries and the associated dead-zones that occur due almost entirely too induced hypoxia from the fertilizer runoff, then why not say so? If not then why is this subject not covered as there were 405 dead-zones in 2008; how many are now? https://www.scientificamerican.com/article/oceanic-dead-zones-spread/ Bakun's 1990 hypothesis that anthropogenic warming will enhance the land-sea temperature differential and intensify alongshore winds is not consistent with observations or CMIP5 future projections (see Rykaczewski et al 2015, GRL) Rykaczewski, R.R., Dunne, J.P., Sydeman, W.J., Garcí_a-Reyes, M., Black, B.A., and Bograd, S.J. (2015). Poleward intensification of coastal upwelling in response to global warming. Geophys. Res. Lett. 42,6424-6431. doi: 10.1002/2015GL064694	The text has been revised to incorporate this suggestion. This sentence is rewritten to say: "Deoxygenation can be attributed to anthropogenic nutrient input, which can lead to the proliferation of primary production and consequently, enhanced consumption of dissolved oxygen by microbial activity."
Nathan	Mantua	Text Region	Chapter 13: Ocean Acidification		459	459	11	16	Rykaczewski, R.R., Dunne, J.P., Sydeman, W.J., Garcí_a-Reyes, M., Black, B.A., and Bograd, S.J. (2015). Poleward intensification of coastal upwelling in response to global warming. Geophys. Res. Lett. 42,6424-6431. doi: 10.1002/2015GL064694	The authors have added the suggested citation in our chapter assessment. The team has added a new section and key finding on upwelling and incorporated new reference.
Nathan	Mantua	Text Region	Chapter 13: Ocean Acidification		461	462	12	13	the statement that "most eastern boundary upwelling areas are predicted to experience intensified upwelling to 2100 [Wang et al. 2015]" is over-simplified. For a more nuanced view, see Rykaczewski et al. (2015). Rykaczewski, R.R., Dunne, J.P., Sydeman, W.J., Garcí_a-Reyes, M., Black, B.A., and Bograd, S.J. (2015). Poleward intensification of coastal upwelling in response to global warming. Geophys. Res. Lett. 42, 6424-6431. doi: 10.1002/2015GL064694	The authors have added the suggested citation in our chapter assessment. The team has added a new section and separate key finding on upwelling which incorporates updated references and downgrades confidence in upwelling changes.
Nathan	Mantua	Text Region	Chapter 13: Ocean Acidification		461	461	14	14	I would replace "notable for the western US" with "notable for the eastern Pacific Ocean"	The text has been revised to incorporate this suggestion.
Nathan	Mantua	Text Region	Chapter 13: Ocean Acidification		462	462	8	9	IPCC AR5 concluded low confidence in common trends in upwelling favorable winds. Sydeman et al 2014 summarizes studies that find increases, decreases, and no change in upwelling intensity for eastern boundary current systems. Garcia-Reyes et al. 2015 state that there is stronger agreement that significant trends of upwelling intensification are evident at higher latitude for all EBUS. However, no attribution studies have been done to demonstrate a link between observed trends and anthropogenic climate forcing, and we cannot discount the role of multi-decadal climate variability in the observed trends. Notably, the US West Coast just experienced record high SSTs in 2014, 2015, and 2016, largely as a consequence of weaker than normal wind intensity (Bond et al 2015; Zaba and Rudnick 2016; DiLorenzo and Mantua 2016). Additionally, there is an observed SST warming trend in the NE Pacific Ocean and along West Coast of North America of ~0.7C per century over 1900-2012 that is associated with long-term trends to low SLP anomalies in the NE Pacific, all of which run counter to the notion that upwelling intensified along the US West Coast in the late 20th Century (Johnstone and Mantua 2014). Based on recent literature reviews and the extraordinary regional ocean temperature anomalies from 2014-2016, I would say the evidence for intensified eastern boundary upwelling rates "low confidence" (at best). Bond, N.A., M.F. Cronin, H. Freeland, and N.J. Mantua. 2015. Causes and impacts of the 2014 warm anomaly in the NE Pacific. Geophys. Res. Letts, 42(9): 3414-3420. DOI: 10.1002/2015GL063306 Di Lorenzo, E., and N. Mantua. 2016. Multi-year persistence of the 2014/15 North Pacific marine heatwave. Nat. Climate Change, doi:10.1038/nclimate3082. Johnstone, J.A., and N.J. Mantua. Atmospheric controls on northeast Pacific temperature trends and variations, 1900-2012. Proceedings of the National Academy of Sciences. www.pnas.org/cgi/doi/10.1073/pnas.1318371111 Zaba, K. D. and D. L. Rudnick, 2016: The 2014-2015 warming anomaly in the Southern California Current System observed by underwater gliders. Geophysical Research Letters, 43, 1241-1248, doi: 10.1002/2015GL067550.	The authors have added the suggested citation in our chapter assessment. The authors have added a new section and separate key finding on upwelling which incorporates updated references and downgrades confidence in upwelling changes.
Harold	Tattershall	Text Region	Chapter 13: Ocean Acidification		466	466	5	6	Under a high future scenario (RCP8.5), the AMOC is projected to decline by 6 Sverdrups (1 x 10 ⁶ m ³ /sec), global average ocean acidity is projected to increase by 100% to 150%). A copy and paste error with the wrong parentheses in this sentence.	The text has been revised to remove stray parentheses.
Michael	MacCracken	Figure	Chapter 13: Ocean Acidification	Figure 13.3	469				The color bar seems quite strange here. Normally, green would be association with growth and the reddish tones with the absence of life--it just seems the colors are reversed if one is trying to give an impression of beneficial or not.	This figure was taken from a published paper. The authors agree that a reversed color system would have been better but did not change it.

First Name	Last Name	Comment Type	Chapter	Figure/Table No.	Start Page	End Page	Start Line	End Line	Comment	Response
John	Bruno	Whole Chapter	Chapter 13: Ocean Acidification						<p>I am a marine ecologist and I have been doing research on impacts of climate change on marine ecosystems for about 15 years. I have written or co-authored numerous synthetic reports and journal articles on this topic.</p> <p>The chapter has many strong aspects, including the very good text on ocean acidification, hypoxia, and ocean circulation. But there is very little text on ocean warming. This glaring omission is nothing short of stunning and must be rectified before the report is published and released. Moreover, I volunteer to take the lead in writing this text.</p> <p>Roughly 90% of the additional heat content being retained due to greenhouse gas emissions is going into the ocean. Ocean warming is having profound direct impacts on marine populations and ecosystems, very strong indirect effects on terrestrial ecosystems via changes in weather, rainfall, temperatures, etc., and effects on countless dimensions in human societies across America. Indeed, most of the impacts described in the report on the land result from ocean warming. Moreover, ocean warming is one of the very best documented effects of carbon emissions. Ocean warming should be a primary focus of the entire report, and at the very least the dominant theme in the "Ocean changes" chapter.</p> <p>The chapter title in the index is: 1. Ocean Changes: Warming, Stratification, Circulation, Acidification, and Deoxygenation.....452</p> <p>Yet in the online review system it's listed as "Chapter 12: Ocean Acidification" which is telling. The chapter needs to include information on ocean warming including: why the oceans are warming, trends in ocean warming broken down by region and depth, and model forecasts for warming under different RCPs. It should also include graphics supporting this text. And finally, it needs to tackle the confusion over the role of ENSO, including the 2016 El Nino, in causing both warming trends and records.</p> <p>This new information can be added without an increase in length by cutting back the text on other topics.</p> <p>There are a few sentences about ocean temperature in the oceans chapter, e.g., 7-12 on page 453: "As discussed in Chapter 12, between 1971-2010, the upper ocean (0-200 m depth) warmed by</p>	<p>As per the recommendation, more effort has been devoted to describing ocean heat content and ocean circulation, linking this chapter to broader climate system changes. The chapter now includes information on ocean warming including: why the oceans are warming, trends in ocean warming broken down by region and depth, and model forecasts for warming under different RCPs. After further literature review, text attributing ocean warming to natural cycles has been removed.</p>
Jay	Peterson	Whole Chapter	Chapter 13: Ocean Acidification						<p>Since this is a chapter on, among other things, change in ocean temperature (warming), the discussion on ocean heat absorption and temperature change should be here. Much of the discussion occurs in Chapter 12 (sea-level rise), and although warming is relevant to Sea Level Rise, one would expect to find the information in the Ocean Change: Warming, etc. chapter.</p> <p>Additionally, a figure depicting the spatial variability in ocean temperature change.....some areas warming faster than others.....would be highly relevant, and is readily available.</p> <p>May want to check the SOCC2 to see how values/language are consistent or not.</p> <p>The chapter is supposed to cover the physical and chemical aspects of climate change in the ocean, but it is imbalanced toward the chemical sector, specifically ocean acidification and deoxygenation. I recommend expanding the treatment of ocean temperature and circulation.</p>	<p>More effort has been devoted to describing ocean heat content and ocean circulation, linking this chapter to broader climate system changes. Ocean heat absorption previously in Chapter 12 has been moved to chapter 13 and additional information on sea surface temperature (SST) and ocean heat content has been added. A table with regional changes and projected changes in SST has been added. A figure depicting the spatial variability in ocean temperature change is present in Chapter on temperature changes. Additional figure on projected SST has been added to Chapter 13.</p> <p>The authors have reviewed the suggested citation in our chapter assessment.</p> <p>More effort has been devoted to describing ocean heat content and ocean circulation, linking this chapter to broader climate system changes.</p>
Allison Frank	Crimmins Schwing	Whole Chapter	Chapter 13: Ocean Acidification							
Frank	Schwing	Whole Chapter	Chapter 13: Ocean Acidification						<p>The description of ocean warming (more specifically changing ocean temperature), circulation, stratification, should be raised to the level of detail given AO. This includes treatment at the global, basin, and regional scales. What are the regional differences? Where are the greatest physical changes? What about the Arctic Ocean?</p> <p>The changes in ocean temperature have a great spectrum of impacts that should be mentioned. These include impacts of basin and regional circulation, stratification, heat content, air-sea exchanges, sea ice, cyclogenesis, etc. The current version only mentions circulation briefly, and focuses on the Atlantic.</p>	<p>More effort has been devoted to describing ocean heat content, ocean circulation and stratification, linking this chapter to broader climate system changes. The chapter now has the regional differences in physical changes and model forecasts for warming under different RCPs. Information on the Arctic Ocean is included mostly in Chapter 11:Arctic, but is now referenced in this chapter.</p> <p>More effort has been devoted to describing ocean heat content, ocean circulation and stratification, linking this chapter to broader climate system changes. The chapter now includes information on why the oceans are warming, trends in ocean warming broken down by basin, region and depth, and model forecasts for warming under different RCPs. Information on sea ice is mostly covered in Chapter 11:Arctic, but is referenced in this chapter. Cyclogenesis is covered in Chapter 1: Our Globally Changing Climate, Chapter 07: Precipitation Change in the United States, Chapter 09: Extreme Storms, and a little in Chapter 12: Sea Level Rise. Ocean circulation information has been expanded and while the focus is still on the Atlantic, changes in upwelling and stratification is covered for other regions.</p>
Frank	Schwing	Whole Chapter	Chapter 13: Ocean Acidification						<p>While I recognize this document is not to address the impacts of climate change, the chapters should at least provide some context about the changes. For example, why is AO, changes in upwelling, changes in the AMOC important, and what might they impact? What other factors should be examined in the context of the physical and chemical changes cited?</p> <p>The chapter mentions that observed changes, such as the global ocean warming trend, are a combination of (anthropogenic) global warming and natural variability. The science now has a much better understanding of these natural and human signal and their cause, which allows a more accurate and confident description and projection of physical and chemical ocean conditions, as well as better attribution.</p>	<p>Although this document only addresses the physical and chemical changes to the climate, the National Climate Assessment will address how these physical and chemical changes lead to biological effects and impacts ecosystems.</p>
Frank	Schwing	Whole Chapter	Chapter 13: Ocean Acidification						<p>Key Finding 5, and elsewhere in the document, the AMOC is projected to decline by 6 Sv. This should be put into context of the total typical transport, as well as why this is important. Does this reflect a 1% or 10% or 100% change in the basin transport? What is the natural historical variability of the AMOC on interannual and decadal scales? How does this compare to other basins and other spatial scales? What is the big deal if the transport declines by 6%, an ice age?</p> <p>The global averages tend to underrepresent the possible impacts of observed and projected changes, so addressing some regional scale trends is needed for context. For example, the Arctic is warming at a much greater rate than the global average, which will have a much greater impact on sea ice than the global trend would indicate. Surface ocean stratification has increased globally by 4% (lines 15-18), but Palacios et al. showed that stratification and heat content have increased by up to an order of magnitude greater in the productive coastal region of the western US. This would have dire ecosystem impacts relative to the global value reported here.</p> <p>Palacios DM, Bograd SJ, Mendelssohn R, Schwing FB. Long-term and seasonal trends in stratification in the California Current, 1950-1993. J Geophys Res. 2004;109:C10016.</p>	<p>The chapter has been extensively revised to include significant new material on ocean warming, ocean heat content, and ocean circulation. After further literature review, the chapter now includes confidence in the increase beyond natural cycles and updated projections for ocean heat content and ocean circulation.</p>
Frank	Schwing	Whole Chapter	Chapter 13: Ocean Acidification						<p>After more literature review, the AMOC section of the chapter has been further developed to identify the different model projections and what a potential decline in AMOC would mean for marine ecosystems and the US. Sources of interannual variability to AMOC has also been added. The authors have removed all mention of sverdrups and put projected decline in percentages.</p>	<p>The text has been revised to incorporate this suggestion. Specific regional changes in sea surface temperature has been added to the chapter, as well as discussion of regional changes in salinity and upwelling.</p>

First Name	Last Name	Comment Type	Chapter	Figure/Table No.	Start Page	End Page	Start Line	End Line	Comment	Response
Huaimin	Zhang	Whole Chapter	Chapter 13: Ocean Acidification						<p>I got the following comments via email, and will provide my input after the quote:</p> <p>-----</p> <p>" this report is supposed to provide the current science on changing climate (physical/chemical aspects) as the foundation for all the other chapters in NCA4.</p> <p>I'm a little concerned that the report doesn't seem to include much info on past or future changes in ocean temperatures affecting the US.</p> <p>Can you please give Chapter 13 "Ocean Changes: Warming, Stratification, Circulation, Acidification, and Deoxygenation" a quick review and provide short input to the drafters by the Feb 3 deadline? Or you can send me input and I can submit.</p> <p>There is a little info on ocean temps in Chapter 13 - but that refers back to only a little more info in Chapter 12 (sea level rise). "</p> <p>-----</p> <p>In response to that, I would like to point the following available datasets that could be used to assess the changes in the US coastal waters/regions/seas:</p> <ol style="list-style-type: none"> 1. Centennial scale 2x2 degree grid and monthly sea surface temperature dataset: This monthly analysis begins in January 1854 continuing to the present and includes anomalies computed with respect to a 1971-2000 monthly climatology. Website: https://www.ncdc.noaa.gov/data-access/marineocean-data/extended-reconstructed-sea-surface-temperature-ersst-v4. 2. Satellite Era (1981-Present) Daily and 0.25x0.25 degree grid sea surface temperature dataset: The NOAA 1/4° daily Optimum Interpolation Sea Surface Temperature (or daily OISST) is an analysis constructed by combining observations from different platforms (satellites, ships, buoys) on a regular global grid. A spatially complete SST map is produced by interpolating to fill in gaps. Website: https://www.ncdc.noaa.gov/oisst. 3. Satellite Era (1987-Present) 6-hourly and 0.25x0.25 degree grid sea surface wind dataset: The Blended Sea Winds dataset contains globally gridded, high-resolution ocean surface vector winds and wind stresses on a global 0.25° grid, and multiple time resolutions of six-hourly, daily, monthly, and 11-year (1995-2005) climatological monthlies. The period of record is July 9, 1987, to present. 	<p>Thank you for the suggested datasets. A table has been added that provides the US coastal regional changes to sea surface temperature as well as the projected changes.</p>
Vincent	Saba	Whole Chapter	Chapter 13: Ocean Acidification						<p>I am shocked how much information on ocean temperature is missing. U.S. waters off the northeast coast have warmed faster than the global ocean over the past 10 years (Pershing et al. 2015). Moreover, the U.S. Northeast Shelf is projected to warm 2-3 times faster than the global ocean (Saba et al. 2016). Temperature change in the ocean will likely be the first order response of many marine organisms and thus I don't understand why Chapter 13 leaves out so much literature and data.</p>	<p>The chapter has been extensively revised to include significant new material on ocean warming, ocean heat content, and ocean circulation. A large literature search was performed to include the latest information on why the oceans are warming, trends in ocean warming broken down by region and depth, and model forecasts for warming under different RCPs.</p>
Roger	Griffis	Whole Chapter	Chapter 13: Ocean Acidification						<p>Although Chapter 1 refers to extensive data on climate impacts on ocean temperatures this chapter includes almost nothing on this major and perhaps best studied impact of climate change on oceans increasing heat content and ocean warming. The Chapter appears to have been written as chapter on ocean acidification and the word "warming" added to the title in the last draft without adding any real content to reflect the rich data on ocean warming and the fact that it is perhaps the best studied and most significant impact of climate change on oceans to date.</p> <p>Additional information on climate related ocean warming and the physical impacts of warming (e.g., stratification, currents and other water movement etc) should be added and made one of the major focal points of Chapter 13 as its new title suggests. Ocean warming should be one of the key messages of Chapter 13 give the state of science on past and projected climate impacts on ocean warming. It should include information not just for global but particularly for US ocean basins and even sub regional where available.</p> <p>For example, U.S. water off the northeast coast have warmed faster than global ocean over the past 10 years (Pershing et al. 2015). Moreover, the U.S. Northeast Shelf is projected to warm 2-3 times faster than the global ocean (Saba et al. 2016). Temperature change in the ocean will likely be the first order response of many marine organisms and thus unclear why Chapter 13 leaves out so much existing literature and data. State of the art IPCC based projections of ocean warming for US ocean regions are available from NOAA web site https://www.esrl.noaa.gov/psd/ipcc/ocn/. NOAA and others have this and other information it is readily available and should be added to this Chapter.</p> <p>Chapter 13 should include similar level of content and treatment regarding ocean warming as it does for ocean acidification given the extensive data and information on ocean warming. Current treatment of past and projected ocean warming in US ocean areas is inadequate in Chapter 13 given the state of knowledge and significance of this factor.</p>	<p>More effort has been devoted to describing ocean heat content, ocean circulation and stratification, linking this chapter to broader climate system changes. The chapter now includes information on ocean warming including: why the oceans are warming, trends in ocean warming broken down by region and depth, and model forecasts for warming under different RCPs.</p>
Andrew	Pershing	Whole Chapter	Chapter 13: Ocean Acidification						<p>Ch. 13 does a nice job covering what is known about ocean acidification. This is an aspect of the global carbon problem that is unique to the oceans, and it certainly warrants a substantial investment of text. I thought the deoxygenation/stratification discussion was also interesting, I'd have thought about stratification from the point of view of phytoplankton bloom dynamics, but I hadn't considered the effect on oxygen levels at depth.</p> <p>I gather from the difference in the title between the document and the outline that the writing team was initially given the charge to cover acidification and that temperature and circulation were added after. After reading the chapter, I think that it needs to more clearly lay out the temperature trends in the ocean. The ocean's ability to store and transport heat underlies many of the climate change stories that appear earlier in the text: precipitation changes, storms, ice dynamics, ENSO, etc. as well as explaining the "hiatus." Temperature is also a first-order driver of ecosystem changes that are occurring in the ocean. Getting these trends documented in CSSR will allow the NCA chapters to move more strongly into the impacts on marine ecosystems. Finally, the treatment of circulation changes is weak. The AMOC is certainly an interesting global climate story, and it would be good to tie this more strongly to consequences for weather in the US. I would also like to see a comparable treatment of circulation changes in the Pacific and the Gulf of Mexico/Caribbean. How will the North Pacific Gyre and California current change? What will happen to the Loop Current?</p> <p>pg. 452. The oceans are an important part of the global climate system. It seems strange that they would appear so late in the report. I would've thought that a broad discussion of climate trends in the ocean (spatial pattern of temperature change, vertical distribution of heat, major climate processes like the AMOC) and the role of the ocean in natural modes like ENSO and the AMO would help support the information in the terrestrially-focused chapters. That would leave this chapter to talk about ocean-specific changes including acidification and deoxygenation.</p> <p>pg 453, L13. "Alleviated" suggests a permanent change. "Dampen" seems more appropriate to me.</p> <p>pg 453, L21-23. The reference to the impact of the ocean in other chapters proves my point that this chapter (or pieces of it) should come earlier in the document.</p> <p>pg 453, L24-27. This section seems to weave back and forth between observed and predicted</p>	<p>More effort has been devoted to describing ocean heat content, ocean circulation and stratification, linking this chapter to broader climate system changes. The chapter now includes information on ocean warming including: why the oceans are warming, trends in ocean warming broken down by region and depth, and model forecasts for warming under different RCPs. Circulation changes are now a larger portion of the oceans chapter as is ocean heat content. Although circulation changes remained focused on AMOC, changes in circulation, upwelling, and stratification are described for most regions.</p>

First Name	Last Name	Comment Type	Chapter	Figure/Table No.	Start Page	End Page	Start Line	End Line	Comment	Response
Arthur	Parsons	Whole Chapter	Chapter 13: Ocean Acidification						<p>Following some e-mail correspondence from USGCRP contributor on this chapter that recommended: "Specifically to point out the need for more information on ocean warming related to US ocean basins even to regional scale if possible. And where possible suggest where the author team might go to get that info so its as easy as possible for them to add in more info on changing ocean temps of US ocean areas"</p> <p>In a quick response due to comment deadline there are three recommendations for 13.1.1. General Section and 13.1.2 Coastal Changes:</p> <ol style="list-style-type: none"> 1. Data and figures on temperature anomalies and vertically averaged temperature anomalies that could perhaps enhance description based on the World Ocean Database and World Ocean Atlas 2013 are available at : https://www.nodc.noaa.gov/OCS/3M_HEAT_CONTENT/ 2. Additional short descriptions of regional features and trends can be found in the annual Bulletin of the American Meteorological Society (BAMS) State of the Climate issues for 2014 and 2015 within the overall Global Ocean Chapters (*2016 in preparation). Blunden, J. and D. S. Arndt, Eds., 2015: State of the Climate in 2014. Bull. Amer. Meteor. Soc., 96 (7), S1a6ñ S267. Blunden, J. and D. S. Arndt, Eds., 2016: State of the Climate in 2015. Bull. Amer. Meteor. Soc., 97 (8), S1a6ñS275, DOI:10.1175/2016BAMSstateoftheClimate.1 3. Recent article that summarizes some heat redistribution findings for the oceans may be useful: Yan, X.-H., Boyer, T., Trenberth, K., Karl, T. R., Xie, S.-P., Nieves, V., Tung, K.-K. and Roemmich, D. (2016), The global warming hiatus: Slowdown or redistribution?. Earth's Future, 4: 472a6ñ482. doi:10.1002/2016EF000417 <p>As a postscript and quick afterthought, the following paper has some regional highlights: Pinsky, M.L., Worm, B., Fogarty, M.J., Sarmiento, J.L., Levin, S.A. "Marine Taxa Track Local Climate Velocities." Science. 341.6151 (2013): 1239-1242.</p>	<p>Thank you for the suggested datasets and literature. More effort has been devoted to describing ocean heat content, ocean circulation and stratification, linking this chapter to broader climate system changes. In addition, a table has been added that provides the US coastal regional changes to sea surface temperature as well as the projected changes.</p>
Marcus	Sarofim	Text Region	Chapter 14: Mitigation		481	481	3	8	<p>I would propose a change in wording: the response in concentrations to a change in emissions is actually immediate, it is just small in proportion to the total concentration. There is a lag in temperature response to a pulse of concentration. Two ways of thinking about this are the response of the system to a pulse of emissions and to a step change in emissions. For a pulse, the maximum concentration change happens immediately, and maximum temperature change happens in a couple decades (and persists nearly indefinitely). For a step change, the concentration would keep changing nearly indefinitely, as would the temperature, because of the 20-30 percent of a CO2 perturbation that persists forever.</p> <p>One example of a potential new wording: Because of the long lifetime of CO2 perturbations in the atmosphere, and because of the inertia of the climate system which means that temperature responses lag concentration changes, the results of any given change in emissions will not be fully realized for several decades. This also means that near-term changes in climate will be largely determined by past and present greenhouse gas emissions, modified by natural variability. The flip side of this fact is that changes in concentrations accumulate over time, such that long-term changes in climate are strongly influenced by emission choices from the present day until the date in question.</p>	<p>The authors agree with the need for more clear wording in this key finding, and appreciate the commenter's suggestion. The first KF has been significantly re-drafted to reflect these comments. The first line now reads: "Warming and associated climate effects from CO2 emissions persist for decades to millennia." The latter points in this comment are better addressed with the re-drafting of the other KFs.</p>
Allison	Crimmins	Text Region	Chapter 14: Mitigation		481	481	7	7	<p>May want to ask a grammar person here, but it feels like it should "near term changes in climate will have been determined by past and present[?]" or something like that.</p>	<p>Changed "will be" determined to "are" determined.</p>
David	Hawkins	Text Region	Chapter 14: Mitigation		481	481	10	18	<p>The stated budget of 1000 GtC for CO2 for a 2°C target is incorrect.</p> <p>As stated in this report, "human activities, primarily burning fossil fuels and deforestation, have emitted more than 600 Pg or GtC into the atmosphere since pre-industrial times.a00 (p. 483, in 23-24) The global cumulative CO2 budget to keep warming levels below 2 degrees C is 790 GtC, after accounting for non-CO2 forcing (66% probability of success).[1] Therefore, only ~200 GtC of CO2 can be emitted, and under current policies, that remaining budget for the 2 degree target will be consumed as early as 2032.[2],[3] See calculation in file "CO2 budget consumption calcs.xlsx," submitted by email as part of these comments.</p> <p>[1] Intergovernmental Panel on Climate Change, 2013, Summary for Policymakers. In: Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change, Technical Summary TFE.8 at 102-103 [Stocker, T.F., D. Qin, G.-K. Plattner, M. Tignor, S.K. Allen, J. Boschung, A. Nauels, Y. Xia, V. Bex and P.M. Midgley (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.</p> <p>[2] Global energy-related CO2 emissions projections are derived from: Energy Information Administration, "International Energy Outlook (IEO) 2016," May 2016, http://www.eia.gov/outlooks/ieo/.</p> <p>[3] CO2 emissions from land use change and cement are derived from: Boden, T.A., G. Marland, and R.J. Andres. 2016. Global, Regional, and National Fossil-Fuel CO2 Emissions. Carbon Dioxide Information Analysis Center, Oak Ridge National Laboratory, U.S. Department of Energy, Oak Ridge, Tenn., U.S.A. doi 10.3334/CDIAC/00001_V2016. Cement emissions were held constant at 2015 levels (0.56 GtC/yr). Due to high variability in land use change emissions in recent years, emissions were held constant at 1 GtC/yr.</p>	<p>This has been corrected in the KF and in the chapter body. The chapter body now provides more detail about the implications of the cumulative carbon budgets when only CO2 vs. CO2+non-CO2 is considered. The KF finding now reads: "Accounting for the temperature effects of non-CO2 species, cumulative CO2 emissions are required to stay below about 800 GtC in order to provide a two-thirds likelihood of preventing 2C of warming, meaning approximately 230 GtC more could be emitted globally."</p>
Harold	Tattershall	Text Region	Chapter 14: Mitigation		481	481	12	14	<p>Given the near-linear relationship between cumulative CO2 emissions and global temperature response, cumulative emissions would likely have to stay below 1,000 GtC for a 2°C objective, leaving about 400 GtC still to be emitted globally.</p> <p>The calculation of 400 GtC is identical to that in AR5, thus used for the Paris Accord, and is questionably incorrect. The remaining a00budgeta00 for emissions is strongly influenced by "climate sensitivity" and that factor is yet to be established, however this factor appears to be increasing according to some scientists and this is an identifiable risk.</p> <p>Further there is no mention that this calculation is based on transient as opposed to the equilibrium temperature; a consideration that directly links "climate sensitivity".</p> <p>Another factor that is not mentioned is that even for RCP2.6 once zero emissions are achieved then the IPCC showed that CDR would be required for 2 centuries or more.</p>	<p>The IPCC AR5 probability of >66% that a cumulative budget of 1,000 PgC would be commensurate with 2C takes into account a range of climate sensitivities. See response above for response to similar comment.</p>
Allison	Crimmins	Text Region	Chapter 14: Mitigation		481	481	14	16	<p>Strongly recommend not using the word "objective". It would be better to talk about 2C as a "threshold" and not a policy objective, to avoid the impression this is a policy recommendation.</p>	<p>Authors are comfortable with the use of "objective" or "target" because in many cases it's a statement of fact (not judgment by the authors) that, for example, 2C is a stated objective among policymakers. "Threshold" is used in this chapter to explain when cumulative carbon budgets may be exceeded.</p>
Michael	MacCracken	Text Region	Chapter 14: Mitigation		481	481	15	18	<p>A JGR of a decade or more ago by the Livermore group made clear that using CO2 equivalent to account for other species tends to underestimate the temperature response by a noticeable amount. These dates thus look perhaps too far into the future.</p>	<p>The revisions we've undertaken in response to above comments will make the point clear that factoring in the non-CO2 effects significantly moves up the dates by which we estimate the cumulative emissions to have reached compatible limits with 2C.</p>

First Name	Last Name	Comment Type	Chapter	Figure/Table No.	Start Page	End Page	Start Line	End Line	Comment	Response
Allison	Crimmins	Text Region	Chapter 14: Mitigation		481	481	19	25	Again, strongly recommend not using the word "objective" or "goal". Rather than being policy prescriptive, this can coldly and quantitatively talk about temperature thresholds and avoid the impression that 2C is a worthy policy goal or objective.	Authors are comfortable with the use of "objective" or "target" because in many cases it's a statement of fact (not judgment by the authors) that, for example, 2C is a stated objective among policymakers. "Threshold" is used in this chapter to explain when cumulative carbon budgets may be exceeded.
Allison	Crimmins	Text Region	Chapter 14: Mitigation		481	481	26	31	As noted in my comments in the ES, I am troubled by this key finding. For one, it is not really much of a finding. Things MAY gain attention? Assessing stuff would be valuable? And you have medium confidence that something MAY happen? Overall, this key finding feels like a nothing burger (it certainly doesn't take an expert to say something may be interesting with medium confidence), and it is calling attention to geoengineering (while very obviously not saying the word geoengineering). It also makes it sound like IF and only IF we can't stay below 2C, then geoengineering will be our only answer. Why couldn't geoengineering be used regardless of the temperature? Why no mention that this could be used in conjunction with other mitigation and adaptation strategies? If anything, isn't this an emerging issue and not a key finding?	Authors agree the commenter is making a valid critique of this key finding and it has been re-worded accordingly. The use of the phrase "additional means" already implies that these technologies may be used in conjunction with other mitigation/adaptation strategies. The "may gain attention" phrase has been removed. That part now reads: "If interest in geoengineering increases with observed impacts and/or projected risks of climate change, assessing the technical feasibility, costs, risks, co-benefits and governance challenges of these additional measures, which are as-yet unproven at scale, is a necessary step before judgments about the benefits and risks of these approaches can be made with high confidence."
Allison	Crimmins	Text Region	Chapter 14: Mitigation		482	482	1	8	I would strongly recommend you rephrase the 2nd thing you cover in this chapter to make it not about answering questions about Paris; instead make it about answering questions about physical climate impacts of mitigation, using Paris and the INDCs as a hypothetical example to answer those questions. Again, you can make the questions about the timing and magnitude of different levels of mitigation and the levels of mitigation required to stay below temperature thresholds (not targets, not goals, not policy objectives). Using Paris as an example rather than the focus of the question will help this chapter avoid some heat (no pun intended) and make it more scientifically objective, less policy prescriptive. I would also drop mention of Paris in the third description of what is covered in this chapter (line 8)	The re-draft of the chapter is now much less Paris-centric. Paris is presented more as a case study embedded within a broader discussion of key climate science concepts relevant for long-term mitigation.
Keya	Chatterjee	Text Region	Chapter 14: Mitigation		482			14	-Needs a summary of state/local actions eg in carbonee	Authors think this is well beyond the scope of this chapter.
Allison	Crimmins	Text Region	Chapter 14: Mitigation		482	482	23	25	It is not clear what you mean by "individual". Individual countries? States? People? This is a bit touchy, and I'm not sure I would say individual actions are "insufficient". That implies some sort of judgement. Keep it science-y: actions below XYZ levels will not result in obvious global changes due to scale.	The general text area this is referring to has been deleted because it did not seem central to the themes of the chapter.
Allison	Crimmins	Text Region	Chapter 14: Mitigation		482	482	31	32	It is unclear what you mean by "near term" and "nearer term" or whether these two terms are one and the same? Because you use "near-term" multiple times, a definition like (between present and 2050) or something would be helpful.	"Near term" has been more specifically defined in the chapter to mean the next couple of decades.
Michael	MacCracken	Text Region	Chapter 14: Mitigation		482	482	33	33	Capitalize Earth	The copyedit has ensured that Earth is capitalized when referring to the planet, and remains lower case in all other instances.
Marcus	Sarofim	Text Region	Chapter 14: Mitigation		483	483	3	6	I think that this is poorly phrased: the rapid response of radiative forcing to changes in SLCFs isn't (at first order) the result of a short lifetime of these gases, but rather because of the strong radiative forcing per ton. The short lifetime just means that the radiative forcing change will not persist as long as for CO2 changes. Proposed wording change: SLCPs are generally substances with high radiative efficiency (warming impact per ton in the atmosphere) but much shorter lifetimes than CO2 (weeks for aerosols such as black carbon, about a dozen years for methane). The high radiative efficiency results in a strong radiative forcing (and therefore temperature) influence per ton of emissions, but the short lifetime means that the radiative forcing change will dissipate more quickly. This combination makes SLCF mitigation important for near-term climate change. Substances with lifetimes of weeks have strong regional effects (in contrast to the longer lived well-mixed gases), and SLCFs such as aerosols and methane have direct health impacts in addition to climate impacts.	Edits are made along the lines suggested by the commenter to more explicitly add the important point that these SLCFs have strong radiative efficiency.
Michael	MacCracken	Text Region	Chapter 14: Mitigation		483	483	3	3	Reference should also be made to Shindell et al. 2012 and UNAEP 2011, and even back to the report for the UN Commission on Sustainable Development done by an expert panel sponsored by Sigma Xi and the UN Foundation that made this point several years earlier.	Shindell et al. 2012 reference has been added.
Marcus	Sarofim	Text Region	Chapter 14: Mitigation		483	483	11	15	I was unable to find anything in Rogelj (2016) (even in the supplementary material) that supports the statement that "stringent near-term SLCF mitigation could potentially increase allowable CO2 budgets for avoiding warming beyond 2°CAC, by up to 25% according to Rogelj et al." Table 2 shows that increasing coverage of sectors and gases yields an impact on 2030 emissions of 0.1 to 1 GtCO2eq/yr, which is small compared to the 30-50 GtCO2eq/yr total emissions in 2030 for most of the scenarios that are consistent with 2 degrees in 2030. I see little evidence of consideration of SLCF mitigation beyond that Table (stringent or near-term or otherwise). I would want stronger support for this kind of claim: maximum allowable CO2 emissions in the 21st century are, according to Rogelj, 750-1400 GtCO2: so 25% of that is 187-350 GtC: even if non-CO2 emissions were fungible with CO2 emissions for allowable CO2 budgets (they aren't, they are good for peak shaving), I don't see how any scenario would yield 200 GtC of near-term SLCF reductions.	The draft was referring to the incorrect Rogelj et al reference. It is Rogelj et al. 2015 not 2016. The correct reference has been added: http://iopscience.iop.org/article/10.1088/1748-9326/10/7/075001/meta This study models numerous scenarios looking at very specific non-CO2 mitigation scenarios and their impacts on compatible CO2 budgets.
Allison	Crimmins	Text Region	Chapter 14: Mitigation		483	483	12	12	You can delete "it is thought" and just tell us your expert opinion having assessed the science	Authors agree with suggested edit.
Keya	Chatterjee	Text Region	Chapter 14: Mitigation		483			23	This section should cite all studies on 100% renewable future - Jacobs etc.	Authors don't understand the relevance of this comment.
Keya	Chatterjee	Text Region	Chapter 14: Mitigation		483	483	23	28	Add detail on what this means.	Authors are not clear on what suggestion this commenter is calling for.
Allison	Crimmins	Text Region	Chapter 14: Mitigation		483	483	23	34	This paragraph is good, but would benefit from a simple graphic that coincides with these numbers. This could be a very important image for this chapter, or even split the paragraph in two and make two simple figures (one GtC allowed, one timing). Also, was this an analysis done by the author team (in which case I'd advocate for a figure even stronger!) or was this someone else's findings (in which case I'd advocate for citations)? I don't understand what the "this" on line 28 is referring to (previous sentence? or first part of the sentence, in which case it could be deleted)	Authors have created a table to capture the numbers discussed in this paragraph. This paragraph has been significantly re-written to more explicitly spell out the cumulative budgets compatible with 2C and 1.5C, and how these budgets and associated timing differ when considering CO2 only vs. the addition of non-CO2. The numbers now presented are a combination of IPCC figures (budget estimates), and some simple math done by the authors using the publicly available RCP data base with historic CO2 provided by the Global Carbon Budget project.

First Name	Last Name	Comment Type	Chapter	Figure/Table No.	Start Page	End Page	Start Line	End Line	Comment	Response
Jan Ivar	Korsbakken	Text Region	Chapter 14: Mitigation		483	483	23	34	In Key Finding no. 2 (on p. 481, lines 10-18) and in Section 14.12 (p. 483, lines 23-34) it is stated that to meet the 2C or the 1.5C objective, approximately 400 GtC and 150 GtC, respectively, could still be emitted globally. Further, it is stated that this would permit approximately 40 years and 15 years, respectively, of further CO2 emissions at close to current emission levels. These figures are misleading, as they do not include the additional heating effect from emissions of non-CO2 greenhouse gas emissions or other non-CO2 climate forcers. There is no realistic scenario in which the effect of non-CO2 forcers is brought anywhere close to zero. Any "budget" for future CO2 emissions should therefore be based on a plausible scenario or range of scenarios for the magnitude of future non-CO2 forcings, as is done in most frequently cited CO2 budgets, including those of the IPCC 5th Assessment Report and the 450 Scenario of the IEA's World Energy Outlook (see, e.g., Table 2.2. on p. 64 of "Climate Change 2014 - Synthesis Report" from the IPCC 5th Assessment Report, and section 8.5.1 of the IEA World Energy Outlook 2016). They find that remaining allowable CO2 emissions for a 50% chance of limiting warming to below 2C to be approximately 300 GtC (IEA) and 250 GtC (IPCC) after adjusting for non-CO2 forcers (after subtracting emissions that have already taken place after those estimates were constructed). The estimates of the remaining number of years for emissions at current levels are especially misleading, given that they compare current CO2-only emissions to a future emissions budget which is meant to be adjusted for the effect of non-CO2 forcings. This is likely to cause readers to believe that we have more time than we actually have. Again, there is no plausible scenario under which non-CO2 forcings are so low that we can continue to emit at current levels for the number of years states in the draft report without exceeding the 2C and 1.5C limits. I would urge you either use figures that have been adjusted for a reasonable range of future non-CO2 forcers, or at the very least state very clearly and very explicitly that the numbers are actually lower due to non-CO2 effects; indicate typical non-CO2-adjusted numbers from the IPCC, IEA or others; and remove any estimate of remaining years of emissions which is not based on adjusted numbers. I realize that the existence of non-CO2 forcers and the fact that they lead to a reduction in the total	This comment and others like it have been addressed by doing a significant re-write and bringing in the numbers and associated implications of the non-CO2 effects.
David	Hawkins	Text Region	Chapter 14: Mitigation		483	483	23	34	As pointed out in our comment on page 481 of this chapter, the report incorrectly assumes the budget for a 2° target is 1000 GtC of CO2. The global cumulative CO2 budget to keep warming levels below 2 degrees C is 790 GtC, after accounting for non-CO2 forcing (66% probability of success).[1] This report errs by ignoring the impact of non-CO2 GHGs on the permissible budget for CO2. As stated in this report, anthropogenic activities, primarily burning fossil fuels and deforestation, have emitted more than 600 Pg or GtC into the atmosphere since pre-industrial times. (p. 483, ln 23-24) Therefore, only ~200 GtC of CO2 can be emitted, and under current policies, that remaining budget for the 2 degree target will be consumed as early as 2032. [2],[3] See calculation in file "CO2 budget consumption calcs.xlsx," submitted by email as part of these comments. Thus, the estimated dates for budget exhaustion in lines 27-34 are much later than what the science supports. First, assuming global CO2 emissions are immediately stabilized at just under 10 GtC is in conflict with all known projections and does not reflect reality. Global CO2 emissions are expected to grow in the near term in all published projections. In the calculation we have done in the spreadsheet file mentioned above, we have used the latest projections from the U.S. Energy Information Administration. [2] That projection includes reductions from the U.S. Clean Power Plan and estimates growth in annual energy-related CO2 emissions of approximately 1.5 GtC between now and 2030. When these projections are used together with conservative (small) estimates for cement and land-use CO2 emissions, the remaining 200 GtC 2 degree budget for CO2 is exhausted by 2032—a period of only 15 years in contrast to this report's figure of 40 years. [1] Intergovernmental Panel on Climate Change, 2013, Summary for Policymakers. In: Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change, Technical Summary TFE.8 at 102-103 [Stocker, T.F., D. Qin, G.-K. Plattner, M. Tignor, S.K. Allen, J. Boschung, A. Nauels, Y. Xia, V. Bex and P.M. Midgley (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA. [2] Global energy-related CO2 emissions projections are derived from: Energy Information Administration, "International Energy Outlook (IEO) 2016," May 2016, "Assuming future global emissions follow the RCP4.5 scenario..."	This comment and others like it have been addressed by doing a significant re-write and bringing in the numbers and associated implications of the non-CO2 effects.
Harold	Tattershall	Text Region	Chapter 14: Mitigation		483	483	29	30	The above statement is a rather massive assumption with no qualification; particularly the associated risks. There is mounting evidence that the natural tree and ocean sinks are progressively declining in their ability to absorb a portion of anthropogenic emissions. In the case of the tree sink there are fires, disease (Bark Beetles in particular) and unsuitable environments as temperatures change. In the case of the ocean sink the situation with phytoplankton is unknown but the last research paper identified a substantial decline in the overall population. The identifiable risk is that as these sinks decline then the calculations, based on an "assumption" of no change in their capacity to absorb anthropogenic emissions, are incorrect. The consequence could at a minimum be that temperature targets would be exceeded earlier than currently projected and thus that intervention could be required earlier than is being suggested.	By referring to the RCP scenarios the authors are referring to the emission assumptions not to the resultant atmospheric concentrations. We do not think there is an action item here.
Keya	Chatterjee	Text Region	Chapter 14: Mitigation		483			34	"This scale of change would require large shifts to renewable energy in the electricity sector, a shift to electrification of transportation and changes in agricultural systems." "This in turn would require large social change demanding such action."	Authors agree with the substance of the comment but we think this delves into a deeper level of mitigation – namely implementation challenges – that go beyond our focus here on underlying and supporting science.
Marcus	Sarofim	Text Region	Chapter 14: Mitigation		483	483	35	37	Strongly disagree: the concept of "cumulative CO2 emissions" is specifically a consequence of the fact that 20-30 percent of CO2 perturbations persist for thousands of years. Therefore, this concept is NEVER "generally expressed in units of net CO2-eq emissions". A rewording of the paragraph to make it more accurate would be: A range of climate forcing agents exist in addition to CO2 (Chapter 2). Most of these have much shorter lifetimes than CO2, and therefore are not amenable to the concept of "cumulative CO2" - however, future emissions of these substances can influence the cumulative carbon limit for any given target. Generally, projections find that there will be net positive forcing compared to present-day due to future concentrations of non-CO2 forcing agents. If these non-CO2 substances do increase in forcing compared to today, that will lead to a reduction in the allowable quantity of CO2-only emissions. Moreover, while the timing of non-CO2 emissions may not matter for long-term equilibrium temperatures, a peak and decline in these concentrations could lead to a peak in temperature that exceeds the long-term equilibrium.	Authors are suggesting deleting this paragraph because of additional non-CO2 material brought in in above paragraphs that now make this information here less useful.
Keya	Chatterjee	Text Region	Chapter 14: Mitigation		484	484	5	7	Very useful	No action necessary.
Michael	MacCracken	Text Region	Chapter 14: Mitigation		484	484	7	7	I'd suggest changing "for" to "from" for clarity	Change made.

First Name	Last Name	Comment Type	Chapter	Figure/Table No.	Start Page	End Page	Start Line	End Line	Comment	Response
Allison	Crimmins	Text Region	Chapter 14: Mitigation		484	484	10	10	The description of what the Paris agreement is and how it works is fine, but to keep this science-y and not a policy document, it would be best to first say you are measuring impacts of mitigation, using the Paris framework as an example (one you are not advocating for or against, but merely using as a scientific tool). Then go into all the details about the agreement, inasmuch as they relate to the scientific analysis of impacts.	Authors are changing the subtitle to address the concern by the commenter. To speak about the Paris agreement it seems the authors must give some basic facts about what the Paris agreement is. The authors do not think we are advocating any policy by providing facts about what the Paris agreement says. Still, background material on the Paris agreement has been scaled back.
Keya	Chatterjee	Text Region	Chapter 14: Mitigation		484	484	21	24	Please add detail about the process and length of time it takes for any nation to leave 3 years and 1 year wait time.	This seems to be a level of detail about the Paris agreement that is not necessary for the purpose of this chapter; and is at odds with other comments received.
Allison	Crimmins	Text Region	Chapter 14: Mitigation		485	485	3	3	You don't need to say that analyses have been undertaken. If they hadn't, you wouldn't be talking about them. Just report the results of your assessment.	Edit made to delete "Analyses have been undertaken".
Allison	Crimmins	Text Region	Chapter 14: Mitigation		485	485	9	9	Could you replace the word "important" (which imparts some judgement) with "necessary" to keep it more science-y?	Edit made.
Allison	Crimmins	Text Region	Chapter 14: Mitigation		485	486	36	7	I'm not sure you need this paragraph at all. It dips more into international policy than is really needed for the scientific assessment of impacts of mitigation, and yet doesn't say much (could be good, could be bad, eh?). Suggest cutting.	This paragraph has been deleted because it strayed into an area not central to the themes of this chapter.
Keya	Chatterjee	Text Region	Chapter 14: Mitigation		486			7	Please add detail on subnational work	Authors do not think going into this level of detail is necessary as this would expand the scope of this chapter, and is at odds with other comments received.
Allison	Crimmins	Text Region	Chapter 14: Mitigation		486	486	8	22	Somewhere in here you may want to note that the limit of 2C is by 2100. I realize you say this earlier, but could be helpful for reference again here	It is not correct that the Paris agreement's 2C objective has a timeframe associated with it.
Keya	Chatterjee	Text Region	Chapter 14: Mitigation		486	486	9	11	This should be a key finding	Points made here are now part of the chapter's key findings.
Keya	Chatterjee	Text Region	Chapter 14: Mitigation		486			22	Please add detail on the rapid near term mitigation scenarios. How much and by when in those scenarios.	Authors do not think it is necessary to add more detail about individual scenarios beyond what is already depicted in Fig. 14.3. More detail would not change the basic points being made here.
Allison	Crimmins	Text Region	Chapter 14: Mitigation		487	489	1	25	In general, I think this section is done well (though could be shortened a smidge) and deserves to be in this chapter, but I would still suggest not making it a key finding, rather title it an emerging issue. Yes, this is a challenging task. But to go from there directly to geoeengineering without mentioning other cost-effective solutions that are already available--e.g. renewable energy and energy efficiency--presents a biased view of what most experts see as promising, much-needed, technically and economically feasible solutions. There is no substitute to doing everything we can to limit GHG emissions.	Authors have largely retained the section on intervention/geoeengineering with revisions, and re-drafted the associated key finding in response to other comments received.
Astrid	Caldas	Text Region	Chapter 14: Mitigation		487	487	4	8	It also distorts the reality that a suite of solutions must be pursued to drive down emissions instead of relying on "silver bullets."	Authors insert the word "additional" to better imply that these are not intended to be substitutes for everything else. The authors do not think it's within scope of this chapter to discuss the array of other mitigation options which are well studied elsewhere. The climate intervention/geoeengineering options being discussed here raise particular climate science questions, which is why they are included in this chapter.
Allison	Crimmins	Text Region	Chapter 14: Mitigation		487	487	11	11	You are careful to say that these methods are yet untested (which is good) but on this line you say that "Both methods reduce temperature". I think to be careful you should caveat this with a "hypothetically" or "theoretically" etc. Again on line 15, you say "CDR directly addresses..." but I would recommend something like "CDR would directly address" to maintain that this is all theoretical. Line 26 "CDR has the limitation" should be "CDR would have the limitation", etc. Also on lines 13 and 14, you don't need to say someone did a report. Just present the finding of the report and cite it. On line 37 you don't have to say "studies have evaluated", just present the results and cite it.	Authors agree with these specific suggestions and have made edits accordingly. The end paragraph of this section has also been made the second paragraph of this section, which further emphasizes the uncertainties and unresolved issues associated with these approaches.
Astrid	Caldas	Text Region	Chapter 14: Mitigation		487	487	13	14	The NAS explicitly pointed out the need for, and critical importance of, appropriate governance structures (not currently in place anywhere) before embarking on widescale deployment of CI. This entire section should be appropriately caveated and include cautionary information from the literature where relevant instead of leaving it to a couple of paragraphs at the end. See also: https://royalsociety.org/~media/Royal_Society_Content/policy/publications/2009/8693.pdf http://bipartisanpolicy.org/wp-content/uploads/sites/default/files/BPC%20Climate%20Remediation%20Final%20Report.pdf	Authors agree that governance concerns are a big issue with these options but it seems beyond the scope of this science report to go into detail about these issues; authors think it is appropriate for the scope of this report to simply point out that governance is important and is taken up elsewhere. The importance of governance issues has also been brought forward to begin this section.
Keya	Chatterjee	Text Region	Chapter 14: Mitigation		487			14	Please add that CI could be combination w/ GHG reduction.	Edit made to similar comment earlier in this paragraph should address this concern.
Astrid	Caldas	Text Region	Chapter 14: Mitigation		487	487	17	18	According to the NAS: "deploying ocean iron fertilization at climatically relevant levels poses risks that outweigh potential benefits."	Authors do not disagree but at this point in the text the different options are simply being listed.
Astrid	Caldas	Text Region	Chapter 14: Mitigation		487	487	17	17	It's important to draw a distinction between these types of interventions which are likely to be less risky (or the risks are better understood) and things like ocean fertilization.	Language has been added to differentiate among the CDR methods. The revised text reads: "Potential CDR approaches include point-source CO2 capture, direct air capture, currently well-understood biological methods on land (e.g., afforestation) and less well-understood and potentially risky methods in the ocean (e.g., ocean fertilization), and accelerated weathering (e.g., forming calcium carbonate on land or in the oceans) (NAS 2015a)."
Astrid	Caldas	Text Region	Chapter 14: Mitigation		487	487	20	20	"in a cost-effective manner": In fact the NAS report on carbon dioxide removal and reliable sequestration cautions that the costs of many current proposals are likely to exceed that of reducing heat-trapping emissions through wide deployment of renewable energy sources and significant reductions in fossil fuel combustion. Also the risks posed many of these interventions are also higher.	Authors added phrase "including how these costs may compare with the costs of other, more traditional GHG mitigation options."
Astrid	Caldas	Text Region	Chapter 14: Mitigation		487	487	21	22	But despite that, the reality is that there are still very significant cost and technological hurdles to deploying it at scale. Just look at the history and current status of coal with CCS, for example. See also http://www.iea.org/publications/freepublications/publication/20YearsofCarbonCaptureandStorage_WEB.pdf	This section does point out that a major hurdle to CDR is achieving large enough scale.
Allison	Crimmins	Text Region	Chapter 14: Mitigation		487	487	22	24	"is considered"? By whom? You are the experts so just say whether it "would be" a particularly effective method or not. I'm not clear what the next sentence means.	Authors are deleting "considered".
Allison	Crimmins	Text Region	Chapter 14: Mitigation		487	487	28	28	I think this paragraph would be strengthened by first explaining what SRM is, similar to how you explained CDR and gave examples of CDR approaches at the beginning of the preceding paragraph	A general description of different possible SRM methods are described later in the paragraph.
Astrid	Caldas	Text Region	Chapter 14: Mitigation		487	487	31	32	This is actually a major RISK of this approach and should be highlighted as such.	Authors agree and have added a phrase to this effect.
Michael	MacCracken	Text Region	Chapter 14: Mitigation		488	489	32	3	I would note that there have been a number of simulations using potential SRM approaches to offset warming or other impacts in just particular regions, such as the Arctic. With aggressive emissions reductions, such approaches might well be useful in moderating the worst regional and irreversible impacts as global emissions are brought down. My recent paper (MacCracken, M. C., 2016: The rationale for accelerating regionally focused climate intervention research, Earth's Future, 4, doi:10.1002/2016EF000450) makes the argument for this time of approach. It is also likely that the governance issues associated with climate intervention would be much more reasonable to deal with than for full global climate intervention. I'd suggest that this matter of regional applications should be covered in this evaluation.	MacCracken reference added to make the point that regional interventions have been proposed.
Astrid	Caldas	Text Region	Chapter 14: Mitigation		489	489	4	5	Re: the very first sentence of this paragraph: This information shouldn't be buried at the end.	Authors make clear at the very beginning of this section that these are approaches as yet untested.

First Name	Last Name	Comment Type	Chapter	Figure/Table No.	Start Page	End Page	Start Line	End Line	Comment	Response
Michael	MacCracken	Text Region	Chapter 14: Mitigation		489	489	4	15	As to overall uncertainties associated with climate intervention, the various approaches use techniques with analogs similar to natural processes that are covered in models and that would keep the Earth system within parameters that have been modeled and experienced, whereas continuing with GHG emissions without climate intervention will surely take the global average temperature and other climate conditions to those not experienced on Earth in millions of years and not within the realm to which models have been applied. Yes, potential climate interventions have been simulated less than GHG-induced change, but I don't think it reasonable at all to suggest that the uncertainties associated with GHG gases plus climate intervention are larger than the uncertainties associated with GHG gases alone. There are indeed governance issues, but the key questions is GHG warming with or without climate intervention, not about climate intervention alone—and I'd argue uncertainties are less with climate intervention being implemented, especially if one starts first with regional interventions as my paper has suggested.	Text has been added addressing this point: "Consider, however, that GHG forcing has the potential to push the climate farther into unprecedented states for human civilization and lead to "surprises" (see chapter 15 of this report) and that therefore CI could prevent climate change from reaching a level with more unpredictable consequences."
Astrid	Caldas	Text Region	Chapter 14: Mitigation		489	489	16	25	I think that this final paragraph needs to be presented at the outset of the discussion to frame it -- much like a warning label on a pack of cigarettes -- rather than as a perfunctory acknowledgement at the end.	This paragraph has been moved to the beginning of this section as suggested.
Keya	Chatterjee	Text Region	Chapter 14: Mitigation		489			26	I would also argue that these issues, presented as "mostly non-scientific dimensions" misses the essential point that they can (and must) be informed by social science research.	These issues are already briefly mentioned and authors think adding whole sections on these issues would go beyond the scope of the chapter.
Allison	Crimmins	Traceable Account	Chapter 14: Mitigation		490	493	1	32	Add section on intergenerational equity; geographic equity and dangers of single nations pursuing CI. The traceable accounts are unfinished/ incomplete. They do not describe the evidence base, they merely provide a citation. Some of these are only one sentence long, which seems quite odd for a chapter that has more uncertainties than maybe any other chapter. Suggest reviewing the traceable accounts guidance and make a larger effort to include this important piece of your chapter.	The traceable accounts have been significantly re-written with additional material.
Michael	MacCracken	Text Region	Chapter 14: Mitigation		490	490	3	8	While there will be a delay with respect to cutting emissions of CO2, cutting emissions of black carbon and short-lived species can lead to a very quick reduction in forcings and so a slowing of the rate of temperature increase. This needs to be mentioned near the top of the set of findings, especially as it can help to make up for the seemingly inevitable slowness in cutting CO2 emissions.	The role of short lived climate forcers, including black carbon explicitly, has been brought into the key findings.
Elizabeth	Burns	Whole Chapter	Chapter 14: Mitigation						Thank you for preparing this special report. I am a Fellow at Harvard University where I work on solar radiation management (SRM). I wanted to comment to let you know that I generally support the direction that this draft report takes regarding SRM. For all of the reasons the report mentions, I believe it is critical that there is more research on SRM. And in particular, I believe it is crucial that federal funds support such research. I therefore agree with the broad statements in this special report that support federal funding for SRM research.	We thank the commenter for this comment.
Keya	Chatterjee	Whole Chapter	Chapter 14: Mitigation						Please include literature on Energiewende and the German transition.	The authors do not understand why inclusion of this is important for this chapter. It appears to be outside the scope of this chapter, which is focused on the scientific understanding of how mitigation actions (affecting emissions/radiative forcing) influence the global climate.
Keya	Chatterjee	Whole Chapter	Chapter 14: Mitigation						Please include citation of Lazard, 2016 on Unsubsidized leveled cost of energy comparison	Here is a link to the annual Lazard study: https://www.lazard.com/perspective/levelized-cost-of-energy-analysis-100/ The authors fail to see why this level of detail about trends within the energy sector is relevant for the purpose of this chapter. The purpose of this chapter is not to go into depth about underlying factors driving emissions, but rather to examine the global climate impacts of large-scale mitigation scenarios.
Keya	Chatterjee	Whole Chapter	Chapter 14: Mitigation						Please include Ren21 (2015), IRENA & IEA data on solar potential and implications for meeting targets.	This is one of the reports by these organizations being referred to: https://www.irena.org/DocumentDownloads/Publications/IRENA-ETSAP%20Tech%20Brief%2010%20Concentrating%20Solar%20Power.pdf The purpose of this chapter is not discuss specific mitigation technologies outside of geoeengineering/climate intervention, precisely because geoeengineering/climate intervention raise unique climate science issues -- in keeping with the scope of this chapter and entire report.
Allison	Crimmins	Whole Chapter	Chapter 14: Mitigation						I won't repeat for every instance, but strongly recommend not using "target", "goal", "objective" language and instead talk only of temperature thresholds. Keep it science-y and not policy-y.	The authors were simply using "objective" to convey what is contained in the Paris Agreement for a policy-relevant (not policy-prescriptive) reference. The authors convey no judgment themselves about what an appropriate objective should be.
Allison	Crimmins	Whole Chapter	Chapter 14: Mitigation						Excellent figures in this chapter.	The authors thank the commenter for this comment.
Scott	Weaver	Whole Chapter	Chapter 14: Mitigation						EDF appreciates the broad view offered in the chapter on mitigation, including the relevance of the Paris Climate Agreement, the mitigation challenges associated with meeting the associated global temperature targets, and inclusion of an assessment of the potential role of various climate intervention strategies.	The authors appreciate this comment, and note that it does not call for any specific action.
Harold	Tattershall	Text Region	Chapter 15: Potential Surprises		500			15	While climate models incorporate important climate processes that can well quantified, this part sentence appears to have a word missing.	The text has been revised to incorporate this suggestion.
Adam	Stein	Text Region	Chapter 15: Potential Surprises		500	500	15	15	There is a grammatical error: need to insert "be" after "can".	The text has been revised to incorporate this suggestion.
Allison	Crimmins	Text Region	Chapter 15: Potential Surprises		500	500	15	15	some grammar issues	The text has been revised to incorporate this suggestion.
Michael	MacCracken	Text Region	Chapter 15: Potential Surprises		500	500	30	33	I am not aware of potential Earth system surprises that would pull back the warming--that is, that would reduce either the warming or the impacts of the warming (well, perhaps widespread collapse of both the Greenland and Antarctic ice sheets, but then sea level rise would be disastrously large). Paleoclimatic records make clear that the global climate can be quite different, at least by plus or minus 6 C or so compared to the present, and for the warmer conditions, there is no indication (perhaps as illustrated by Venus) of rapid processes that would bring global cooling (except perhaps a world destroying asteroid collision or deadly disease vector). It thus seems to me that this sentence needs to give a sense of the sign of the surprises being talked about--that is, that the situation is at least likely to cause significantly worse situations, or greater changes, if the surprises become evident. I would agree that there could be potential technological surprises that could allow more rapid emission reductions than are currently projected, so it might also be acknowledged that promoting energy technology research should be aggressively promoted along with strong efforts to reduce emissions with available technologies and the longer the delay in the effort, the more likely climate change is likely to become greater than currently being projected.	Human-system impacts and drivers are beyond the scope of this report. AMOC collapse is an example of a potential surprise that could partially offset warming, especially in the North Atlantic region.
Allison	Crimmins	Text Region	Chapter 15: Potential Surprises		501	501	10	10	breadbaskets is kind of slang-y. May want to be more technical. Also while the word "ignored" is true, you may want to avoid being so negative about it- you can just just say "are not captured by"	The text has been revised to incorporate this suggestion. We have replaced with "major agricultural regions" and "not captured by".
Michael	MacCracken	Text Region	Chapter 15: Potential Surprises		501	501	24	26	These are both quite limited examples, from an areal perspective. Drought in Africa might be a larger scale example or the lack of very cold winter temperatures that have allowed the pine bark beetle to kill forests over most of northwestern North America.	Ecological impacts, such as the spread of the pine bark beetle, are outside the scope of this report and belong instead to the NCA. Drought in Africa is outside the geographic scope of CSSR and the NCA.
Allison	Crimmins	Text Region	Chapter 15: Potential Surprises		502	502	27	27	I would suggest being more careful with the wording here (e.g. our primary concern). You want to remain objective and coldly examine the possibility of both climate benefits and damages, or you'll be accused of cherry picking.	The text has been revised to incorporate this suggestion. We have clarified that this is the primary concern of risk management, not "our" primary concern.
Allison	Crimmins	Text Region	Chapter 15: Potential Surprises		503	503	6	8	This is the third time in a relatively short amount of space that you've mentioned the heat/drought connection. I think you can tighten the language here and in the preceding paragraphs to avoid redundancy	The text has been revised to incorporate this suggestion.
Allison	Crimmins	Text Region	Chapter 15: Potential Surprises		503	503	32	34	You already talked about the example of breadbasket failures earlier in the chapter- maybe pick another example or cut one of the instances to reduce redundancy	The authors only mentioned this briefly at the beginning as an example; here the team unpacks it in more detail. The authors also added an additional example.

First Name	Last Name	Comment Type	Chapter	Figure/Table No.	Start Page	End Page	Start Line	End Line	Comment	Response
Adam	Smith	Figure	Chapter 15: Potential Surprises	15.1	504				Below are the links to graphics and data for the "NOAA Billion Dollar Weather Events"... 1 - the U.S. 2016 Billion-dollar Weather and Climate Events Map: https://www.ncdc.noaa.gov/billions 2 - the time-series on U.S. Billion-dollar event frequency, annual cost, and 5-year cost average (1980-2016): https://www.ncdc.noaa.gov/billions/time-series 3 - Statistics table for all 200+ U.S. Billion-dollar disasters since 1980 (data valid as of Jan. 2017): https://www.ncdc.noaa.gov/billions/summary-stats	The figure is already based on these data and a citation is included in the reference list for this chapter. The reviewer must have missed this information.
Allison	Crimmins	Text Region	Chapter 15: Potential Surprises		505	505	3	8	May want to make it more clear that these would be acting on top of other climate changes in the US (additional to the temperature increases that caused the AMOC changes, additional SLR, etc) Critical positive feedbacks not captured sufficiently by global climate models could include: Apparently missing from the list is the release of carbonaceous materials from both the Tundra based permafrost and the offshore permafrost; particularly from the ESAS.	The text has been revised to incorporate this suggestion.
Harold	Tattershall	Text Region	Chapter 15: Potential Surprises		505			17	Though the release of permafrost carbon would probably not be fast enough to trigger a runaway self-amplifying cycle leading to a permafrost-free Arctic.	Thank you for your comment. These feedbacks are already discussed extensively.
Harold	Tattershall	Text Region	Chapter 15: Potential Surprises		505	505	35	37	What is the basis for such a broad claim? There is considerable evidence that on the Tundra quantities of methane are already being released due to various processes and that at a depth of 70 meters are substantial concentrated deposits.	Thank you for your comment. The authors have added an additional citation to Schuur et al 2015 assessment to clarify the support this claim.
Michael	MacCracken	Text Region	Chapter 15: Potential Surprises		506	506	38	38	What about collapse of the marine food chain due to ocean acidification--that could be disastrous? Needs to be mentioned.	The focus of this report is not on impacts of climate change, although it does acknowledge that tipping elements can exist in large-scale ecosystems that have climate effects.
Allison	Crimmins	Text Region	Chapter 15: Potential Surprises		507	507	16	25	Not exactly "yet unidentified". Suggest reviewing LaRiviere 2012 (Late Miocene decoupling of oceanic warmth and atmospheric carbon dioxide forcing) at http://www.nature.com/nature/journal/v486/n7401/abs/nature11200.html and similar papers (e.g. Ravelo) for reasoning for Miocene warming	The referenced paper is about the Late Miocene, not the Middle Miocene Climatic Optimum. However, the authors have replaced "as yet unidentified" with "as yet unmodeled" and added the statement "There is some evidence that such unmodeled feedbacks may be related to a significant change in the vertical distribution of heat in the tropical ocean (LaRiviere et al., 2012).".
Marcus	Sarofim	Text Region	Chapter 15: Potential Surprises		507	508	35	5	It might be relevant to cite Friedrich et al. (http://advances.sciencemag.org/content/2/11/e1501923.full) here as another example of potential non-linear climate sensitivity.	The text has been revised to incorporate this suggestion.
Allison	Crimmins	Text Region	Chapter 15: Potential Surprises		507	507	36	36	Suggest reviewing recent Science paper (Friedrich et al 206) using paleo records to discuss potential non-linearities in climate sensitivity: http://advances.sciencemag.org/content/2/11/e1501923.full	The authors now note: "Paleo-data for the last 800 kyr suggest a gradual increase in climate sensitivity with global mean temperature over glacial-interglacial cycles (von der Heydt et al., 2014; Friedrichs et al., 2017), although these results are based on a time period with CO2 concentrations lower than today."
Erica	Brown	Traceable Account	Chapter 15: Potential Surprises		509	511	1	33	The Traceable Accounts section has checkboxes to indicate the confidence level in each key finding. In some chapters, multiple boxes (two or three) have been checked for certain key findings. While this is explained in the subsequent narrative as the confidence levels in multiple factors contributing to the key finding, it is unnecessarily confusing and initially appears contradictory. The boxes should be eliminated so that the reader can proceed immediately to the narrative explanation. â The Traceable Accounts section in this chapter includes an area for a summary sentence or paragraph for each key finding. The sentences provided do not summarize the key findings but instead explain what data was used. Delivering these summaries would be useful for readers with non-technical backgrounds and a need to understand the conclusions. The summaries will also aid utility water resources planners in communicating the conclusions of the report to their stakeholders.	The editorial team has revised the traceable accounts for better consistency.
Adam	Smith	Figure	Chapter 15: Potential Surprises	15.1	514				In 2016, the U.S. experienced 15 weather and climate disaster events with losses exceeding \$1 billion each across the United States - 2nd highest event total on record behind the 16 events in 2011. These events included drought, wildfire, 4 inland flood events, 8 severe storm events, and a tropical cyclone event. Cumulatively, these 15 events led to 138 fatalities and caused \$46.0 billion in total, direct costs. Perhaps most surprising were the 4 separate billion-dollar inland flood (i.e., non-tropical) events during 2016, doubling the previous record, as no more than 2 billion-dollar inland flood events have occurred in a year since 1980. Three of these flood events were clustered in Louisiana and Texas between March and August, collectively causing damage approaching \$15.0 billion. This is a notable record, further highlighted by the numerous other record flooding events that impacted the U.S. in 2016. For more context, see: https://www.climate.gov/news-features/blogs/beyond-data/2016-historic-year-billion-dollar-weather-and-climate-disasters-us	This figure is based on the NOAA billion-dollar disaster information, including that of 2016.
Astrid	Caldas	Whole Chapter	Chapter 15: Potential Surprises						In addition to the climate science literature on surprises and tipping points, this chapter would benefit hugely from a discussion of the appropriate climate policy responses (risk management frameworks, robust decision-making under deep uncertainty etc.). These include insights from the literature on risk and insurance. Some suggestions: - Weitzman M. GHG Targets as Insurance Against Catastrophic Climate Damages. Journal of Public Economic Theory. 2012;14 (2) :221-244. - IPCC SREX report: http://www.ipcc.ch/report/srex/ (especially the sections on managing the risks) - Hallegatte et al. 2012 http://elibrary.worldbank.org/doi/abs/10.1596/1813-9450-6193 - Lontzek et al. 2015. Stochastic integrated assessment of climate tipping points indicates the need for strict climate policy. Nature Climate Change 5, 441â444 (2015) doi:10.1038/nclimate2570 - Lemoine, D. & Traeger, C. Watch your step: Optimal policy in a tipping climate. Am. Econ. J. 6, 137â166 (2014).	Thank you for your comment, but your suggestion is outside the scope of this report.
brian	huberty	Whole Document							I will make these comments again.... Since the IPCC declared wetlands to be the most significant landscape feature subject to climate change, it is an embarrassment that wetlands are not addressed as a specific chapter. More importantly, the report needs to reflect why climate changes over time which in geologic history was due to the Milankovitch Cycles. And point out why we are moving towards warming when in effect, the world should be moving towards a cooler period. One of the best and simplest examples to portray this change is using the pollen core research (Dr. Herb Wright). And if the reader needs further proof, show the yearly lake ice out date trends over the last century which shows the shift from May to April and now even March throughout most of the Midwest.	First, changes in wetlands are an impact of climate change (along with human effects on wetlands), while this document focuses on the science of climate change itself. The budget for methane emissions do include wetlands. The science is not clear as to how much cooling would have been expected from Milankovitch by this time period. Authors do discuss the many indicators of a warming climate.

First Name	Last Name	Comment Type	Chapter	Figure/Table No.	Start Page	End Page	Start Line	End Line	Comment	Response
Kevin	Trenberth	Whole Document							<p>This report has very outdated approaches to dealing with climate change. It has become increasingly established that global warming effects are pervasive and the memory is the ocean heat content, which is greatly under appreciated in this report. As a result, conditions over the oceans are warmer and moister than they otherwise would be. But natural variability continues, much as it always has. The net result on any occasion or for any storm is always a combination of natural variability plus climate change. And when the two are going in the same direction, new extremes occur and records are broken (see Trenberth et al 2015 for example). This framing is woefully missing in this report.</p> <p>It does not mention ocean heat content in the summary. Sec 12.4.2 is about ocean heat uptake and fails to include the latest studies and understanding. In particular, the memory of past climate change is in the oceans and this changes the ocean environment to be warmer and moister. In addition OHC changes are a measure of Earth's energy imbalance (EEI) as documented in the following</p> <p>Trenberth, K. E., J. T. Fasullo, and T. G. Shepherd, 2015: Attribution of climate extreme events. Nat. Clim. Change, 5, 725-730 doi:10.1038/NCLIMATE2657, http://dx.doi.org/10.1038/nclimate2657.</p> <p>von Schuckmann, K., M. D. Palmer, K. E. Trenberth, A. Cazenave, D. Chambers, N. Champollion, J. Hansen, S. A. Josey, N. Loeb, P.-P. Mathieu, B. Meyssignac, and M. Wild, 2016: Earth's energy imbalance: An imperative for monitoring. Nature Climate Change, doi:10.1038/NCLIM-15030445C, 138-144.</p> <p>Cheng, L., K. E. Trenberth, M. D. Palmer, J. Zhu, and J. P. Abraham, 2016: Reconciling observed and modeled ocean heat content changes since 1970. Ocean Sci., 12, 925-935, doi:10.5194/os-2016-16. [PDF]</p> <p>Trenberth, K. E., J. T. Fasullo, K. von Schuckmann and L. Cheng, 2016: Insights into Earth's energy imbalance from multiple sources. J. Climate, 29, 7495-7505. doi:10.1175/JCLI-D-16-0339. [PDF]</p>	<p>Authors have increased the discussion on ocean heat content (and it is now discussed in the Executive Summary). Overall, further discussion on ocean processes has been expanded (especially Chapter 13).</p>
Andrew	Beckwith	Whole Document							<p>It is a bread and butter document as to the basics of known climate change. It should have added the Conveyor belt pull of warm water from the Equator to the northern Hemisphere, as this breakdown of the conveyor belt is what is leading to dramatic lows in terms of January temperatures, as well as elevated highs in the summer months. Aside from that, the basics of the document are known climatic science and I endorse them. The attitude of the Trump administration to this topic is literally threatening the survival of the Earth and is incomprehensible. Not to say that there are or would be modifications of some of the conclusions. But this document in conjunction with the Club of Rome's seminal work has one overall conclusion. I.e. times up. Denial will only do one thing. Wreck the biosphere and this due to know nothing ideology. And corporate greed.</p>	<p>The comment in the second sentence does not generally agree with peer-reviewed science literature. Authors have added to the discussion on ocean processes, especially in Chapter 13.</p>
nathan	pate	Whole Document							<p>My comment is that I accept the scientific consensus that AGW is real and largely anthropogenic. Also, I believe that any comments herein where a financial interest is the primary motivation should be largely ignored. This issue is existential, not financial.</p>	<p>Thank you. No changes to document required.</p>
Astrid	Caldas	Whole Document							<p>The comments submitted by me are consolidated comments from various scientists and analysts from the Union of Concerned Scientists. They are not my personal comments.</p>	<p>Thank you.</p>
Harold	Tattershall	Whole Document							<p>After reading this document I have one overarching question; who or what is the ultimate target audience? Aligned with that question is how many steps are envisaged between the final document and the ultimate target audience? Additionally, can that target audience act effectively on the problem?</p> <p>The impression conveyed by this document is that the Chief Scientific Officer of the nation, or the equivalent, will present the overall conclusions to policy makers as a basis for their decision making with regard to the appropriate response to the progression of climate change. Given the stated stance of the current US administration towards climate change it is highly unlikely that any increased concern, and thus an elevated response will occur, and much more likely that current responses will be diminished.</p> <p>It is more than reasonable to assume that scientists are intelligent people and the vast majority are extremely concerned about the state of the climate. However, merely compiling a document with little regard for alternate avenues for concerted action has all the hallmarks of ðŸŒˆwe did our jobs over to you (irrespective of the consequences)!</p> <p>One risk, and this document claims it considers risk, is that governmental action at best will be subpar based on past performance and in particular the most recent example of the Paris Accord. A planned fallback is that 5-year assessments will be made to specify increased action with an identifiable risk that this will invariably understated, under-implemented, and thus merely delay to the inevitable outcome of climate change; a catastrophic threat to civilization!</p> <p>Climate change poses a quandary to society in that action must be taken decades ahead of speculated events that may or may not impart deleterious impacts of some unknown strength. Scientists, in isolation, have absolutely no ability to install the necessary countermeasures; this will require the involvement, and thus the participation, of many established and diverse groups within society. Of these groups probably the most important are the military and business. The military has already been outspoken regarding the potential impacts of climate change, identifying it as a true mounting existential threat with potential multiplier characteristics. The business community has demonstrated entirely different response characteristics that vary from funding denial campaigns to Nicely done!</p>	<p>The audience and the purpose of this report is discussed in the front matter (i.e., About This Report). Most of the review comment seems a personal diatribe and any comments about the actual report are not based on the peer-reviewed scientific literature and/or do not relate to the purpose of this report. The final points about non-linearity are actually discussed throughout the assessment.</p>
Gyami	Shrestha	Whole Document							<p>As appropriate, please cross-reference the next Sustained National Climate Assessment report, the 2nd State of the Carbon Cycle Report (SOCCR-2) which will be published soon after the CSSR.</p>	<p>Authors cannot cross-reference reports that have not been published by the time this report was submitted for final clearance (June 2017). SOCCR-2 is mentioned in Chapter 10, however.</p>
Joseph	Zajac	Whole Document							<p>over use of undefined terms with extreme. climate extremes, climate related extremes, old extremes, cold temperature extremes, cool extremes , daily. precipitation extremes, extreme climate events, extreme coastal storm events, extreme daytime temperatures, extreme event, extreme events, extreme flows, extreme heat, extreme heat events</p>	<p>Word check was made. Authors have attempted to ensure proper use of terminology. A Glossary has been added as an appendix for particularly key terms.</p>
Joseph	Zajac	Whole Document							<p>use of undefined terms with massive. massive carbon dioxide release, massive corals, massive flows, massive under-ice blooms, massive urban centers.</p>	<p>Word check was made. Authors have attempted to ensure proper use of terminology. A Glossary has been added as an appendix for particularly key terms.</p>
Joseph	Zajac	Whole Document							<p>use of undefined terms with heavy. heavy precipitation events, heavy precipitation, heavy rainfall, heavy rainfall events, heavy/extreme precipitation.</p>	<p>We will check to make sure they are adequately defined.</p>
Joseph	Zajac	Whole Document							<p>over use of undefined terms with severe. severe anxiety reactions, severe beach erosion, severe bleaching event, severe burning, severe climate change impacts, severe climate induced risk, severe climate regimes, severe coastal flooding, severe consequences, severe constraints, severe cyclones.</p>	<p>Word check was made. Authors have attempted to ensure proper use of terminology.</p>
Joseph	Zajac	Whole Document							<p>over use of undefined terms with intense. intense algal blooms, intense bushfires, intense convective precipitation, intense cyclones, intense drought, intense erosion, intense erosive events, intense eutrophication, intense exportation of food, intense extremes of precipitation, intense extreme events.</p>	<p>Word check was made. Authors have attempted to ensure proper use of terminology.</p>
Marcus	Sarofim	Whole Document							<p>I commend the author team for a well written, well researched, quality assessment of climate science.</p>	<p>Thank you.</p>

First Name	Last Name	Comment Type	Chapter	Figure/Table No.	Start Page	End Page	Start Line	End Line	Comment	Response
Keely	Brooks	Whole Document							The Water Utility Climate Alliance (WUCA) strongly encourages continued federal support, synthesis and distribution of climate research.	Thank you. No changes to the document.
Keely	Brooks	Whole Document							The members of WUCA, and numerous other essential service providers, need actionable science in order to make capital investments that will be resilient in the face of an uncertain future.	Thank you for the comment. No changes to the document.
Keely	Brooks	Whole Document							The federal government, and the agencies that are participants in the USGCRP, have an essential role to play in building the scientific foundation that is necessary to make sound and well-informed decisions.	Thank you. No change to this document.
Keely	Brooks	Whole Document							This distillation of what we know regarding climate change, with its varying degrees of likelihood and confidence, represents an important input to the NCA4 and the continued evolution in our understanding of climate changes implications for society.	Thank you for the kind comment.
Keely	Brooks	Whole Document							We encourage the GCRP, through its programmatic efforts, to complement the physical science of this report with a renewed focus on the social science implications of climate change -- the implications on economics, decision making, management, etc. Our understanding of the physical changes we can expect from climate change -- the changes in precipitation patterns, in temperature, in sea level, etc. -- ultimately need to be integrated into the government and private sector decision making processes throughout society in order to prepare our nation.	Thanks you for the comment. No changes to this document.
Keely	Brooks	Whole Document							To achieve this, and to meet Goal #2 of the GCRP Strategic Plan, "Inform decisions: Provide the scientific basis to inform and enable timely decisions on adaptation and mitigation", we believe it is essential to establish a meaningful Sustained Assessment process to complement the statutorily required National Climate Assessment report.	Thank you for the comment. No changes to this document.
Keely	Brooks	Whole Document							The sustained assessment should focus on establishing collaborative partnerships, enhancing and organizing the scientific foundations for managing the risks and opportunities of climate change, providing the infrastructure to support a sustained process and diversifying the resource base.	Thank you for the comment. No changes to this document.
Keely	Brooks	Whole Document							We encourage the author team to both check and increase the precision of language used in the presentation of all findings. Inadvertent over/understatements on impacts across geographic and temporal scales could harm decision-makers through improper use of information. For example, several general statements about the western US/EI in Chapter 8 are not consistent with the regions defined in Figure 1 graphics or summarized findings and should be more exact.	The report has been extensively revised for better clarity.
Keely	Brooks	Whole Document							We are very appreciative of the thoughtful design and inclusion of the confidence levels. This metric yields significant value in the practical understanding and application of this research product.	Thank you.
Keely	Brooks	Whole Document							The likelihood definition and statements are in line with other similar reports of which the Water Utility Climate Alliance has made similar comments. This definition mostly depends upon climate model agreement and a cautionary note regarding limitations of using model agreement to insinuate predictive skill must be noted. Limitations such as common model physics and the potential for model outcomes to be on the wrong trajectory of change, should be included as part of this description. Stakeholders are often not aware of the important difference between projection agreement and historical probabilistic assessments, which leads to a false sense of certainty.	The Front Matter has been revised for better clarity. Authors are limited by the length that would be required for a more extensive discussion of all aspects of model treatments of various processes.
Keely	Brooks	Whole Document							On the media and political fronts, new information is often considered more predictive or better than older information. This is challenging for practitioners to keep on top of as new information is always emerging and actions are based on older, less politically valued information. We recognize the need to focus on CMIP5 results in this report and a note regarding new information would help practitioners defend decisions to not stop mid-assessment because "new" science is out. A similar example is the use of DeConto et al 2016 latest work in the Sea Level Rise Chapter. We recommend the inclusion of a cautionary sentence and use of more conservative language in discussing these findings.	The writing team has attempted to be careful in discussion of any recent citations throughout the report, including the discussion on DeConto et al. and other related papers.
Keely	Brooks	Whole Document							There is a lack of consistency between chapters related to referencing English units in the text, followed by the metric unit equivalent in parenthesis (e.g. Chapter 1, p. 49, line 22 uses metric then English in parenthesis compared to Chapter 4, p. 158 line 27 which is the opposite).	The assessment has undergone a thorough copyedit in an attempt to ensure consistency on the use of these units.
Allison	Crimmins	Whole Document							While this document has greatly improved from the last time I read through it, and has obviously benefited from copyediting, I think that it would further benefit from serious shortening. This report would be strengthened by reducing redundancies and distilling the most important science in clear, concise language. This document could easily shed 80-100 pages. As noted in my other comments, Chapter 1 could easily drop 10 of those pages and Chapter 4 could be almost completely eliminated, as almost all of the content is either redundant (as in actually copy/pasted in other chapters) or better suited for an appendix (there is at least another 20 pages cut right there). Rather than being comprehensive, the report as a whole lacked a consistent level-of-detail as the reader moved from section to section or chapter to chapter, which means the reader is unable to know which things are the most important and which are not (e.g. the 14th detail about one topic will seem just as important as the second detail on another topic). The readers will be looking to the expert authors of this report to make those decisions for them, so that they know everything they're reading is the distillation of the scientific literature and the current state of the science. There is wisdom in the old maxim "if I had more time, I would have written a shorter letter".	Significant efforts has been expended to shortening a number of sections to increase accessibility. That said, other reviews have asked for additional text, resulting in a net gain in page count ... albeit slight.
Nancy	Green	Whole Document							The entire document needs to be updated to include information for 2016. This is important because many federal and state agencies have legal or policy requirements to base their analyses, planning, and decisions on the best scientific information available, and a document that is based on 2015 conditions does not represent the best available scientific information.	As much as possible, the report now includes 2016 in the analyses.
									The lag time between the analyses and the publication of the final assessment needs attention.	

First Name	Last Name	Comment Type	Chapter	Figure/Table No.	Start Page	End Page	Start Line	End Line	Comment	Response
Erica	Brown	Whole Document							<p>1. The water sector supports continued federal investment in research in this area to promote science-based decision-making. Scientific information such as the kind provided in this report helps water utility managers and other decision makers make informed decisions about significant infrastructure investments. Therefore it is important for the most recent information, like the upcoming Fourth National Climate Assessment (NCA4), to continue and to be made available to decision-makers.</p> <p>2. The process set up for a sustained national climate assessment facilitates the ability of the federal government to be able to get the latest information out to local decision makers, such as water utility managers, through the development of reports such as this Climate Science Special Report. It's a helpful process that should continue to be sustained moving forward to NCA4 and beyond.</p> <p>3. The Traceable Accounts sections are very useful. Having a succinct description of the evidence base, the new information since the last report, remaining uncertainties and assessment of confidence based on evidence is helpful for utility water resources planners and decision makers.</p> <p>4. The Traceable Accounts sections include an area for a summary sentence or paragraph for each key finding. The sentences provided do not summarize the key findings but instead explain what data was used. Delivering these summaries would be useful for readers with non-technical backgrounds and a need to understand the conclusions. The summaries will also aid water resources planners in communicating the conclusions of the report to their stakeholders.</p> <p>5. Some Traceable Accounts sections have checkboxes to indicate the confidence level in each key finding. In some chapters, multiple boxes (two or three) have been checked for certain key findings. While this is explained in the subsequent narrative as the confidence levels in multiple factors contributing to the key finding, it is unnecessarily confusing and initially appears contradictory. The boxes should be eliminated so that the reader can proceed immediately to the narrative explanation.</p> <p>6. Some of these chapters are more focused on a discussion of model projections and as a result also on the attribution of phenomena to global climate change. For a scientific report, this might be ok, yet it important to recognize that discussing the trends in observations taken on the ground would be more helpful. These comments are submitted on behalf of Natural Resources Defense Council.</p>	<p>Authors and the editorial staff at the Technical Support Unit have revised the traceable accounts for better consistency. Much of the discussion of water here is really for the National Climate Assessment (impacts).</p>
David	Hawkins	Whole Document							<p>We agree with the conclusion that this report is needed to capture the significant advances in the science since the May 2014 Third U.S. National Climate Assessment, relating to climate change and the role of humans in changing the climate. This Climate Science Special Report is an important contribution to the legally mandated National Climate Assessment.</p> <p>An important issue that is not adequately discussed in the report is the increase in risks for a number of ecosystem and human health and welfare indicators that are associated with futures with higher temperature changes from pre-industrial levels. The Special Report should contain a synthesis similar to the IPCC "reasons for concern" (RFC) approach that summarizes the magnitude of the risks for key indicators as a function of global temperature increases from pre-industrial levels. According to the IPCC, RFCs "illustrate the implications of warming and of adaptation limits for people, economies and ecosystems across sectors and regions. They provide one starting point for evaluating dangerous anthropogenic interference with the climate system."*</p> <p>The five RFCs are associated with: (1) Unique and threatened systems, (2) Extreme weather events, (3) Distribution of impacts, (4) Global aggregate impacts, and (5) Large-scale singular events. Further work has been conducted on the RFC framework to expand on the complementary climate change metrics to global mean temperature change and to better account for possible changes in social and ecological system vulnerability.**</p> <p>This work*** reveals that medium to high levels of risk (for example to arctic systems, coral reefs, human health and agriculture) are associated with current levels of global mean temperature increase, and that additional thresholds are crossed at levels lower than the ones considered in the Report:</p> <ul style="list-style-type: none"> • RFC1 (Unique and Threatened Systems): "A transition from Moderate to High risk occurs over the range ~1.1-1.6°C" • RFC2 (Extreme Weather Events): "The transition to High risk is located at ~1.6 °C" • RFC3 (Distribution of Impacts): "The transition to High risk occurs between ~1.6 and ~2.6°C" • RFC4 (Global Aggregate Impacts): "A Moderate risk level occurs at warming of ~1.6-2.6°C" 	<p>While an important series of comments, these largely apply to potential impacts of climate change and not to the issues of climate science discussed here. Therefore they are more applicable to the NCA process than they are to this document.</p>
Andrew	Pershing	Whole Document							<p>The scientific community has been considering the impact of carbon dioxide on global climate for decades (centuries even). Multiple lines of evidence support the conclusion that excess carbon dioxide in the atmosphere causes the planet to warm, and that the warming that we can see on both land and in the ocean can only be explained by rising levels of carbon dioxide. I appreciate the strong tone of this document. It is entirely consistent with body of evidence accumulated by years of painstaking research. Please make sure that the strong messages in this document remain.</p>	<p>Thank you.</p>
Nancy	Green	Whole Document							<p>Throughout the document, the appropriate reference period needs to be included in the legend for each figure, table, or statement regarding projections.</p>	<p>Authors have implemented guidance to provide better consistency on the discussion of reference periods.</p>
Nancy	Green	Whole Document							<p>Although it is user-friendly to use the terms "higher scenario," "mid-high scenario," "mid-low scenario" and "lower scenario" these need to be accompanied by text that provides the actual basis for them, i.e., the four Representative Concentration Pathways, RCPs 8.5, 6.0, 4.5 and 2.6, respectively. This ought to be part of the text (or footnoted) for every figure, table, or text statement using such terms.</p>	<p>The authors respectfully disagree. The nomenclature is established early in the report that is then used in other chapters.</p>

First Name	Last Name	Comment Type	Chapter	Figure/Table No.	Start Page	End Page	Start Line	End Line	Comment	Response
Nancy	Green	Whole Document							<p>In my view, the single biggest problem with the draft text is the treatment of projections under RCP 2.6. It is a very significant that the very substantial assumptions involved in RCP 2.6 are not described nor are their implications discussed. It is particularly important that the document clearly make a distinction between what is theoretically "plausible" for purposes of international discussions of climate policies, as compared to what is realistic for purposes of planning and management.</p> <p>Ideally, text and figures that compare outcomes under a "higher scenario" and "lower scenario" ought to be revised to use the "mid-low" (i.e., RCP 4.5) for the low end of the range, rather than using the "lower scenario" (i.e., RCP 2.6), e.g., Figure ES 2 & 4.1, Fig. ES 3 & 6.7 and many others. Figures and text that rely on RCP 2.6 to illustrate the "low" end of the range of possible futures are misleading in light of the practical implausibility and highly speculative nature of RCP 2.6. Such projections are subject to misinterpretation (whether unintentional or deliberate); for example, projections based on the "lower scenario" (i.e., RCP 2.6) could be used as part of the basis for questioning the need for action and/or to attempt to justify very limited action in relation to climate mitigation and climate adaptation.</p> <p>The text ought to acknowledge that the RCPs provide a basis for modeling and research to help inform policy deliberations and the projected outcomes based on RCPs reflect what is theoretically conceivable or possible, but not necessarily what is realistic. The text needs revision to describe the assumptions underlying RCP 2.6 and the scientific concerns about the practical feasibility and the impacts of various negative emissions approaches needed to achieve RCP 2.6, including technological, economic, environmental, and social and policy/political concerns. Further, results of the analysis by Sanderson et al. 2016 show that the due to the emissions which already have occurred: "the exact trajectory of RCP 2.6 is now impossible." Also, their paper and others point to very substantial problems that result from deferring the start of the assumed levels of mitigation, which forces even greater reliance on larger emissions reductions in the future plus greater reliance on negative emissions approaches which involve substantial uncertainties and basically are highly speculative in terms of being implemented at any meaningful scale or having the desired effects.</p>	The discussion of the RCPs has been revised for better clarity, particularly where these scenarios are discussed in depth (Chapter 4).
Scott	Weaver	Whole Document							<p>Environmental Defense Fund (EDF) appreciates the opportunity to offer comments on the USGCRP Climate Science Special Report (CSSR) and fully supports the USGCRP's efforts in meeting their legally mandated requirements to provide the National Climate Assessment as required by the U.S. Global Change Research Act of 1990. In general, EDF finds the report to be well grounded in the scientific evidence necessary for a robust and factual assessment of changes to the climate system of consequence to U.S. national interests. The observational and model based analyses underpinning this assessment are produced by world class scientific research groups from around the world providing our Nation and the international scientific community with a valuable service. EDF supports elevating the importance of linking anthropogenic climate change to extreme weather events writ large, and the inclusion of the scientific improvements in the attribution of specific weather events over the U.S. to climate change. Furthermore, EDF appreciates that the CSSR includes a nuanced recognition of the challenges inherent in climate attribution science. An example of this is the potential for climate change to influence severe convective weather environments in the future, but that an appropriate scientific assessment of past changes in a specific class of events, for instance tornadoes, is not quite possible given the spurious changes in the historical tornado database. EDF also appreciates the broad view offered in the chapter on mitigation, including the relevance of the Paris Climate Agreement, the greenhouse gas mitigation challenges associated with meeting the agreement's associated global temperature targets, and the inclusion of an assessment of the potential role of various climate intervention strategies.</p> <p>To be sure, there are areas where EDF feels the report could be improved. Examples include: potentially overstating the role that Arctic climate change has in influencing changes in mid latitude weather, that naturally occurring climate variability modes are being affected by human caused climate change, and reconciling the apparent contradiction posed by the co-occurrence of increasing western U.S. drought with an increase in precipitation from more land falling atmospheric rivers over the same region. Other possible areas for clarification include the lack of a physical explanation for the summertime cooling trend over a large portion of the central and eastern U.S., and an improved reconciliation for the lack of a consensus amongst the scientific community regarding the</p>	Authors and the editorial team have extensively revised the entire report for better clarity, including discussion of the issues raised by the reviewer.
Michael	MacCracken	Whole Document							<p>This report will be a very valuable baseline document for the upcoming National Assessment. While I have many specific comments, its scope, tone and level of discussion is very helpful and appropriate, and the findings seem very solid on a scientific basis (so based on very convincing evidence). In that the public, business community and government policymakers generally make decisions based on relative likelihood and a desire to avoid risk (so, undertaking stress tests and due diligence tests), the findings here are actually quite cautiously stated and so provide a very solid basis for moving on to consider the impacts of the changes that are indicated here; indeed, it would really be helpful if there could be a bit more done and a summary of the findings expressed using alternative framings of risk, so summarizing how much more serious the changes to consider would be if they wanted to encompass allow for a 10% chance that they would occur, and as well how limited the impacts might be if one wanted to have a 90% confidence that the results would occur (this latter would actually be quite close to the results reported because of the caution inherent in scientific practice, but nuances on this could be discussed). Overall, however, the authors are thus to be commended for their efforts and the report should be suitably revised based on their evaluation of the validity of the review comments and then that version provided as the best summary evaluation of the scientists and experts involved before any government review takes place at the policy level, in that policy evaluation would be expected to bring other considerations to bear and what these considerations are and the changes called for provided as a separate document.</p>	Thank you. In the revised report, authors have attempted to increase the discussion on risk framing.

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Michael	MacCracken	Whole Document							<p>A significant problem across the report is that there is some inconsistency in the framing that is used in expressing the results. In many locations in the report, the traditional scientific hypothesis-testing framework is used, not providing any indication about what can be said about a particular topic unless there is two-sigma significance. What this framing is and means is not well laid out in the report and there are a number of locations in the report where phrases are used that disguise that this is the framing used. For example, on page 289, line 10, the phrase "clearly attributed" is used to express a finding. My suspicion is that this is jargon for indicating that there is not two-sigma significance. Using jargon like this is exactly what caused the confusion and commotion over the Detection and Attribution chapter with lead author Ben Santer in the IPCC Second Assessment Report. It used jargon in the chapter (at least the version that went out for government review) and then when this was viewed as contradictory to findings expressed in a relative likelihood framework (a balance of evidence shows a discernible human influence), all sorts of commotion and objections arose that even persist to over 20 years later. It is absolutely essential that all such jargon be replaced by clear indications of what test has been applied, and my specific comments indicate some locations I found of this sort of problem, but guidance on this needs to be given to all. Using the hypothesis-testing two-sigma framing is in many situations fine to use in building the pyramid of knowledge. This report, however, is going out for use by policymakers, decision makers, resource managers and others, and in many of those situations there decision-making framework is relative likelihood or even focusing on relatively small risks of likelihood (e.g., business leaders are supposed to do stress tests on plausible worst cases. This might be having a 5% likelihood rather than on findings based on a 95% likelihood used by the scientific community). In the first US National Assessment, farmers, for example, made the point that scientists simply do not have the right to withhold indications of what might be happening until they have two-sigma significance and are absolutely sure they will be right; the farmers made clear that they work with uncertainty all the time, and they have the right to all indications scientists have along with the various limitations and uncertainties that might apply. An example from another field was when HIV patients objected when the medical community was withholding medicines that might be useful while waiting until</p>	The writing team has revised the discussion throughout for better clarity on likelihood and confidence statements.
Pierre	Comizzoli	Whole Document							<p>This a very thorough and informative document. There are no comments at this point.</p>	Thank you.