Comment ID	From Page	From Line	To Page	To Line	Comment	Response
14592	0	0	0	0	General comment: a great progress since the 0-order draft, but still work to be done to streamline and shorten the material, and make the text more effective. Many sections read like textbook rather than asssessment, and could build more on what was known in AR5 and describe how the assessment changes (or not) since then. Some sections do this, but most don't. In quite some cases some well designed Tables could help to summarize or shorten text. My comments are on behalf of chapter 2 wrg to overlaps and/or inconsistencies, but also also more generally as an atmospheric scientist with broad interest in climate issues. [Frank Dentener, Italy]	Noted, we took it into account during SOD consolidation, shortening where possible, avoiding text book style paragraphs, reminding AR5 statements and implementing tables to summarize where possible.
47890	0	0	0	0	Assessment Structure: If possible, assessment conclusions should be provided in a structured traceable account of how these statements were derived. For example, sections / subsections can start with previous IPCC report conclusions (AR5 or AR6 Special Reports) and then provide an update of the more recent literature, clearly laying out the lines of evidence. Each section / subsection can then conclude with assessment statements. This section currently reads more as a review than an assessment. In addition, please make sure the ES uncertainty language is clearly tracable to the underlying chapter text. [WGI TSU, France]	Noted and taken into account for SOD
41500	0	0	0	0	some parts of ES refer to NH3 and some to ammonia. Would make consistent [Amanda Maycock, United Kingdom (of Great Britain and Northern Ireland)]	fixed
41514	0	0	0	0	This is a good start for the ES but in general there needs to be clearer statements about what aspects are consistent with AR5 and what findings have changed since AR5 [Amanda Maycock, United Kingdom (of Great Britain and Northern Ireland)]	Accepted -- we have added a summary of the state of assessment in AR5, progress since the AR5, and an updated AR6 assessment for each section. Section 6.3.1 has been rewritten entirely to summarize AR5, and state developments since up to AR6, along with linkages to other chapters
47920	0	0	0	0	Could a schematical overview figure explaining what topics to expect where in the chapter be introduced at the beginning? This coudl help understand where each SLCF species is assessed? Alternativly could the chapter structure be modified to more easily follow the difference SLCF species throughout the text? [WGI TSU, France]	Noted, a roadmap figure has been added and the chapter outlines key words are indicated to help a larder audience to find specific contents in the chapter. The introductory section (6.1) has been fully rewritten and shortened and do the link between the content of chapter 6 and the previous assessments.
56132	0	0	0	0	stratospheric water vapor is a short lived climate forcer; this issue might not be discussed in this chapter, but a link should be made. [Rolf Müller, Germany]	Taken into account, feedbacks are now described in the SOD (section 6.3).
41550	0	0	0	0	I found some overlap between the introductory material in 6.1 and the subsequent sections. For example, 6.1.2.1 and [Amanda Maycock, United Kingdom (of Great Britain and Northern Ireland)]	Taken into account, Section 6.1 changed according to multiple reviewer comments
48024	0	0	0	0	Scoping Outline Check: All bullets from approved outline are covered in the first order draft but please note there is a greater focus on AQ than descibed in the outline bullets. Aerosols could be more clearly identified in the current ch6 structure. Finally, please take car not to overstep into wg2&3 assessment topics in parts of chapter 6. [WGI TSU, France]	Noted

28832	0	0	0	0	I like the remit of the chapter and its clear intro. It generally read as a useful review rather than an assessment. Section 6.3.2 and 6.3.3 currently discuss global ERF estimates, even though their titles are regional ERF. They also read as more of a review than an assessment and don't form any clear estimate. The asessment parts do overlap with CHapter 7 and differ. The later ERF estimates on projections is good in this chapter though as we don't go there. I think its better if maybe chapter 6 does ERF by emisison source, but we do ACI and ARI total ERF? We could also swap around sections. Happy to discuss though. Note Chapter 5 should take the NPP effect of fire etc., into their estimates of feedback... [Piers Piers Forster, United Kingdom (of Great Britain and Northern Ireland)]	Accepted -- the chapter has been rewritten as an assessment and the conflicting estimates of ERF between chapters 6 and 7 have been resolved.
48042	0	0	0	0	Please be careful to not include statements that can be interpreted as policy perscriptive or value based in the assessment. IPCC reports should be policy relevant but not policy perscriptive. [WGI TSU, France]	Accepted -- we are removing the policy prescriptive and/or value-based.
48050	0	0	0	0	Please check the correct use of IPCC Confidence/Uncertainty language. In some cases some assessment arguments are provided with uncertainty language without a discussion of the results of cited papers. Please refer to the IPCC guidance note on uncertainty: https://wg1.ipcc.ch/SR/documents/ar5_uncertainty-guidance-note.pdf [WGI TSU, France]	Accepted -- we have checked the correct use of IPCC Confidence/Uncertainty language throughout.
27832	0	0	0	0	verify the format of the chemical formulas (subscript) [Poot Delgado Carlos Antonio, Mexico]	Editorial. Issues like this will be fixed at the latest before the publication of the report (the accepted draft will undergo professional copy-editing). The chemical symbol formatting has been determined to be a Word template problem. The subscripts and chemical symbols had been formatted correctly, but upon transfer of the Word file to a different computer, formatting corruptions were introduced.
47808	0	0	0	0	Chapters 2, 5 and 7 class methane as long-lived but chapter 6 classes it as short-lived. [WGI TSU, France]	Taken into account and made clearer in the SOD.
27842	0	0	0	0	verify the format of the subscripts [Poot Delgado Carlos Antonio, Mexico]	Editorial. Issues like this will be fixed at the latest before the publication of the report (the accepted draft will undergo professional copy-editing). The chemical symbol formatting has been determined to be a Word template problem. The subscripts and chemical symbols had been formatted correctly, but upon transfer of the Word file to a different computer, formatting corruptions were introduced.
28870	0	0	0	0	Good idea tor a FAQ. Could add one on short-lived mitigation potential, or better still to make title of exisiting FAQ more clearer about mitigation? - "How will mitigation of short-lived climate forcers affect air quality and climate?" [Piers Piers Forster, United Kingdom (of Great Britain and Northern Ireland)]	This is the subject of subsections in 6.6.3 and 6.6.4 for SSP and 6.5.3 for SLCF scenario discussed in the literature for other purposes than climate ,FAQ6.1 and 6.2 also discuss some aspects of SLCF mitigation

27852	0	0	0	0	This chapter requires a thorough revision in editorial terms, it has too many errors [Poot Delgado Carlos Antonio, Mexico]	Editorial. Issues like this will be fixed at the latest before the publication of the report (the accepted draft will undergo professional copy-editing). The chemical symbol formatting has been determined to be a Word template problem. The subscripts and chemical symbols had been formatted correctly, but upon transfer of the Word file to a different computer, formatting corruptions were introduced.
41680	0	0	0	0	In general there needs to be more cross-chapter links to connect the detailed chemical processes discussed here into the rest of the report, e.g. to chapters 2, 3 and 4 in particular but also chapters 7, 10 [Amanda Maycock, United Kingdom (of Great Britain and Northern Ireland)]	Noted
47864	0	0	0	0	Key comment: Chapter 6 reads quite fragmented and would benefit from a more structured and consistent approach to dealing with the individual SLCF species. Could a mapping table be introduced in Section 6.1 to show where each species is assessed? Or could the chapter be resturcuted to make this clearer? From reading the chapter, the importance of regionality is clear but this again could be highlighted more consistently (could the chapter perhaps be structured to focus on the global to begin with and then on the regional aspects, with a consistent ordering of the SLCFs?). In what way does the regionality and SLCFs in chapter 6 relate to the Atlas chapter? Could the Atlas be used to develop the importance of the regional distribution of SLCFs? [WGI TSU, France]	Noted. The regions of the atlas have been used for figures in 6.3. However regional boundaries of interest for climate are not always the most relevant for SLCF. Interaction with atlas reinforced
47870	0	0	0	0	The assessment for each SLCF would benefit from additional context when each SLCF is introduced. Understandig the importance of each species up front will help readers engage more and understand the importance of these species. [WGI TSU, France]	Taken into account. See notably the Table 6.1 in SOD.
9740	0				When mentioning BVOC emissions and their potential future evolution, I think too little emphasis is given to the direct impact of atmospheric CO2 concentration on plant emission capacity. And yet, this so called "CO2 inhibition effect", which has more been observed for isoprene, could offset the temperature change impact on emissions. It must be acknowledged that there is still a great deal of uncertainty as to this effect (range, different response in different ecosystems, few plant species studied to date), but it is worth to be mentioned. Here are some interesting papers that could be cited: Possell et al. (2005), Wilkinson et al. (2009), Heald et al. (2009), Young et al. (2009), all adressing the CO2 inhibition effect for isoprene and/or its potential role on emissions and atmosphere chemistry. Thanks. [JULIETTE LATHIERE, France]	Accepted - text included. Thank you for important comment. Agreed. Section 6.2.1.2 revised to include discussion of CO2 inhibition effect. Focus & refs is on knowledge updates since AR5 2013.
51986	0				There is a need in this chapter to consistently either subscript or not chemical symbols such as CH4. Elsewhere subscripts have been the norm so that would be my suggestion here. [Peter Thorne, Ireland]	This has been determined to be a Word template problem. The subscripts and chemical symbols had been formatted correctly, but upon transfer of the Word file to a different computer, formatting corruptions were introduced. This issue will be resolved between the chapter and the TSU.

51994	0				This chapter makes greater use of intra-chapter boxes than chapters to date (I have been reviewing chapters in order). Perhaps it is worth thinking whether all of these are required as boxes with a view to cross-report stylistic consistency? [Peter Thorne, Ireland]	Noted - communicated to TSU
51996	0				There is a heterogeneity in style between sections. Personally I preferred 6.2.2 style which is also reasonably close to that in chapters 1 to 4. Regardless of chosen style it would be helpful to try to be more homogeneous in approach in subsequent iterations from the viewpoint of the reader. [Peter Thorne, Ireland]	Noted, we took it into account during SOD consolidation.
51998	0				There is a tendancy in many places to get into text book style definitions. Perhaps much of this material is required, but equally, for consistency across the report it may be worth reviewing these pieces and minimising the degree to which text-book level backgraound is given in preference to the substantive assessment. [Peter Thorne, Ireland]	Noted, we shortened significantly the 6.1 section to limit text book explanations and had it in mind for the SOD consolidation.
38440	0				Review Comments on First Draft Report of the IPCC AR6, Chapter 6 The structure Entire structure of Chapter 6 under review is well-designed, maintains a semblance of sequential continuity, coherence between past scientific evidence and present academic and scientific knowledge to make future projections. Comprehensiveness Treatment of the main thematic subject in this chapter is reasonably comprehensive to provide appropriate coverage to sub-themes in a proportionate manner. Emphasis on global and regional perspectives on issues described and analyzed in this chapter have been seemingly accorded uniform priority that is essential to maintain thematic unity, coherence and clarity. Balance of the Assessment Asemblance of steadiness is discernible in the overall assessment as well as assessment of each sub-theme in this chapter and that is helpful in comprehending academic and scientific appreciation of future projections either in emissions or air pollution. Overlaps No overlaps have been found in chapter under review. Inconsistencies	Noted
52008	0				Another overall well written chapter. Relative to earlier chapters, much more recourse made to pre-2013 literature. The draft would benefit from increased focus on post-AR5 literature and what that means for our understanding. [Peter Thorne, Ireland]	Noted

52014	0				Reading through the chapter I wonder whether the current structure is optimal. I keep getting returned repeatedly to consideration of topics e.g. BC from different angles again and again. This leads to a degree of repetition but, also I wonder whether the reader may be more interested in a vertical per-SLCF view rather than the current horizontal per-effect type structure? [Peter Thorne, Ireland]	Noted - We were attentive to avoid redundancy and have consistency throughout the chapter, in particular regarding BC.
53552	0				The authors should establish contact with Ch7 authors on emission metrics [Jan Fuglestvedt, Norway]	Noted and done
55606	0				Usage of terminology--e.g., GHG versus LLGHG versus LLCF, meaning of SLFC (radiatively active species only, or also precursors--needs to be consistent throughout chapter (report). [Larry Horowitz, United States of America]	Noted - attention has been paid for the SOD to a consistent use of acronyms and terminology across the chapter.
55608	0				Metris of radiative forcing need to be more carefully defined throughout chapter. Do numbers given refer to IRF, DRF, ERF? Emissions-based or concentration-based forcings? [Larry Horowitz, United States of America]	Radiative forcing calculations is taken on by Chapter 7, using emissions and concentrations provided by Chapter 6.
53842	0				At LAM1 and LAM2 we agreed to aim for using a common core set of scenarios across chapters - to the extent possible given the literature. Please keep this ambition in mind for SOD, and check consistency with ch1 and ch4. [Jan Fuglestvedt, Norway]	Noted
24926	0				This chapter needs to address the impact of climate change on composition. This could be another section or section 6.5 could be expanded to include composition more generally, and not just AQ. [William Collins, United Kingdom (of Great Britain and Northern Ireland)]	Rejected, this section already deals with impact of climate change on global atmospheric composition when it is relevant for surface level concentrations.
50796	0				You have captured many of the elements that are needed to describe the short-lived climate forcers. However, and especially the executive summary could be written in an easier to grasp manner especially for non-experts and policymakers. Since this is a field with growing interest from policymakers it is of key importance that the chapter communicates well. [Ole-Kristian Kvissel, Norway]	Accepted -- the executive summary has been entirely revised for compliance with the template provided by the WGI Technical Support Union.
43122	0				In general, the document is comprehensive and covers a wide range of topics related to SLCFs. The authors should be commended for their efforts. There are some typos, grammatical errors, and inconsistencies (due to multiple authors), which I will not list them as they can be fixed with copy-editing. [Luisa Molina, United States of America]	Noted, Thank you.
42100	0				I am surprised that this chapter on SLCF does not mention contrails and aviation-induced cirrus. I suggest to at least add a reference to chapter 7, but other SLCFs are considered in both chapters, so there might be something to say about contrails also here : regional distribution, future trends ? (even if the share of contrails within the total forcing is small, it need to be well documented because they have a more significant role within the impact of the aviaiton) [Philippe Marbaix, Belgium]	Aerosol-cloud interactions is treated in chapter 7 in the SOD and Aviation contribution is discussed in SOD section 6.5
43124	0				Some of the sections are a bit wordy and redundant, and in some instances, repetitious. While it is important to cite the sources, however, it seems there are too many references and some are cited multiple times in the same paragraph, which affect the flow and the readability. In fact, one can find numerous references for each of the topics presented; which one or how many studies (or references) to cite depend on the contributing authors. Perhaps the chapter could include General References by topics, this will allow readers who want to conduct more in-depth review of a specific topic to search for the references they need. [Luisa Molina, United States of America]	Noted - We were attentive to avoid redundancy and limit repetitions of references in the same paragraph.

43126	0				One suggestion to save space (as well as consistency) is to use the acronyms., For example, SLCFs instead of Short-lived climate forcers, once it has been defined in the introduction. e.g, in Section 6.3 line 21-32 use the long name four times while using SLCFs twice in the same paragraph. Likewise, BC for black carbon, SOA for secondary organic aerosol, also for chemical compounds: once their chemical formulas are defined, it might be better to use them, e.g., O3 for ozone, CH4 for methane, etc. This also makes it easier to navigate (search) specific item in the online document. [Luisa Molina, United States of America]	Noted - attention has been paid for the SOD to make a better and consistent use of acronyms across the chapter.
53648	0				I suggest the authors read ch2 of SRCCL to check for material that needs to be included/reflected - and for inconsistencies in general [Jan Fuglestvedt, Norway]	Noted and conclusions of the SRCCL considered in sections 6.1, 6.2 and 6.5 of the SOD.
53650	0				Chapter 6 is hard to read and is rather fragmented. It needs a more structured and consistent approach to dealing with the individual SLCF species. A better overview in the start could help the reader. It may also be necessary to consider other structures to improve the presentation. [Jan Fuglestvedt, Norway]	Taken into account
53652	0				The importance of regionality is relatively clear but could be highlighted more consistently [Jan Fuglestvedt, Norway]	Noted
53654	0				The ERF concept is central to SLCF. This is used but not explained very well. I suggest a very short explanation with a clear link to ch7 where this is presented more thoroughly. [Jan Fuglestvedt, Norway]	Accepted -- the concept of ERF is now explained early in the chapter (revised 6.3.1.2) with a link to chapter 7.
11672	0				"Section 6.3: SLCF radiative forcing and impact" has substantial overlap with "Chapter 7: The Earth's energy budget, climate feedbacks and climate sensitivity". This overlap needs to be avoided, the same topic should not be discussed twice in the report. The discussion in section 6.3 is incomplete. More reference to the respective (sub)sections in Chapter 7 need to be included in section 6.3 and the discussion in section 6.3 needs to focus only on what is not covered in Chapter 7. [David Neubauer, Switzerland]	Accepted -- the overlap with chapter 7 on global metrics has been removed, links to chapter 7 inserted, and section 6.3 has been more strongly focused on regional aspects of SLCF forcing.
53656	0				The inteface and division of materail/topics between ch6 and ch7 need some careful considerations. Aerosols is one such topic. I suggest that 6.3 cover global & regional aerosol RF per species. And the impacts on dT per species (withouthut stepping into 4.4.4). THis will support the assessment in ch7 where there is less focus on species. [Jan Fuglestvedt, Norway]	Accepted -- we have elevated the emphasis on regional forcing by aerosols to better complement chapter 7. Section 6.3.1 now includes linkages to chapter 7 (and elsewhere in WGI) where these concepts are assessed.
53662	0				Chapter 6 sometimes adresses the cost of mitigation. This is more WGIII material and collaboration with authors form WGIII is needed (e.g. as CAs) [Jan Fuglestvedt, Norway]	Taken into account, we do not assess the cost of mitigation and make a very limited use of it in SOD.
11686	0				In section 6.3.1.1 the rapid adjustments (semi-direct aerosol effect) to the direct aerosol effect is not mentioned. [David Neubauer, Switzerland]	Accepted -- brief discussion of rapid adjustments have been added to 6.3.1.1 with linkages to chapter 7.
9384	0				It might be helpful to check for coherence of chapter 6 with other chapters, e.g. chapter 7. This refers to the terminology as well as to the findings, e,g, with rerspect to uncertainty reltaed to aerosol forcing etc. [Klaus Radunsky Radunsky, Austria]	Taken into account
11688	0				In section 6.3.1.1 aerosol-cloud interactions (indirect aerosol effects) are not mentioned. [David Neubauer, Switzerland]	Rejected -- indirect vs. direct in section 6.3.1.1 refers to species that are produced via atmospheric chemistry from precursors vs. directed emitted

11690	0				Section 6.3.1.2 has overlap with "Chapter 8: Water cycle changes". References to the respective (sub)sections in Chapter 8 need to be included in section 6.3.1.2. [David Neubauer, Switzerland]	Accepted -- references to respective subsections in chapter 8 have been added to 6.3.1.2 (renumbered to section 6.3.1.3 in SOD).
39370	0				The description about the impacts of SLCFs on climate change is most important in this chapter because it is a report of Intergovernmental Panel on “Climate Change”. Therefore, the subsection 6.3.4 should be upgraded to the section. The independent section about the impacts on climate change, especially on temperature and precipitation, is essential for policy makers and public toward the Paris Agreement in which the detail description are needed for each measure on SLCFs. [Toshihiko Takemura, Japan]	Noted
39372	0				The order of 6.4 and 6.5 should be exchanged. [Toshihiko Takemura, Japan]	Accepted. Section orders have been exchanged.
39374	0				Discuss whether the contents in 6.5 are combined with those in 6.3.4 as “Impacts between SLCFs and Climate Change.” [Toshihiko Takemura, Japan]	Rejected
31966	0				The text includes so many accronyms (most of thetime not defined in the text) that, as is, it is almost unreadable for non specialists. [Marie-France Loutre, Switzerland]	Noted - attention has been paid for the SOD to make a better and consistent use of acronyms across the chapter.
55776	0				Could you comment on nesting models of various scales down to the local scale, especially when investigating urbanization? [Ariane Middel, United States of America]	Urbanization is only discussed to explain how it is considered in emissions. Chapter 6 does note discuss nesting as its assessments essentially rely on global models.
31974	0				Some words about dust in a paleo context would be welcome in this chapter [Marie-France Loutre, Switzerland]	Rejected, the dust in paleo context are discussed in Chapter 2
53488	0				The topics for thss chapter span a lot of scales and effects. It is a rapidly evoling field and it is a challenge to cover all this in a coherent way. The chapter as it is now is quite heterogeneous in style, perspective and level of detail. It needs stronger coordination across the sections in order to develop into a coherent chapter. More efforts are needed to tie together all the information and details given in the sections. [Jan Fuglestvedt, Norway]	Noted, we paid attention to made the chapter more homogeneous for SOD.
44530	0				(Comment submitted to C6, C7 and C10.) The treatment of the processes behind aersol-climate interactions needs to be strengthened through the report. Currently, processes are introduced in Chapter 6 (6.3.1), but only briefly. Then ERF is assessed in Chapter 7, but only globally. In Chapter 10, many regional studies and processes are discussed that rely e.g. on aerosol-precipitation interactions (such as Sahel precipitation trends), but they do not assess the progress in the underlying understanding. My suggestion would be that the process description is strengthened in Chapter 6, up to and including assessments of implications for estimates of regional ERFs and weather/climate interactions. The final assessments for ERF and regional climate can still reside in chapters 7 and 10, but can then refer back to the most recent process litterature in Chapter 6. However other divisions are of course possible, which is why I submit this comment to all three chapters. [Bjorn Samset, Norway]	Taken into account -- process discussion for ACI is now housed in chapter 7
53490	0				The chapter also needs to do more assessment, and not only review and descriptions [Jan Fuglestvedt, Norway]	Noted and taken into account for SOD

28946	1	1	1	1	My overarching comment is that there is an impressive amount of material in this chapter, but, in common with most other chapters I looked at, I feel that the Chapter is much longer than it needs to be. In places it becomes as much a textbook, or historical review, of SLCFs, rather than an assessment of the current state of the field and it would benefit from significant pruning. I also note in passing that I felt other chapters I looked at were in a more advanced state than this one, but perhaps there are particular circumstances to explain this. Having read Chapter 7, it is clear that there is a need for significant interaction with them ahead of the SOD, as there are various clear overlaps and someone somewhat inexplicable things (e.g. why contrails are covered there rather than here). [Keith Shine, United Kingdom (of Great Britain and Northern Ireland)]	Noted, we took it into account during SOD consolidation, shortening where possible, avoiding text book style paragraphs, reminding AR5 statements and implementing tables to summarize where possible. Aerosol-cloud interactions are now described in ch 7.
42028	1	1	1	1	My overarching comment is that there is an impressive amount of material in this chapter, but, in common with most other chapters I looked at, I feel that the Chapter is much longer than it needs to be. In places it becomes as much a textbook, or historical review, of SLCFs, rather than an assessment of the current state of the field and it would benefit from significant pruning. [Keith Shine, United Kingdom (of Great Britain and Northern Ireland)]	Noted
15568	1	1			I would like to suggest to change a title into “Short-lived Climate Pollutants.“ [SANG-WOOK YEH, Republic of Korea]	Rejected - Title is given by the IPCC outlines agreed in IPCC plenary session.
41762	2	36	2	36	Possibly change title to make link to 6.2.1 and 6.2.2 clearer. E.g. "Implications of SLCF abundances for Atmospheric Oxidizing Capacity" [Jan Cermak, Germany]	Title has been updated in the FGD.
26976	4	1	9	30	Please give the full meaning of abbreviations with the first mentioning of a term (BC, OH, LULCC,NMHC, ODS, HDFC, HFC, NMVOC, BVOC, …). [Joachim Rock, Germany]	Editorial. Acronyms have been listed AR6 Annex.
14012	4	3	4	5	The Executive summary needs to be more elaborative to capture the true essence of the chapter. It should not start with an acronym such as SLCFs (Suggestive Para for replacement- "This chapter makes an assessment of scientific literature describing short-lived climate forcers (SLCFs) which continue to contribute the largest uncertainty to estimates and interpretations of the Earth’s changing energy budget focusing on the changes in sources and abundances of SLCFs. The chapter aims to assess how SLCFs contribute and respond to climate change while discussing their importance and influence for climate and relevant policies with an eye on identification of knowledge gaps and future scenarios. It presents an updated account of the SLCFs with following major conclusions:") [Nikhil Kant, India]	Accepted-text revised.
31006	5	1	5	1	At the moment the summary lacks a clear organisation. I suggest having a clear hierarchy between statements, with new/revised findings being given prominence. It would also be good to have a consistent set of statements across SLCF. [Nicolas Bellouin, United Kingdom (of Great Britain and Northern Ireland)]	Accepted-executive summary fully revised
53492	5	1	9	1	The ES needs to follow the guidlines given. It is also too much of a list of issues rather than highlighting findings from the assessment. [Jan Fuglestvedt, Norway]	Accepted-text revised
53494	5	1	9	1	I suggest you start the ES by defining SLCF (what componenst are included) [Jan Fuglestvedt, Norway]	Accepted-text revised
50802	5	1	9	30	Please consider to write the abreviations used, especially in the executive summary at least once, and preferably the first time it is used. [Ole-Kristian Kvissel, Norway]	Accepted - text revised

47250	5	1	9	30	I find the executive summary rather piece meal. It will help to connect the diifferent threads to provide a more connected summary. For example, bringing the emission changes together, processes e.g. changes to RF and co-benefits of SLCFs. Also there is only one line 26 on page 8 that mentions regional effects in airquality. More could be said from section 6.5.3. [Ranjeet Sokhi, United Kingdom (of Great Britain and Northern Ireland)]	Accepted-text revised
47866	5	1	9	30	A synthesis of the key messages for ch6 is needed as there are too many at present for an ES. Pleasee see other chapters's structures as guidance, e.g., chapter 5. [WGI TSU, France]	Accepted-text revised
48000	5	1	9		Executive Summary formatting is incorrect. Please bold the first sentence of each paragraph to highlight the main assessment conclusion, followed with additional details in unbold text. Please synthsise points further to have fewer key messages for policymakers. [WGI TSU, France]	Accepted - text revised
55572	5	3	5	3	Define SLCF on first use [Larry Horowitz, United States of America]	Accepted - text revised
31964	5	3	5	3	Starting with a explantion about what is meant with SLCF would be extremely useful. [Marie-France Loutre, Switzerland]	Accepted-text revised
55822	5	3	5	4	" largest uncertainty to estimates and interpretations of the Earth’s changing enery budget". Do not think it is a consensus that this contributes the 'largest' uncertainy to the estimates and interpretations of the Earth's changing energy budget. [venkatachalam ramaswamy, United States of America]	Noted
9382	5	3	5	4	The uncertainty to the Earth's changing energy budget: It is confusing that this chapter uses two differemt terms for the same issue because also the term Earth radiation budget or Earth radiation energy budget is used. It is strongly recommended to use only one term. It is noted that chapter 7 uses the term "Earth energy budget. [Klaus Radunsky Radunsky, Austria]	Accepted-text revised
14596	5	3	5	5	The executive summary is missing following key-elements of what is described in the details below it: changes in atmospheric processes and the co-benefits for health and ecosystems. Probably something about the near-term importance for mitigation of climate change is already needed here. [Frank Dentener, Italy]	Noted but not applicable: executive summary fully revised
47858	5	3	5	5	A short introductory paragraph to the scope of the chapter is a good idea for an ES but the first sentence is actually an assessment and perhaps is better placed in the chapter itself. Suggest to start this paragraph with an introduction to what is a SLCF, which species are covered, why they deserve their own noel chapter in the AE6, and then discuss the main sections of the chapter. [WGI TSU, France]	Accepted-text revised.
16356	5	3	9	30	Pleasse define all the abbreviations and acronyms used in the Executive Summary where they are iontrouced. Don't pre-suppose that the reader will know what they all mean. [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted-text revised
29830	5	5	5	5	I believe "contribute and respond to climate change" should be change to "contribute to climate system response" [Govindasamy Bala, India]	Rejected - we emphasize here the two-way coupling. SLCFs contribute to climate while they are influenced by climate change.
14594	5	9	5	9	I suggest to use the word chemical component instead of species- which for most people will have a biological meaning. [Frank Dentener, Italy]	Noted - and considered for the FGD.
41490	5	9	5	9	unclear if this statement applies to long-lived gases or just short-lived. It should be more specific what is included in "all species" for the purposes of chapter 6 as this will be different to elsewhere in the report [Amanda Maycock, United Kingdom (of Great Britain and Northern Ireland)]	Accepted-text revised.
41492	5	9	5	9	why is ammonia highlighted here? Was there some uncertainty in this statement before now that warrants special attention on ammonia? [Amanda Maycock, United Kingdom (of Great Britain and Northern Ireland)]	Accepted-text revised.

55574	5	9	5	9	Define scope of "all species" here. [Larry Horowitz, United States of America]	Noted but not applicable: executive summary fully revised
9380	5	9	5	9	Please explain in a footnote what species are understood to be SLCF. [Klaus Radunsky Radunsky, Austria]	Accepted-text revised
51646	5	9	5	9	Just to be clear, 50% of all emissions originate from Asia, or 50% of all SLCFs orignate from Asia? [Lindsey Cook, Germany]	Accepted - relative magnitudes of emissions clarified
53498	5	9	5	9	the sentence "Currently more than 50% of anthropogenic emissions of all species (including NH3) originate from..." is not precise. What is "all species". And how calulated? Temp, RF, time period? [Jan Fuglestvedt, Norway]	Accepted-text revised
24674	5	9	5	11	I presume this sentence just refers to SLCFs? [William Collins, United Kingdom (of Great Britain and Northern Ireland)]	Accepted-text revised
29832	5	9	5	11	A couple sentences on the historical perspective on regional aspects of emissions of SLCF would be extremely useful in this context. You cannot just jump to today's emissions directly. The starting of ES looks really odd. [Govindasamy Bala, India]	Not applicable the executive summary has been thoroughly modified but past trends in emissions are now discussed.
47514	5	9	5	11	Currently more than 50 % of anthropogenic emissions of all species originate from Asia (where 60% of the human population live), compared to .. % originating from North America and Europe, (where 14 % of human population live). When mentioning regional emissions, always mention regional populations. [Birgit van Munster, United Kingdom (of Great Britain and Northern Ireland)]	Noted.
6842	5	9	5	11	Does "all species" in this sentence really refer to all species or should it be "all short-lived climate forcer species"? [Eva Yvonne Pfannerstill, Germany]	Accepted-text revised
14598	5	9	5	28	I suggest to shorten and bring out more clearly: the location and composition of emissions has been changing with important consequences for impacts on climate. [Frank Dentener, Italy]	Accepted-text revised
29836	5	9	5	28	This whole discussion on the regional sources of emissions should belong to WG3 report. Instead, it would be good to start with some scientific discussion in WG1 report. [Govindasamy Bala, India]	Rejected-WG3 is about impacts. Regional emissions belong to WG1.
50358	5	9			Is this also holds true for tropospheric ozone? [Tirthankar Banerjee, India]	This holds for emissions of precursors of tropospheric O3
16358	5	10	5	10	Replace 'in Asia' with 'there' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Noted but not applicable: executive summary fully revised
31008	5	11	5	11	Would be useful to qualify that statement. Is that "in equal parts", or mostly AQ policies, or mostly export of factories? [Nicolas Bellouin, United Kingdom (of Great Britain and Northern Ireland)]	Accepted-text revised
16360	5	14	5	14	remove : and insert ( ) between North and China [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Noted but not applicable: executive summary fully revised
31010	5	14	5	15	Awkward phrasing since the species that decline are key players in terms of climate change and air quality. I would suggest dividing the summary in two: species whose emissions decrease and species whose emissions increase. It would also be good to link those emissions changes to climate impacts early on in the summary. [Nicolas Bellouin, United Kingdom (of Great Britain and Northern Ireland)]	The executive summary has been thoroughly modified and this assertation does not appear anymore
29834	5	21	5	23	I do not think CMIP5 and CMIP6 project emissions of SLCF. The emissions are rather prescribed to CMIP5 and CMIP6. [Govindasamy Bala, India]	Noted but not applicable: executive summary fully revised
9164	5	21	5	23	While it is good that NH3 emissions from wastewater and human waste are now included, it demonstrates that climate science is still evolving. [Jim O'Brien, Ireland]	Noted.
16362	5	25	5	25	Edit to '..increasing and have about doubled since 1950' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Noted but not applicable: executive summary fully revised

41494	5	25	5	28	Is this finding different from AR5? Be more specific about whether this is a new finding or whether the confidence level has changed since AR5 [Amanda Maycock, United Kingdom (of Great Britain and Northern Ireland)]	Noted but not applicable: executive summary fully revised
46134	5	28	5	28	Qualify here that you mean the large reductions are for the NA and Europe regions [Cynthia Randles, United States of America]	Noted but not applicable: executive summary fully revised
14600	5	30	5	35	The term/concept LULCC is perhaps less known than LULUCF (which is recognized in UNFCCC). It would be helpful to somewhere explain why LULCC is more appropriate (possibly with linkage to SR on Land) [Frank Dentener, Italy]	Accepted-text revised
14604	5	30	5	36	Not clear at this point why isoprene emissions are lifted out as LULUCF induced, but not for instance biomass burning, Nox, NH3 emissions (even if assessment is that they are less important). [Frank Dentener, Italy]	Not applicable this point is not anymore in the executive summary
55576	5	31	5	31	Define LULCC on first use [Larry Horowitz, United States of America]	Accepted - text revised
31012	5	31	5	31	In addition to the acronym LULCC not being defined yet, it would be good to state what qualifies a species to be an LULCC. [Nicolas Bellouin, United Kingdom (of Great Britain and Northern Ireland)]	Accepted-text revised
9386	5	31	5	31	Please explain the abbreviation LULCC (Land Uses and Land Cover Changes). [Klaus Radunsky Radunsky, Austria]	Accepted-text revised
53496	5	31	5	31	As far as I can see, LULCC is not defined anywhere in the chapter (land use and land cover change) [Jan Fuglestvedt, Norway]	Accepted-text revised
43384	5	31	5	42	The term LULCC is never defined either in the ES or in the chapter proper. [Kristina Pistone, United States of America]	Accepted - text revised
28948	5	32	5	32	I encourage the authors to banish the word "change" when the sign of the change is known, as it is here [Keith Shine, United Kingdom (of Great Britain and Northern Ireland)]	Rejected- remove 'change' may lead to confusion
16364	5	32	5	32	Change to Pre-Industrial for consistency with other Chapters and to reflect use as a proper noun [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted - text revised
55578	5	32	5	34	Hgih confidence seems to strong for this claim. [Larry Horowitz, United States of America]	Noted , the sentence does not appear anymore in the ES.
28950	5	35	5	35	Be useful to indicate what is ultimately driving the feedback. Temperature change [Keith Shine, United Kingdom (of Great Britain and Northern Ireland)]	Not applicable the executive summary has been thoroughly modified and this assertation does not appear anymore
14602	5	38	5	38	Some coordination with Ch 5 is need wrg to CH4- with similar messages.. On the other I am missing some key-statements on ozone-depleting components emissions, which are probably not elsewhere, and quit important as well. [Frank Dentener, Italy]	Noted but not applicable: executive summary fully revised
9388	5	38	5	40	It seems to be important to address also the linkage to the results for the concentration of CH4 in the atmosphere - see page 6 lines 36 to 39. This seem to relate to significant uncertainties related to emissions of CH4, be it natural and/or anthropogenic. [Klaus Radunsky Radunsky, Austria]	Noted but not applicable: executive summary fully revised
47868	5	38	5	40	Box 2.2 in Chapter 2 of the SRCCL addresses methodological aspects of esimating GHG emissions. Would a cross-reference be useful in this ch6 section? Additionally, should this ES statement link to 6.2.2.4 (methane) and not 6.2.1. (Natural Sources)? [WGI TSU, France]	Noted but not applicable: executive summary fully revised
28952	5	39	5	39	"steadily growing" is a bit vague. Include the rate of growth? [Keith Shine, United Kingdom (of Great Britain and Northern Ireland)]	Noted but not applicable: executive summary fully revised
28954	5	42	5	42	Is the sign of the "impact" universally negative - if so, say so [Keith Shine, United Kingdom (of Great Britain and Northern Ireland)]	Noted but not applicable: executive summary fully revised
38196	5	42	5	43	This sentence is not on emissions. The paragraph should be moved to the “forcing” or “impact” part. [Hitoshi Matsui, Japan]	Accepted-text revised

31014	5	46	5	46	Statements on abundance trends mirror those on emissions (except for ammonia perhaps), which is expected for SLCF, so why not merge the statements together? That would make a strong link between emissions (on which policy can act), concentrations, and climate effects. [Nicolas Bellouin, United Kingdom (of Great Britain and Northern Ireland)]	Accepted-text revised
55582	5	48	5	48	Clarify that NOx *burden* increase is being referred to here (?) [Larry Horowitz, United States of America]	Noted but not applicable: executive summary fully revised
24676	5	48	5	48	Is it not "virtually certain" that Nox has increased - is there any plausible way it might not have? [William Collins, United Kingdom (of Great Britain and Northern Ireland)]	Noted but not applicable: executive summary fully revised
16366	5	48	5	48	Change to Pre-Industrial for consistency with other Chapters and to reflect use as a proper noun [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Noted but not applicable: executive summary fully revised
53500	5	48	5	48	I suggest you write " (NO + NO2) " after "NOx" [Jan Fuglestvedt, Norway]	Accepted-text revised
55580	5	48	5	52	Assessment seems to have changed from "high confidence"/"medium confidence" in Emissions section to "very likely"/"likely" in this paragram. Why? [Larry Horowitz, United States of America]	Noted but not applicable: executive summary fully revised
49962	5	49			Satellite instuments, such as OMI, detect tropospheric column NO2, not NOx [Owen Cooper, United States of America]	Noted but not applicable: executive summary fully revised
28956	5	51	5	51	This decline doesn't seem consistent (I know it doesn't have to be) with what is implied under the emissions section on this page (line 14) [Keith Shine, United Kingdom (of Great Britain and Northern Ireland)]	Noted but not applicable: executive summary fully revised
16354	5		78		This chapter was not an easy read! First, keeping track of all the abbreviations and acronyms across over 70 pages of text is well-nigh impossible, especially when these are introduced early on in the Chapter (for example BVOCs should be defined on page 7, but by the time I get to page (eg) 50+ I have forgotten what they are). I strongly suggest incorporating a table of acronyms and abbreviations somewhere around Section 6.1, to which the reader can easily refer, rather than having to trawl through the text to find the details. Such an approach is used successfully in Chapter 2 and makes for a much easier read. Second, the quality of editing of this Chapter is appalling, with inconsistencies in spelling, style and general grammar not only between pages but between paragraphs. I know this is only a first draft but I am concerned to see reviewers being presented with so many issues. Fundamentally, if a student presented me with work of this quality I would fail them, and too often my eye was drawn to picking out these issues rather than looking in detail at the science. There is the danger that a reader will perceive poorly edited and sloppy text as representing sloppy (and unreliable) science. I have flagged a lot of these points below, primarily as editorial issues but I could have flagged them as substance issues too, for the reasons just mentioned. [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Noted and considered in SOD
16368	6	1	6	1	Edit to 'declined between 1980 and 2015, with…' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Noted but not applicable: executive summary fully revised
28828	6	1	9	30	I liked aspects of the fact based ES, but it was generally too long and disjointed. Connfidence statementas seemred littered in an ad-hoc way. E.g. The paragraph that restated the SR1.5 conclusions had high confidence? Generally I would not mix agreement and evidence statements in with confidence statmeents in the ES. I would also consider bringing out and sythesising the main headline points, especially for anything you might want to see at SPM level [Piers Piers Forster, United Kingdom (of Great Britain and Northern Ireland)]	Accepted-text revised

40644	6	1			The executive summary is obviously an early draft so I am not commenting on minor substantive issues in the summary. [Daniel Murphy, United States of America]	Noted
16370	6	2	6	2	Delete 'time' to remove a tautology [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Noted but not applicable: executive summary fully revised
41496	6	3	6	3	"trends are more scattered" suggest finding alternative scientific wording [Amanda Maycock, United Kingdom (of Great Britain and Northern Ireland)]	Noted but not applicable: executive summary fully revised
47652	6	5	6	9	The executive summary is not organized in such a way as to be accessible to readers. There are a number of SLCF's that are discussed, but there needs to be an opening paragraph that frames the discussion for the reader and rank-orders these forcing agents or discusses why they are broached in the particular order in which they are presented. [Daniel Feldman, United States of America]	Accepted - executive summary fully revised
47654	6	5	6	9	The discussion of SLCF's, if it includes future emissions scenarios, is incomplete unless it undertakes a serious discussion about solar radiation management through stratospheric sulfate aerosol injection. Sulfate aerosols are short-lived and force the climate system, and this includes purposeful deployment of such aerosols. Readers will be confused if they seek information about all significant SLCF's such as sulfate aerosols but only have an incomplete assessment of the forcing that may occur in the 21st Century. [Daniel Feldman, United States of America]	Noted but not applicable: executive summary fully revised.
28958	6	7	6	7	I am not sure what the "modern period" means [Keith Shine, United Kingdom (of Great Britain and Northern Ireland)]	Noted but not applicable: executive summary fully revised
31016	6	7	6	7	Time periods are all over the place, and terms like "modern period" are unclear. Would it be possible to use the same periods for all species? [Nicolas Bellouin, United Kingdom (of Great Britain and Northern Ireland)]	The executive summary has been thoroughly modified and time period have been made clear
24678	6	7	6	8	Should state what the estimate of modern period global total CO distribution actually is. [William Collins, United Kingdom (of Great Britain and Northern Ireland)]	Noted but not applicable: executive summary fully revised
44218	6	7	6	8	The previous text has reffered to many recent times (1980-2015, 2005-2015, etc.), so here it would be helpful to define 'modern period' when discussing CO. [Drew Shindell, United States of America]	Noted but not applicable: executive summary fully revised.
41498	6	8	6	8	"in the modern period" define what time period this refers to [Amanda Maycock, United Kingdom (of Great Britain and Northern Ireland)]	Noted but not applicable: executive summary fully revised
16372	6	8	6	8	Delete , after 'period' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Noted but not applicable: executive summary fully revised
28960	6	10	6	10	"well understood" or "well observed"? [Keith Shine, United Kingdom (of Great Britain and Northern Ireland)]	Noted but not applicable: executive summary fully revised
40646	6	10	6	10	It is not clear whether this statement refers to the vertical distribution of ammonia within the column or the total column abundance of ammonia as a function of region. In either case, I think that the evidence of the chapter is that ammonia abundance is qualitatively understood – emissions sources and sink processes are known – but that the ammonia abundance is quantitatively not as well understood, since there are so few high quality measurements, especially far from sources. [Daniel Murphy, United States of America]	Noted but not applicable: executive summary fully revised.
16374	6	10	6	10	Insert 'the' after 'of' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Noted but not applicable: executive summary fully revised

53502	6	10	6	12	Strange to refer to the previous assessment in the ES. While it certainly makes sense to build on previous work and assessments, I hope the assessments done in AR6 - in this chapter and other chapters such as ch5 and 7 - will form the basis for ES statements [Jan Fuglestvedt, Norway]	Accepted-text revised.
14606	6	20	6	23	A discussion on the development of other aerosol components than carbonaceous aerosol seems missing. Where is dust, sulfate, nitrate. [Frank Dentener, Italy]	Accepted-text revised.
53504	6	21	6	21	LWP shoudl be defined in ES [Jan Fuglestvedt, Norway]	Noted but not applicable: executive summary fully revised
31018	6	21	6	23	Good to mix trends and climate effects, but that is not done consistently for all species. [Nicolas Bellouin, United Kingdom (of Great Britain and Northern Ireland)]	Noted but not applicable: executive summary fully revised
38198	6	21	6	23	This sentence (“There is increased..”) should be moved to the “forcing” or “impact” part. This paragraph should focus on recent findings of processes and abundances such as BC aging and its long-range transport, new particle formation, SOA formation, and ice nucleating particles. [Hitoshi Matsui, Japan]	Accepted-text revised.
16376	6	22	6	22	Change 'maybe' to 'may be' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Noted but not applicable: executive summary fully revised
41502	6	22	6	23	"that BC causes significant model spread in predicted precipitation compared to other climate drivers." This does not make sense and needs more careful wording [Amanda Maycock, United Kingdom (of Great Britain and Northern Ireland)]	Accepted-text revised.
24680	6	25	6	26	The "remained constant" needs to have a range, otherwise it is "exceptionally unlikely" that OH has remained exactly constant. [William Collins, United Kingdom (of Great Britain and Northern Ireland)]	Noted but not applicable: executive summary fully revised
25980	6	25	6	26	Since OH varies, by definition it cannot be absolutly constant. For this likelihood statement to make sense, some range of variation or trend around constant is needed. Suggest providing a range of variation around constant that is associated with the likelihood assessment. Since this paragraph uses this statement to discuss the cause (or unknown cause) of methane slowdown, the variation in OH that would be needed to cause the slowdown may be the appropriate magnitude to consider in defining what is meant by constant. [Haroon Kheshgi, United States of America]	Noted but not applicable: executive summary fully revised
40996	6	26	6	26	“longer time scales” is a very vague term. [Johannes Laube, Germany]	Noted but not applicable: executive summary fully revised
16378	6	29	6	29	Edit for grammar and sense: '..ability tp elcuidate accurately the interannual variability in OH from the 1980s to the present.' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted - text revised
31020	6	30	6	32	Too much specialist knowledge assumed from the reader here. [Nicolas Bellouin, United Kingdom (of Great Britain and Northern Ireland)]	Noted but not applicable: executive summary fully revised
44408	6	31			It is not ture that there is "no observational evidence for aerosol impact on ice clouds." Christensen et al. (2016), JGR doi:10.1002/2016JD025245 quantified the radiative effects from major cloud type regimes (stratus, stratocumulus, cumulus, altocumulus, altostratus, nimbostratus, and deep convection) sorted by cloud top temperature and came to the conclusion that the aerosol indirect effect is dictated by warm boundary layer clouds. Aerosol impacts on ice clouds were also observed by Storer et al. (2014), JGR, doi:10.1002/2013JD020272. [Matthew Christensen, United Kingdom (of Great Britain and Northern Ireland)]	Noted but not applicable: executive summary fully revised
14608	6	36	6	36	There is a similar message in Chapter 5. Chapter 2 key message for CH4 is about increases since 2011 (the last date in AR5)- seems consistent. [Frank Dentener, Italy]	Noted but not applicable: executive summary fully revised

28962	6	36	6	36	I am not sure what the source of doubt is here. Isnt in "unequivocal"? Actually, the main text says this at 28:21 and I would use the same wording here. [Keith Shine, United Kingdom (of Great Britain and Northern Ireland)]	Noted but not applicable: executive summary fully revised
47512	6	36	6	39	Will Methane be discussed both in chapter 5 and chapter 6? [Birgit van Munster, United Kingdom (of Great Britain and Northern Ireland)]	yes, but cross chapter consistency is checked
47860	6	36	6	39	The recent changes in methance concentration are also covered in Chapter 5 (Section 5.2.2) and the Special Report on Land (SRCCL, Section 2.4.2). The SRCCL Ch2 Exec Summary statement on this topics is as follows. "The pause in the rise of atmospheric CH4 concentrations between 2000 and 2006 and the subsequent renewed increase appear to be partially associated with land use and land use change. The recent depletion trend of the 13C isotope in the atmosphere indicates that higher biogenic sources explain part of the current CH4 increase and that biogenic sources make up a larger proportion of the source mix than they did before 2000 (high confidence). In agreement with the findings of AR5, tropical wetlands and peatlands continue to be important drivers of inter-annual variability and current CH4 concentration 6 increases (medium evidence, high agreement). Ruminants and the expansion of rice cultivation are also important contributors to the current trend (medium evidence, high agreement). There is significant and ongoing accumulation of CH4 in the atmosphere (very high confidence)." please check for consistency and provide an update from the SRCCL and chapter 5. A callout to this special report is needed if the methane assesent is kept in chapter 6. [WGI TSU, France]	Noted-cross chapter issue are regularly checked
40998	6	36	7	6	This is somewhat repetitive of Chapter 2 and needs more inter-chapter coordination. [Johannes Laube, Germany]	Accepted- this cross chapter issue has been resolved in SOD
47952	6	37	6	37	Moderate evidence' should be medium evidence. IPCC uncertainty language used incorrectly. Please refer to the IPCC guidance note on uncertainty for correct list of terms that can be used: https://wg1.ipcc.ch/SR/documents/ar5_uncertainty-guidance-note.pdf [WGI TSU, France]	Noted-uncertainty language has been checked
47644	6	37	6	39	This sentence needs to indicate the limited constraints provided by current flask and remote sensing observational network, such as described in Turner et al (doi:10.1073/pnas.1814297116) [Daniel Feldman, United States of America]	Noted but not applicable: executive summary fully revised
28964	6	38	6	38	Suggest including possibility that this increase (like isoprene earlier) could have a component of climate feedback [Keith Shine, United Kingdom (of Great Britain and Northern Ireland)]	Noted but not applicable: executive summary fully revised
55584	6	41	6	43	Studies such as Mickley et al and Parrish et al seem to raise issues concerning mid-latitude ozone trend assessments at mid-latitudes. Is medium-to-high agreement warranted? [Larry Horowitz, United States of America]	Noted but not applicable: executive summary fully revised
8028	6	41	6	43	I suppose the reader might be more interested in wht kind of changes can be seen in those locations, rather than that changes are "robust". Also the first half of this sentence is too complicated for me -- robust evidence with a medium to high level of agreement, but then medium confidence? About what? [Olaf Morgenstern, New Zealand]	Noted but not applicable: executive summary fully revised
24682	6	41	6	45	Should state what the changes in ozone actually are. [William Collins, United Kingdom (of Great Britain and Northern Ireland)]	Noted but not applicable: executive summary fully revised
44220	6	41	6	45	This paragraph describes the confidence associated with data on ozone changes without telling us anything at all about what the changes themselves. Not very interesting to a reader! [Drew Shindell, United States of America]	Noted but not applicable: executive summary fully revised

6844	6	41	6	50	This paragraph discusses changes in tropospheric ozone and their certainty level, but a statement on the direction of these changes (increase, decrease, where?), in the way it is provided for the other SLCFs discussed on this page, is missing. [Eva Yvonne Pfannerstill, Germany]	Noted but not applicable: executive summary fully revised
41504	6	42	6	42	does this statement apply to tropospheric AND stratospheric ozone? Please clarify [Amanda Maycock, United Kingdom (of Great Britain and Northern Ireland)]	Noted but not applicable: executive summary fully revised
9390	6	42	6	42	It should be clarified that this paragarph addresses troposheric ozone but not stratospheric ozone. [Klaus Radunsky Radunsky, Austria]	Noted but not applicable: executive summary fully revised
16380	6	42	6	42	Change to '20th Century' for correctness (in this context 'century' is a proper noun) and consistency elsewhere in the WGI documentation [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Noted but not applicable: executive summary fully revised
28966	6	43	6	43	Some text missing in this bullet? [Keith Shine, United Kingdom (of Great Britain and Northern Ireland)]	Noted but not applicable: executive summary fully revised
55586	6	43	6	45	This senstence is unclear and should be rewritten. [Larry Horowitz, United States of America]	Noted but not applicable: executive summary fully revised
8026	6	43	6	45	I don't understand this sentence. How can profiles for NA and Europe be used to draw conclusions about the tropics and southern midlatitudes? Please rephrase / clarify. [Olaf Morgenstern, New Zealand]	Noted but not applicable: executive summary fully revised
28924	6	43	6	45	The sentence doesn't make sense, but the point I suspect it's making is dubious (refer SPARC LOTUS report). [Matt Tully, Australia]	Noted but not applicable: executive summary fully revised
16382	6	44	6	44	Insert 'the' after 'to' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Noted but not applicable: executive summary fully revised
25982	6	46	4	47	In this statement it is unclear whether one is refering to the change in RF since 2010 (since AR5) or since preindustrial time. Suggest clarifying. [Haroon Kheshgi, United States of America]	Accepted-text revised.
14610	6	47	6	47	Key message on tropospheric and stratospheric ozone are consistent with chapter 2, which focuses on observed quantities [Frank Dentener, Italy]	Noted
28968	6	47	6	47	There is no information here on the sign, size and attribution of any ozone change. [Keith Shine, United Kingdom (of Great Britain and Northern Ireland)]	Noted but not applicable: executive summary fully revised
55588	6	47	6	48	Mention also satellite retrievals as evidence for ozone burden estimates [Larry Horowitz, United States of America]	Noted but not applicable: executive summary fully revised
24684	6	47	6	50	This should state what the tropospheric ozone burden is. I don't think it is a crucial point for the ES to say that the confidence in individual models is lower than in the multi-model mean. [William Collins, United Kingdom (of Great Britain and Northern Ireland)]	Noted but not applicable: executive summary fully revised
49964	6	48	6	50	This sentence needs to be re-worked as it seems to be trying to make two different statements and some key words appear to be missing. The first part of the sentence seems to be talking about ozone profiles above North America and Euorpe, while the second part seems to be talking about the tropics and the southern hemisphere, and it's not clear if surface ozone or profiles are being discussed. [Owen Cooper, United States of America]	Noted but not applicable: executive summary fully revised
49966	6	48			This sentence needs to be re-worked because it's not clear how the individual models are evaluated. Does the following suggested sentence get the intended point across? "However, there is medium confidence (low to medium agreement and medium evidence) that an individual model can provide an accurate estimate of the tropospheric ozone burden, and the related ozone budget terms." [Owen Cooper, United States of America]	Noted but not applicable: executive summary fully revised
16384	6	52	6	54	Not sure why all this text is in italics. [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Noted but not applicable: executive summary fully revised

41506	6	52	6	54	Poor grammar and needs rewording [Amanda Maycock, United Kingdom (of Great Britain and Northern Ireland)]	Noted but not applicable: executive summary fully revised
44222	6	52	6	54	I'm not sure what time period the 'unpreturbed from ODS period' refers to. I would fully accept that the column is low currently compared with just before ODS (e.g. the 1960s or early 1970s), but not obvious to me that we can conclude this is the case relative to preindustrial as tropospheric abundances may have been substantially lower. As the next phrase about forcing refers to preindustrial, I think it's important to define what the phrase I mentioned means here. [Drew Shindell, United States of America]	Noted but not applicable: executive summary fully revised
24686	6	52	6	55	Estimates of radiative forcing should refer to chapter 7. Note there the stratospheric ozone forcing is larger than AR5. [William Collins, United Kingdom (of Great Britain and Northern Ireland)]	Noted but not applicable: executive summary fully revised
16386	6	53	6	53	Change to Pre-Industrial [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Noted but not applicable: executive summary fully revised
55590	6	53	6	53	Clarify wording of "unperturbed from ODS period", e.g., to "prior to ODS increases". [Larry Horowitz, United States of America]	Noted but not applicable: executive summary fully revised
41000	6	53	6	53	I recommend changing this to “during the ODS-unperturbed period”. [Johannes Laube, Germany]	Noted but not applicable: executive summary fully revised
51648	7	1	7	3	Maybe help the reader better understand how something can increase in the atmosphere, with decreased growth rates? Obvious to a scientist but to a reader is confusing. [Lindsey Cook, Germany]	Noted but not applicable: executive summary fully revised
14612	7	1	7	6	Chapter summarizes overall HCFC trends in terms of RF. Need to cross check numbers with Chapter 6. [Frank Dentener, Italy]	Accepted -- #s validated against Ch. 6
55592	7	1	7	6	Mention finidings regarding recent CFC-11 trends? [Larry Horowitz, United States of America]	Noted but not applicable: executive summary fully revised
28970	7	4	7	4	A problem with the assessment's structure is that not all HFCs are SLCFs (this is recognised later) and perhaps should be clear here. [Keith Shine, United Kingdom (of Great Britain and Northern Ireland)]	Noted but not applicable: executive summary fully revised
41510	7	4	7	6	OK but to give a more balanced picture you might consider adding a sentence here on HFC projections in light of the Kigali Amendment to the Montreal Protocol [Amanda Maycock, United Kingdom (of Great Britain and Northern Ireland)]	Noted but not applicable: executive summary fully revised
51636	7	8	7	13	Beautifully clear, thank you. [Lindsey Cook, Germany]	Noted
55732	7	8	7	30	Cite ERF estimates from aerosols from Ch.7. [Larry Horowitz, United States of America]	Accepted-text revised
38200	7	8	8	15	A paragraph on LAP impact on snow/ice darkening should be added to this section ("SLCF radiative forcing and impact"). [Hitoshi Matsui, Japan]	Rejected - not new assessment since SROCC that could be elevated in the ES.
29842	7	8	8	15	The ES could start with this section as I see more science here. [Govindasamy Bala, India]	ES is fully revised.
47880	7	10	7	12	Citations should not appear in an ES, only in the underlying chapter. [WGI TSU, France]	Editorial, and fixed.
24688	7	10	7	12	This shouldn't use AR5 to justify an ES statement. And if there hasn't been new understanding since AR5 then it probably doesn't need to be in the ES. [William Collins, United Kingdom (of Great Britain and Northern Ireland)]	Accepted-text revised
14618	7	10	8	15	Sequences of key-statements can be organized better, e.g. anthropogenic emissions, natural emissions and feedbacks, impacts on changing precipitation/circulation, impacts on air quality. [Frank Dentener, Italy]	Accepted - executive summary fully revised
9392	7	11	7	11	Clarify that this sentence addresses troposheric ozone. [Klaus Radunsky Radunsky, Austria]	Noted but not applicable: executive summary fully revised

41508	7	14	7	14	"The models agree that the increasing emissions" which models and emissions of what? Please clarify [Amanda Maycock, United Kingdom (of Great Britain and Northern Ireland)]	Noted but not applicable: executive summary fully revised
55594	7	14	7	14	Add "of ozone precursors" after "emissions" [Larry Horowitz, United States of America]	Noted but not applicable: executive summary fully revised
14614	7	14	7	17	Key message on ozone is well supported by the observational summary in Chapter 2. It also supported well by lack-of-knowledge: chapter 2 p 93-l37-45 which makes the argument that observation based improvement of models is the only way to gain trust in RF estimates. [Frank Dentener, Italy]	Noted
24690	7	14	7	18	These numbers will presumably be updated with CMIP6 data. Chapters 6 and 7 will need to ensure the numbers are consistent. [William Collins, United Kingdom (of Great Britain and Northern Ireland)]	Noted
51974	7	15			Given that the increase has only medium confidence and that this is assessed as unchanged since AR5 it feels odd to then go on to describe it as a fact that confidence has increased in the following sentence. I would use a less definitive construct here for narrative continuity and to avoid any unwarranted issues arising. More generally this summary should be reviewed and revised for internal consistency. [Peter Thorne, Ireland]	Accepted - text revised
16388	7	16	7	16	Change to '20th Century' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Noted but not applicable: executive summary fully revised
31022	7	17	7	17	Relying on model is not necessarily cause for low confidence. There would need to be a statement about model quality first. [Nicolas Bellouin, United Kingdom (of Great Britain and Northern Ireland)]	Noted but not applicable: executive summary fully revised
24692	7	20	7	23	Better to say that systematic changes in LWP are small, rather than categorically asserting that none occur. [William Collins, United Kingdom (of Great Britain and Northern Ireland)]	Noted but not applicable: executive summary fully revised
14616	7	20	7	30	There is a lack of quantification (RF) estimates here. Some of this bullet would fit better on the header of 'processes' in the previous Atmospheric processes?? [Frank Dentener, Italy]	Noted and considered in SOD
31024	7	21	7	21	Would say "subsequent adjustments" to clearly link with the previous sentence. [Nicolas Bellouin, United Kingdom (of Great Britain and Northern Ireland)]	Noted but not applicable: executive summary fully revised
46658	7	21	7	21	Define LWP [WGI TSU, France]	Editorial
28972	7	22	7	22	Need to be clear that this is referring to the impact of aerosol on clouds, rather than feedback related processes [Keith Shine, United Kingdom (of Great Britain and Northern Ireland)]	Noted but not applicable: executive summary fully revised
55596	7	22	7	22	Add "robust" before "observational". [Larry Horowitz, United States of America]	Noted but not applicable: executive summary fully revised
40648	7	22	7	23	Saying that "there is no observational evidence for a significant response of ice clouds to aerosol perturbations" is misleading for two reasons. First, the statement is not neutral. It sounds as if a tentative conclusion is that there is no significant response. A better statement would be "there is no strong observational evidence to constrain whether or not there has been a significant response of ice clouds to aerosol perturbations." Second, there is some mild evidence, see review comments to section 6.3.2. [Daniel Murphy, United States of America]	Noted but not applicable: executive summary fully revised
31026	7	27	7	29	I don't follow that implication. If models struggle to represent aerosols and their climate effects, why would an ensemble of models be any better? [Nicolas Bellouin, United Kingdom (of Great Britain and Northern Ireland)]	Noted but not applicable: executive summary fully revised

40650	7	32	7	40	This is one of my more important comments. This pair of conclusions is both very important and problematic. I believe it is important to clearly state, as done here, that the temperature response from regional SCLFs can extend across at least a hemisphere. It can be surprising how common it is to see the misunderstanding that, for example, sulfate aerosol over the eastern US cools just the eastern US (and not other places), BC over India only warms India, and so forth. This chapter is a good place to address that. It would be useful to state the same conclusion both ways: temperature responses extend over wide regions, and temperature responses are not purely local. What is problematic is that both here and in section 6.3.4 there is a lack of conceptual clarity about the reasons for the regional patterns of the temperature responses to SLCFs. There is no clear distinction between what is common to all forcings and what is specific to a given forcing. An example is the statement on line 37-38 that “SO2 emissions reductions…increase surface temperature in the northern hemisphere high latitudes.” Readers could easily think that this pattern is something specific to SO2. My interpretation is that because of Arctic amplification almost any warming occurs strongly at northern high latitudes. It doesn’t matter if the positive forcing is from SO2 reductions, GHG increases or whatever. But there are forcings where at least part of the temperature pattern is due to the SLCF. BC emitted at high latitudes probably has an even larger effect at high latitudes, larger than a similar positive forcing from GHGs, because of BC on snow. Throughout section 6.3.4 these distinctions between common and special temperature patterns need to be kept clear. [Daniel Murphy, United States of America]	Accepted-text revised
55598	7	35	7	35	Should "GHG" be changed to "LLCF" here? [Larry Horowitz, United States of America]	Noted but not applicable: executive summary fully revised
41512	7	37	7	37	"may lead to the strongest response" of what? Climate? All SLCFs? [Amanda Maycock, United Kingdom (of Great Britain and Northern Ireland)]	Accepted-text revised.
55600	7	37	7	37	Clarify that this sentence refers to strongest *climate* response. [Larry Horowitz, United States of America]	Accepted - text revised
49968	7	37			It's not clear what is meant by "strongest response". Is SO2 being compared to all other SLCFs? [Owen Cooper, United States of America]	This is compared to BC and OC. Text is revised
16390	7	38	7	38	Capitalise 'Northern Hemisphere' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted - text revised
16392	7	39	7	39	Insert , after 'precipitation' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted - text revised
29838	7	42	7	44	I believe that the ITCZ shifts southward for NH cooling. [Govindasamy Bala, India]	Noted but not applicable: executive summary fully revised
16394	7	43	7	43	Capital C required for 'cell' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Noted but not applicable: executive summary fully revised
31028	7	43	7	44	Are all elements in that chain really virtually certain? [Nicolas Bellouin, United Kingdom (of Great Britain and Northern Ireland)]	Noted but not applicable: executive summary fully revised
55602	7	46	7	46	"net sign of the influence" --> "sign of the net influence" [Larry Horowitz, United States of America]	Noted but not applicable: executive summary fully revised
29840	7	46	7	47	The magnitude of the global radiative forcing is too small. Why to even talk about this in terms of global mean radiative forcing? I agree that the cook stove related emissions may have large regional signature. [Govindasamy Bala, India]	This is for measures to reduce SLCFs and mitigate warming
28974	7	49	7	49	Since the previous para talks about cookstoves, this leaves an ambiguity as to what "fires" means here - presumably biomass burning? [Keith Shine, United Kingdom (of Great Britain and Northern Ireland)]	Accepted-changed to biomass burning

55604	7	50	7	50	Is this intended to refer to aerosol-cloud radiative influence *from fires*? [Larry Horowitz, United States of America]	Accepted-clarified in the text.
49974	7	51			This statement should be attributed to section 6.4.2.2 Biomass burning, not Section 6.4.2.1 Household biofuel burning [Owen Cooper, United States of America]	Noted but not applicable: executive summary fully revised
16396	7	53	7	53	Change to Pre-Industrial [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted - text revised
41002	7	53	7	55	What is the lower end of that estimate? [Johannes Laube, Germany]	Noted but not applicable: executive summary fully revised.
24694	7	53	7	55	This is a very dramatic statement and will no doubt attract a lot of attention, so it is essential that it can be fully backed up. There doesn't however seem much discussion of it in 6.4.2.3 other than a brief reference to a single study. [William Collins, United Kingdom (of Great Britain and Northern Ireland)]	Not applicable. the executive summary has been thoroughly modified and this assertation does not appear anymore
9394	7	53	7	55	This is an interesting finding. However, it needs some further clarification what the contribution of the CO2 emissions from LULCC has been. [Klaus Radunsky Radunsky, Austria]	Not applicable, the point is no longer in the executive summary
51650	7	53	7	55	Are you saying that LULCC are responsible for 45% of global warming to date? If not, please can you write more clearly? And if so, an important message for the effectiveness of urgent action on these activities - expand. [Lindsey Cook, Germany]	Noted but not applicable: executive summary fully revised
40652	7	53	7	55	After multiple readings I don't understand what this conclusion says. [Daniel Murphy, United States of America]	Noted but not applicable: executive summary fully revised.
49970	7	53			Here it states that "Preindustrial to present day anthropogenic LULCC have resulted in a global warming that is equivalent to up to 45% of the net anthropogenic global warming including...". This number does appear in Section 6.4.2.3, but it does not appear in the section's summary statement. The statements in the Executive Summary need to be consistent with the summary statements at the end of each section. [Owen Cooper, United States of America]	Accepted - text revised
14620	7	54	7	54	Not clear whether net anthropogenic warming pertains to all GHGs and other factors, or only SLCFs? How does this connect to the isoprene message on page 6.5? [Frank Dentener, Italy]	Noted and considered in SOD
49972	7	55			This summary statement comes from Section 6.4.2.3 on page 60, but here in the summary statement it says that it comes from Section 6.4.2.2., which is incorrect. Section 6.4.2.2. deals with biomass burning, not LULCC. [Owen Cooper, United States of America]	Noted but not applicable: executive summary fully revised
41004	8	10	8	11	Consider moving the two statements on cookstoves so that they are next to each other. [Johannes Laube, Germany]	Noted but not applicable: executive summary fully revised
44224	8	10	8	11	This seems to me to follow logically (and a bit obviously) from the similar result on page 7, lines 46-47 (so could combine and/or delete). If the point is to include CO2 changes based on sustainability of fuel source, that could be made clear and then this would not simply duplicate the prior statement. [Drew Shindell, United States of America]	Accepted-text revised
28976	8	13	8	13	As written this indicates there is only medium confidence that SO2, for example, leads to cooling. Don't we have more confidence in this? [Keith Shine, United Kingdom (of Great Britain and Northern Ireland)]	This sentence considers all SLCFs

25984	8	13	8	15	I would think that reductions in HFCs would contribute to climate mitigation with comparable or higher confidence as methane, yet this statement seems to contradict that assessment. Suggest considering if the statement (e.g. sign) is of lower confidence for HFCs than methane and correcting if appropriate. [Haroon Kheshgi, United States of America]	Not applicable the executive summary has been thoroughly modified
44226	8	13	8	15	The first phrase would be much more useful to readers if it described the effects of SLCF reductions on air quality, ie. That they improve air quality, rather than only giving the confidence associated with the unspecified impacts. [Drew Shindell, United States of America]	Accepted-text revised
44228	8	13	8	15	The conclusions about climate seem incorrect to me. Not only methane reductions have clear climate benefits, but also reductions in the short-lived halocarbons (as included in your Figure 6.1) and reductions in specific BC-rich sectors such as wick lamps (pretty much BC only) or sources in high albedo regions (which give stronger BC impacts relative to OC). If you're speaking only of 'across-the-board' reductions, then I agree that BC doesn't make the list, but then I think it should be clear that that's what's meant. [Drew Shindell, United States of America]	Accepted and considered in FGD ES
51652	8	13	8	15	Connect air quality to uman consequence to engage reader - positive conseqence with action, i.e.: 'high confidence in the effects of reduced emissions of SLCFs' on air quality and the corresonding reduction in mortaliy rates as a result… [Lindsey Cook, Germany]	Noted but not applicable: executive summary fully revised
31030	8	14	8	15	It would be surprising if aerosols, taken together, exert a positive radiative forcing so it should be possible to make a statement on the climate impact of decreasing overall emissions. [Nicolas Bellouin, United Kingdom (of Great Britain and Northern Ireland)]	Noted but not applicable: executive summary fully revised
24696	8	14	8	15	Surely it is "virtually certain" that methane reduction will contribute to climate mitigation. Is there any plausible way that methane reduction would counter climate mitigation? [William Collins, United Kingdom (of Great Britain and Northern Ireland)]	Noted but not applicable: executive summary fully revised
41006	8	15	8	15	This should be “climate change mitigation”. [Johannes Laube, Germany]	Noted but not applicable: executive summary fully revised
31968	8	17	8	17	It seems that only land ecosystems are considered. Are Ocean ecosystems considered elsewher? How do these ecosystems repond to dust input? Is there any diredt/indirect impact on the biogechemical cycle that can be related to SLCF? [Marie-France Loutre, Switzerland]	The executive summary has been thoroughly modified
16398	8	19	8	19	Insert 'the' after 'with' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted - text revised
14622	8	19	8	19	Why only climate change from LL GHGs? I guess ozone would respond to all forcers? Suggest to make one header for airquality and related impacts on health, agricultural production and (semi-)natural ecosystems [Frank Dentener, Italy]	Not applicable the executive summary has been thoroughly modified
41516	8	19	8	19	Use of LLCF should be consistent with rest of assessment where the same gases may be called WMGHGs or LLGHGs [Amanda Maycock, United Kingdom (of Great Britain and Northern Ireland)]	Accepted-text revised
25986	8	19	8	19	should be SLCFs not LLCF (If not then suggest writing out what is LLCFs rather than using the acronym) [Haroon Kheshgi, United States of America]	Accepted - text revised
33444	8	19	8	23	The finding regards "unpolluted regions": it would be good to have some statement about the likely direction of climate effects on ozone concentrations in polluted regions (which, to my understanding, is an increase - see, e.g., Nolte et al. for the US) [Marcus Sarofim, United States of America]	The executive summary has been thoroughly modified

44230	8	20	8	23	This may be true, but is a conclusion about the areas we probably care least about, the unpolluted areas. So yes, out over the ocean, or far from where people live, surface ozone is likely to decrease. This will affect hardly anyone or any crops. It would be much more valuable to tell us what happens in polluted, populated areas, even if the answer is that we don't know. [Drew Shindell, United States of America]	Accepted- and modified in the SOD ES
33446	8	25	8	25	Does this key finding include possible wildfire-PM links, plant-VOC-PM links, increased windblown dust, etc.? [Marcus Sarofim, United States of America]	The executive summary has been thoroughly modified and these aspects are now considered in FGD ES
41008	8	25	8	26	This a very vague statement that needs some clarification and quantification: What is the effect and how small is it? [Johannes Laube, Germany]	Noted but not applicable: executive summary fully revised.
55610	8	25	8	26	Given sign of effect of climate change on PM. [Larry Horowitz, United States of America]	Noted , the sentence does not appear anymore in the ES.
44232	8	25	8	26	We keep getting conclusions about confidence levels of changes without being told what the changes are! I don't see the value in letting us know that we now have high confidence in a change in PM but not telling us which way even the change occurs. [Drew Shindell, United States of America]	Noted : executive summary fully revised.
49976	8	25			This summary statement needs to provide more information. Which direction is climate change shifting the PM burden? Is it increasing or decreasing? [Owen Cooper, United States of America]	Noted but not applicable: executive summary fully revised.
41218	8	28	9	10	there should be a much stronger emphasis on impact of PM on health [Jean-Francois Lamarque, United States of America]	Noted Negative health impact is made clearer but health impact quantification is not in the scope of WG1
47882	8	28	9	10	Impacts on human health and crops are WG2 assessment areas and go beyond the mandate of the WG1, specifically the CH6 outline. [WGI TSU, France]	Accepted -text revised
14624	8	30	8	30	sentence imcomplete [Frank Dentener, Italy]	Noted but not applicable: executive summary fully revised
6846	8	30	8	31	PM impact on human health is missing (only household solid fuels are mentioned later on, in l. 37) [Eva Yvonne Pfannerstill, Germany]	Rejected. This topic belongs to WG3 and falls out of the scope of this chapter
44234	8	30	8	43	There are four paragraphs here that mention impacts without saying the sign. The IPCC is supposed to be policy-relevant, but saying things like the impacts are 'substantial' or things 'impact agriculture' or 'impact human health' without saying what the impacts are is really not policy-relevant at all, just needlessly vague. It's not as if there's any question in the scientific community that ozone is bad for human health rather than good, but policy-makers don't necessarily know that. [Drew Shindell, United States of America]	Noted but not applicable: executive summary fully revised
9396	8	30	8	54	These findings are relevant from a broader environmental perspective. However, it would be more helpful in the context of the AR6 if the authors try to identify the relevance with respect to global warming, radiative forcing, emissions/removals of GHGs. [Klaus Radunsky Radunsky, Austria]	Noted but not applicable: executive summary fully revised
16400	8	35	8	35	Delete , after CO [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Noted but not applicable: executive summary fully revised
41518	8	37	8	38	Should be made clear these are negative health consequences [Amanda Maycock, United Kingdom (of Great Britain and Northern Ireland)]	Noted but not applicable: executive summary fully revised
41520	8	40	8	43	"influence the climate system" in what way? Can you be more specific [Amanda Maycock, United Kingdom (of Great Britain and Northern Ireland)]	Noted but not applicable: executive summary fully revised
14626	8	40	8	50	What is the connection with key message on p7 l 33? [Frank Dentener, Italy]	Accepted - connection clarified
28978	8	41	8	41	"changes" - does this imply uncertainty about the sign of the effect? [Keith Shine, United Kingdom (of Great Britain and Northern Ireland)]	Noted but not applicable: executive summary fully revised

16402	8	45	8	45	I would say 'impairs' rather than 'damages' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Noted but not applicable: executive summary fully revised
55612	8	45	8	45	Move this finding up before previous. [Larry Horowitz, United States of America]	Noted but not applicable: executive summary fully revised
51976	8	45	8	46	If you are certain there I no need to use a confidence qualifier surely? I would remove the confidence qualifier. [Peter Thorne, Ireland]	Noted but not applicable: executive summary fully revised
16404	8	48	8	48	Change 'influences' to 'influence' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Noted but not applicable: executive summary fully revised
41522	8	48	8	48	"New evidence since AR5" [Amanda Maycock, United Kingdom (of Great Britain and Northern Ireland)]	Noted but not applicable: executive summary fully revised
55614	8	49	8	50	Change to "rate of particles and traces gases including ozone itself". [Larry Horowitz, United States of America]	Noted but not applicable: executive summary fully revised
44236	8	52	8	52	I'm surprised that there is only 'growing evidence' and 'medium confidence' that fire emissions affect regional air quality and human health. Isn't this something we've known for centuries by just looking at the air when there are large fires (the air quality part would thus be 'certain' I'd think), and the human health effects from particulates are so well established that the overall would probably be 'virtually certain'. [Drew Shindell, United States of America]	Noted but not applicable: executive summary fully revised
25990	8	52	8	53	I would think that it is well established that biomass burning affects air quality, in which case the evidence is not growing since it already exists. Suggest reconsidering this statement to be for examplerobust evidence/high agreement [Haroon Kheshgi, United States of America]	Noted but not applicable: executive summary fully revised
55616	8	53	8	53	Change to "vegetation damage resulting from fire air pollution" [Larry Horowitz, United States of America]	Noted but not applicable: executive summary fully revised
14628	9	1	9	6	Message is important, but should be more generalized. [Frank Dentener, Italy]	Accepted-executive summary fully revised
16406	9	2	9	2	Insert , after China [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Noted but not applicable: executive summary fully revised
24698	9	2	9	6	This ES point is much more detailed that the others. Ideally the ES points would have a common style. I would suggest that this point is too detailed, but the other points aren't detailed enough. [William Collins, United Kingdom (of Great Britain and Northern Ireland)]	Accepted -text revised
14630	9	12	9	12	A bit odd title, hopefully the whole report is policy relevant. Suggest: "role of SLCF in mitigation trajectories" [Frank Dentener, Italy]	Accepted-executive summary fully revised
47874	9	12	9	30	As the IPCC report is written for poliymakers, the policy relevance (particularly in the executive sulmmary) should be throughout. Please check that some of these statements do not go into WG2 or WG3 outlines. Particularly the statement on costs of mitigation measures (6.6.4). [WGI TSU, France]	Accepted -text revised
25992	9	14	9	16	Since SLCFs as defined in this chapter include cooling aerosols, deep reductions of some SLCFs could lead to more RF and warming. Suggest refering to reductions in RF, and be more precise when refering to emission reductions. [Haroon Kheshgi, United States of America]	Noted but not applicable: executive summary fully revised
39376	9	14	9	16	A difference between SLCPs defined in CCAC and SLCFs should be strictly distinguished. [Toshihiko Takemura, Japan]	Noted, SLCF are now defined at the beginning of the chapter 6.
51656	9	14	9	30	This 'policy relevance' section was REALLY CLEAR AND HELPFUL. Could it be in all chapter summaries? [Lindsey Cook, Germany]	Noted
14632	9	18	9	18	This key-finding should be rephrased using more the scientific arguments. Something like …long-term objectives can not be achieved unless SLCF and LLGHGs are mitigated immediately and synchronously. [Frank Dentener, Italy]	Noted but not applicable: executive summary fully revised

53506	9	18	9	19	Ch6 is certainly policy relevant, but needs to be policy neutral. The statement "There is a general consensus…" needs to be changed into a more neutral formulation [Jan Fuglestvedt, Norway]	Noted but not applicable: executive summary fully revised
47956	9	18	9	19	IPCC reports are policy neutral and relevant but not prescriptive. Please avoid using emotive language or value based statements or using terms like should, must, need in the text when referencing actions or decisions. [WGI TSU, France]	Noted but not applicable: executive summary fully revised
24700	9	18	9	19	This point seems too policy prescriptive. [William Collins, United Kingdom (of Great Britain and Northern Ireland)]	Noted but not applicable: executive summary fully revised
40654	9	18	9	19	I found this statement a little ambiguous. With some stretching “should not reduce” can be read either as prescriptive (it would be a bad idea for politicians to use reductions of SLCFs as a substitute for CO2…) or as a statement of fact (politicians probably won’t use reductions of SLCFs as a substitute for CO2…). If the former it may be too policy prescriptive for this report, if the latter I would disagree. [Daniel Murphy, United States of America]	Noted but not applicable: executive summary fully revised
39378	9	18	9	19	This sentence indicates components which have positive radiative forcing, Therefore, “SLCFs” should be replaced to “SLCPs”. [Toshihiko Takemura, Japan]	Noted but not applicable: executive summary fully revised
51980	9	21	9	23	Are you trying to say that the net benefits of action are positive? If so can this be formulated better? If not what are you trying to say here? This finding is unclear to me as written presently. [Peter Thorne, Ireland]	Noted but not applicable: executive summary fully revised
28980	9	21	9	23	This wasn’t very clear to me (especially the meaning of "can dominate") [Keith Shine, United Kingdom (of Great Britain and Northern Ireland)]	Noted but not applicable: executive summary fully revised
56688	9	21	9	23	Under policy relevance, the co-benefits of climate mitigation for air quality and human health is also undertaken in WGIII based on the agreed outline and may be provided with additional referral or cross-working group box. In addition SR15 found that "improved air quality resulting from projected reductions in many non-CO2 emissions provide direct and immediate population health benefits in all 1.5°C model pathways" including the particular emphasis on page 18. [Kilkis Siir, Turkey]	Noted but not applicable: executive summary fully revised
51654	9	21	9	23	The word 'dominate' is confusing - it can make costs more, or by improving health can make costs into benefits, or? [Lindsey Cook, Germany]	Noted but not applicable: executive summary fully revised
14634	9	22	9	22	benefits dominate the costs, sounds strange=>The monetary benefits of reducing air pollutation by climate mitigation measures, maybe larger than the mitigation costs… [Frank Dentener, Italy]	Noted but not applicable: executive summary fully revised
53658	9	22	9	23	Is there a basis for saying this? I am also not sure if this should be included: targets can dominate the costs of the climate measures (high agreement, medium evidence)" [Jan Fuglestvedt, Norway]	Noted but not applicable: executive summary fully revised
47648	9	25	9	25	Change "complementary" to “complementarily” [Daniel Feldman, United States of America]	Noted but not applicable: executive summary fully revised
28830	9	25	9	27	This didn't make sense, mitigation pathways have SLCF increasing temperture due to SO2 decline? [Piers Piers Forster, United Kingdom (of Great Britain and Northern Ireland)]	Noted but not applicable: executive summary fully revised
53508	9	29	9	30	More substance will come later on this, I hope. [Jan Fuglestvedt, Norway]	Noted
14636	9	29	9	30	This key-finding should also consider the different appreciation of air pollution policies under the SSP storylines. If this statement comes before the previous one, there is a logical connection. [Frank Dentener, Italy]	Accepted - text revised
44278	10	1	10	1	In this section it could be helpful to readers to note that discussions sometimes consider the warming agents only, and refer to those as short-lived climate pollutants or SLCPs instead of the more general short-lived climate forcers. That's consistent with Ch 2 of SR1.5 which also notes this briefly. [Drew Shindell, United States of America]	Noted

52530	10	1	10	46	In this section, you should note, and discuss, the importance of the fact that SLCFs don't just have an impact on climate and air quality - many SLCFs are actually criterial air pollutants, which many countries have regulated for decades due to their impact on public health and the envirnoment. For example, the US Clean Air Act requires the US EPA for six 'criteria air pollutants': tropospheric ozone, particulate matter, carbon monoxide, lead, sulfur dioxide, nitrogen dioxide. Five of the six criteria air pollutants are also SLCFs. [Nathan Borgford-Parnell, Switzerland]	Noted
24702	10	1			This section should define SLCF explicitly, in particular what is the cut-off in lifetime between an LLGHG and an SLCF? The first paragraph seems to suggest lifetimes much greater than the order of a year. Which category does methane fit into? The lifetimes for HCFCs and HFCs (section 6.1.2.1) span fractions of a year to several decades. Is there a dividing line to say which of these are LLGHGs and which SLCFs? This chapter uses both LLGHG and WMGHG (and sometimes even LLCF). Consistent terminology should be used throughout. [William Collins, United Kingdom (of Great Britain and Northern Ireland)]	taken into account
53510	10	3	10	15	Good that you mention the previously used term NTCF and other terms. (Please note that SR1.5 used another term - Long lived climate forcers (LLCF). See ch1 and ch2 in SR1.5) [Jan Fuglestvedt, Norway]	Noted
55618	10	3	10	15	Clarify that CH4 is treated here as an SLCF rather than LLGHG (?) [Larry Horowitz, United States of America]	taken into account
14638	10	3	10	24	Not sure if Figure 6.1 is needed. The details also raise questions: e.g. is it really possible that the lifetime (assuming average over a year), of CH4 can as short a 2 months, and shorter than that of CO? How are the spatial scales chosen. Etc etc. Some words on CH4, which is a bit in between SL and LL, meaning that it is globally well mixed. [Frank Dentener, Italy]	Noted
37768	10	5	10	8	The sentence that spans these lines is inconsistent with methane (with a lifetime of around a single decade) being referred to as long-lived in Chapter 2 and Chapter 5. [Adrian Simmons, United Kingdom (of Great Britain and Northern Ireland)]	taken into account, SLCF definition and lifetime discussion focussed
47650	10	8	10	8	Change "well-mixed" to "well-mixed in the troposphere" [Daniel Feldman, United States of America]	accepted
52528	10	9	10	9	SLCFs are not also know as short-lived climate pollutants (SLCPs). They are a subset of SLCFs which have a positive climate forcing. [Nathan Borgford-Parnell, Switzerland]	Noted
24704	10	9	10	10	Are SLCFs and SLCPs equivalent terms? Some use SLCPs to only refer to warming agents. It would be good to provide a definitive explanation here that others in future will be able to refer to. [William Collins, United Kingdom (of Great Britain and Northern Ireland)]	Noted
40544	10	9	10	11	The definition of SLCFs in AR6 is "[…] with atmospheric lifetimes shorter than those of LLGHGs". However, methane is a GHG and is considered as a SLCF in AR6. In AR5, the definition of SLCF is "those compounds whose impact on climate occurs primarily within the first decade after their emission (AR5, Box 8.2). However, the lifetime of methane is ~8.2-12.3 years (AR6, Fig.6.1). It would be good to revisit the definition of SLCF in AR6 and/or explain why methane is considered as a SLCF. [Rosa Flores, Turkey]	taken into account, SLCF definition and lifetime discussion focussed
47252	10	10	10	11	"with atmospheric lifetimes of shorter than those of LLGHGs": please add a specific range to the lifetimes of SLCPs, e.g., "shorter than 10 years" [Guang Zeng, New Zealand]	taken into account
16408	10	13	10	13	Delete , after AR5 [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	accepted

28982	10	17	10	17	I am puzzled by the absence of a discussion on contrails, which are surely an SLCF. Presumably assessed elsewhere and a cross referene would be beneficial [Keith Shine, United Kingdom (of Great Britain and Northern Ireland)]	Noted, reference to chapter 7, sections 7.3.3.2, 7.3.4.2 added
28984	10	17	10	17	Section 8.3.2 of WG1 AR5 clearly identifies methane as a well-mixed greenhouse gas. I think it is important to make clear that there is a definitional grey-area here and and also help the reader understand the difference between the NTCF usage in AR5 and the SLCF usage here. Also the fact that many halogenated substances are not SLCFs needs to be made clear - it is not so now. [Keith Shine, United Kingdom (of Great Britain and Northern Ireland)]	taken into account
41010	10	17	10	18	As is apparent from Figure 6.1 almost all currently important HFCs, HCFCs and halons are LLGHGs with lifetimes on the order of decades to centuries and should in my opinion therefore be covered exclusively by Chapter 2. I appreciate that there is a historical dimension to this structure, so at the very least there should be some explanation as to why these gases – and also CH4 - appear in two different places of AR6. [Johannes Laube, Germany]	taken into account
53512	10	17	10	24	useful clarification. A shorter version is needed in ES [Jan Fuglestvedt, Norway]	noted
44240	10	17	10	24	It would be good here to have a definition of the lifetime boundary between SLCF and LLCF. Methane is S, so clearly longer than that, but there are a lot of halocarbons so good to define this up front. [Drew Shindell, United States of America]	taken into account
14640	10	18	10	18	Avoid the perception that there is such a thing as 'a NH4NO3' aerosol, aerosol have a composition which is variable. Speak about aerosol chemical components. [Frank Dentener, Italy]	accepted, text changed to emphasise composition
41524	10	18	10	18	The inclusion of HFCs as SLCFs needs more careful justification than that given in the opening paragraph of Section 6.1 given that the lifetimes of HFCs vary from a couple of years to several centuries. This potential mis-match is evident in Figure 6.1. Are all HFCs included or just those with short lifetimes? [Amanda Maycock, United Kingdom (of Great Britain and Northern Ireland)]	taken into account
47254	10	18	10	18	Please add hydrochlorofluorocarbons (HCFCs), halons, after "hydrofluorocarbons (HFCs)" [Guang Zeng, New Zealand]	accepted
44470	10	19	10	19	primary and secondary organic carbon (POA and SOA): carbon should be replaced with "aerosol" [VIJAY SONI, India]	accepted
38202	10	19			“Primary and secondary organic carbon (POA and SOA)” should be “Primary and secondary organic aerosol (POA and SOA)”. I suggest using OA for organic aerosols rather than OC in this chapter. Currently, OC is used in many parts but OA is also used in some parts, and this is a bit confusing. [Hitoshi Matsui, Japan]	Noted
55620	10	20	10	21	Unclear phrasing. Change to, e.g., "not radiatively active but affect the abundance of radiatively active species" [Larry Horowitz, United States of America]	Noted
16410	10	24	10	24	Capital S for 'section' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	accepted
31032	10	27	10	40	I do not understand how the spatial scale dimension of Figure 6.1 was obtained, and how to interpret it. Tropospheric aerosols for example are transported between continents, so the spatial scales in the figure seem short. Also, it would be useful to state that spatial scales and lifetimes are not a direct indication of climate relevance. The radiative sensitivity to changes in the concentrations of a given species also matters. [Nicolas Bellouin, United Kingdom (of Great Britain and Northern Ireland)]	Not applicable. Figure has been removed.

40546	10	29	10	29	In Fig. 6.1, the names of the SLCFs and their precursors are difficult to identify based on the labels used (i.e., colors and symbols). Since the data are not overlapped on the figure, it would be better to add the names on the side of the graph, next to their corresponding SLCF. [Rosa Flores, Turkey]	Not applicable. Figure has been removed.
16412	10	29	10	31	Subscripts required for numbers in chemical formulae [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Not applicable. Figure has been removed.
53514	10	29	10	38	Useful figure. [Jan Fuglestvedt, Norway]	Not applicable. Figure has been removed.
16414	10	33	10	34	Change 'Halons' to 'halons' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Not applicable. Figure has been removed.
28986	10	34	10	34	I don’t think these are "errors" in so much as "spread" [Keith Shine, United Kingdom (of Great Britain and Northern Ireland)]	Not applicable. Figure has been removed.
47876	10	43	10	43	IPCC reports are policy neutral and relevant but not prescriptive. Please avoid using emotive language or value based statements or using terms like should, must, need in the text when referencing actions or decisions. [WGI TSU, France]	Not applicable
42030	10	43	10	43	"Harming" One puzzle to me (maybe I am out of date) in this chapter is the role that nitrogen fertilisation from Nox emissions can enhance carbon uptake by vegetation. I couldn’t find any mention of this in the chapter on this. I can understand that this fertilization could be viewed as "harming" in the wider sense, but I dont thnk that is the nuance here. I note that Chapter 7 mention this fertilisation in passing (referring to Zaehle et al., 2015). [Keith Shine, United Kingdom (of Great Britain and Northern Ireland)]	Not applicable
28988	10	43	10	43	"Harming" One puzzle to me (maybe I am out of date) in this chapter is the role that nitrogen fertilisation from Nox emissions can enhance carbon uptake by vegetation. I couldn’t find any mention of this in the chapter on this. I can understand that this fertilization could be viewed as "harming" in the wider sense, but I dont think that is the nuance here. I note that Chapter 7 mention this fertilisation in passing (referring to Zaehle et al., 2015). [Keith Shine, United Kingdom (of Great Britain and Northern Ireland)]	Not applicable
12838	10	43	10	46	Because SLCFs can also impact human health, agriculture, and ecosystems in addition to warming the atmosphere, it is important that regulations/laws reflect the urgency of mitigating these powerful forcers. Some regulations exist, but not nearly enough to sufficiently address the problem. Air quality observations in major cities like Delhi, Beijing, and many others around the world are an indication that these regulations must be increased, thoroughly implemented, and rigorously enforced to ensure maximum compliance. [Durwood Zaelke, United States of America]	noted

12840	10	43	10	46	Deposition of aerosols—especially black carbon—on snow and ice surfaces can reduce albedo and increase warming as a self-reinforcing feedback. See Tedesco M., et al. (2016) The darkening of the Greenland ice sheet: trends, drivers, and projections (1981–2100), THE CRYOSPHERE 10:477–496, 478 ("The presence of LAI such as soot (black carbon, BC), dust, organic matter, algae, and other biological material in snow or ice also reduces the albedo, mostly in the visible and ultraviolet regions (Warren, 1982). Such impurities are deposited through dry and wet deposition, and their mixing ratios are enhanced through snow water loss in sublimation and melting (Conway et al., 1996; Flanner et al., 2007; Doherty et al., 2013). Besides grain growth and LAI, another cause of albedo reduction over the GrIS is the exposure of bare ice: once layers of snow or firn are removed through ablation, the exposure of the underlying bare ice will further reduce surface albedo, as does the presence of melt pools on the ice surface (e.g. Tedesco et al., 2011)."); World Bank & International Cryosphere Climate Initiative (2013) ON THIN ICE: HOW CUTTING POLLUTION CAN SLOW WARMING AND SAVE LIVES, 2 ("Climate benefits for cryosphere regions from black carbon reductions carry less uncertainty than they would in other parts of the globe and are sometimes very large. This is because emissions from sources that emit black carbon—even with other pollutants—almost always lead to warming over reflective ice and snow."); Arctic Monitoring and Assessment Programme (AMAP) (2017) ADAPTATION ACTIONS FOR A CHANGING ARCTIC: PERSPECTIVES FROM THE BARENTS AREA, 72 ("Highly reflective surfaces, such as snow and ice in the Arctic increase light absorption by BC particles in the atmosphere. BC also absorbs light after deposition onto (and then into) snow and ice, where it accelerates the melt process (Pedersen et al., 2015). BC has made an important contribution to the observed rise in Arctic surface temperature through the 20th century (although carbon dioxide is still the major factor driving the rise in Arctic temperature) (Quinn et al., 2008; Koch et al., 2011; AMAP, 2015a). It may be technically possible to reduce global anthropogenic BC emissions by up to 75% by 2030 (Shindell et al., 2012; AMAP, 2015a; Stohl et al., 2015).	Noted
14642	10	43	10	46	It is a bit a reversed argument. Most SLCFs are regulated in their quality as air pollutant, some because they are depleting stratospheric ozone, while CH4 is regulated under climate policies, but also an air pollutant. [Frank Dentener, Italy]	accepted, text changed : SLCF are regulated in their quality as air pollutants (e.g. aerosol, O3), because they are depleting stratospheric ozone (HFCs, …), or under climate policies (e.g. CH4).
12670	10	43	10	46	Because SLCFs can also impact human health, agriculture, and ecosystems in addition to warming the atmosphere, it is important that regulations/laws reflect the urgency of mitigating these powerful forcers. Some regulations exist, but not nearly enough to sufficiently address the problem. Air quality observations in major cities like Delhi, Beijing, and many others around the world are an indication that these regulations must be increased, thoroughly implemented, and readily enforced to ensure maximum compliance. [Kristin Campbell, United States of America]	Noted

12672	10	43	10	46	Black carbon also has impacts on reducing albedo of snow/ice. Deposition of aerosols—especially black carbon—on snow and ice surfaces can reduce albedo and increase warming as a self-reinforcing feedback. See Tedesco M., et al. (2016) The darkening of the Greenland ice sheet: trends, drivers, and projections (1981–2100), THE CRYOSPHERE 10:477–496, 478 ("The presence of LAI such as soot (black carbon, BC), dust, organic matter, algae, and other biological material in snow or ice also reduces the albedo, mostly in the visible and ultraviolet regions (Warren, 1982). Such impurities are deposited through dry and wet deposition, and their mixing ratios are enhanced through snow water loss in sublimation and melting (Conway et al., 1996; Flanner et al., 2007; Doherty et al., 2013). Besides grain growth and LAI, another cause of albedo reduction over the GrIS is the exposure of bare ice: once layers of snow or firn are removed through ablation, the exposure of the underlying bare ice will further reduce surface albedo, as does the presence of melt pools on the ice surface (e.g. Tedesco et al., 2011)."); World Bank & International Cryosphere Climate Initiative (2013) ON THIN ICE: HOW CUTTING POLLUTION CAN SLOW WARMING AND SAVE LIVES, 2 ("Climate benefits for cryosphere regions from black carbon reductions carry less uncertainty than they would in other parts of the globe and are sometimes very large. This is because emissions from sources that emit black carbon—even with other pollutants—almost always lead to warming over reflective ice and snow."); Arctic Monitoring and Assessment Programme (AMAP) (2017) ADAPTATION ACTIONS FOR A CHANGING ARCTIC: PERSPECTIVES FROM THE BARENTS AREA, 72 ("Highly reflective surfaces, such as snow and ice in the Arctic increase light absorption by BC particles in the atmosphere. BC also absorbs light after deposition onto (and then into) snow and ice, where it accelerates the melt process (Pedersen et al., 2015). BC has made an important contribution to the observed rise in Arctic surface temperature through the 20th century (although carbon dioxide is still the major factor driving the rise in Arctic temperature) (Quinn et al., 2008; Koch et al., 2011; AMAP, 2015a). It may be technically possible to reduce global anthropogenic BC emissions by up to 75% by 2030	Noted
44238	10	43	10	46	It would be good, in my opinion, to differentiate here that whereas most SLCFs are subject to regulation for air quality purposes, F-gasesand methane are instead subject to regulation largely for climate purposes (via the Montreal Protocol and subsequent amendments and UNFCCC, respectively). [Drew Shindell, United States of America]	accepted, text changed : SLCF are regulated in their quality as air pollutants (e.g. aerosol, O3), because they are depleting stratospheric ozone (HFCs, …), or under climate policies (e.g. CH4).
47256	10	53	10	53	Change to: "In AR5, the concept of air quality-climate interaction was also introduced" [Guang Zeng, New Zealand]	Accepted
47906	10		16		Assessment Structure: If possible, assessment conclusions should be provided in a structured traceable account of how these statements were derived. For example, sections / subsections can start with previous IPCC report conclusions (AR5 or AR6 Special Reports) and then provide an update of the more recent literature, clearly laying out the lines of evidence. Each section / subsection can then conclude with assessment statements. This section currently reads more as a review than an assessment. In addition, please make sure the ES uncertainty language is clearly tracable to the underlying chapter text. [WGI TSU, France]	Not applicable, section 6.1 introductory to chapter 6
16416	11	3	11	3	Quantify short time horizons [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted
28990	11	4	11	4	I tihnk "radiative forcing" would be more appropriate than "climatic effect" [Keith Shine, United Kingdom (of Great Britain and Northern Ireland)]	Accepted

40656	11	4	11	4	I believe you mean to say “local radiative forcing”, not “climatic effect”. No SLCF has an effect comparable to CO2 on important climate effects such as global mean temperature or sea level rise. [Daniel Murphy, United States of America]	Accepted
24706	11	12	11	13	The AR6 is an assessment rather than a review, so it doesn't need to refer readers to other sources of literature. If findings from SR1.5 are relevant to AR6 they need to be stated again, if not then they don't need to be mentioned. [William Collins, United Kingdom (of Great Britain and Northern Ireland)]	Rejected. In fact, the sentence referred to in this comment is introducing the following sentence that explains what the 1.5 Report says. The two sentences have been put together.
53516	11	12	11	14	Not sure if I would say that ch1 in SR1.5 had a detailed analysis on SLCFs. But it was adressed. See also ch2 in SR1.5 [Jan Fuglestvedt, Norway]	Rejected. The text says "more detailed" with respect to the previous assessments.
16418	11	13	11	13	Change 'fall' to 'autumn' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted
53518	11	15	11	21	Check this summary of what SR1.5 said - e.g. with some of the authors form ch2 and ch1 that are involved in this report. [Jan Fuglestvedt, Norway]	Noted
12842	11	15	11	21	Furthermore, reduction of anthropogenic aerosols will contribute additional warming by way of unmasking warming that is presently being offset by the reflective properties of aerosols. Aerosols from air pollution will decline in the coming years as a means for preserving air quality and promoting healthier air conditions, but their removal will lead to additional warming of 0.3 ºC in 2050 and 0.6 ºC in 2100. See Xu and Ramanathan (2017) Well below 2 °C: Mitigation strategies for avoiding dangerous to catastrophic climate changes, Proc. Natl. Acad. Sci. 114(39):10315–10323; Ramanathan and Xu (2010) The Copenhagen Accord for limiting global warming: Criteria, constraints, and available avenues, Proc. Natl. Acad. Sci. 107(18):8055–8062; Ramanathan and Feng (2008) On avoiding dangerous anthropogenic interference with the climate system: Formidable challenges ahead, Proc. Natl. Acad. Sci. 105(38):14245–14250. [Durwood Zaelke, United States of America]	Noted. This issue is already in the text.
12844	11	15	11	21	Note also the role of brown carbon. Brown carbon is also a potent climate forcer that is sometimes ignored in climate models, leading to the conclusion that the combination of organic carbon co-emitted with black carbon causes net global cooling. Brown carbon’s warming effect appears to be offsetting some or all of the lighter organic carbon’s cooling effect. Thus, reducing emissions from black carbon sources may still reduce warming. Feng Y., et al. (2013) Brown carbon: a significant atmospheric absorber of solar radiation, ATMOS. CHEM. PHYS. 13:8607–8621 (“Inclusion of the strongly absorption of BrC in our model causes the direct radiative forcing (global mean) of organic carbon aerosols at the TOA to change from cooling (−0.08 W m−2[1 SEP]) to warming (+0.025 W m−2).”); Andreae M. O. & Ramanathan V. (2013) Climate’s dark forcings, SCI. 340(6130):280–281; Bahadur R., et al. (2012) Solar absorption by elemental and brown carbon determined from spectral observations, PROC. NAT’L. ACAD. SCI. 109(43):17366–17371 (“The results demonstrate that current climate models that treat OC as nonabsorbing are underestimating the total warming effect of carbonaceous aerosols by neglecting part of the atmospheric heating, particularly over biomass-burning regions that emit BrC.”). [Durwood Zaelke, United States of America]	Noted. This issue is already in the text

12674	11	15	11	21	Furthermore, reduction of anthropogenic aerosols will contribute additional warming by way of unmasking warming that is presently being offset by the reflective properties of aerosols. Aerosols from air pollution will decline in the coming years as a means for preserving air quality and promoting healthier air conditions, but their removal will lead to additional warming of 0.3 ºC in 2050 and 0.6 ºC in 2100. See Xu and Ramanathan (2017) Well below 2 °C: Mitigation strategies for avoiding dangerous to catastrophic climate changes, Proc. Natl. Acad. Sci. 114(39):10315–10323; Ramanathan and Xu (2010) The Copenhagen Accord for limiting global warming: Criteria, constraints, and available avenues, Proc. Natl. Acad. Sci. 107(18):8055–8062; Ramanathan and Feng (2008) On avoiding dangerous anthropogenic interference with the climate system: Formidable challenges ahead, Proc. Natl. Acad. Sci. 105(38):14245–14250. [Kristin Campbell, United States of America]	Same as comment 12842
12676	11	15	11	21	Note also the role of brown carbon. Brown carbon is also a potent climate forcer that is sometimes ignored in climate models, leading to the conclusion that the combination of organic carbon co-emitted with black carbon causes net global cooling. Brown carbon's warming effect appears to be offsetting some or all of the lighter organic carbon's cooling effect. Thus, reducing emissions from black carbon sources may still reduce warming. Feng Y., et al. (2013) Brown carbon: a significant atmospheric absorber of solar radiation, ATMOS. CHEM. PHYS. 13:8607–8621 ("Inclusion of the strongly absorption of BrC in our model causes the direct radiative forcing (global mean) of organic carbon aerosols at the TOA to change from cooling (−0.08 W m−2[1]SEP) to warming (+0.025 W m−2)."); Andreae M. O. & Ramanathan V. (2013) Climate's dark forcings, SCI. 340(6130):280–281; Bahadur R., et al. (2012) Solar absorption by elemental and brown carbon determined from spectral observations, PROC. NAT'L. ACAD. SCI. 109(43):17366–17371 ("The results demonstrate that current climate models that treat OC as nonabsorbing are underestimating the total warming effect of carbonaceous aerosols by neglecting part of the atmospheric heating, particularly over biomass-burning regions that emit BrC."). [Kristin Campbell, United States of America]	Same as comment 12844
24708	11	16	11	16	"there is evidence" may be better than "it is evidenced". [William Collins, United Kingdom (of Great Britain and Northern Ireland)]	Accepted
28992	11	18	11	18	This confidence that SO2 reductions lead to a warming contradicts the Exec Summary at 8:13 [Keith Shine, United Kingdom (of Great Britain and Northern Ireland)]	Noted, Executive Summary to be revised.
31034	11	18	11	19	I suspect the "high confidence" is only on the fact that aerosol and methane changes would compensate each other, but the actual, quantified, level of compensation is quite uncertain. [Nicolas Bellouin, United Kingdom (of Great Britain and Northern Ireland)]	Rejected. These are results of the 1.5 Report.
41526	11	23	11	23	"of the warming SLCFs (CH4 and BC)" if HFCs are being classed as SLCFs for the purposes of the assessment they should also be mentioned here [Amanda Maycock, United Kingdom (of Great Britain and Northern Ireland)]	Not applicable.
47678	11	23	11	29	This paragraph is really a global assessment and does not consider finer scale regioal heterogenieties [Ranjeet Sokhi, United Kingdom (of Great Britain and Northern Ireland)]	Noted. These are evidences from the 1.5 Report.
28994	11	24	11	24	The implied level of confience in the the impact of BC contradicts Exec Summary at 8:13 [Keith Shine, United Kingdom (of Great Britain and Northern Ireland)]	Noted, Executive Summary to be revised.
44472	11	24	11	24	1.5° (C is missing) [VIJAY SONI, India]	Accepted
53520	11	27	11	29	reference needs format correction [Jan Fuglestvedt, Norway]	Accepted. Format has been corrected

16420	11	27	11	29	Change reference details to de Coninck et al. [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted. Format has been corrected
44474	11	27	11	29	citation in bracket should be (de Coninck et al., 2018) [VIJAY SONI, India]	Accepted. Format has been corrected
38204	11	32			The role of this (6.1.2) and next (6.1.3) sections is not clear to me. Why are there two sections for emissions (6.1.2.1 and 6.2.1)? Processes (6.1.2.2 and 6.2.2) and climate/AQ impact (6.1.3 and 6.3) also have two sections. Please clarify why this structure is used (why they are described separately). I think it's better to describe/summarize one topic in one section. [Hitoshi Matsui, Japan]	Not Applicable, sections changed in accordance with reviewer comments
14644	11	36	11	36	Why only t CH4->all lifetimes. Wildfires are appearing in natural and anthropogenic, which is correct but may be confusing if not further explained. [Frank Dentener, Italy]	Taken into account
40550	11	36	11	36	Fig. 6.2 is not clear by itself. Particularly, the relationship among various processes (i.e., emissions, air pollution, chemistry and aging, radiative forcing, and changes) is not explained in the text. Anthropogenic emissions is connected to CH4, LLGHG, SLCF however, natural emissions is not. This implies that biogenic SLCF NMHCs, NOx, CH4, and others are of secondary origin (i.e., oxidation chemistry and aging). [Rosa Flores, Turkey]	Taken into account, figure revised
40548	11	36	11	38	This sentence is not clear (i.e., "[..] through atmospheric chemistry processes or impact the lifetime of SLCF are depicted"). [Rosa Flores, Turkey]	Taken into account
46136	11	39	11	40	Wild fires are listed as both natural and anthropogenic in this caption [Cynthia Randles, United States of America]	Taken into account, figure revised
47258	11	41	11	42	Suggest to replace "interactions" with more explicit wording like "absorbing" and "blocking"? i.e., "Radiative forcing by SLCF can be net positive through absorbing IR radiation, net negative through blocking solar radiation, and…" [Guang Zeng, New Zealand]	Taken into account
28996	11	42	11	42	Since 50% of the incoming solar radiation is in the IR (the near-IR) some better label than IR is needed here [Keith Shine, United Kingdom (of Great Britain and Northern Ireland)]	Taken into account
28998	11	43	11	43	"sources AND SINKS" ? [Keith Shine, United Kingdom (of Great Britain and Northern Ireland)]	Taken into account
55622	11	43	11	43	Should be "*decreases* of surface albedo". [Larry Horowitz, United States of America]	Accepted
38206	11	43			"increases of the surface albedo" --> "decreases of the surface albedo" [Hitoshi Matsui, Japan]	Accepted
31970	11	44	11	44	Volcanoes can be influenced by climate change'. What does that mean? The frequency? The intensity of the volcani eruption will increase? decrease? Or is it the impact of the volcanic eruption? This should be elaborate in the text. It would be interesting to look into past (remote past) to identify how the volcanoes were influenced by climate change. Paleo can maybe anwer that question. [Marie-France Loutre, Switzerland]	Not applicable, sentence clarified
55624	11	44	11	45	Unclea what is meant by this sentence. Is air pollution influencing biogenic emissions or vice versa? [Larry Horowitz, United States of America]	Taken into account
47260	11	47	11	47	Suggest to change "… processes such as specific reaction rates" to "… processes through modifying reaction rates" [Guang Zeng, New Zealand]	Taken into account
47262	11	47	11	47	Suggest to change "For completeness," to "Furthermore," [Guang Zeng, New Zealand]	Taken into account
16422	11	53	11	53	Text mising after 'in' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Taken into account - text revised

41528	11	53	11	53	"as depicted in" appears to be reference missing [Amanda Maycock, United Kingdom (of Great Britain and Northern Ireland)]	Accepted - text revised; Table 6.1 added
47264	11	53	11	53	Figure number is missing between "In" and "anthropogenic" [Guang Zeng, New Zealand]	Editorial
44476	11	53	11	55	The sentence "As depicted in…." is incomplete. [VIJAY SONI, India]	Accepted - text revised; Table 6.1 added
56306	11	53	11	55	Sentence is missing a reference and is therefore incomplete [zahrah musa, Netherlands]	Taken into account - text revised; combined with comment 16422
16424	11	55	11	55	Capital S for 'section' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Editorial
47266	11	55	11	55	Suggest to change "Atmospheric chemistry in this context is both, a source and sink of SLCFs" to "Atmospheric chemistry in this context both produces and removes SLCFs" [Guang Zeng, New Zealand]	Editorial
16426	11	56	11	56	Subscript 3 required [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Editorial
40578	11		12		This section talks only about lifetimes of ozone and aerosols. Other SLCFs like NOx, methane, etc. also need to be mentioned. [Chaitri Roy, India]	Taken into account - combined with other comments [49978; 24714; 40658]; discussed with review editor
14646	12	1	12	30	Suggest to shorten discussion on lifetime to the minimum. E.g. the short O3 lifetime in urban surroundings may be different if not considering fast recycling reactions. Is it relevant to know this for the IPCC? [Frank Dentener, Italy]	taken into account, SLCF definition and lifetime discussion focussed
16428	12	2	12	2	Capital S for 'section' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Editorial
24714	12	6	12	13	The ozone lifetimes will need to be updated with CMIP6 results. There have probably also been other post-AR5 studies that could be included in the assessment. [William Collins, United Kingdom (of Great Britain and Northern Ireland)]	Taken into account - combined with other comments [49978; 24714; 40658]; discussed with review editor
40658	12	6	12	13	I believe that the detailed ozone lifetime may be ill-posed since a perturbation may have a rather different lifetime than the burden divided by sources. A review editor (Prather) is actually the expert on this question. The detailed lifetime, however, is not important for the chapter. Table 6.2 is sufficient and this paragraph could be deleted for brevity. [Daniel Murphy, United States of America]	Taken into account - combined with other comments [49978; 24714; 40658]; discussed with review editor
49978	12	7			A clear reference needs to be provided regarding ozone's lifetime of several week in the upper troposphere. The reference provided, Monks et al., 2015b, does not provide any analysis on ozone lifetime. Monks et al 2015a only states that, "its lifetime in the free troposphere is of the order of several weeks (Stevenson et al., 2006; Young et al., 2013)". Monks et al., 2015a says nothing about ozone's lifetime in the upper troposphere. Young et al. 2013 and Stevenson et al. 2006 provide no specific estimates of ozone's lifetime in the upper troposphere, only that it has a globally averaged lifetime of 22-23 days. Stevenson et al. 2006 do vaguely state that ozone's lifetime increases with altitude, but they provide no numbers. [Owen Cooper, United States of America]	Taken into account - combined with other comments [49978; 24714; 40658]; discussed with review editor

40660	12	15	12	21	Given the large uncertainties and overlap in the ranges, this paragraph could be simplified to a single sentence stating a lifetime of 2.4 to 17 days for POA, SOA, BC. This range also applies to anthropogenic sulfate. What this paragraph does not do is provide any insight into the reasons for various lifetimes. It might be useful to say that all these aerosols have similar lifetimes, but sea salt has a shorter lifetime because it consists of large particles emitted into a moist environment with efficient wet removal (Tsigaridis mentions this, there are better references but using Tsigaridis would keep the reference list short). Some volcanic sulfate and biomass burning aerosol have longer lifetimes because they have higher injection altitudes. [Daniel Murphy, United States of America]	Taken into account - combined with other comments [40660; 31036]
31036	12	16	12	16	The longer modelled lifetimes were typically a consequence of assuming that BC is hydrophobic, so its wet removal is slow. Few recent models make such an assumption anymore, so the higher end of that range is difficult to support. [Nicolas Bellouin, United Kingdom (of Great Britain and Northern Ireland)]	Taken into account - combined with other comments [40660; 31036]
38208	12	17			"OC" --> "OA" [Hitoshi Matsui, Japan]	Editorial
16430	12	19	12	19	Deklete , after al. [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Editorial
40662	12	23	12	30	This statement about aerosol scavenging depending on solubility is incorrect. The easiest thing is to remove this paragraph, but so the authors know why I'm saying it is incorrect: There are two main types of wet removal, CCN removal whereby a particle is removed after a cloud droplet grows on it, and removal by impaction below cloud by rain and snow. Impaction does not depend at all on solubility, only on size (Croft et al., 2009, ACP, 4653). CCN removal is also primarily determined by size, not solubility (McFiggans et al., already cited, Dusek et al., 2006, Science, 312, 1375-1378). In addition, except very close to sources almost all particles have enough soluble material on them for wet removal. What matters more for wet scavenging is the injection altitude and how wet the air is (Kleinman and Daum, JGR, 1991, 96, 991-1005; Murphy et al., ACP, 2019). It is true that models use a transformation to hygroscopic to model wet removal. That can be viewed more as a tuning for near- and far-field deposition than a physical effect. A partial exception to all this is fresh diesel soot, which has more or less the exact physical properties required to make changes in hygroscopicity somewhat important. [Daniel Murphy, United States of America]	Not Applicable, sections changed in accordance with reviewer comments
55626	12	27	12	27	Add "(or precursor emission sources)" after "their sources." [Larry Horowitz, United States of America]	Editorial
27472	12	27	12	29	It has been documented that giant mineral dust particles can be transported at larger distances than expected by graviational theories. These large particles (up to 75 µm in diameter) can affect Rfari and Rfaci significantly and should be taken into account in future simulations (e.g. van der Does, M., et al. (2018). "The mysterious long-range transport of giant mineral dust particles." Sci Adv 4(12): eaau2768 and Weinzierl, B., et al. (2017). "THE SAHARAN AEROSOL LONG-RANGE TRANSPORT AND AEROSOL-CLOUD-INTERACTION EXPERIMENT Overview and Selected Highlights." Bulletin of the American Meteorological Society 98(7): 1427-1451, and references therein) [Vassilis Amiridis, Greece]	Not Applicable, sections changed in accordance with reviewer comments
16432	12	28	12	28	Delete 'a' and change um to µm [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Editorial
44478	12	28	12	28	replace "um" with "µm" [VIJAY SONI, India]	Editorial

38210	12	28	12	29	I think “particles less than 100 nm can have significant larger lifetime” should be rephrased because these particles have faster coagulation rate (hence shorter lifetime in terms of this process) than larger particles. [Hitoshi Matsui, Japan]	Not Applicable, sections changed in accordance with reviewer comments
38212	12	29	12	30	It’s better to describe average lifetimes for both fine and coarse particles individually. They have quite different lifetimes in the atmosphere. The values here should also be consistent with those in Fig 6.1. [Hitoshi Matsui, Japan]	Not Applicable, sections changed in accordance with reviewer comments
50360	12	29			Better not to include any specific days for aerosol residence time as it depends on multiple factors especially local meteorology. And there is no average aerosol composition, it depends on sources. Better not to confuse readers. [Tirthankar Banerjee, India]	Not Applicable, sections changed in accordance with reviewer comments
31038	12	30	12	30	It's going to be difficult to get that value, especially since the height at which aerosols are transported also affects their lifetime. Perhaps separate boundary layer, free troposphere, and stratospheric lifetimes? [Nicolas Bellouin, United Kingdom (of Great Britain and Northern Ireland)]	Not Applicable, sections changed in accordance with reviewer comments
41220	12	35	12	45	no mention of CMIP6 emissiosn? [Jean-Francois Lamarque, United States of America]	Accepted - text revised; Reference added in line 40
14650	12	35	13	24	This paragraph reads quite as 'textbook' rather than assessing. I am wondering if Table 6.1 can be transformed to included global and key-region emissions, and the text can assess what we know about these ranges? On the other hand text can also be intergrated in later sections with more detailed discussions on emissions? Currently the discussion gives some contributions for biomass burning, but not for others. [Frank Dentener, Italy]	Seems we did not manage to communicate the point in 6.1 that is intro (give structure to CH6).
14648	12	36	12	36	..and chlorine containing components. [Frank Dentener, Italy]	Accepted - text revised
29000	12	36	12	36	I think HFCs and HCFCs belong to the list of exceptions [Keith Shine, United Kingdom (of Great Britain and Northern Ireland)]	Accepted - text revised
29002	12	36	12	36	"emissions" I wasn’t clear which emissions (NH3 and NMVOC) were referred to here [Keith Shine, United Kingdom (of Great Britain and Northern Ireland)]	Accepted - text revised; 'NH3' added
38214	12	36			“The majority of emissions” --> “The majority of NH3 emissions” [Hitoshi Matsui, Japan]	Accepted - text revised
16434	12	38	12	38	Delete , after 'distribution' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Editorial
29004	12	44	12	44	Maybe a subtle point, but I refrigeration and AC are only "key sources" of HFCs etc through leakage and poor disposal. Emission of HFCs is not an inherent consequence of refrigeration unlike, for example, the emission of CO2 from burning fossil fual (except in a few cases where they are the by-product of manufacturer).I feel this needs to be reflected in the discussion somewhere. [Keith Shine, United Kingdom (of Great Britain and Northern Ireland)]	Accepted
39056	12	45	12	45	Xiang et al., PNAS, 2014 is also a good reference for this statement. Please check [Prabir Patra, Japan]	Noted
16436	12	48	12	48	Delete , after 'savannahs' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Editorial
29006	12	48	12	53	Unclear if this is referring to biomass burning due to human activity, or whether it includes natural fires [Keith Shine, United Kingdom (of Great Britain and Northern Ireland)]	Taken into account - text revised; it refers to both, i.e., agricultural fires are typically anthropogenic while forest or savannah fires can be both
16438	12	49	12	49	Insert space after SLCFs [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Editorial
16440	12	50	12	50	Insert ', respectively' after BC [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Editorial

27830	12	50	12	50	verify the following text OC, CO, [Poot Delgado Carlos Antonio, Mexico]	Editorial
16442	12	51	12	51	Capitalise 'Southern Hemishere' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Editorial
14652	12	52	12	52	Biomass burning is important for NH3, and CH4 as well. NH3 10-20 %. [Frank Dentener, Italy]	Accepted - text revised
47666	13	5	13	5	There appears to be an omission here after "As depicted in". [Daniel Feldman, United States of America]	Editorial
41530	13	5	13	5	"as depicted in" appears to be reference missing [Amanda Maycock, United Kingdom (of Great Britain and Northern Ireland)]	Accepted - text revised; Figure 6.2 added
16444	13	5	13	5	Text missing after 'in' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Editorial
29008	13	5	13	5	Not clear why natural methane emissions are not included in this paragraph [Keith Shine, United Kingdom (of Great Britain and Northern Ireland)]	Taken into account - the structure section 6.1 has been revised, respective methane discussion has been revised and now included in section 6.2
56308	13	5	13	5	Sentence is missing a reference and is therefore incomplete [zahrah musa, Netherlands]	Editorial
6848	13	5	13	7	"Land ecosystems return to the atmosphere an estimated 1-2% of gross primary production in the form of biogenic volatile organic compounds (BVOCs)" - you could add: "a fraction which can (regionally) increase significantly when the ecosystems are stressed, e.g. from drought or warming." Up to 10% loss of plant carbon via BVOCs under stress are mentioned in this publication: Peñuelas, J. (2003). BVOCs: plant defense against climate warming? Trends Plant Sci. 8, 105–109. doi: 10.1016/S1360-1385(03)00008-6. This may also be a cross connection with chapter 5 as there is suggested to be a feedback of Climate Change on ecosystem BVOC carbon loss, which is so far not mentioned anywhere in the draft (as far as I have seen). [Eva Yvonne Pfannerstill, Germany]	Not applicable. Section restructured
27484	13	5	13	16	The impact of desertification on the atmospheric SLCF burden is not taken into appropriate consideration in the report. The following sentense can be added to acknowledge this factor related to anthropogenic dust: "Perturbations in human land use and desertification affects mineral dust production and corresponding impacts on radiation and weather patterns (1, 2)" 1. Mahowald, N. M., et al. (2010). "Observed 20th century desert dust variability: impact on climate and biogeochemistry." Atmospheric Chemistry and Physics 10(22): 10875-10893. 2. Solomos, S., Ansmann, A., Mamouri, R.-E., Binietoglou, I., Patlakas, P., Marinou, E., and Amiridis, V.: Remote sensing and modelling analysis of the extreme dust storm hitting the Middle East and eastern Mediterranean in September 2015, Atmos. Chem. Phys., 17, 4063-4079, doi:10.5194/acp-17-4063-2017, 2017. [Vassilis Amiridis, Greece]	Taken into account - the chapter includes now a dedicated 'dust' text
16446	13	7	13	7	Change BVOC to BVOCs and subscript 3 in O3 [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Editorial
49982	13	9	13	11	This sentence on lightning NOx seems to be missing some words to provide context. When saying that its impact is disproportionate….disproportionate to what? Is the goal to state that in the upper troposphere lightning NOx has a greater impact than anthropogenic NOx? [Owen Cooper, United States of America]	Not applicable. Section restructured
16448	13	10	13	10	Delete , after 'troposphere' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Editorial

47268	13	10	13	10	"it has a disproportionately large impact on ozone": the impact is probably exaggerated. Suggest to change to "relatively large impact on ozone due to the more efficient ozone production in the free troposphere". Please note that lightning NOx has large uncertainties. [Guang Zeng, New Zealand]	Noted
16450	13	11	13	11	Subscrfipot 3 for O3 [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Editorial
16452	13	12	13	12	Insert 'a' after 'be' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Editorial
16454	13	16	13	16	Reference required [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted - text revised
16456	13	20	13	20	Change 'gasses' to 'gases' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Editorial
29010	13	20	13	20	"or" should be "and/or" [Keith Shine, United Kingdom (of Great Britain and Northern Ireland)]	Editorial
41012	13	20	13	21	This is incorrect. There are several HFCs with significantly longer lifetimes. Also, this should be “greenhouse gases”. Thirdly, both HCFCs and halons act as ODSs while also being GHGs [Johannes Laube, Germany]	Taken into account - combined with other comments [41012; 52534;53524; 41014; 29014]
52534	13	20	13	21	This sentence doesn't fully capture the nuance of the F-gases. HCFCs are both ODSs and GHGs, whereas HFCs are only GHGs. [Nathan Borgford-Parnell, Switzerland]	Taken into account - combined with other comments [41012; 52534;53524; 41014; 29014]
29012	13	21	13	21	Not clear to me what the "latter" is referring to, especially as HCFCs are ODSs [Keith Shine, United Kingdom (of Great Britain and Northern Ireland)]	Editorial
53524	13	22	13	22	If you want to use the VSLS label, then you need to introduce that earlier [Jan Fuglestvedt, Norway]	Taken into account - combined with other comments [41012; 52534;53524; 41014; 29014]
41014	13	23	13	23	Also, not all VSLS contribute to ozone depletion as some are too short-lived to reach the stratosphere. [Johannes Laube, Germany]	Taken into account - combined with other comments [41012; 52534;53524; 41014; 29014]
29014	13	23	13	23	VSLSs do contribute, but I believe their current contribution is tiny compared to CFCs, HCFCs, halons etc [Keith Shine, United Kingdom (of Great Britain and Northern Ireland)]	Taken into account - combined with other comments [41012; 52534;53524; 41014; 29014]
24710	13	29	13	34	More discussion of OH is needed here including the opposing effects of Nox, methane and NVOCs. [William Collins, United Kingdom (of Great Britain and Northern Ireland)]	Noted - section 6.1 was restructured and revised
41222	13	29	13	53	this section requires a much expanded discussion of the science on SOA since AR5 [Jean-Francois Lamarque, United States of America]	Noted - section 6.1 was restructured and revised
14654	13	29	13	53	The processes discussed are only a subset of many other process of relevance. The text reads textbook, it could be more about how process uncertainty influence the chain from emissions to concentrations and impacts=>uncertainty statements [Frank Dentener, Italy]	Noted - section 6.1 was restructured and revised
40552	13	29	13	53	Section 6.1.2.2 (key processes) briefly mentions ozone, secondary aerosol, and sulfate and nitrate aerosol. Additional SLCF should be considered with detailed processes that have been identified after the publication of AR5. [Rosa Flores, Turkey]	Noted - section 6.1 was restructured and revised
53522	13	30	13	30	Something missing here: "see " [Jan Fuglestvedt, Norway]	Editorial
41532	13	30	13	30	"see …" appears to be reference missing [Amanda Maycock, United Kingdom (of Great Britain and Northern Ireland)]	Editorial
16458	13	30	13	30	Text mising after 'see' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Editorial

55850	13	31	13	31	nitrate radical needs to be written without (-) as now written it corresponds to nitrate aerosol component [MARIA KANAKIDOU, Greece]	Editorial
16460	13	31	13	31	Superscript - required [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Editorial
16462	13	32	13	32	Capital S for 'section' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Editorial
41534	13	37	13	40	References needed here for stratosphere-to-troposphere exchange [Amanda Maycock, United Kingdom (of Great Britain and Northern Ireland)]	Noted - section 6.1 was restructured and revised
8030	13	39	13	40	My impression is that tropopause folds and intrusions are just the mechanism by which stratospheric ozone is mixed into the troposphere. The overall amount is mostly set by "downward control" (i.e. the large-scale overturning of the stratosphere which supplies ozone to the extratropical "middle world" named so by James Holton.) [Olaf Morgenstern, New Zealand]	Noted - section 6.1 was restructured and revised
55628	13	42	13	42	Add "of O3" after "reactions." [Larry Horowitz, United States of America]	Editorial
38216	13	44	13	46	This sentence should be combined with the next paragraph. [Hitoshi Matsui, Japan]	Noted - section 6.1 was restructured and revised
50362	13	52			Most commonly explained process of SOA evolution is the oxidation of volatile organic compounds (VOCs), resulting into less volatile compounds which further partitioned into condensed phase. Another pathway for SOA formation is the reaction of less volatile organics already emitted in atmosphere as particulate matter (Robinson et al., 2007; Hallquist et al, 2009). Singh et al., 2018 (http://dx.doi.org/10.1016/j.atmosenv.2017.03.008) [Tirthankar Banerjee, India]	Not applicable. Section restructured
16464	13	53	13	53	Change 'vapor' to 'vapour' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Editorial
24712	13	53	13	53	If the OVOCs form aerosol they must *always* lower the compound's vapour pressure. [William Collins, United Kingdom (of Great Britain and Northern Ireland)]	Noted - section 6.1 was restructured and revised
47680	14	1	15	21	There is no quantitative data or evidence to support the statements in this section. [Ranjeet Sokhi, United Kingdom (of Great Britain and Northern Ireland)]	Accepted, text changed accordingly
24716	14	3	14	14	This could be a bit clearer on whether these ERFs are classified by emitted species or by atmospheric concentrations. E.g. both ozone and ozone precursors are mentioned [William Collins, United Kingdom (of Great Britain and Northern Ireland)]	Not Applicable, Section changed according o review comments
41536	14	5	14	5	Here first reference is made to ERF in the chapter, while the introductory section 6.1.1 mentions only radiative forcing. I suggest briefly mentioning the important distinction of RF and ERF for some SLCFs in the introductory sections of the chapter with appropriate links to chapter 7 [Amanda Maycock, United Kingdom (of Great Britain and Northern Ireland)]	Not Applicable, Section changed according o review comments
12846	14	5	14	6	Somewhere in this chapter (either here or earlier), ERF should be defined more thoroughly to clarify how it is calculated and how it is used within this report and how it may be used/understood by policymakers. The previous reference to it being defined here as it is in AR5 is a helpful reference, but should be defined again in this report for ease of reading, especially given that the RF of SLCPs depends upon the timescale for which they are considered. [Durwood Zaelke, United States of America]	Not Applicable, Section changed according o review comments

12678	14	5	14	6	Somewhere in this chapter (either here or earlier), ERF should be defined more thoroughly to clarify how it is calculated and how it is used within this report and how it may be used/understood by policymakers. The previous reference to it being defined here as it is in AR5 is a helpful reference, but should be defined again in this report for ease of reading, especially given that the RF of SLCPs depends upon the timescale for which they are considered. [Kristin Campbell, United States of America]	Not Applicable, Section changed according o review comments
41224	14	5	14	22	what about indirect effects, like o3 affecting plant upatke and therefore CO2? [Jean-Francois Lamarque, United States of America]	Not Applicable, Section changed according o review comments
31040	14	6	14	6	and also the characteristics of their surrounding environment (e.g. surface albedo, presence and type of clouds, ...) [Nicolas Bellouin, United Kingdom (of Great Britain and Northern Ireland)]	Not Applicable, Section changed according o review comments
52536	14	6	14	7	SLCFs with positive radiative forcing are known as short-lived climate pollutants. [Nathan Borgford-Parnell, Switzerland]	Not Applicable, Section changed according o review comments
16466	14	7	14	7	Subscripts for numbers in chemical formulae required [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Not Applicable, Section changed according other review comments
29016	14	7	14	7	AR5 is clear that HCFCs (especially HCFC22) are bigger contributors to forcig than HFCs [Keith Shine, United Kingdom (of Great Britain and Northern Ireland)]	Not Applicable, Section changed according o review comments
16468	14	7	14	8	Italicise 'virtually certain' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Not Applicable, Section changed according other review comments
24718	14	7	14	8	NMVOCs also lead to SOA and so it is not "virtually certain" that they have induced a positive ERF. [William Collins, United Kingdom (of Great Britain and Northern Ireland)]	Not Applicable, Section changed according o review comments
53526	14	7	14	10	You write that CO and NMVOC produce CO2 in the atmosphere. You need to make the distinction between biogenic and fossil origin of these source gases. Or don't list CO2 as a product. [Jan Fuglestvedt, Norway]	Not Applicable, Section changed according o review comments
45688	14	7			mention Etminan? Etminan, M., et al. "Radiative forcing of carbon dioxide, methane, and nitrous oxide: A significant revision of the methane radiative forcing." Geophysical Research Letters 43.24 (2016). [Euan Nisbet, United Kingdom (of Great Britain and Northern Ireland)]	Not Applicable, Section changed according o review comments
16470	14	9	14	9	Subscripts for numbers in chemical formulae required [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Not Applicable, Section changed according other review comments
55630	14	10	14	10	Change to "NOx *emissions are* estimated to have … through the effects of NOx on …." [Larry Horowitz, United States of America]	Not Applicable, Section changed according o review comments
16472	14	11	14	11	Subscripts for numbers in chemical formulae required [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Not Applicable, Section changed according other review comments
38218	14	12			"OC" --> "OA" [Hitoshi Matsui, Japan]	Not Applicable, Section changed according o review comments
38220	14	13			"BC" --> "BC and BrC", or "BC" --> "LAP" [Hitoshi Matsui, Japan]	Not Applicable, Section changed according o review comments
16474	14	14	14	14	Capital S for 'section' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Not Applicable, Section changed according other review comments
8032	14	14	14	14	Add "sustained" after "ambitious". [Olaf Morgenstern, New Zealand]	Not Applicable, Section changed according o review comments
11674	14	14	14	14	References to the respective (sub)sections in Chapter 7 need to be included [David Neubauer, Switzerland]	Not Applicable, Section changed according o review comments
24720	14	16	14	16	"atmospheric distribution" since some SLCFs are present in the stratosphere. [William Collins, United Kingdom (of Great Britain and Northern Ireland)]	Not Applicable, Section changed according o review comments

12848	14	16	14	22	Further, black carbon has impacts on the climate once it has left the atmosphere. Deposition of black carbon on snow and ice surfaces can reduce albedo and increase warming as a self-reinforcing feedback. See Tedesco M., et al. (2016) The darkening of the Greenland ice sheet: trends, drivers, and projections (1981–2100), THE CRYOSPHERE 10:477–496, 478 ("The presence of LAI such as soot (black carbon, BC), dust, organic matter, algae, and other biological material in snow or ice also reduces the albedo, mostly in the visible and ultraviolet regions (Warren, 1982). Such impurities are deposited through dry and wet deposition, and their mixing ratios are enhanced through snow water loss in sublimation and melting (Conway et al., 1996; Flanner et al., 2007; Doherty et al., 2013). Besides grain growth and LAI, another cause of albedo reduction over the GrIS is the exposure of bare ice: once layers of snow or firn are removed through ablation, the exposure of the underlying bare ice will further reduce surface albedo, as does the presence of melt pools on the ice surface (e.g. Tedesco et al., 2011)."); World Bank & International Cryosphere Climate Initiative (2013) ON THIN ICE: HOW CUTTING POLLUTION CAN SLOW WARMING AND SAVE LIVES, 2 ("Climate benefits for cryosphere regions from black carbon reductions carry less uncertainty than they would in other parts of the globe and are sometimes very large. This is because emissions from sources that emit black carbon—even with other pollutants—almost always lead to warming over reflective ice and snow."); Arctic Monitoring and Assessment Programme (AMAP) (2017) ADAPTATION ACTIONS FOR A CHANGING ARCTIC: PERSPECTIVES FROM THE BARENTS AREA, 72 ("Highly reflective surfaces, such as snow and ice in the Arctic increase light absorption by BC particles in the atmosphere. BC also absorbs light after deposition onto (and then into) snow and ice, where it accelerates the melt process (Pedersen et al., 2015). BC has made an important contribution to the observed rise in Arctic surface temperature through the 20th century (although carbon dioxide is still the major factor driving the rise in Arctic temperature) (Quinn et al., 2008; Koch et al., 2011; AMAP, 2015a). It may be technically possible to reduce global anthropogenic BC emissions by up to 75% by 2030	We added a phrase about the BC effects on snow, and the Warren reference. We added Tedesco and Warren references
55632	14	16	14	22	Switching from concentration-based forcing discussed in previous paragraph to emission-based forcings in this paragraph. Need to clarify these two different concepts. [Larry Horowitz, United States of America]	Not Applicable, Section changed according o review comments

12680	14	16	14	22	Further, black carbon has impacts on the climate once it has left the atmosphere. Deposition of black carbon on snow and ice surfaces can reduce albedo and increase warming as a self-reinforcing feedback. See Tedesco M., et al. (2016) The darkening of the Greenland ice sheet: trends, drivers, and projections (1981–2100), THE CRYOSPHERE 10:477–496, 478 ("The presence of LAI such as soot (black carbon, BC), dust, organic matter, algae, and other biological material in snow or ice also reduces the albedo, mostly in the visible and ultraviolet regions (Warren, 1982). Such impurities are deposited through dry and wet deposition, and their mixing ratios are enhanced through snow water loss in sublimation and melting (Conway et al., 1996; Flanner et al., 2007; Doherty et al., 2013). Besides grain growth and LAI, another cause of albedo reduction over the GrIS is the exposure of bare ice: once layers of snow or firn are removed through ablation, the exposure of the underlying bare ice will further reduce surface albedo, as does the presence of melt pools on the ice surface (e.g. Tedesco et al., 2011)."); World Bank & International Cryosphere Climate Initiative (2013) ON THIN ICE: HOW CUTTING POLLUTION CAN SLOW WARMING AND SAVE LIVES, 2 ("Climate benefits for cryosphere regions from black carbon reductions carry less uncertainty than they would in other parts of the globe and are sometimes very large. This is because emissions from sources that emit black carbon—even with other pollutants—almost always lead to warming over reflective ice and snow."); Arctic Monitoring and Assessment Programme (AMAP) (2017) ADAPTATION ACTIONS FOR A CHANGING ARCTIC: PERSPECTIVES FROM THE BARENTS AREA, 72 ("Highly reflective surfaces, such as snow and ice in the Arctic increase light absorption by BC particles in the atmosphere. BC also absorbs light after deposition onto (and then into) snow and ice, where it accelerates the melt process (Pedersen et al., 2015). BC has made an important contribution to the observed rise in Arctic surface temperature through the 20th century (although carbon dioxide is still the major factor driving the rise in Arctic temperature) (Quinn et al., 2008; Koch et al., 2011; AMAP, 2015a). It may be technically possible to reduce global anthropogenic BC emissions by up to 75% by 2030	Not Applicable, Section changed according o review comments
40664	14	16	16	22	A very well-written paragraph, you might consider moving it to the introduction or conclusions. [Daniel Murphy, United States of America]	Thank you. No longer applicable , section 6.1 has been reorganized and rewritten.
41538	14	17	14	19	Reference needed [Amanda Maycock, United Kingdom (of Great Britain and Northern Ireland)]	References to Shindell et al., 2013, 2017 were added
24722	14	17	14	19	This could refer to section 7.7.2.4 which discuss rate vs accumulation more fully [William Collins, United Kingdom (of Great Britain and Northern Ireland)]	A link to section 7.7.2.4 was added
49984	14	18			Seeing as ozone and SOA are not emitted but produced in the atmosphere, here it should say, "the total radiative forcing of an individual SLCF is related to its rate of emission or production …" [Owen Cooper, United States of America]	Not Applicable, Section changed according o review comments
53528	14	19	14	19	You may add "and spatially heterogeneous sources" after "short lifetimes" [Jan Fuglestvedt, Norway]	Text added as suggested
55634	14	19	14	19	LLGHG or LLCF? [Larry Horowitz, United States of America]	Not Applicable, Section changed according o review comments
24724	14	19	14	20	Methane, and some of the halocarbons are not heterogeneously distributed (depending on where Ch 6 decides to draw the line distinguishing short-lived from long-lived). [William Collins, United Kingdom (of Great Britain and Northern Ireland)]	A phrase was added to address to the Methane issue: "Methane is an exception, and is rather homogeneous due to the longer lifetime compared to other SLCF."
29018	14	20	14	22	While this is indeed true for many SLCFs, I don't think some of the statements here are true for things like methane, HCFC22 and HFC134a. I feel more nuance is needed [Keith Shine, United Kingdom (of Great Britain and Northern Ireland)]	A phrase was added to address to the Methane issue: "Methane is an exception, and is rather homogeneous due to the longer lifetime compared to other SLCF."

55636	14	21	14	21	Add "of SLFC" after "impacts." [Larry Horowitz, United States of America]	Not Applicable, Section changed according o review comments
53664	14	25	14	25	6.1.3.2: be sure to check interface with WGII [Jan Fuglestvedt, Norway]	"Not applicable"- Section no longer included in the chapter
51988	14	25	15	21	This section feels more like a review than an assessment and there is as a result a lack of traceability to the assessment findings that arise. Rather than providing a list of literature there needs to be an attempt to summarise and synthesise that literature leading to the substantive assessment finding. This issue is most acute for the latter components of this section which become just reference lists with no attempt to summarise, compare, contrast and assess. [Peter Thorne, Ireland]	Accepted, text changed accordingly
41764	14	25	15	21	It seems odd to me that a chapter of the WP1 report should venture beyond the physics of the Earth-Atmosphere system and into impacts on agricultural systems, human health etc., i.e. impacts of poor air quality. The heading of 6.1.3.2 also does not suggest this in my view. Suggestion: Focus on Earth-Atmosphere system, how SLCFs are distributed, and what AQ results from this, but not human health impacts etc. [Jan Cermak, Germany]	Accepted, text changed accordingly
14658	14	27	14	27	It would be good to describe the AR5 starting point. WG1 Chapter 2 had some discussion on visibility. Not sure where the others issues were and what was said in AR5 (or 1.5). [Frank Dentener, Italy]	"Not applicable"- Section no longer included in the chapter
16476	14	27	14	27	Delete , after 'visibility' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	"Not applicable"- Section no longer included in the chapter
16480	14	27	14	28	This is misleading, as agricultural systems are also ecosystems, so separating these in this way could be erroneous. Why not say, 'ecosystems including agricultuiral systems' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	"Not applicable"- Section no longer included in the chapter
55798	14	27	14	31	Why air pollutant(s)? Surely this is always plural? [Christopher Smith, United Kingdom (of Great Britain and Northern Ireland)]	"Not applicable"- Section no longer included in the chapter
24726	14	27	14	33	This seems to be a bit overkill for a definition of air pollutant. I imagine every reader will already understand what the term means. [William Collins, United Kingdom (of Great Britain and Northern Ireland)]	"Not applicable"- Section no longer included in the chapter
49986	14	27			Studies on the impacts of air pollution typically focus on human heath and vegetation. It's rare to see any mention of impacts on animals. Are there authoritative references on the impact of air pollution on animals? Animals are not metioned anywhere else in this chapter. [Owen Cooper, United States of America]	"Not applicable"- Section no longer included in the chapter
16478	14	28	14	28	Delete , after 'ecosystems', but see next comment [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	"Not applicable"- Section no longer included in the chapter
16482	14	29	14	29	Insert space aftre full stop [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	"Not applicable"- Section no longer included in the chapter
50364	14	29			The line should be: The physical and chemical nature of these pollutants regulate ambient air quality. [Tirthankar Banerjee, India]	"Not applicable"- Section no longer included in the chapter
49988	14	32	14	33	Here the air qualtiy standard needs to be placed in the context of the term "metric". For example: "An air quality standard is typically based on a particular concentration metric, for example daily averages of near-surface concentrations of specific pollutants." [Owen Cooper, United States of America]	"Not applicable"- Section no longer included in the chapter

43128	14	35	14	36	The references list only (WHO, 2016). On the other hand, WHO (2018) released news and fact sheet in May 2018: 4.2 million premature deaths out of 7 million from outdoor air pollution; indoor pollution causes 3.8 million premature deaths in 2016. https://www.who.int/en/news-room/fact-sheets/detail/ambient-(outdoor)-air-quality-and-health. See also: https://www.who.int/airpollution/data/cities/en/ [Luisa Molina, United States of America]	taken into account
44242	14	35	14	37	In addition to the WHO estimates, the recent study of Burnett et al., PNAS, 2018 finds 8.0 million premature deaths annually due to outdoor (ambient) air pollution alone. Hence this result, based on new cohort studies for high pollution areas in Asia, has substantially larger values than WHO. I suggest the range be expanded to encompass both here. [Drew Shindell, United States of America]	taken into account
31042	14	36	14	36	It would be good to quantify the average life expectancy loss -- it is in the order of a few months. [Nicolas Bellouin, United Kingdom (of Great Britain and Northern Ireland)]	taken into account
55638	14	36	14	36	"mio" -> "mil"? Also, give time period over which these premature deaths were estimated to have occurred. [Larry Horowitz, United States of America]	"Not applicable"- Section no longer included in the chapter
16484	14	36	14	36	Not clear what 'mio' means [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Not applicable. Section restructured
16486	14	36	14	36	Insert , after 'pollution' and 'are' after 'half [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	"Not applicable"- Section no longer included in the chapter
44482	14	36	14	36	replace mio with million [VIJAY SONI, India]	"Not applicable"- Section no longer included in the chapter
14656	14	37	14	37	Not incorrect, but also not very clear. I would connect the sentence to the previous one. WHO, 2018. These, and similar estimates, are based on epidemiological studies, disentangling many confounding factors, and therefore provide only indirect evidence for specific causal relationships. Historically, the epidemiological studies have focused on relationships with PM2.5 aerosol, while there is growing evidence for the more specific roles of size, composition or number. Here could also be some discussion on the treshold values defined by WHO- 10 ug/m3. This means that in almost regions reductions of SLCF would lead to tangeable health benefits. [Frank Dentener, Italy]	taken into account
44480	14	37	14	37	World Health Organization, 2018 is missing from reference list. Premature death data may please be checked. [VIJAY SONI, India]	"Not applicable"- Section no longer included in the chapter
44244	14	37	14	38	Yes, the majority are based on correlation, but this gives a misleading picture of our understanding of the health impacts of PM as there is a huge body of literature establishing biological pathways. See, for example, the Integrated Science Assessmetn of the US EPA which finds that there is compelling evidence for a causal connection, not just correlation. [Drew Shindell, United States of America]	taken into account
50366	14	37			The epidemiological research use mutiple statitistical analysis including correlation, so better replace by statistical means. In line 38, do not firmly establish to contrary to that of line 43, which indicate high confidence in air pollution health effects. [Tirthankar Banerjee, India]	"Not applicable"- Section no longer included in the chapter
41540	14	43	14	43	state this is a negative impact on health [Amanda Maycock, United Kingdom (of Great Britain and Northern Ireland)]	Not applicable
29020	14	43	14	43	I cant reconcile the "ihigh confidence" with the heavy caveats in the previous paragraph [Keith Shine, United Kingdom (of Great Britain and Northern Ireland)]	Not applicable
44460	14	43	14	43	The statement at line 43 seems to be contradictory to previous para. [VIJAY SONI, India]	Not applicable

14660	14	45	14	45	North America/Europe are brightening. Are there studies analysing the consequences for e.g. RUE (radiation use efficieny in plant growth). [Frank Dentener, Italy]	"Not applicable"- Section no longer included in the chapter
16488	14	45	14	45	I sugest inserting 'other' before 'ecosystems' and delete , after 'ecosystems' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	"Not applicable"- Section no longer included in the chapter
55640	14	45	14	47	Effect of increased diffuse radiation? [Larry Horowitz, United States of America]	Not Applicable - Chapter 6 LAM3 decision to completely rewrite section 6.1 along with several sections to be deleted including this. Please also see reviewer comments # 41764 and 53664
16490	14	47	14	47	Change 'geographic' to 'geographical' and give examples [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	"Not applicable"- Section no longer included in the chapter
16492	14	51	14	52	This is a non seq. from the previous paragraph [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Not applicable
41016	15	1	15	1	This should be “lightning”. [Johannes Laube, Germany]	"Not applicable"- Section no longer included in the chapter
16494	15	1	15	1	Insert 'the' after first 'on' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	"Not applicable"- Section no longer included in the chapter
44246	15	1	15	2	The choice of citations regarding recent research on the effects of ozone on health is odd. One paper is from 2012, so not so recent, and the Fleming et al study is not really about health (it mentions it, so I guess ok here) whereas the Nuvolone et al study is EU only. I would suggest adding more recent, very relevant papers: (1) Turner, M.C., et al., Long-Term Ozone Exposure and Mortality in a Large Prospective Study. American Journal of Respiratory and Critical Care Medicine, 2016. 193(10): p. 1134-1142. (2) Seltzer, K., et al.,, Measurement-based assessment of health burdens from long-term ozone exposure in the United States, Europe, and China, Env. Res. Lett., 13, 104018, 2018. (3) and potentially, Lim CC, Hayes RB, Ahn J, Shao Y, Silverman DT, Jones RR, Garcia C, Bell ML, Thurston GD. Long-term Exposure to Ozone and Cause-Specific Mortality Risk in the US. American journal of respiratory and critical care medicine. 2019 May. [Drew Shindell, United States of America]	Accepted, text changed accordingly
16496	15	3	15	3	Change carbon monoxide to CO [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	"Not applicable"- Section no longer included in the chapter
16498	15	5	15	5	Change 'on' to 'of' and insert 'the' after 'of' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	"Not applicable"- Section no longer included in the chapter
41542	15	8	15	8	state this is a negative impact on health [Amanda Maycock, United Kingdom (of Great Britain and Northern Ireland)]	Not applicable, assessment of health impacts removed

49990	15	9			Here it is stated: "However, there is medium confidence on human health impacts from ambient concentrations of other trace gases such as NOx, CO, and SO2." Why is the confidence only medium, and not high? NOx, CO and SO2 have been the focus of air quality regulations for decades in the USA and Europe. The air quality standards for these pollutants are based on epidemiological and clinical studies and the standards are revised every few years to account for new findings. Can the authors point to any review studies that state that there is less confidence in the health impacts of these pollutants compared to ozone, and would this require a confidence level of medium? But a bigger question is, why is this statement even in the report? WGI is tasked with assessing the scientific evidence for climate change and has no mandate for assessing the impacts of air pollution on human health. This would be a topic for WGII. [Owen Cooper, United States of America]	Accepted, text changed accordingly
14662	15	12	15	17	Assess what these studies found. [Frank Dentener, Italy]	Accepted, text changed accordingly
55642	15	12	15	17	Provide an estimate of the yield loss from literature. [Larry Horowitz, United States of America]	Accepted, text changed accordingly
16500	15	13	15	13	Change sulphur dioxide to SO2 [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	"Not applicable"- Section no longer included in the chapter
44252	15	14	15	17	One thing we found interesting in our recent analysis regarding agriculture and SLCFs was that as CO2 has a fertilization effect whereas HFCs do not and methane not only doesn't fertilize but makes ozone, the net impact of SLCFs could be as large or larger (or even the opposite sign) to that of CO2 and so SLCFs might be extremely important to crop yields, much more so than their relative impact on global mean temperatures would suggest. If you wanted to discuss that, the citation is: Shindell, D., G. Faluvegi, P. Kasibhatla, R. Van Dingenen, Spatial patterns of crop yield change by emitted pollutant, Earth's Future, 7, 101-112, doi:10.1029/2018EF001030, 2019. [Drew Shindell, United States of America]	Noted
16502	15	17	15	17	Please give some more information about the yield changes/effects [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted, text changed accordingly
55644	15	21	15	21	In table, "volcanos" --> "volcanoes" [Larry Horowitz, United States of America]	"Not applicable"- Section no longer included in the chapter
6850	15	23	16	3	Should "solvents" maybe be broadened to "Solvents and other chemical products" (this would include e.g. siloxanes, terpenes etc. which are part of many chemical consumer products that are in urban areas becoming major sources of NMVOCs, see also chapter 6.2.2.3 and the McDonald et al. (2018) reference in there)? [Eva Yvonne Pfannerstill, Germany]	Accepted
29022	15	25	15	25	Entry on refrigeration: I suggest making clear that the emisison comes from leakage/disposal rather than from using refrigeration and AC. Also puzzled by the exclusion of CO2 from this row, when it is included in others. [Keith Shine, United Kingdom (of Great Britain and Northern Ireland)]	Accepted, leakage pointed out. As this entry refers to leakage of operating liquid only, the CO2 emission associated with refrigeration/AC is covered in the energy consumption entry.
27474	15	25	16	1	In Table 6.1: The emitted species from volcanoes can be named as Volcanic Ash and not Dust, to be dinstinguished by desert dust [Vassilis Amiridis, Greece]	Accepted
51990	15	25			Table caption is insufficient and needs to be expanded. In particular what does the final column refer to? I assume this is LLGHGs impacted by the SLCF and/or co-produced LLGHGs but this should be made explicit either way? [Peter Thorne, Ireland]	Accepted, Caption changed and columns explained
49992	15	25			In Table 6.1, the stratosphere should be listed under Natural Sources because it is a natural source of tropospheric ozone [Owen Cooper, United States of America]	Accepted

16504	15	26	16	1	If the table is to be split over two pages then please duplicate the column headings at the top of the second page [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Noted
45690	15	26			methane is emitted in large quantities by biomass burning. [Euan Nisbet, United Kingdom (of Great Britain and Northern Ireland)]	Accepted
53046	16	1	16	54	An important point to make here is uncertainty. We are quite certain that reductions in methane emissions will both reduce climate change and result in health co-benefits. We are moderately certain about BC from some sectors such as transportation. For sectors such as biofuel consumption, the sign of the climate impact is not clear (particularly with recent indications that BC temperature impact may be weak - e.g., Stjern etal 2017. doi: 10.1002/2017JD027326), see also uncertainty analysis in some of the cited literature (Rogelj et al., 2015, Smith and Mizrahi). [Steven Smith, United States of America]	Noted
53660	16	6	17	9	This section has some statements on costs. While I think it is OK to go outside the traditional frame, we should also be sure to build this on a robust assessment. And coordination with WGIII is needed (e.g. as CAs). And you should not elevate his to the ES unless you have a very solid basis. [Jan Fuglestvedt, Norway]	See #53530
53530	16	8	16	9	I dont think this sentcne works well. I guess your point is that also LLGHGs affect the rate, not only SLCF? If so, needs a better presentation of the point you want to make. [Jan Fuglestvedt, Norway]	Accepted. Taken into account. The section 6.1 has been totally revised and shortened and section 6.1.4 is no longer in the chapter. Elements form 6.1.4 have been included in 6.5. with consideration of this comment.
14666	16	8	17	9	The section presents an interesting overview of a variety of policy angels, but doesn't assess the validity or plausibility of the se various viewpoints. It would probably be worth to define better the specific aspects/questions that this section tries to address. For instance what can we say (+uncertainty) on the role of SLCPs for rate of temperature change- maximum, minimum, separate or integrated airpollution /cc policies. Is it an option to integrate this section with section 6.6 where the discussion is partly repeated? [Frank Dentener, Italy]	See #53530
16506	16	9	16	10	Subscripts for numbers in chemical formulae required [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	See #45692
12850	16	9	16	13	Reduction of anthropogenic aerosols will contribute additional warming by way of unmasking warming that is presently being offset by the reflective properties of aerosols. Aerosols from air pollution will decline in the coming years as a means for preserving air quality and promoting healthier air conditions, but their removal will lead to additional warming of 0.3 ºC in 2050 and 0.6 ºC in 2100. Xu and Ramanathan (2017) Well below 2 °C: Mitigation strategies for avoiding dangerous to catastrophic climate changes, Proc. Natl. Acad. Sci. 114(39):10315–10323; Ramanathan and Xu (2010) The Copenhagen Accord for limiting global warming: Criteria, constraints, and available avenues, Proc. Natl. Acad. Sci. 107(18):8055–8062; Ramanathan and Feng (2008) On avoiding dangerous anthropogenic interference with the climate system: Formidable challenges ahead, Proc. Natl. Acad. Sci. 105(38):14245–14250; Ramanathan, Molina, and Zaelke (2017) Well Under 2 Degrees Celsius: Fast Action Policies to Protect People and the Planet from Extreme Climate Change. [Durwood Zaelke, United States of America]	See #53530

45692	16	15			Perhaps also Nisbet, E. G., et al. "Very strong atmospheric methane growth in the 4 years 2014–2017: Implications for the Paris Agreement." Global Biogeochemical Cycles 33.3 (2019): 318-342. [Euan Nisbet, United Kingdom (of Great Britain and Northern Ireland)]	Taken into account. The section 6.1 has been totally revised and shortened and section 6.1.4 is no longer in the chapter. Elements form 6.1.4 have been included in 6.5. with consideration of this comment.
16508	16	18	16	18	Capital S for 'section' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	See #45692
49264	16	18	16	19	The use of the term 'species' seems inappropriate, as the term is not mentioned beforehand and it requires further clarification on the actual meaning of the term used. [EE LING LEE, Malaysia]	See #45692
53532	16	20	16	21	Seems you are thinking about what WGI did here. But please also check what WGIII did on SLCF. [Jan Fuglestvedt, Norway]	See #53530
24728	16	20	16	21	In AR5 the policy-relevance of SLCFs was specifically addressed in the WG III report [William Collins, United Kingdom (of Great Britain and Northern Ireland)]	See #53530
12852	16	23	16	30	Speed is a key metric, and climate solutions must be measured along this dimension as well as along the conventional metrics: the question that needs to be answered is how quickly a climate solution can deliver avoided warming, with SLCPs providing avoided warming at 2050 of up to 0.6C and CO2 avoiding up to 0.1C to 0.3C; at 2100, SLCPs avoid 1.2C warming and CO2 avoids 1.6 to 1.9C. SLCP reductions are critical for vulnerable areas like the Arctic and because they can slow progression of tipping points and self-reinforcing feedbacks. Aerosols from air pollution will decline in the coming years as national efforts are undertaken to improve air quality, but their removal will lead to additional warming of 0.3 ºC in 2050 and 0.6 ºC in 2100. See Xu and Ramanathan (2017) Well below 2 °C: Mitigation strategies for avoiding dangerous to catastrophic climate changes, Proc. Natl. Acad. Sci. 114(39):10315–10323; Ramanathan and Xu (2010) The Copenhagen Accord for limiting global warming: Criteria, constraints, and available avenues, Proc. Natl. Acad. Sci. 107(18):8055–8062; Ramanathan and Feng (2008) On avoiding dangerous anthropogenic interference with the climate system: Formidable challenges ahead, Proc. Natl. Acad. Sci. 105(38):14245–14250; Ramanathan, Molina, and Zaelke (2017) Well Under 2 Degrees Celsius: Fast Action Policies to Protect People and the Planet from Extreme Climate Change. [Durwood Zaelke, United States of America]	See #53530
42340	16	23	16	30	Speed is a key metric, and climate solutions must be measured along this dimension as well as along the conventional metrics: the question that needs to be answered is how quickly a climate solution can deliver avoided warming, with SLCPs providing avoided warming at 2050 of up to 0.6C and CO2 providing up to 0.1C to 0.3C; at 2100 of up to 1.2C and CO2 providing up to 1.6C to 1.9C . See Xu and Ramanathan (2017) Well below 2 °C: Mitigation strategies for avoiding dangerous to catastrophic climate changes, Proc. Natl. Acad. Sci. 114(39):10315–10323. [Gabrielle Dreyfus, United States of America]	See #53530

12682	16	23	16	30	Reduction of anthropogenic aerosols will contribute additional warming by way of unmasking warming that is presently being offset by the reflective properties of aerosols. Aerosols from air pollution will decline in the coming years as a means for preserving air quality and promoting healthier air conditions, but their removal will lead to additional warming of 0.3 ºC in 2050 and 0.6 ºC in 2100. See Molina M., et al. (2009) Reducing abrupt climate change risk using the Montreal Protocol and other regulatory actions to complement cuts in CO2 emissions, PROC. NAT'L. ACAD. SCI. 106(49):20616–20621; Xu and Ramanathan (2017) Well below 2 °C: Mitigation strategies for avoiding dangerous to catastrophic climate changes, Proc. Natl. Acad. Sci. 114(39):10315–10323; Ramanathan and Xu (2010) The Copenhagen Accord for limiting global warming: Criteria, constraints, and available avenues, Proc. Natl. Acad. Sci. 107(18):8055–8062; Ramanathan and Feng (2008) On avoiding dangerous anthropogenic interference with the climate system: Formidable challenges ahead, Proc. Natl. Acad. Sci. 105(38):14245–14250; Ramanathan, Molina, and Zaelke (2017) Well Under 2 Degrees Celsius: Fast Action Policies to Protect People and the Planet from Extreme Climate Change. [Kristin Campbell, United States of America]	See #53530
12684	16	23	16	30	Speed is a key metric, and climate solutions must be measured along this dimension as well as along the conventional metrics: the question is how quickly a solution can deliver avoided warming. SLCP's contribute to the rate of warming, which is important for particularly vulnerable areas like the Arctic and the speed with which we approach tipping points and self-reinforcing feedbacks. Reduction of anthropogenic aerosols will contribute additional warming by way of unmasking warming that is presently being offset by the reflective properties of aerosols. Aerosols from air pollution will decline in the coming years as a means for preserving air quality and promoting healthier air conditions, but their removal will lead to additional warming of 0.3 ºC in 2050 and 0.6 ºC in 2100. See Molina M., et al. (2009) Reducing abrupt climate change risk using the Montreal Protocol and other regulatory actions to complement cuts in CO2 emissions, PROC. NAT'L. ACAD. SCI. 106(49):20616–20621; Xu and Ramanathan (2017) Well below 2 °C: Mitigation strategies for avoiding dangerous to catastrophic climate changes, Proc. Natl. Acad. Sci. 114(39):10315–10323; Ramanathan and Xu (2010) The Copenhagen Accord for limiting global warming: Criteria, constraints, and available avenues, Proc. Natl. Acad. Sci. 107(18):8055–8062; Ramanathan and Feng (2008) On avoiding dangerous anthropogenic interference with the climate system: Formidable challenges ahead, Proc. Natl. Acad. Sci. 105(38):14245–14250; Ramanathan, Molina, and Zaelke (2017) Well Under 2 Degrees Celsius: Fast Action Policies to Protect People and the Planet from Extreme Climate Change. [Kristin Campbell, United States of America]	See #53530
39058	16	23	16	38	Need to clean up the text for repeatation. The two paragraphs can be merged to one. [Prabir Patra, Japan]	See #45692
16510	16	26	16	28	Subscripts for numbers in chemical formulae required [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	See #45692
52538	16	27	16	30	SLCFs with positive radiative forcing are known as short-lived climate pollutants. [Nathan Borgford-Parnell, Switzerland]	See #53530
49994	16	27	16	30	This is a repeat of what was stated on lines 9-12 immediately above. [Owen Cooper, United States of America]	See #45692
38222	16	27	16	30	This sentence should be removed. This sentence is similar to the sentence at Page 16, Lines 9-12. [Hitoshi Matsui, Japan]	See #53530

29024	16	27	16	30	Repeats first paragraph of ths subsection [Keith Shine, United Kingdom (of Great Britain and Northern Ireland)]	See #45692
49266	16	27	16	30	Overlapped with line 9 to 13. [EE LING LEE, Malaysia]	See #53530
47270	16	28	16	28	suggest to replace "HFCs" with "halogenated carbon compounds" [Guang Zeng, New Zealand]	See #45692
52532	16	31	16	38	When discussing the policy relevance of SLCF, it could be worth reviewing publications wherein countries themselves express why they find SLCFs policy relevant. For example, Ghana's Fourth National Greenhouse Gas Inventory Report includes all SLCPs and other air pollutants (NOx, CO, NMVOCs and PM2.5) (https://unfccc.int/sites/default/files/resource/gh_nir4-1.pdf). In their inventory report, Ghana states that they included these non-Kyoto basket emissions because "The widening of the variety of gases in the inventory was crucial because it helped to enhance the utility and relevance of the results beyond climate change to the impacts of SLCPs and air pollution on human lives, agricultural productivity, ecosystems, and sustainable development." [Nathan Borgford-Parnell, Switzerland]	See #45692
52540	16	32	16	33	Shindell 2012 and UNEP/WMO 2011 both focus on the climate and air quality benefits of implementing 16 mitigation measures which primarily focus on methane and black carbon-rich PM sources. These 16 measures were specifically selected because they result in a net negative climate forcing - meaning that they were specifically selected to not significantly impact emissions of cooling aerosols or sources of PM which has a less favorable ration of BC/OC. By definitition, the Shidnell 2012 results do not address all SLCF and do not address the total theoretical mitigation potential of all SLCPs ove the next 25 years. It is innacurate to represent the 0.5C avoided wamring from Shindell 2012 as the theoretical maximum climate benefit achievable from SLCP mitigation, as it is also innacurate to attribute it to the climate impact of SLCF mitigation. [Nathan Borgford-Parnell, Switzerland]	See #53530
52978	16	32	16	33	Shindell 2012 and UNEP/WMO 2011 both focus on the climate and air quality benefits of implementing 16 mitigation measures which primarily focus on methane and black carbon-rich PM sources. These 16 measures were specifically selected because they result in a net negative climate forcing - meaning that they were specifically selected to not significantly impact emissions of cooling aerosols or sources of PM which has a less favorable ratio of BC/OC. By definitition, the Shidnell 2012 results do not address all SLCFs and do not address the total theoretical mitigation potential of all SLCPs over the next 25 years. It is innacurate to represent the 0.5C avoided warming from Shindell 2012 as the theoretical maximum climate benefit achievable from SLCP mitigation, as it is also innacurate to attribute it to the climate impact of SLCF mitigation. [Nathan Borgford-Parnell, Switzerland]	See #53530

53042	16	32	16	34	This statement does not reflect the literature. In general, the 0.5°C estimate from Shindell et al. has not been replicated in the literature using more detailed analysis (in addition to those cited, also Rogelj et al., 2015, Stohl etal 2015). Stohl etal 2015, using more complex models found essentially the same estimate as Smith and Mizrahi (when comparing like-with-like scenarios. The main difference was that in their central estimate Smith and Mizrahi assumed that cost effective methane reductions would occur in their reference case while Stohl did not. Leading to a slightly higher SLCF impact in Stohl et al. See Smith and Mizrahi SI where the result with no assumed reference case methane abatement is presented. The result is identical to that from Stohl et al.). This second factor should also be mentioned (e.g., that estimates differ due to different boundaries for what is considered SLCF mitigation vs reference scenario.). Overall, the literature does not provide strong support a contention that, for central climate parameters, that SLCF mitigation can result in a 0.5°C reduction in temperature by mid-century. This should be made clear in the assessment. [Steven Smith, United States of America]	See #53530
49996	16	32	16	34	Here it is stated that a global temperature increase of 0.5 C over the next 25 years would be a slowed rate of increase. Slow compared to what? According to AR6 Chapter 2, the global temperature increased by 0.7 C from 1980 to 2018, which is a rate of 0.18 C per decade. An increase of 0.5 C over the next 25 years would have a rate of 0.2 C per decade, which is HIGHER than the current rate. So how is 0.5 C over 25 years a slowing of the temperature increase? The text then goes on to say that a warming of 0.16 C by 2050 would be an average value. If the increase was 0.16 C per decade then that would be an average rate, which is similar to the present rate, but if 0.16 C is the total increase from 2018 to 2050 then this would be a very low estimate. [Owen Cooper, United States of America]	See #53530
44250	16	32	16	35	It would be useful to elaborate a bit here, and tell the reader that much of the apparent discrepancy between these studies is due to them looking at different types of policies, e.g. all air quality improvements, which emphasize the abundant cooling aerosols, vs improvements targeted at warming agents, or using different baselines, etc. So it's more subtle than being uncertain and a matter of debate, but conclusions naturally depend upon the details of the question being asked and there are many policy options so that the net benefit of SLCF reductions in a blanket sense will of course have a large spread of results. Inother words, while there are indeed important physical science uncertainties, much of the spread referred to here comes instead from differing socio-economic assumptions, which it would be helpful to make clear. [Drew Shindell, United States of America]	See #53530

52542	16	32	16	38	In a section titled 'Policy relevance,' it is worth reflecting on the inherent policy bias expressed in this paragraph. Asking what relevance SLCF mitigation has on long-term climate targets should require at least some context about the policy relevance of near-term climate/development/public health/food security benefits, and, posibly even more importantly, some discussion of the policy relevance (or lack of relevance) of presenting a largely false political choice between long-term and short-term climate objectives. Article 2 of the the Paris Agreement does not contain a long-term climate target and it does not reference 2100 or beyond. However, Article 2 does specifically "aim to strengthen the global response to the threat of cliamte change, in the context of sustainable development and efforts to eradicate poverty...." Sustainable development and efforts to erradicate poverty are very near-term and very policy relevant objectives and the IPCC SR1.5 report concluded that they are objectives which are inherently linked to both near and long-them climate objectives. Section 6.1.4 should strive to strive to present near- and long-term climate objectives a simultansouly achievable and only true conflicts when it provides necessary context to policymaking. [Nathan Borgford-Parnell, Switzerland]	See #45692
24730	16	32	16	38	This paragraph should try to assess why it is not possible (or alternatively whether it is in fact possible) to evalue the effects of SLCFs on climate change as presumably we understand the physical principles. From a quick glance at the studies cited, it seems they all mitigate different species, therefore it doesn't seem a fair comparison. [William Collins, United Kingdom (of Great Britain and Northern Ireland)]	See #53530
14664	16	35	16	36	The Stefler reference is slightly misinterpreted: it rather states that *in the presence of strong GHG mitigation policies* additional ambitious air pollution policies do not change too much the long-term objectives (but do matter on a decadal timescale). [Frank Dentener, Italy]	See #53530
53534	16	35	16	38	I think this sentence needs improved formulation. A general consesus among who? And I suggets you make it conditional; ie. Something like this: "….in order to achieve a defined goal, then it has been shown that……." [Jan Fuglestvedt, Norway]	See #53530
49998	16	35	16	38	It's not clear what is being said here. Is this a judgement statement, in which someone is trying to say that we can and should reduce SLCFs emissions, but if we do we don't want governments to think that they can now slow down their efforts to reduce LLGHGs? Why is this assessment of policy included in WG1, which is supposed to focus on the scientific basis for climate change? I think this commentary should be removed and taken up by other working groups of IPCC, which focus on policy. [Owen Cooper, United States of America]	See #53530
24732	16	35	16	38	This argument on pressure to mitigate could be seen as too policy prescriptive for IPCC (particularly WG I). It might be better to make physical statements, such as that mitigation of SLCFs alone is not sufficent to reduce temperatures in line with UNFCCC goals. [William Collins, United Kingdom (of Great Britain and Northern Ireland)]	See #53530
16512	16	40	16	40	Change 'to mitigate' to 'of mitigating' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	See #45692
29026	16	43	16	43	I commend 10.5194/acp-15-10529-2015 to you as a significant paper in this area [Keith Shine, United Kingdom (of Great Britain and Northern Ireland)]	See #53530
16514	16	45	16	45	Don't italicise et al. [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	See #45692

6852	16	49	16	51	you could also cite this publication: Lelieveld, J.; Klingmüller, K.; Pozzer, A.; Burnett, R. T.; Haines, A.; Ramanathan, V. (2019): Effects of fossil fuel and total anthropogenic emission removal on public health and climate. Proceedings of the National Academy of Sciences of the United States of America, 116, 7192–7197. doi: 10.1073/pnas.1819989116 [Eva Yvonne Pfannerstill, Germany]	See #53530
52544	16	51	16	51	it's unclear what dominate means in the context of this sentence. [Nathan Borgford-Parnell, Switzerland]	See #45692
44248	16	51	17	1	As the economic consequences carry great weight with policy makers, I think the more citations to butress this the better, so I suggest adding my 2018 paper (Shindell, D., G. Faluvegi, K. Seltzer, C. Shindell, Quantified, Localized Health Benefits of Accelerated Carbon Dioxide Emissions Reductions, Nature Climate Change, 8, 291-295, 2018) and the Vandyck et al 2018 paper already in your reference list. [Drew Shindell, United States of America]	See #53530
50000	17	1	17	4	What is the point of this sentence? It says that new studies are being conducted, but what should we conclude from these new results? [Owen Cooper, United States of America]	See #53530
16516	17	2	17	2	Change 'analyses' to 'analyse' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	See #45692
31044	17	6	17	7	That is an important point that needs to be elaborated on. What prevents co-benefits from automatically happening? [Nicolas Bellouin, United Kingdom (of Great Britain and Northern Ireland)]	See #53530
53536	17	6	17	9	I suggest softening this. Is it a fact? [Jan Fuglestvedt, Norway]	See #53530
12854	17	6	17	9	Additional example of co-benefits associated with SLCP mitigation comes from the phasedown of HFCs under the Kigali Amendment and the simultaneous opportunity to improve energy efficiency that will help reduce overall energy use and the emissions associated with producing it. For example, improving energy efficiency of air conditioners and other cooling equipment and switching to lower GWP refrigerants as required by the Kigali Amendment to the Montreal Protocol could avoid even more warming, up to 100 Gt CO2-eq cumulatively through 2050. Sachar et al. (2018) Solving the Global Cooling Challenge: How to Counter the Climate Threat from Room Air Conditioners. Rocky Mountain Institute, P. 24 (“The 5X solution saves up to 100 gigatons of cumulative emissions by 2050.”); Shah et al. (2015), Benefits of Leapfrogging to Superefficiency and Low Global Warming Potential Refrigerants in Room Air Conditioning. Berkeley, CA, USA. (“While there is some uncertainty associated with emissions and growth projections, moving to efficient room air conditioning (~30% more efficient than current technology) in parallel with low-GWP refrigerants in room air conditioning could avoid up to ~25 billion tonnes of CO2 in 2030, ~33billion in 2040, and ~40 billion in 2050, i.e. cumulative savings up to 98 billion tonnes of CO2 by 2050.”); Cooling for All; and Birmingham Energy Institute, University of Birmingham (2018) A Cool World: Defining the Energy Conundrum of Cooling for All; see also Carvalho S., et al. (2014) Alternatives to High-GWP Hydrofluorocarbons. [Durwood Zaelke, United States of America]	See #53530
47954	17	6	17	9	IPCC reports are policy neutral and relevant but not prescriptive. Please avoid using emotive language or value based statements or using terms like should, must, need in the text when referencing actions or decisions. [WGI TSU, France]	See #53530

42342	17	6	17	9	Additional example of co-benefits associated with SLCP mitigation comes from the phasedown of HFCs under the Kigali Amendment and the simultaneous opportunity to improve energy efficiency that will help reduce overall energy use and the emissions associated with producing it. For example, improving energy efficiency of air conditioners and other cooling equipment and switching to lower GWP refrigerants as required by the Kigali Amendment to the Montreal Protocol could avoid even more warming, up to 100 Gt CO2-eq cumulatively through 2050. Sachar et al. (2018) Solving the Global Cooling Challenge: How to Counter the Climate Threat from Room Air Conditioners. Rocky Mountain Institute, P. 24 ("The 5X solution saves up to 100 gigatons of cumulative emissions by 2050."); Shah et al. (2015), Benefits of Leapfrogging to Superefficiency and Low Global Warming Potential Refrigerants in Room Air Conditioning. Berkeley, CA, USA. ("While there is some uncertainty associated with emissions and growth projections, moving to efficient room air conditioning (~30% more efficient than current technology) in parallel with low-GWP refrigerants in room air conditioning could avoid up to ~25 billion tonnes of CO2 in 2030, ~33billion in 2040, and ~40 billion in 2050, i.e. cumulative savings up to 98 billion tonnes of CO2 by 2050."); Cooling for All; and Birmingham Energy Institute, University of Birmingham (2018) A Cool World: Defining the Energy Conundrum of Cooling for All; see also Carvalho S., et al. (2014) Alternatives to High-GWP Hydrofluorocarbons. [Gabrielle Dreyfus, United States of America]	See #53530
12686	17	6	17	9	Additional example of co-benefits associated with SLCP mitigation comes from the phasedown of HFCs under the Kigali Amendment and the opportunity to improve energy efficiency that will help reduce overall energy demand the emissions associated with it. For example, improving air conditioner energy efficiency and switching to lower GWP refrigerants as required by the Kigali Amendment to the Montreal Protocol could avoid even more warming, up to 100 Gt CO2-eq cumulatively through 2050 (Shah et al., 2015; Purohit and Höglund-Isaksson, 2017). Shah et al. (2015), Benefits of Leapfrogging to Superefficiency and Low Global Warming Potential Refrigerants in Room Air Conditioning. Berkeley, CA, USA. ("While there is some uncertainty associated with emissions and growth projections, moving to efficient room air conditioning (~30% more efficient than current technology) in parallel with low-GWP refrigerants in room air conditioning could avoid up to ~25 billion tonnes of CO2 in 2030, ~33billion in 2040, and ~40 billion in 2050, i.e. cumulative savings up to 98 billion tonnes of CO2 by 2050."). Optimizing energy efficiency within refrigeration—through both engineering improvements and switching to low-GWP alternatives to HFCs, which are readily available on the market—and maintain the infrastructure are important to limiting food waste while also promoting food security, helping prevent emissions from waste as well as helping achieve various SDGs. See Sustainable Energy for All (2018) Chilling Prospects: Providing Sustainable Cooling for All; and Birmingham Energy Institute, University of Birmingham (2018) A Cool World: Defining the Energy Conundrum of Cooling for All; See also Carvalho S., et al. (2014) Alternatives to High-GWP Hydrofluorocarbons. [Kristin Campbell, United States of America]	See #53530

49268	17	9	17	9	I would suggest to include a paragraph to talk about the importance of 'prevention' aspects to human-induced activities causing climate change, rather than just focusing on 'mitigation' aspects. This is because 'mitigation' is treating the consequences of climate change while 'prevention' is to dealing with the root cause. [EE LING LEE, Malaysia]	See #53530
49270	17	13	14	34	I would like to recommend the replacement of Box 6.1 and Figure 1 with similar presentation representing policy relevance. [EE LING LEE, Malaysia]	Rejected as WG1 material is not to be prescriptive.
40554	17	13	17	13	Fig. 1 in Box 6.1 is very similar to Fig. 6.2. The discussion in Box 6.1 should include a higher level of detail regarding sources and processes leading to tropospheric SLCF impacts and these details should be included in the figure in order to make it different than Fig. 6.2. [Rosa Flores, Turkey]	Not applicable - Box content refocused
41226	17	13	17	33	why weather and not climate in this box? Also this does not includes nitrogen depositon, which is a big driver of CO2 uptake. Not convinced by the figure [Jean-Francois Lamarque, United States of America]	Not applicable - Box content refocused
53538	17	13	17	34	No reference to Box 6.1, figure 2 [Jan Fuglestvedt, Norway]	Not applicable - Box content refocused
16518	17	21	17	21	Change to 'absorbing/reflecting' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Box has been rewritten and renumbered as Box 6.2.
24734	17	22	17	22	This should refer to the AR6 assessment here (section 6.3) rather than Boucher et al. (2013) [William Collins, United Kingdom (of Great Britain and Northern Ireland)]	Not applicable - Box content refocused
16520	17	24	17	25	This is poor expression. Arguably, everything is a component of an ecosystem, so wherever the depostion occurs it could affect an ecosystem. I suggest a rewroding to 'Their deposition can also affect ecosystems, including the cryosphere (Shindell..' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Not applicable - Box content refocused
38224	17	24	17	26	I think supply of nutrients (e.g., N, P, Fe) from atmosphere to ocean and land surface (through aerosol deposition) can be mentioned somewhere in this chapter. (if this topic is described in another chapter, please cite the chapter/section somewhere in this chapter) [Hitoshi Matsui, Japan]	Not applicable - Box content refocused
14668	17	31	17	31	Box 6.1 figure and Figure 6.2 are quite similar. Needed? [Frank Dentener, Italy]	Figures in SOD have been modified.
55772	17	38	17	45	"There is limited evidence but high agreement that the GMST response to urbanization changes is negligible": is this due to the large ocean surface? There is a large body of literature from the remote sensing community that shows hotter surfaces in urban areas than in their surroundings (SUHI, surface urban heat isand, with peak during the daytime) [Ariane Middel, United States of America]	Not applicable - section restructured
7188	17	39			In section 6.2, please mention an important fact that SLCF strongly interacts with the abundance of solar ultra-violet radiation, which is contaminated by SLCF and also affected by climate change, e.g., clouds, surface albedo, etc., and current ESMs with interactive atmospheric chemistry properly simulate those processes (Watanabe et al. 2012). Watanabe, S., T. Takemura, K. Sudo, T. Yokohata, and H. Kawase (2012), Anthropogenic changes in the surface all-sky UV-B radiation through 1850–2005 simulated by an Earth System model, Atmos. Chem. Phys., 12, 5249-5257, doi:10.5194/acp-12-5249-2012. [Shingo Watanabe, Japan]	Rejected. Not relevant. The interactions of SLCFs with radiation are covered in section 6.3
39380	17	39			The section 6.2 is too lengthy considering the balance with description on the impacts of SLCFs on climate change. This is because this report on Climate Change, not chemical compositions. [Toshihiko Takemura, Japan]	Noted and has been reworked.

24808	17	39			It would be very valuable if section 6.2 could link SLCF emissions and abundances, i.e. how much of the observed changes are due to which emission changes. This is particularly important for tropospheric and stratospheric ozone, but also secondary aerosols e.g. sulphate and nitrate. [William Collins, United Kingdom (of Great Britain and Northern Ireland)]	Accepted. Attribution of changes in SLCF abundances to emissions is assessed as much as possible in section 6.2.2
53540	17	41	17	41	change "structure" to "pattern" ? [Jan Fuglestvedt, Norway]	Accepted - text revised
16522	17	41	17	41	Insert 'the' after 1950, [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted - text revised
40666	17	41	17	41	“1950” isn’t right – a typo? [Daniel Murphy, United States of America]	Rejected - Based on the CMIP data, e.g., Figure 3 in Hoesly et al. (2018). The 1950 is approximate (in fact could be until 1960, depending on the species) but the point is that this is before a change started to happen with growth in several regions outside or NA and Europe, mostly Asia, that took over.
53542	17	45	17	46	"more than 50% of anthropogenic emissions of all species (including NH3) originate from…" is not precise. What is "all species". And how calulated? Temp, RF, time period? [Jan Fuglestvedt, Norway]	Accepted - text revised; changed to "...more than 50% of anthropogenic emissions of all SLCF species (including NH3) originating currently from Asia" - text in bold indicates additions. The text refers to the change in emissions over the last decades and reflects situation in about 2010-2015.
27476	17	51	17	51	You may add the following information that comes from active remote sensing techniques that can distinguish between anthropogenic and natural aerosols: "Active remote sensing techniques with polarization sensitivity such as CALIPSO are used nowadays to distinguish between natural non-spherical aerosols and spherical particles of anthropogenic origin, to better estimate the pollution trends in the last decade (e.g. 1;2), which is especially important over Asia (3)" 1. Amiridis, V., Marinou, E., Tsekeri, A., Wandinger, U., Schwarz, A., Giannakaki, E., Mamouri, R., Kokkalis, P., Binietoglou, I., Solomos, S., Herekakis, T., Kazadzis, S., Gerasopoulos, E., Proestakis, E., Kottas, M., Balis, D., Papayannis, A., Kontoes, C., Kourtidis, K., Papagiannopoulos, N., Mona, L., Pappalardo, G., Le Rille, O., and Ansmann, A., LIVAS: a 3-D multi-wavelength aerosol/cloud database based on CALIPSO and EARLINET, Atmospheric Chemistry and Physics, 15, 7127-7153, doi:10.5194/acp-15-7127-2015, 2015 2. Marinou, E., Amiridis, V., Binietoglou, I., Tsikerdekis, A., Solomos, S., Proestakis, E., Konsta, D., Papagiannopoulos, N., Tsekeri, A., Vlastou, G., Zanis, P., Balis, D., Wandinger, U., and Ansmann, A.: Three-dimensional evolution of Saharan dust transport towards Europe based on a 9-year EARLINET-optimized CALIPSO dataset, Atmos. Chem. Phys., 17, 5893-5919, doi:10.5194/acp-17-5893-2017, 2017 3. Proestakis, E., Amiridis, V., Marinou, E., Georgoulias, A. K., Solomos, S., Kazadzis, S., Chimot, J., Che, H., Alexandri, G., Binietoglou, I., Daskalopoulou, V., Kourtidis, K. A., de Leeuw, G., and van der A, R. J.: Nine-year spatial and temporal evolution of desert dust aerosols over South and East Asia as revealed by CALIOP, Atmos. Chem. Phys., 18, 1337-1362, https://doi.org/10.5194/acp-18-1337-2018, 2018. [Vassilis Amiridis, Greece]	Not relevant

47908	17		39		Assessment Structure: If possible, assessment conclusions should be provided in a structured traceable account of how these statements were derived. For example, sections / subsections can start with previous IPCC report conclusions (AR5 or AR6 Special Reports) and then provide an update of the more recent literature, clearly laying out the lines of evidence. Each section / subsection can then conclude with assessment statements. This section currently reads more as a review than an assessment. In addition, please make sure the ES uncertainty language is clearly tracable to the underlying chapter text. [WGI TSU, France]	Not applicable - section restructured
24736	18	1	18	17	Why are CMIP6 emissions different to CMIP5 - what new information has become available? [William Collins, United Kingdom (of Great Britain and Northern Ireland)]	Taken into account - comments #14670, #24736, #31046, #41544 addressed jointly; The text revised to highlight the benefit of common datasets like CMIP5/6 and what are the improvements in CMIP6.
16524	18	5	18	5	Don't italicise et al. [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Editorial
47272	18	5	18	6	"for several species … show for all species" - is this contradictory? Please rephrase [Guang Zeng, New Zealand]	Accepted - text revised; "for several species" deleted
16526	18	7	18	7	Insert 'Section' after 'see' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted - text revised
16528	18	11	18	12	Quantify 'significant increase' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted - text revised: the significant replaced with " 10-20%"
16530	18	17	18	17	Capitalise 'Southern Hemishere' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Rejected - this refers to Africa's part on the southern hemisphere, rather than Southern Hemisphere and so I believe it should not be capitalized.
41018	18	20	18	20	If HFCs etc. are to stay in this chapter they should be covered here. [Johannes Laube, Germany]	Taken into account - Text revised to reflect on the key sources and trends for HFCs, HCFCs
55038	18	20	21	17	Visualization of source/emission changes via a map would be helpful, particularly since source distributions affect atmospheric burden patterns of SLCFs. [Ina Tegen, Germany]	Noted - While we considered using a map in a similar way as in AR5 (e.g. as Figure 11.23ab in Chapter 11), we concluded that since we deal with several species there would be a need to generate a lot of Figures. We believe that it is sufficient to use the charts (as Fig 6.3-4) - However, the Figures have been revised to show global and regional trends for each specie in one line making the interpretation of regional vs global trends easier and more informative.
31046	18	22	18	23	Would be useful to have an assessment of why CMIP6 emissions might be better than their predecessor. For example, why should we have more confidence in pre-1950 trends in CMIP6 than in CMIP5? [Nicolas Bellouin, United Kingdom (of Great Britain and Northern Ireland)]	Taken into account - comments #14670, #24736, #31046, #41544 addressed jointly; The text revised to highlight the benefit of common datasets like CMIP5/6 and what are the improvements in CMIP6.

14670	18	22	19	56	1. Figure 6.3 and 6.4 are useful but could probability be combined. 2. The text is quite 'descriptive', but not sufficiently assessing how good we know the past global and regional anthropogenic emissions, and distributions, which information is vital to asssesing its impact on climate. It needs to 'defend' better why the community efforts on CMIP5 and CMIP6 are chosen as representative for a large set of emissions estimates, and what are the resulting quantified (and not quantified) uncertainties. Some link in this or later section to what it means for ERF would be very good to understand how important it really is. [Frank Dentener, Italy]	Taken into account - text and Figures revised. 1. Figure 6.3/4 revised showing global and regional emissions of a particular species in one row - effectively it is one Figure but fairly large extending over two pages (landscape). 2. The text revised to highlight the benefit of common datasets like CMIP5/6 and what are the improvements.
53544	18	23	18	23	"dramatically" sounds sloppy. Change to "substantially" ? [Jan Fuglestvedt, Norway]	Accepted - text revised
41544	18	23	18	26	Since the changes between CMIP5 and CMIP6 emissions datasets seem important can you briefly summarise what are the main underpinning causes of the updates in CMIP6? [Amanda Maycock, United Kingdom (of Great Britain and Northern Ireland)]	Taken into account - comments #14670, #24736, #31046, #41544 addressed jointly; The text revised to highlight the benefit of common datasets like CMIP5/6 and what are the improvements in CMIP6.
40668	18	25	18	30	This paragraph could use clarification. First it says NOx, BC, and OC are lower, than it says they differences are below 10%. This is not so much poor writing as it is just hard to describe complex differences in time series with text. If the difference between CMIP5 and CMIP6 is important, consider a figure to show the differences. If the difference between CMIP5 and CMIP6 is not important, consider deleting the paragraph. If there is a figure the text could focus on the reasons for any differences, which is more in line with being an assessment as opposed to a review. [Daniel Murphy, United States of America]	Taken into account - The respective Figure 6.3-4 have been revised to show CMIP5 and CMIP6 and text revised to improve clarity and also make more an 'assessment' type writing highlighting key reasons for differences - see also comments#14670, #24736, #31046, #41544
16532	18	30	18	30	Capital S for 'sections' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Editorial
41546	18	36	18	36	"devastating pollution episodes" unclear what measure is being used to determine devastation (deaths, crops etc) so suggest rewording to a more clearly quantitative statement [Amanda Maycock, United Kingdom (of Great Britain and Northern Ireland)]	Accepted - text revised : word 'devastating' deleted and added after 'episodes': "with PM concentrations several times higher than the national standards"
29028	18	36	18	36	A reference is needed to support the use of an emotive term such as "devastating" [Keith Shine, United Kingdom (of Great Britain and Northern Ireland)]	Accepted - text revised : word 'devastating' deleted and added after 'episodes': "with PM concentrations several times higher than the national standards"
50368	18	42			This is report that India's annual emissions of CH4 have not changed significantly (0.2 ± 0.7 Tg yr^{-1}) between 2010 and 2015, suggesting that major CH4 sources did not change appreciably. Ganesan et al December 2017 Nature Communications 8(1) [Tirthankar Banerjee, India]	Rejected, this particular section does not discuss methane.
24738	18	43	18	44	Results from Hoesly are shown later on in the chapter, I suggest referring to these here. [William Collins, United Kingdom (of Great Britain and Northern Ireland)]	Accepted - text revised

44254	18	43	18	45	Yes, and the lack of rapid drop-offs in emissions as in the RCPs is also consistent with improved understanding of the link between emissions and economic growth which does not support the existence of an environmental Kuznets' curve for SLCFs (other than SO2 from some sources): Ru, M., D. Shindell, K. Seltzer, S. Tao, Q. Zhong, The long-term relationship between emissions and economic growth for SO2, CO2 and BC, Env. Res. Lett., 13, 124021, 2018. [Drew Shindell, United States of America]	Taken into account - Text revised to include the provided reference as well as other studies where the issue of Kuznets theory and analysis of emission changes of several SLCF species are discussed. Some other work suggested actually that also NOx changes can be described by env Kuznets curve but an important point it that the relationships for SO2, NOx are different - unlike it was assumed in RCPs
16534	18	47	18	47	Change 'have' to 'has' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted - text revised
16536	18	48	18	48	Quantifuy 'decline strongly' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted - text revised: added : "reaching nearly 70% reduction by 2017"
40670	18	52	19	13	These paragraphs contain some unnecessary detail. Could shorten or even delete the paragraphs for brevity. [Daniel Murphy, United States of America]	Rejected - We believe there is a need to provide update on the recent trends and their reasons because they are different from CMIP5 and some of these are relevant also at the global scale. Finally, several reviewers commented on more specific discussion of the reasons for differences and key benefits of the latest CMIP6 estimates which drive on the material referred also here.
16538	19	4	19	4	Edit reference to Hoesly et al. (2018) [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Editorial
24740	19	9	18	13	I don't think this paragraph is necessary, as it doesn't seem relevant to talk about the discovery of oil and cars. [William Collins, United Kingdom (of Great Britain and Northern Ireland)]	Noted - The paragraph text has been revised (including suggestions in comments #37770, #53546, among others). Some of the events are mentioned along the text of this section as they can be considered as turning points for some pollutant's species.
53546	19	9	19	9	I think this needs reformulation: "Discovery of oil and a car marks the beginning..." [Jan Fuglestvedt, Norway]	Accepted - text revised
41548	19	9	19	9	"and a car" reword [Amanda Maycock, United Kingdom (of Great Britain and Northern Ireland)]	Accepted - text revised
16540	19	9	19	9	Edit to 'Discovery of oil and invention of cars' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted - text revised
55800	19	9	19	11	sentence needs to be re-written [Christopher Smith, United Kingdom (of Great Britain and Northern Ireland)]	Accepted - text revised
37770	19	9			"Discovery of" "a car" is an odd way of putting it. "a car" could be replaced by "development of the internal combustion engine" - vehicles are mentioned later in the sentence. [Adrian Simmons, United Kingdom (of Great Britain and Northern Ireland)]	Accepted - text revised
40580	19	15	19	16	"……since 1950 about doubled" change this to "….and their concentrations have almost doubbled since 1950" [Chaitri Roy, India]	Accepted - text revised

12856	19	15	19	27	Note also the role of brown carbon. Brown carbon is also a potent climate forcer that is sometimes ignored in climate models, leading to the conclusion that the combination of organic carbon co-emitted with black carbon causes net global cooling. Brown carbon's warming effect appears to be offsetting some or all of the lighter organic carbon's cooling effect. Thus, reducing emissions from black carbon sources may still reduce warming. Feng Y., et al. (2013) Brown carbon: a significant atmospheric absorber of solar radiation, ATMOS. CHEM. PHYS. 13:8607–8621 ("Inclusion of the strongly absorption of BrC in our model causes the direct radiative forcing (global mean) of organic carbon aerosols at the TOA to change from cooling (−0.08 W m−2[SEP]) to warming (+0.025 W m−2)."); Andreae M. O. & Ramanathan V. (2013) Climate's dark forcings, SCI. 340(6130):280–281; Bahadur R., et al. (2012) Solar absorption by elemental and brown carbon determined from spectral observations, PROC. NAT'L. ACAD. SCI. 109(43):17366–17371 ("The results demonstrate that current climate models that treat OC as nonabsorbing are underestimating the total warming effect of carbonaceous aerosols by neglecting part of the atmospheric heating, particularly over biomass-burning regions that emit BrC."). [Durwood Zaelke, United States of America]	Taken into account - Text revised to refer to brown carbon in this section but more discussion added in the section 6.2.2.8 of Chapter 6 where carbonaceous aerosols are discussed. There, we include suggested by the reviewers as well as more recent literature.
12858	19	15	19	27	These emissions are particularly harmful when emitted proximate to snow/ice b/c reduce the albedo and amplify warming. Deposition of aerosols—especially black carbon—on snow and ice surfaces can reduce albedo and increase warming as a self-reinforcing feedback. See Tedesco M., et al. (2016) The darkening of the Greenland ice sheet: trends, drivers, and projections (1981–2100), THE CRYOSPHERE 10:477–496, 478 ("The presence of LAI such as soot (black carbon, BC), dust, organic matter, algae, and other biological material in snow or ice also reduces the albedo, mostly in the visible and ultraviolet regions (Warren, 1982). Such impurities are deposited through dry and wet deposition, and their mixing ratios are enhanced through snow water loss in sublimation and melting (Conway et al., 1996; Flanner et al., 2007; Doherty et al., 2013). Besides grain growth and LAI, another cause of albedo reduction over the GrIS is the exposure of bare ice: once layers of snow or firn are removed through ablation, the exposure of the underlying bare ice will further reduce surface albedo, as does the presence of melt pools on the ice surface (e.g. Tedesco et al., 2011)."); World Bank & International Cryosphere Climate Initiative (2013) ON THIN ICE: HOW CUTTING POLLUTION CAN SLOW WARMING AND SAVE LIVES, 2 ("Climate benefits for cryosphere regions from black carbon reductions carry less uncertainty than they would in other parts of the globe and are sometimes very large. This is because emissions from sources that emit black carbon—even with other pollutants—almost always lead to warming over reflective ice and snow."); Arctic Monitoring and Assessment Programme (AMAP) (2017) ADAPTATION ACTIONS FOR A CHANGING ARCTIC: PERSPECTIVES FROM THE BARENTS AREA, 72 ("Highly reflective surfaces, such as snow and ice in the Arctic increase light absorption by BC particles in the atmosphere. BC also absorbs light after deposition onto (and then into) snow and ice, where it accelerates the melt process (Pedersen et al., 2015). BC has made an important contribution to the observed rise in Arctic surface temperature through the 20th century (although carbon dioxide is still the major factor driving the rise in Arctic temperature) (Quinn et al., 2008; Koch et al., 2011; AMAP, 2015a). It may be	Taken into account - Text revised to refer to brown carbon in this section but more discussion added in the section 6.2.2.8 of Chapter 6 where carbonaceous aerosols are discussed. There, we include suggested by the reviewers as well as more recent literature.

12688	19	15	19	27	Note also the role of brown carbon. Brown carbon is also a potent climate forcer that is sometimes ignored in climate models, leading to the conclusion that the combination of organic carbon co-emitted with black carbon causes net global cooling. Brown carbon's warming effect appears to be offsetting some or all of the lighter organic carbon's cooling effect. Thus, reducing emissions from black carbon sources may still reduce warming. Feng Y., et al. (2013) Brown carbon: a significant atmospheric absorber of solar radiation, ATMOS. CHEM. PHYS. 13:8607–8621 ("Inclusion of the strongly absorption of BrC in our model causes the direct radiative forcing (global mean) of organic carbon aerosols at the TOA to change from cooling (−0.08 W m−2[1 SEP]) to warming (+0.025 W m−2)."); Andreae M. O. & Ramanathan V. (2013) Climate's dark forcings, SCI. 340(6130):280–281; Bahadur R., et al. (2012) Solar absorption by elemental and brown carbon determined from spectral observations, PROC. NAT'L. ACAD. SCI. 109(43):17366–17371 ("The results demonstrate that current climate models that treat OC as nonabsorbing are underestimating the total warming effect of carbonaceous aerosols by neglecting part of the atmospheric heating, particularly over biomass-burning regions that emit BrC."). [Kristin Campbell, United States of America]	Taken into account - Text revised to refer to brown carbon in this section but more discussion added in the section 6.2.2.8 of Chapter 6 where carbonaceous aerosols are discussed. There, we include suggested by the reviewers as well as more recent literature.
12690	19	15	19	27	These emissions are particularly harmful when emitted proximate to snow/ice b/c reduce the albedo and amplify warming. Deposition of aerosols—especially black carbon—on snow and ice surfaces can reduce albedo and increase warming as a self-reinforcing feedback. See Tedesco M., et al. (2016) The darkening of the Greenland ice sheet: trends, drivers, and projections (1981–2100), THE CRYOSPHERE 10:477–496, 478 ("The presence of LAI such as soot (black carbon, BC), dust, organic matter, algae, and other biological material in snow or ice also reduces the albedo, mostly in the visible and ultraviolet regions (Warren, 1982). Such impurities are deposited through dry and wet deposition, and their mixing ratios are enhanced through snow water loss in sublimation and melting (Conway et al., 1996; Flanner et al., 2007; Doherty et al., 2013). Besides grain growth and LAI, another cause of albedo reduction over the GrIS is the exposure of bare ice: once layers of snow or firn are removed through ablation, the exposure of the underlying bare ice will further reduce surface albedo, as does the presence of melt pools on the ice surface (e.g. Tedesco et al., 2011)."); World Bank & International Cryosphere Climate Initiative (2013) ON THIN ICE: HOW CUTTING POLLUTION CAN SLOW WARMING AND SAVE LIVES, 2 ("Climate benefits for cryosphere regions from black carbon reductions carry less uncertainty than they would in other parts of the globe and are sometimes very large. This is because emissions from sources that emit black carbon—even with other pollutants—almost always lead to warming over reflective ice and snow."); Arctic Monitoring and Assessment Programme (AMAP) (2017) ADAPTATION ACTIONS FOR A CHANGING ARCTIC: PERSPECTIVES FROM THE BARENTS AREA, 72 ("Highly reflective surfaces, such as snow and ice in the Arctic increase light absorption by BC particles in the atmosphere. BC also absorbs light after deposition onto (and then into) snow and ice, where it accelerates the melt process (Pedersen et al., 2015). BC has made an important contribution to the observed rise in Arctic surface temperature through the 20th century (although carbon dioxide is still the major factor driving the rise in Arctic temperature) (Quinn et al., 2008; Koch et al., 2011; AMAP, 2015a). It may be	Taken into account - Text revised to refer to brown carbon in this section but more discussion added in the section 6.2.2.8 of Chapter 6 where carbonaceous aerosols are discussed. There, we include suggested by the reviewers as well as more recent literature.
16542	19	26	19	26	Capital C for 'century' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Editorial
16544	19	32	19	32	To avoid confusion with negatives, change - to : and also 'level' to 'levels' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Editorial

37772	19	32			It is hard to reconcile the "high confidence" that there has been a steady rise in methane emissions over the last two decades with this Chapter's statement of "low confidence" in the causes of methane release after a period of little or no growth in the first few years of this century, and with various statements in Chapter 5. See comments 2 and 252. [Adrian Simmons, United Kingdom (of Great Britain and Northern Ireland)]	Taken into account - the text revised to accommodate for Chapter 5 consistency and most recent literature about emissions and concentrations trends discussed also in section 6.2.2.4 in this chapter.
16546	19	36	19	36	Capital S for 'section' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Editorial
16548	19	38	19	38	Edit to ''The invention of the Haber-Bosch…' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Editorial
24742	19	38	19	39	I don't think this needs to go back to Harber-Bosch. The changes since AR5 are useful. [William Collins, United Kingdom (of Great Britain and Northern Ireland)]	Noted
40672	19	38	19	45	This paragraph contains some unnecessary detail (e.g. when Haber-Bosch was invented). Could shorten for brevity. [Daniel Murphy, United States of America]	Rejected - We believe that giving such perspective and reference in time is useful and in this particular case proposed edits would not change the length much.
16550	19	45	19	45	Capital S for 'section' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Editorial
16552	19	51	19	51	Edit reference to Hoesly et al. (2018) [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted. Referenced by Mendeley formatting.
16554	20	7	20	7	References need editing, only the dates should e in brackets [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Noted.
41020	20	16	20	16	Halogenated VSLS should be covered in this section. [Johannes Laube, Germany]	Rejected. Covered in Section 6.2.2.9.4.
7756	20	16	20	16	While prior IPCC reports discuss the vital role of water vapour in climate, water vapour and its role in positive and sometimes negative feedback goes unmentioned in this chapter. Please see the next comment. [Forrest Mims, United States of America]	Rejected. Chapter 6 is focussed on SLCFs. Water vapour is not SLCF. Feedbacks are discussed in Section 6.3.1. and water processes discussed in Chapter 8.
55036	20	16	21	17	it should be clearly pointed out which and how natural sorces may be affected by climeta change. [Ina Tegen, Germany]	Accepted - text revised. New Section 6.3.6. that assesses impacts of climate change on natural emissions in terms of non-CO2 biogeochemical feedbacks.
14672	20	16	21	19	This section could summarize studies in a Table- with assessed likely ranges. Not mentioned in this paragraph are components like DMS and other sulfur components, nitrgoen components, halogens, biogenic aerosols, ammonia which have natural sources and which emissions can change under climate change. Assessment of is needed. [Frank Dentener, Italy]	Accepted - text revised. Now include new Section 6.3.6 that assesses Non-CO2 biogeochemical feedbacks.
16556	20	18	20	18	Quantify 'last decades' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Not Applicable. Sentence removed.
16558	20	21	20	21	Insert 'The' before 'Atmospheric' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Not Applicable. Sentence no longer included in Section.
41552	20	24	20	27	suggest also consider Banerjee et al (2014; doi: 10.5194/acp-14-9871-2014) in this assessment [Amanda Maycock, United Kingdom (of Great Britain and Northern Ireland)]	Rejected.
40582	20	32	20	33	emmited from what??? Statement is vague [Chaitri Roy, India]	Accepted - text revised "from vegetation".
6854	20	32	20	33	Something is missing in this sentence. Maybe "…are emitted by plants/natural sources"? [Eva Yvonne Pfannerstill, Germany]	Accepted - text revised. Included "from vegetation".
16560	20	33	20	33	Delete , after 'aldehydes' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted -text revised. Deleted.

24744	20	38	20	42	This seems too detailed on isoprene emission. [William Collins, United Kingdom (of Great Britain and Northern Ireland)]	Accepted - text revised. Isoprene does have special status for global atmospheric chemistry since it is the largest single source BVOC emission so it is referred to specifically but now in less technical details.
40674	20	39	20	46	There is unnecessary detail here (e.g. biological function of isoprene) that could be shortened for brevity. [Daniel Murphy, United States of America]	See #24744
16562	20	44	20	44	Change world's to World's [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Not Applicable. Sentence no longer included in Section.
6856	20	48	20	50	Maybe here mentioning a possible (probably low confidence?) feedback of global change on BVOC emissions makes logical sense. E.g. "As opposed to the normal 1-2% carbon loss via BVOCs, plants could lose up to ~10% carbon in the form of BVOCs under abiotic stress. (Peñuelas, 2003)". [Eva Yvonne Pfannerstill, Germany]	Accepted. Thank you for insightful comment. New Section 6.3.6 included on Non-CO2 biogeochemical feedbacks including BVOC-climate.
24746	20	48	21	7	This is a useful comparison of the drivers of isoprene and monoterpenes. [William Collins, United Kingdom (of Great Britain and Northern Ireland)]	Noted. Thank you. We now also include Section 6.3.6 on Non-CO2 biogeochemical feedbacks.
16564	20	49	20	49	Delete , after 'temperature' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted - text revised
29030	20	52	20	52	make clear the sign of the change [Keith Shine, United Kingdom (of Great Britain and Northern Ireland)]	Accepted - text revised. Sign of change made clear.
16566	20	52	20	52	Change to Pre-Industrial Period [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Rejected.
16568	20	56	20	56	Change to Pre-Industrial Period [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Rejected.
16570	20	56	20	56	Space required between 'day and '(' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted - text revised
29032	21	5	21	7	In the context of an assessment, there is no information content in this sentence [Keith Shine, United Kingdom (of Great Britain and Northern Ireland)]	Noted. Text removed.
6858	21	5	21	7	One could question the relevance of the sentence and the citation "A study in the Amazon found…" in this context. How is this related to land use? [Eva Yvonne Pfannerstill, Germany]	Noted. Section is not only about land use change. It covers knowledge on other main drivers of BVOC emissions e.g. temperature. This sentence refers specifically to higher terpenoids in the tropics. The preceding sentence provides context: "The historical evolution of monoterpene and sesquiterpene emissions is less well studied and there is no robust consensus on even the sign of the change."
16572	21	6	21	7	Please give more details (eg changes concentration for X to Y under temperature rise/change of A to B) [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Noted. Chapter now includes Section 6.3.6 on Non-CO2 biogeochemical feedbacks that provides quantitative results from AerChemMIP.
24748	21	9	21	17	These seem rather specific numbers and details for fire emissions compared to the discussion of other sources in this section. They seem to be from single studies - how robust are they? Do they agree with the CMIP6 forcing dataset? Do the carbon emissions agree with chapter 5? [William Collins, United Kingdom (of Great Britain and Northern Ireland)]	Noted. Biomass burning emissions now included in their own Section 6.2.1.3 and completely revised text.

16574	21	11	21	12	Don't split units across a line. [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted - text revised.
16576	21	13	21	15	Space required between 'health' and '(', ') and 'and', and 'frequency' and '(' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted - text revised
40676	21	15	21	17	I'm concerned about the use of a short-term correlation to make a statement about long-term fire frequency. An alternative hypothesis is that the average frequency of fires is fixed, they just choose warm years. There should be good literature to show that more fires are expected in a warmer climate, I don't have a specific citation. [Daniel Murphy, United States of America]	Noted. Agreed. Biomass burning emissions now included in their own Section 6.2.1.3 and completely revised text.
55040	21	17	21	17	Note that in populated regions/industrialized countries fire suppression by humans would also play a role, masking natural changes [Ina Tegen, Germany]	Noted. Thank you. Now discussed in Section 6.2.1.3.
11676	21	21	23	34	References to (sub)sections in Chapter 7 would be useful [David Neubauer, Switzerland]	Accepted. Reference to sections 2.2 and 7.3.5.4 have been added
40678	21	23	21	30	Box 6.2.6 This box is far too long and off the point of the chapter. Shorten to a half-page, or delete. [Daniel Murphy, United States of America]	Taken into account. See response to #24750.
53548	21	23	23	30	I miss a bit more focus on impact on climate in this box. [Jan Fuglestvedt, Norway]	Taken into account. Title and Text have been modified to focus on atmospheric abundance of SLCF.
14674	21	23	23	30	I think the box is interesting, but at least a page too long for effective communications.I propose to change atmospheric chemistry models into atmospheric chemistry-climate models. [Frank Dentener, Italy]	Taken into account. Please see response to #24750. The title has been revised to: Atmospheric abundance of SLCFs: from process level studies to global chemistry-climate models
43130	21	23	23	32	Box 6.2. The contents of this box seems to be rather long (especially adding two figures) and some sentences are redundant. Suggest to shorten the contents, eg., Line 26-33 "Together laboraotory.....shortcomings in chemical mechanisms." can be deleted; i.e., start the box with "This box....." -- it is likely the readers are familiar with the "three pillars" of atmospheric chemistry. Similarly, the other paragraphs can be shortened. It is fine to be inclusive, but perhaps there are too many references and some are cited multiple times. [Luisa Molina, United States of America]	Accepted. Text has been shortened, the number of references have been reduced. The box contains only one figure Box 6.2 Figure 1.
24750	21	23			Box 6.2 seems to be overly long (>2 pages). It could benefit from being more focussed on what the reader needs to know. [William Collins, United Kingdom (of Great Britain and Northern Ireland)]	Taken into account. Together with comments #40678, 43130, we have shortened the text for this box and focused it towards communicating how we derive knowledge of atmospheric abundance of SLCFs using process-level, observations and global chemistry-climate models.
27478	21	26	21	35	The role of remote sensing from both ground (e.g. ACTRIS RI and EARLINET/GALION) and space, should be also acknowledged here as a validation tool fro models, after the implementation of new parameterizations. [Vassilis Amiridis, Greece]	Not applicable as we have removed references to specific measurement networks
55852	21	55	22	4	there are two different categories of lumped techniques, the molecular and the structural lumping. Here you mention only the molecular lumping (one species respresenting a family of compounds) you need to add the structural lumping in which a chemical structure is the lumping unit as is done in the widely used carbon bound mechanism. [MARIA KANAKIDOU, Greece]	Accepted. Notation for the chemical structure in lumping has been added.

28926	22	13	22	14	It is wrong to pick out and name just the SHADOZ network, when the majority of ozonesonde sites (especially long-term ones) belong to WMO-GAW and/or NDACC. [Matt Tully, Australia]	Not applicable as we have removed references to specific measurement networks
47274	22	13	22	15	Should also include ground-based remote sensing measurements of total and partial columns of trace gases, e.g, Network for the Detection of Atmospheric Composition Change - NDACC [Guang Zeng, New Zealand]	Not applicable as we have removed references to specific measurement networks
51992	22	17	22	18	Also in Section 2.2, and this worth noting here perhaps in subsequent drafts [Peter Thorne, Ireland]	Accepted. We have added references to section 2.2 and 7.3.5.4
47276	22	42	22	42	References for "MCM, ISORROPIA" should be added [Guang Zeng, New Zealand]	Taken into account. Added references for these models. Removed explicit names of the models to save space.
16578	22	52	22	52	Edit reference to Gaudel et al., 2018 [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Not applicable. This reference has been removed as text has been revised
16580	22	53	22	53	Edit reference to Young et al., 2018 [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Not applicable. This reference has been removed as text has been revised
47278	23	2	23	3	Model's transport scheme (and photolysis scheme) should also be mentioned here. [Guang Zeng, New Zealand]	Accepted. Text has been modified to include reference to photolysis scheme and mixing and convective transport mechanisms
38226	23	3	23	4	Please clarify what “model implementation” means. [Hitoshi Matsui, Japan]	Taken into account. We have deleted "model implementation" as this was a remnant from a previous iteration.
41554	23	6	23	8	Suggest considering Orbe et al (2018; doi: 10.5194/acp-18-7217-2018) in this assessment who discuss how nudging affects tracer transport [Amanda Maycock, United Kingdom (of Great Britain and Northern Ireland)]	Rejected. Thank you for bringing this paper to our attention. This sentence conveys that models are run in nudged mode to minimize biases in the simulated meteorology for comparison of modelled chemical composition with observations. While relevant, this references does not directly address the message of this sentence. We have added relevant references.
38228	23	6			“nudged mode” --> “nudged or offline meteorology mode” [Hitoshi Matsui, Japan]	Accepted. Text has been modified.
47670	23	13	23	14	Has this assumption been tested? Is it testable? [Daniel Feldman, United States of America]	Noted. This assumption is testable as long as there is relatively good coverage of observations, as has been shown for climate studies (Knutti et al 2010 https://journals.ametsoc.org/doi/full/10.1175/2009JCLI3361.1). For example, multi model studies of SLCFs, such as ozone and CO, show that multimodel average generally shows better comparison with observations rather than individual models (Eyring et al., 2007; Shindell et al., 2006; Young et al 2013; Naik et al. 2013)
47280	23	15	23	17	Is this shortcoming in sampling representative when assessing ensemble means? If so, what could be implied for future improvement in sampling? [Guang Zeng, New Zealand]	Taken into account. See response to #47672

47672	23	16	23	17	Is there a framework for assessing model independence in the context of SLCF? If so, the approach takes by Sanderson et al 2017 (doi:10.5194/gmd-10-2379-2017) for temperature and precipitation can be cited as a reasonable path forward. [Daniel Feldman, United States of America]	Accepted. Currently, there is no preferred method to address the issue of model interdependence (as well as sampling) specifically for SLCFs, though an approach has been highlighted based on the skill of the models (Change et al 2019 https://doi.org/10.5194/gmd-12-955-2019). We add Chang and Sanderson studies to make this point.
55646	23	41	23	41	In table under NH3, list gas-aerosol partitioning under Evolution column(?) [Larry Horowitz, United States of America]	No longer applicable, as this table has been completely revised to the new Tablle.61
29034	23	41	23	41	The entry on ozone is a bit ambiguous. Mentioning "transport from stratosphere" makes it sound like this row refers to tropospheric ozone [Keith Shine, United Kingdom (of Great Britain and Northern Ireland)]	Not relevant as this table has been deleted.
14676	23	41	24	1	This table makes Figure 6.1 somewhat redudant. But if kept they should be consistent. [Frank Dentener, Italy]	No longer applicable, merged with Table 6.1. Figure 6.1 has been eliminated.
38230	23	41			Please use one line for each aerosol species in Table 6.2 because each aerosol species has different sources, sinks, evolutions, and lifetimes. This table should have at least 8 lines for aerosols (BC, POA, SOA, SO4, NO3, NH4, sea salt, mineral dust). [Hitoshi Matsui, Japan]	resolved.
24752	23	41			I didn't quite understand the "evolution" column. It only seems to have a few entries. Is it necessary? [William Collins, United Kingdom (of Great Britain and Northern Ireland)]	Resolved in Table 6.1.
40584	23	44	24	28	The source "emmisions" should be more specific like vehicles, industry, fossil fuel, etc. [Chaitri Roy, India]	Rejected. Specific sources of emissions for various SLCFs have been provided in Table 6.1
50002	24	1			In Table 6.2 the lifetime of ozone is given as hours-months with a reference to Seinfeld and Pandis, 1998. In this book they list ozone's lifetime at 10 km and 20 N in wintertime as being 100 days (page 259), which is consistent with months. However they provide no reference as to where they got this number. I realize that the lifetime of ozone in the upper troposphere is often stated to be on the order of months, but we haven't been able to find a research paper that shows how this number was determined. Seinfeld and Pandis is not a sufficient reference and a research paper needs to be found to support this claim. [Owen Cooper, United States of America]	Noted. The lifetime of ozone varies with altitude, season and latitude. Here, we document lifetime in both the stratosphere and troposphere providing a range. References have been updated
40586	24	7	24	13	This paragragh is very loosely written... "The distribution (spatial and temporal) of SLCFs in the Earth's atmosphere and their lifetime (residence time, Table 6. 2) are determined by a number of physical and chemical processes. The physical processes include deposition (dry, wet, sedimentation), and long-range transport (inter-continental or stratospheric-tropospheric exchange)Chemical interaction between several primary pollutants (emitted directly, covered in Section 6.2.1) and other chemically active species, including particles and water vapor, in the presence of solar radiation to produce radiatively active secondary species. ....."..... Line [Chaitri Roy, India]	Accepted. Text revised.
16582	24	10	24	10	Change 'vapor' to 'vapour' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted. Text revised.
40588	24	14	12	16	Fragmented statement [Chaitri Roy, India]	Accepted. Text revised.

41228	24	19	25	50	no mention of ice cores or estimates of trends in deposition (e.g. Lamarque et al., 2013) [Jean-Francois Lamarque, United States of America]	Taken into account. The paragraph includes evidence from ice cores - "Quantitative constraints derived from isotopic composition of atmospheric nitrate inferred from ice cores provide evidence of increasing anthropogenic NOx sources since pre-industrial times (Geng et al., 2014; Hastings et al., 2009)." We have also added the following "Global NOx emission trends in bottom-up inventories (section 6.2.1) as well as model simulations of nitrogen deposition (Lamarque et al., 2013a) are in qualitative agreement with these observational constraints."
45694	24	46			maybe mention hydrogen as an indirect greenhouse gas? Warwick, N. J., et al. "Impact of a hydrogen economy on the stratosphere and troposphere studied in a 2-D model." Geophysical Research Letters 31.5 (2004). [Euan Nisbet, United Kingdom (of Great Britain and Northern Ireland)]	Rejected. Line number does not exist on the page
40680	24		24		Table 6.2 6 Except for sea salt and perhaps mineral dust, the lifetimes of primary and secondary aerosols are more or less the same. Sea salt has a shorter lifetime because it the particles are large and salt aerosol is emitted into a wet environment. Most dust has a shorter lifetime because the particles are large. The table is confusing because Seinfeld and Pandis (1998) is an outdated reference for the sulfate lifetime. Even in AR3 Chapter 5 there was a newer discussion of the sulfate lifetime. The lifetime of NH3 has no reference and should be < or equal to a day, not hours. The lifetime from two studies I am aware of are 0.6 and 0.9 days (Feng and Penner, JGR, 2007, 112, D01304, Adams et al., JGR, 1999, 109, 13791). [Daniel Murphy, United States of America]	Accepted. References have been updated.
41556	25	6	25	18	You might also assess here new work on NO2 using OMI and TropOMI satellites, e.g. by Richard Pope and Martyn Chipperfield [Amanda Maycock, United Kingdom (of Great Britain and Northern Ireland)]	Rejected. Thank you for highlighting these studies but we feel there are enough references in this paragraph
24754	25	6	25	18	It would be good to discuss what assumptions on NO/NO2 ratios are necessary when interpreting NO2 columns. [William Collins, United Kingdom (of Great Britain and Northern Ireland)]	Accepted. Reference to Silvern et al (2018) has been added that discusses uncertainties related to NO/NO2 ratios
16584	25	11	25	11	Insert 'the' after 'including' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted. Text revised
16586	25	14	25	15	Don't split units across a line. [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Noted.

8200	25	18	25	18	There is a history of studies attributing NOx emissions to lightning activity using satellite NO2 column data. Given that thunderstorms can occur in similar locations to forest fires, the studies also of relevance to similar estimates for biomass burning. https://www.atmos-chem-phys.net/14/3277/2014/acp-14-3277-2014.html and https://www.atmos-chem-phys.net/10/10965/2010/ and https://www.atmos-chem-phys.net/5/2311/2005/ [Declan Finney, United Kingdom (of Great Britain and Northern Ireland)]	Accepted. We have modified this sentence to "Similarly, lower, but significant and highly variable, NO2 columns are observed over biomass burning regions in the tropical and boreal forests (Castellanos et al., 2014; Tanimoto et al., 2015), due to either direct NOx emissions or influence from coincident lightning activity (Miyazaki et al., 2014)."
16588	25	21	25	21	Delete 'time' to remove a tautology [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted. Text revised
44462	25	22	25	35	Duncan et al., 2016 studied the NO2 and SO2 Column trend for major urban areas of the world for the period 2005-2014 and found NO2 column % change varying from -6.83 ± 10.1 to +26.6 ± 10.4 over various cities of India. Krotkov et al., 2016 also examined changes in both SO2 and NO2 over the world's most polluted regions for the period 2005-2014 and found the growth rates of (50 ± 20%) in OMI-observed NO2 columns during 2005–2014 particularly over the industrial regions in Chhattisgarh and Odisha of India (not for whole India). Both these studies are based on particular region of a country and not whole country specific. These studies do not provide change in SO2 and NO2 column over any country. The complete para needs to be rewritten. [VIJAY SONI, India]	Taken into account. We have revised the text to indicate that the overall trends in India are being driven by hotspot areas experiencing rapid expansion of the power sector.
16590	25	29	25	30	Edit to '..during 2005 to 2015 (Duncan et al., 2016;...' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted. Text revised
16592	25	31	25	31	Edit to '..over 2005-2010 (Duncan..' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted. Text revised
24756	25	37	25	44	I presume this paragraph will be updated with CMIP6 results. [William Collins, United Kingdom (of Great Britain and Northern Ireland)]	Accepted. Yes, this has been done now based on Griffiths et al. submitted (2019)
16594	25	38	25	38	Change to Pre-Industrial [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Noted. All references to 'pre-industrial' follow IPCC conventions
16596	25	41	25	41	Change to Pre-Industrial [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Noted. All references to 'pre-industrial' follow IPCC conventions
16598	25	42	25	42	I suggest deleting 'present-day' and just saying 2000. [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted. Text revised
16600	25	43	25	43	Change to Pre-Industrial [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Noted. All references to 'pre-industrial' follow IPCC conventions
53550	25	46	25	46	I find it very strange to have this in a footnote (#4) [Jan Fuglestvedt, Norway]	Taken into account. Text has been revised
14678	25	46	25	46	I assume this summary statement is about global Nox? Can it be quantified?. Regionally I think the statement can be *certain*, and perhaps it is also justified for global numbers? [Frank Dentener, Italy]	Accepted. Text has been revised to indicate that there is high confidence that global tropospheric NOx has increased from pre-industrial to present
24758	25	46	25	46	Is not "virtually certain" NOX has increased, is there any plausible way it could be negative? [William Collins, United Kingdom (of Great Britain and Northern Ireland)]	Accepted. See response to #14678
16602	25	46	25	46	Change to 'Pre-Industrial times' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Noted. All references to 'pre-industrial' follow IPCC conventions

47928	25	46	25	50	Please check the use of this IPCC uncertainty language term. Are you able to provide a traceable account to assigning this uncertainty statement? Note that likelihood statements are quantified terms - phrases like likely and very likely have quantifiable probabilities associated with them. Please check it has been used correctly here. Please refer to the IPCC guidance note on uncertainty: https://wg1.ipcc.ch/SR/documents/ar5_uncertainty-guidance-note.pdf [WGI TSU, France]	Taken into account.
53558	26	1	27	12	Check consistency vs ch 5 [Jan Fuglestvedt, Norway]	Noted
16604	26	5	26	5	Change to 'quality' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted- text revised
16606	26	10	26	10	Insert 'the' after 'from' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted- text revised
47282	26	13	26	13	Should "columnar" be "column"? [Guang Zeng, New Zealand]	Accepted- text revised
16608	26	16	26	16	Change to 'reconstruct' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted- text revised
24760	26	17	26	19	How confident is the assessment that CO was higher in the 1950s? [William Collins, United Kingdom (of Great Britain and Northern Ireland)]	Accepted - text revised, confidence level reported
16612	26	19	26	19	Change to 'early 1970s' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted- text revised
16610	26	19	26	20	Give rates as exponentials [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted- text revised
29036	26	20	26	20	ppb is used elsewhere in the report [Keith Shine, United Kingdom (of Great Britain and Northern Ireland)]	Accepted- text revised
53556	26	25	26	25	I suggest changing 89% to "approximately 90%" [Jan Fuglestvedt, Norway]	Accepted -text revised
24762	26	25	26	25	What's the uncertainty range on the 89%? [William Collins, United Kingdom (of Great Britain and Northern Ireland)]	Accepted -text revised
16614	26	25	26	26	Change to Pre-Industrial [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted- text revised
16616	26	30	26	30	Change 'like;' to 'such as' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted- text revised
24764	26	31	26	35	This should state whether the reason for the CO underestimate is understood, and what the implications of an overestimate are for e.g. OH and O3 budgets. [William Collins, United Kingdom (of Great Britain and Northern Ireland)]	Taken into account - Please see ozone (6.2.2.5.1) and OH (section 6.2.3) as well
16618	26	32	26	33	Capitalise Southern Hemisphere [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted- text revised
55648	26	37	26	47	Comapre with observation-based CO burden trends. [Larry Horowitz, United States of America]	Taken into account - observation based CO trends are reported.
37774	26	37			Change "modelling" to "data assimilation". Flemming et al. (2017) was a paper on reanalysis. [Adrian Simmons, United Kingdom (of Great Britain and Northern Ireland)]	rejected - data assimilation is also a model. Besides Flemming et al 2017 also present results from forward model with a reduction rate of (-0.36 % yr -1).
37776	26	40			Change "Model simulation reported" to either "Data assimilation indicates" or the more specific "Assimilation of data, from MOPITT in particular, indicates". Flemming et al. also reported a value from a model simulation, but that rate of decrease of CO was different to the value quoted in the FOD, which is from the data assimilation. [Adrian Simmons, United Kingdom (of Great Britain and Northern Ireland)]	Accepted -text revised
16620	26	41	26	44	Give rates as exponentials [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted- text revised

14682	26	42	26	42	AR5 assessed aconsistent decline of CO columns for 2002–2010 over a number of polluted regions in Europe, North America and Asia with a global trend of about –1% yr–1 (Yurganov et al., 2010; Fortems-Cheiney et al., 2011; Worden et al., 2013). This is repeated here. But is there now information that goes beyond this? [Frank Dentener, Italy]	Accepted- Text revised newer information assessed
24766	26	49	27	9	This needs to make clear how our understanding of the budgets has changes since AR5. It would be useful to have a table of the CO budget terms, possibly including trends. [William Collins, United Kingdom (of Great Britain and Northern Ireland)]	Taken into account - New information available since AR5 have been updated in terms of budget and trends
16622	26	50	26	51	Give rates as exponentials [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted- text revised
55650	26	51	26	51	Why is this range (from CH4 oxidation) so large, given the constraints on global CH4 budget? [Larry Horowitz, United States of America]	Taken into account - these values are what is reported by different models with different emissions and chemistry
41022	27	5	27	9	It would help this entire chapter enormously to start with the state of science at time of AR5 and then to give updates (instead of giving references to AR5 in seemingly random places). This has been realised much more consistently e.g. in Chapter 2. [Johannes Laube, Germany]	Accepted - have changed the structure of the subsection to reflect progress in state of science since AR5
16624	27	11	27	11	Italicise 'high confidence' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted- text revised
53554	27	11	27	12	What does "since AR5" mean here? Development in atmospheric levels, or development in science and estimates …? [Jan Fuglestvedt, Norway]	Taken into account - text revised
14680	27	11	27	12	Can the numbers be quantified, what exactly is the modern period? Is our knowledge on changes since pre-industrial changed, and what the assessment of the importance of this? [Frank Dentener, Italy]	Accepted - text revised and now the years have been explicitly defined
50004	27	11			What is the definition of "modern period"? [Owen Cooper, United States of America]	Accepted - text revised
29038	27	12	27	12	Not clear what "modern period" means [Keith Shine, United Kingdom (of Great Britain and Northern Ireland)]	Accepted - text revised
16626	27	12	27	12	Italicise 'medium confidence' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted- text revised
38232	27	17	27	26	This paragraph should be moved to the emission section (6.2.1). [Hitoshi Matsui, Japan]	Noted. Section 6.2.2.3 has been fully rewritten.
24768	27	17	27	26	The NMVOC description is a bit textbook. How has our understanding changed since AR5? [William Collins, United Kingdom (of Great Britain and Northern Ireland)]	Noted. Section 6.2.2.3 has been fully rewritten.
14684	27	17	27	55	It would be nice to start with a summary of where we were with AR5, and how this is now changing in AR5 - the recent uptick. [Frank Dentener, Italy]	Noted. Section 6.2.2.3 has been fully rewritten.
29040	27	21	27	21	I would say "significant direct impacts" - these substances are infrared absorbers and their direct impact has been quantified in this context e.g. 10.1016/S1352-2310(98)00220-9 (although small it is likely competive with many HFCs) [Keith Shine, United Kingdom (of Great Britain and Northern Ireland)]	Noted. Section 6.2.2.3 has been fully rewritten.
55652	27	22	27	22	"most abundant NMVOC" -- does this refer to emissions, rather than atmospheric burden? If so, clarify in text. [Larry Horowitz, United States of America]	Accepted - text revised. Clarified "BVOC emission".
16628	27	31	27	31	Change 'NH' to 'Northern Hemisphere' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted - text revised
41558	27	36	27	36	twenthieth type [Amanda Maycock, United Kingdom (of Great Britain and Northern Ireland)]	Not Applicable - text removed.

16630	27	36	27	36	Change ‘twentieth century’ to ‘20th Century’ for correctness (in this context ‘century’ is a proper noun) and consistency elsewhere in the WG1I documentation [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Not Applicable - text removed.
46138	27	40	27	44	Rather than just stating that the abundances of C2-C5 NMHCs are now increasing, can you give a sense, relative to the rest of the timeseries, how much of an increase is being observed for the 2005-2010 period? Is this increase statistically significant? Is attribution to oil and gas production uncertain? Here and at the end of this section you should indicate level of understanding and agreement separately for knowledge of the timeseries and knowledge of attribution. [Cynthia Randles, United States of America]	Noted. Section 6.2.2.3 has been fully rewritten.
24770	27	44	27	49	This discussion of HCHO might not be necessary as none of the assessment in this paragraph relies on it. [William Collins, United Kingdom (of Great Britain and Northern Ireland)]	Noted. Section 6.2.2.3 has been fully rewritten.
16632	27	47	27	47	Change 'large' to 'largely' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Noted. Section 6.2.2.3 has been fully rewritten.
6860	27	48	27	50	I don't think it is true that the McDonald study cited in this sentence used aircraft measurements. According to the methods section of the paper, it is a modelling study which compared their data with measurements from a ground site in Pasadena and some indoor measurements. So I would suggest summing up this study a bit differently: "A recent modelling study suggests an emergent shift in U.S. urban NMVOC sources from transportation to chemical products (i.e. household chemicals, personal care products, solvents, etc.), which is not in accordance with emission inventories currently used." and add the following sentence: "Similarly, comprehensive NMVOC observations in a European city found large discrepancies with emission inventories, mainly attributed to oxygenated solvents from consumer products (Karl et al., 2018)." (reference: Karl, T.; Striednig, M.; Graus, M.; Hammerle, A.; Wohlfahrt, G. (2018): Urban flux measurements reveal a large pool of oxygenated volatile organic compound emissions. Proceedings of the National Academy of Sciences of the United States of America, 115, 1186–1191.) [Eva Yvonne Pfannerstill, Germany]	Noted. Section 6.2.2.3 has been fully rewritten.
53560	28	4	29	18	Check consistency vs ch 5 [Jan Fuglestvedt, Norway]	Noted. See response to #53560 and #24776
29088	28	6	28	6	"near-infrared" not "UV"! [Keith Shine, United Kingdom (of Great Britain and Northern Ireland)]	Accepted. Text revised
41560	28	6	28	7	Etminan et al (2016) highlight the near-infrared absorption by CH4 not ultraviolet [Amanda Maycock, United Kingdom (of Great Britain and Northern Ireland)]	Accepted. See response to #29088
24772	28	6	28	7	Most of the effect found in Etminan is in the near-IR part of the solar spectrum rather than the UV. [William Collins, United Kingdom (of Great Britain and Northern Ireland)]	Accepted. See response to #29088
24774	28	6	28	17	A lot of this is very similar to section 5.2.2. I suggest it only needs to appear once and one chapter can refer to the other. Be careful of citing a review paper such as Saunois as evidence since there isn't a transparent link to evidence for the assertions made here - for instance the OH sink being >90% of the total quoted here doesn't come from any studies by Saunois themselves, rather they cite Ehhalt 1995. It would be more transparent if this is made clearer that this number comes from a 25 year old study rather than being from new post-AR5 information. [William Collins, United Kingdom (of Great Britain and Northern Ireland)]	Accepted. To avoid overlap with chapter 5, assessment of changes in methane budget and reasons for recent methane growth are eliminated from this section.
41562	28	6	29	15	Connection needed here to Chapter 2 who will also discuss methane changes [Amanda Maycock, United Kingdom (of Great Britain and Northern Ireland)]	Accepted. See response to #53560 and #24776

55654	28	8	28	8	Tropospheric + stratosphere O3? [Larry Horowitz, United States of America]	Accepted. Text is revised
16634	28	10	28	10	Sense unclear. Isn't there an overlap between 'thermogenic' and 'pyrogenic', if you have incompletely combusted fossil fuels? [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Taken into account. Text has been revised to reference section 5.2.2 for details on methane emissions
46140	28	11	28	14	Please give a better sense of the relative contribution of different sources to the global emissions of methane (e.g. from the Global Methane Project) [Cynthia Randles, United States of America]	Not applicable. To avoid overlap with chapter 5, assessment of changes in methane budget and reasons for recent methane growth are eliminated from this section.
16636	28	12	28	12	Delete , after 'landfills' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Not applicable. This section has been condensed based on reviewer comments to avoid overlap with Chapter 5. The comment is therefore not applicable here
16638	28	13	28	13	Capital S for 'section' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted.
55656	28	16	28	16	"over" --> "in the" [Larry Horowitz, United States of America]	Taken into account. Text has been revised.
45696	28	17			Mention Hossaini paper? Hossaini, Ryan, et al. "A global model of tropospheric chlorine chemistry: Organic versus inorganic sources and impact on methane oxidation." Journal of Geophysical Research: Atmospheres 121.23 (2016). [Euan Nisbet, United Kingdom (of Great Britain and Northern Ireland)]	Not relevant anymore as the methane section is solely focused on its lifetime, assessment of its sources and sinks is performed in Chapter 5
14686	28	19	28	19	A good reference to chapter 2. Chapter 2 has a few sentences statement on issues elaborated here in a full paragraph which makes some sense. However I guess there is more overlap with Chapter 5. As an 'uninformed' reader I would probably first go to Chapter 5 to learn about methane. Further dialogue on the best way to proceed is probably needed. [Frank Dentener, Italy]	Accepted. Text is revised to be consistent with chapter 2 about atmospheric methane trends. To avoid overlap with chapter 5, assessment of changes in methane budget and reasons for recent methane growth are eliminated from this section.
55658	28	19	28	19	"a factor of 2.5" --> 120% [Larry Horowitz, United States of America]	Accepted. Text is revised
47886	28	19	28	25	Current global concentrations of methane are also covered in ch2 (Section 2.2.4.2.2 Methane) and Ch7 (Table 7.4) of this report. Please avoid repetition and instead cross-reference to other sections where relevant. [WGI TSU, France]	Accepted. Text has been revised to cite chapter 2 for atmospheric methane trends. To avoid overlap with chapter 5, assessment of changes in methane budget and reasons for recent methane growth are eliminated from this section.
53562	28	19	28	25	This overlaps with ch5. I don't think this is needed here. [Jan Fuglestvedt, Norway]	Accepted. To avoid overlap with chapter 5, assessment of changes in methane budget and reasons for recent methane growth are eliminated from this section.
24776	28	19	28	25	This paragraph should cite chapter 2 rather than replicate their assessment. [William Collins, United Kingdom (of Great Britain and Northern Ireland)]	Accepted. Text has been revised to cite chapter 2 for atmospheric methane trends.
16640	28	20	28	20	Change to Pre-Industrial, and capital S for 'section' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Editorial.
45698	28	20			Better to use the 2018 number: 1857.7 plus/minus 0.7ppb and to state this is for the remote marine surface. [Euan Nisbet, United Kingdom (of Great Britain and Northern Ireland)]	Taken into account. Text is revised to cite chapter 2 for methane trends.
50006	28	21			What is the defintion of contemporary period? This term is not used anywhere else in Chapter 6 or Chapter 2. Table 2.1 in Chapter 2 defines "Present" as 1995-2014 [Owen Cooper, United States of America]	Taken into account. Text is revised to cite chapter 2 for methane trends.

16642	28	24	28	24	Delete 'time' to remove a tautology [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted.
45700	28	25			Mention the acceleration from 2014. It's really more of a dog-leg, up from 2007-2013, then much faster in 2014, then fast since….see Nisbet et al. (cited in next paragraph) [Euan Nisbet, United Kingdom (of Great Britain and Northern Ireland)]	Taken into account. Text has been revised to cite chapter 2 for atmospheric methane trends.
37778	28	27	26	28	This needs to be reworded. If sources and sinks change, atmospheric transport must change. The methane is transported in the atmosphere from source to sink, even though the transport is not the main driver of the change. Changing "due to" to "by" in the second of these lines might be all that is needed. [Adrian Simmons, United Kingdom (of Great Britain and Northern Ireland)]	Not applicable. To avoid overlap with chapter 5, assessment of changes in methane budget and reasons for recent methane growth are eliminated from this section.
39062	28	27	28	29	I think the Nisbet and Turner et al. papers are for long-term perspective and that of Pandey et al. is inter-annual scale. It may be confusing or misleading to the readers. Please clarify [Prabir Patra, Japan]	Not applicable. To avoid overlap with chapter 5, assessment of changes in methane budget and reasons for recent methane growth are eliminated from this section.
24778	28	27	28	34	The burden changes and top-down vs bottom-up issues are already covered in Ch 5. Ch 5 can be referred to here rather than repeated. [William Collins, United Kingdom (of Great Britain and Northern Ireland)]	Accepted. To avoid overlap with chapter 5, assessment of changes in methane budget and reasons for recent methane growth are eliminated from this section.
41078	28	36	28	39	I strongly suggest NOT referencing Schaefer et al. (2016) here, as the Schwietkze et al. (2016) paper published 6 months later In Nature (with many co-authors in common between the two papers) strongly stated the 13C data set used by Schaefer et al. was not up to the job. And more importantly, note that Worden et al. (2017) pointed out a major flaw with both the Schaefer et al. and Schwietkze et al papers: they assumed biomass burning was constant over time. Correcting for a decrease in biomass burning since 2007, Worden et al. (2017) reach a fundamentally different conclusion: the 13C signal of atmospheric methane went down since 2007 because of the decreased biomass burning, and the major increase in methane emissions since then is from fossil fuels, NOT biogenic sources. Worden, J.R., Bloom, A.A., Pandey, S., Jiang, Z., Worden, H.M., Walter, T.W., Houweling, S., and Röckmann, T., Reduced biomass burning emissions reconcile conflicting estimates of the post-2006 atmospheric methane budget, Nat. Communic., 8, 2227, doi:10.1038/s41467-017-02246-0, 2017. [Robert Howarth, United States of America]	Not applicable. To avoid overlap with chapter 5, assessment of changes in methane budget and reasons for recent methane growth are eliminated from this section.
41086	28	36	28	39	I strongly suggest NOT referencing Schaefer et al. (2016) here, as the Schwietkze et al. (2016) paper published 6 months later In Nature (with many co-authors in common between the two papers) strongly stated the 13C data set used by Schaefer et al. was not up to the job. And more importantly, note that Worden et al. (2017) pointed out a major flaw with both the Schaefer et al. and Schwietkze et al papers: they assumed biomass burning was constant over time. Correcting for a decrease in biomass burning since 2007, Worden et al. (2017) reach a fundamentally different conclusion: the 13C signal of atmospheric methane went down since 2007 because of the decreased biomass burning, and the major increase in methane emissions since then is from fossil fuels, NOT biogenic sources. [Robert Howarth, United States of America]	Not applicable. To avoid overlap with chapter 5, assessment of changes in methane budget and reasons for recent methane growth are eliminated from this section.

25994	28	36	28	52	The recent GRL paper by Lan et al https://doi.org/10.1029/2018GL081731 that looks at propane was well may provide further support for this paragraph on the ambiguity of causes of trends. Suggest assessing this paper here. [Haroon Kheshgi, United States of America]	Not applicable. To avoid overlap with chapter 5, assessment of changes in methane budget and reasons for recent methane growth are eliminated from this section.
44256	28	36	28	52	There are several very recent studies relevant here that the authors might consider including. Asumption of stable ethane/methane ratios was recently questioned in Lan, X., Tans, P., Sweeney, C., Andrews, A., Dlugokencky, E., Schwietzke, S., et al. (2019). Long-term measurements show little evidence for large increases in total U.S. methane emissions over the past decade. Geophysical Research Letters, 46. https://doi.org/10.1029/2018GL081731. Maasakkers et al (ACP) is another potentially relevant one. FInally, for the isotopic signals, there's a different hypothesis in Howarth (2019): Is Shale Gas a Major Driver of Recent Increase in Global Atmospheric Methane?, Biogeosciences Discuss., https://doi.org/10.5194/bg-2019-131, in review, 2019, so I think it'd be good to see how that paper fares under review and if accepted, to include that possibility (that unconventional gas has a different isotopic signature than conventional, requiring a reinterpretation of the meaning of the observed isotopic trends). [Drew Shindell, United States of America]	Not applicable. To avoid overlap with chapter 5, assessment of changes in methane budget and reasons for recent methane growth are eliminated from this section.
24780	28	36	29	8	This discusion of isotopes and OH is already covered in X-Ch box 5.1. It doesn't need to be repeated here. [William Collins, United Kingdom (of Great Britain and Northern Ireland)]	Not applicable. To avoid overlap with Chapter 5, this section has been revised. Assessment of the reasons for renewed methane growth are solely covered in chapter 5. Also see response to #14716
55660	28	42	28	43	Awkward phrasing "more isotopically lighter". Explain more clearly how "isotopically lighter fossil fuel emissions" compare isotopically to biogenic emissions. [Larry Horowitz, United States of America]	Not applicable. To avoid overlap with chapter 5, assessment of changes in methane budget and reasons for recent methane growth are eliminated from this section.
16644	28	46	28	46	Insert 'rather' after 'microbial' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Not applicable. To avoid overlap with chapter 5, assessment of changes in methane budget and reasons for recent methane growth are eliminated from this section.
41024	28	55	28	55	I suggest changing this to “radical abundances” or similar. [Johannes Laube, Germany]	Not applicable. To avoid overlap with chapter 5, assessment of changes in methane budget and reasons for recent methane growth are eliminated from this section.

47872	28		29		The recent changes in methance concentration are also covered in Chapter 5 (Section 5.2.2) and the Special Report on Land (SRCCL, Section 2.4.2). The SRCCL Ch2 Exec Summary statement on this topics is as follows. "The pause in the rise of atmospheric CH4 concentrations between 2000 and 2006 and the subsequent renewed increase appear to be partially associated with land use and land use change. The recent depletion trend of the 13C isotope in the atmosphere indicates that higher biogenic sources explain part of the current CH4 increase and that biogenic sources make up a larger proportion of the source mix than they did before 2000 (high confidence). In agreement with the findings of AR5, tropical wetlands and peatlands continue to be important drivers of inter-annual variability and current CH4 concentration 6 increases (medium evidence, high agreement). Ruminants and the expansion of rice cultivation are also important contributors to the current trend (medium evidence, high agreement). There is significant and ongoing accumulation of CH4 in the atmosphere (very high confidence)." please check for consistency and provide an update from the SRCCL and chapter 5. A callout to this special report is needed if the methane assessent is kept in chapter 6. [WGI TSU, France]	Not applicable. Assessment of methane changes is no longer considered in chapter 6.
16646	29	1	29	1	Capital S for 'section' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Not applicable. To avoid overlap with chapter 5, assessment of changes in methane budget and reasons for recent methane growth are eliminated from this section.
45702	29	1			The Naus et al and Nicely et al papers are mentioned later, but could be referenced here also?- would support the inference in italics later in this paragraph. [Euan Nisbet, United Kingdom (of Great Britain and Northern Ireland)]	Not applicable. To avoid overlap with chapter 5, assessment of changes in methane budget and reasons for recent methane growth are eliminated from this section.
16648	29	2	29	2	Delete , after al. [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Not applicable. To avoid overlap with chapter 5, assessment of changes in methane budget and reasons for recent methane growth are eliminated from this section.
47930	29	4	29	8	Please check the use of this IPCC uncertainty language term. Are you able to provide a traceable account to assigning this uncertainty statement? Note that likelihood statements are quantified terms - phrases like likely and very likely have quantifiable probabilities associated with them. Please check it has been used correctly here. Please refer to the IPCC guidance note on uncertainty: https://wg1.ipcc.ch/SR/documents/ar5_uncertainty-guidance-note.pdf [WGI TSU, France]	Noted.
24782	29	6	29	7	The "remained constant" needs to have a range, otherwise it is "exceptionally unlikely" that OH has remained exactly constant. [William Collins, United Kingdom (of Great Britain and Northern Ireland)]	Not applicable. To avoid overlap with Chapter 5, this section has been revised. Assessment of the reasons for renewed methane growth are solely covered in chapter 5. Also see response to #14716
16650	29	7	29	7	Capital S for 'section' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Not applicable. To avoid overlap with chapter 5, assessment of changes in methane budget and reasons for recent methane growth are eliminated from this section.

29042	29	10	29	10	"virtaully certain". Isnt this really unequivocal? [Keith Shine, United Kingdom (of Great Britain and Northern Ireland)]	Not applicable. To avoid overlap with Chapter 5, this section has been revised. Assessment of the reasons for renewed methane growth are solely covered in chapter 5.
47646	29	10	29	15	This paragraph needs to indicate the limited constraints provided by current flask and remote sensing observational network, such as described in Turner et al (doi:10.1073/pnas.1814297116) and indicate that the low confidence is a result of competing explanations for the varying and sometimes contradictory cause(s) of the historical trajectory of atmospheric methane. [Daniel Feldman, United States of America]	Not applicable. To avoid overlap with Chapter 5, this section has been revised. Assessment of the reasons for renewed methane growth are solely covered in chapter 5.
12860	29	10	29	15	Note that the Arctic could transition from a carbon sink to a carbon source as soon as the mid-2020s, with permafrost becoming a greater source of methane. Schaefer K., et al. (2011) Amount and timing of permafrost carbon release in response to climate warming, TELLUS SERIES B CHEMICAL & PHYSICAL METEOROLOGY 63(2):165–180, 165 ("We predict that the [permafrost carbon feedback (PCF)] will change the arctic from a carbon sink to a source after the mid-2020s and is strong enough to cancel 42–88% of the total global land sink. The thaw and decay of permafrost carbon is irreversible and accounting for the PCF will require larger reductions in fossil fuel emissions to reach a target atmospheric CO2 concentration."). [Durwood Zaelke, United States of America]	Not applicable. To avoid overlap with Chapter 5, this section has been revised. Assessment of the reasons for renewed methane growth are solely covered in chapter 5.
14688	29	10	29	15	Chapter 2 key message: There is robust evidence that the concentrations of all three major long-lived greenhouse gases have continued to increase since 2011 by 15 ppm for CO2, 47 ppb for CH4 and 5.6 ppb for N2O. Their abundances are now 118.1 ± 1.6 ppm, 1043 ± 6 ppb and 59 ± 4 ppb respectively above pre-industrial levels (very high confidence). Clearly this key-message needs to combined with Chapter 6 for a technical summary. [Frank Dentener, Italy]	Noted.
12692	29	10	29	15	Note that the Arctic could transition from a carbon sink to a carbon source as soon as the mid-2020s, with permafrost becoming a greater source of methane. Schaefer K., et al. (2011) Amount and timing of permafrost carbon release in response to climate warming, TELLUS SERIES B CHEMICAL & PHYSICAL METEOROLOGY 63(2):165–180, 165 ("We predict that the [permafrost carbon feedback (PCF)] will change the arctic from a carbon sink to a source after the mid-2020s and is strong enough to cancel 42–88% of the total global land sink. The thaw and decay of permafrost carbon is irreversible and accounting for the PCF will require larger reductions in fossil fuel emissions to reach a target atmospheric CO2 concentration."). [Kristin Campbell, United States of America]	Not applicable. To avoid overlap with Chapter 5, this section has been revised. Assessment of the reasons for renewed methane growth are solely covered in chapter 5.
37780	29	10	29	15	The text here contradicts the likelihood statement made in Chapter 5 on page 5-7, lines 4 and 5. [Adrian Simmons, United Kingdom (of Great Britain and Northern Ireland)]	Not applicable. To avoid overlap with Chapter 5, this section has been revised. Assessment of the reasons for renewed methane growth are solely covered in chapter 5.
25996	29	11	29	15	There have been attempts to attribute the renewed growth to different factors, but studies differ in their conclusions. This does not support the attribution conclusion stated in line 11. Suggest changing to "There have been attempts to attribute the renewed growth in methane to changes in ..." [Haroon Kheshgi, United States of America]	Not applicable. To avoid overlap with Chapter 5, this section has been revised. Assessment of the reasons for renewed methane growth are solely covered in chapter 5.

55662	29	12	29	12	Explain how the terms "thermogenic and pyrogenic" (used here) correspond to terms used earlier ("fossil fuel", "biomass burning"). [Larry Horowitz, United States of America]	Not applicable. To avoid overlap with chapter 5, assessment of changes in methane budget and reasons for recent methane growth are eliminated from this section.
47940	29	13	29	13	Moderate evidence' should be medium evidence. IPCC uncertainty language used incorrectly. Please refer to the IPCC guidance note on uncertainty for correct list of terms that can be used: https://wg1.ipcc.ch/SR/documents/ar5_uncertainty-guidance-note.pdf [WGI TSU, France]	Noted.
27834	29	17	29	17	attend the placeholders [Poot Delgado Carlos Antonio, Mexico]	Accepted. Placeholders have been addressed to the best of our ability.
26852	29	17	29	17	A paper to consider: Zhao, Y., et al.: Inter-model comparison of global hydroxyl radical (OH) distributions and their impact on atmospheric methane over the 2000-2016 period, doi:10.5194/acp-2019-281, Atmos. Chem. Phys. Discuss., 2019. [Ragnhild Bieltvedt Skeie, Norway]	Noted.
24784	29	17	29	18	Yes, it will be very important to discuss changes in understanding of the lifetime and adjustment time in the next draft. [William Collins, United Kingdom (of Great Britain and Northern Ireland)]	Noted
14690	29	21	32	18	Chapter 2 is happy with the complimentarity of the sections 6.2.2.5 and 2.2.5.2/2.2.5.3 (tropospheric/stratospheric ozone). Some suggestions: what was the starting point in AR5, and how is it changed in AR6. Recommend to use the same 'phrasing': In summary, xxx-> to make clear that this is the main message to be propagated. [Frank Dentener, Italy]	Noted
24786	29	26	29	30	AR6 shouldn't rely on citing AR5 (Myhre et al. 2013) for supporting evidence. It should assess what is new since AR5. [William Collins, United Kingdom (of Great Britain and Northern Ireland)]	Accepted. This is an introductory statement for ozone profile abundances. As such the reference of AR5 has been substituted by other relevant references (Lelieveld and Dentener, 2000; Cooper et al., 2014)
37782	29	27			Is there no ozone at all in the mesosphere? Should "most of" or "almost all of" be inserted before "the remainder"? [Adrian Simmons, United Kingdom (of Great Britain and Northern Ireland)]	Accepted and revised accordingly.
53564	29	30	29	30	You may consider referring to the latest WMO/UNEP Ozone Assessment [Jan Fuglestvedt, Norway]	The reference in this sentence has been revised following comment 24786. There is reference on the latest WMO/UNEP Ozone Assessment in Section 6.2.2.5.2 for stratospheric ozone changes.
46682	29	33	31	41	Assessment on modes of variability occurs in Section 1.3.3; Section 2.4; Section 3.7; Section 4.4.3, 4.5.3; Section 6.2.2.5.1; Section 7.1.1/2 ; Section 8.3.1.3.2, 8.3.2.2, 8.3.2.4.1, 8.3.2.9.1, 8.4.2.5,8.5.2.2.1, 8.3.2.9.2, 8.4.2.5, 8.3.2.9.3, 8.4.2.5, 8.3.2.9.4, 8.4.2.5, Figure 8.43, 8.5.2.2.1, 8.5.2.2.1; Section 9.2.2.1, 9.2.2.3, Section 9.4.3.2, BOX 9.2, 9.2.3.1, Table 9.1, Section 9.2.1, Cross-Chapter Box 9.1, BOX 9.2, 9.6.2.1.1, 9.6.2.1.2, 9.5.4.7, 9.2.5; Section 10.1.4.2, 10.4.2.2, 10.6.3.3; Section 11.3.1, 11.7.1.1, 11.6.2, 11.1.5,11.4.1, 11.6.1, Table 11.4; Section 12.4.1, 12.4.4.3, 12.5.2.3; Section Atlas.5.2.1.2, Atlas.5.3.1.1, Atlas.5.3.2.1, Atlas.5.5.1.1, Atlas.5.5.2.1, Atlas.5.6.2.1, Atlas.5.6.3.1, Atlas.5.10.2.1, Atlas.5.10.2.2. This topic is addressed in ES of Chapter 2, 3, 4, 7, 11, addressed in box in chapter 9, and broadly addressed in above-mentioned subsections in chapter 1, 2, 3, 4, 6, 7, 8, 9, 10, 11, 12. [WGI TSU, France]	Noted

24810	29	33			Section 6.2.2.5.1 should try to attribute these tropospheric ozone changes to precursors. AR5 used Stevenson et al. 2013 for this. Has there been any new information since AR5? To what extent have ODSs affected tropospheric ozone? [William Collins, United Kingdom (of Great Britain and Northern Ireland)]	Taken into consideration and revised accordingly to ensure consistency.
16652	29	34	29	34	Insert - between stratosphereand troposphere [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	revised to stratosphere-troposphere exchange (STE)
24788	29	34	29	54	It might be useful to provide a table of the ozone budget terms. Hopefully these will be updated with CCMI and AerChemMIP values for the next draft. Has there been any advance in understanding of the ozone budget, or are these just newer models? [William Collins, United Kingdom (of Great Britain and Northern Ireland)]	Taken into consideration. The current numbers are based on the TOAR paper by Young et al. (2018). Their Figure 3 summarizes the modelled values for the budget terms using results from the models that took part in ACCENT (Stevenson et al., 2006) and ACCMIP (Young et al., 2013), as well as recent single model studies (after Myhre et al., 2013; their Table 8.1). Table 8.1 of AR5 has been updated including also respective budget terms from AerChemMIP.
40590	29		32		This section reads very clumsy. There is no clear message on an overall value of trend.The paragraphs need to be reorganized. Comparisons between model and obersations need to be made. Also studies from in-situ obervations and ozonesonde seem to be neglected. [Chaitri Roy, India]	Taken into consideration. There is a Figure added showing the near surface ozone trends around the world based on in-situ observations. There is also another figure that has been added showing the comparison of observed from satellites and modelled tropospheric ozone column trends. Ozone sondes are not neglected as there are free tropospheric ozone trends reported.
8202	30	1	30	1	Evidence has been provided that lightning is important for tropospheric ozone (and OH) variability. It also gave evidence that lightning is more important than biomass burning for variability of tropospheric ozone https://agupubs.onlinelibrary.wiley.com/doi/full/10.1002/jgrd.50857 [Declan Finney, United Kingdom (of Great Britain and Northern Ireland)]	Accepted and revised accordingly adding the proposed reference for the role of Lightning. This comment actually refers to the sentence in lines 1-4 of page 31.
16654	30	4	30	6	Change to Pre-Industrial [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Editorial -Copyedit to be completed prior to publication
52000	30	6			I think care required here over referring to 1850 as a pre-industrial benchmark year. See discussion in chapter 1 and also consider that for forcing 1750 continues to constitute a benchmarlk. [Peter Thorne, Ireland]	Accepted. Text has been revised accordingly.
37784	30	6			For consistency with terminology introduced in Chapter 1, "pre-industrial benchmark year of 1750" should be changed to "pre-industrial baseline period around 1750". [Adrian Simmons, United Kingdom (of Great Britain and Northern Ireland)]	Accepted. Text has been revised accordingly.
16656	30	10	30	10	Capital C for 'century' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted
47284	30	10	30	11	"the reported ozone values were probably lowered by emissions of other anthropogenic trace gases": the cause of lowered ozone values could be explained more explicitly. [Guang Zeng, New Zealand]	Accepted and revised accordingly.

47932	30	11	30	11	Please check the use of this IPCC uncertainty language term. Are you able to provide a traceable account to assigning this uncertainty statement? Note that likelihood statements are quantified terms - phrases like likely and very likely have quantifiable probabilities associated with them. Please check it has been used correctly here. Please refer to the IPCC guidance note on uncertainty: https://wg1.ipcc.ch/SR/documents/ar5_uncertainty-guidance-note.pdf [WGI TSU, France]	Taken into consideration.
16658	30	12	30	12	Capital C for 'century' and remove hyphen [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted
47286	30	21	30	22	Although one can refer to Tarasick (2019), it would be useful to specify how ozone profiles were measured from which the TCO was derived from. Could add the types of measurements that were used to derive TCO (e.g., sonde? Umkehr?) after "ozone profile". [Guang Zeng, New Zealand]	Accepted and revised accordingly.
16660	30	25	30	25	Change 'Northern' to 'northern' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted
16668	30	29	30	29	Reference required [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted and a reference was added. The trends at the three sites (MLO, Samoa, South Pole) are all addressed by Cooper et al., 2019.
16662	30	35	30	36	Don't split units across a line. [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Noted
16664	30	38	30	38	Insert 'the' after 'With' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted
24790	30	38	30	42	Suggest to combine this paragraph with that above, to say what changes there is robust evidence and medium high agreement on. [William Collins, United Kingdom (of Great Britain and Northern Ireland)]	Taken into consideration and revised accordingly.
16666	30	39	30	40	Change ‘twentieth century’ to ‘20th Century’ for correctness (in this context ‘century’ is a proper noun) and consistency elsewhere in the WGI documentation [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted
47288	30	40	30	40	Suggest to replace "morden period" with "present-day" [Guang Zeng, New Zealand]	Accepted
47290	30	44	30	45	This sentence needs to be rephrased, for example, as "It is essential that the long-term ozone trends are represented in the model so that the ozone radiative forcing from … can be assessed" [Guang Zeng, New Zealand]	Accepted
24792	30	44	30	53	This needs to be explain how STT is different to STE. [William Collins, United Kingdom (of Great Britain and Northern Ireland)]	Stratosphere-Troposphere Exchange (STE) understood as the flux of air or trace constituents across the tropopause including both directions; the Stratosphere to Troposphere Transport (STT) and Troposphere to Stratosphere Transport (TST). (Stohl, A., et al., Stratosphere-troposphere exchange: A review, and what we have learned from STACCATO, J. Geophys. Res., 108(D12), 8516, doi:10.1029/2002JD002490, 2003.).
16670	30	45	30	45	Change to Pre-Industrial times, and insert 'the' before 'present' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted
16672	30	55	30	55	Insert , after 'Furthermore' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted

24794	30	55	31	17	What is the message from this list of variability studies? I'm not sure this paragraph is necessary. [William Collins, United Kingdom (of Great Britain and Northern Ireland)]	Accepted. The paragraph has been substantially reduced.
16674	31	2	31	2	Insert 'the' after 'as' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted
16676	31	3	31	3	Add (NAO) if you are defining the other modes [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted
16678	31	8	31	8	Subscript 3 required for O3 [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted
41564	31	8	31	17	what is the overall conclusion here? It is not clear [Amanda Maycock, United Kingdom (of Great Britain and Northern Ireland)]	Not applicable. The paragraph has been removed.
16680	31	9	31	9	Exponential rate required [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted
16682	31	10	31	10	Subscript 3 required for O3 [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted
47682	31	19	31	33	Very little distinction is made between ground level and upper level ozone which is important to assess the impact of future climate change on human health. Examination ground level ozone and its longer term trends on regional scales will provide a more robust analysis of the impacts of interactions between climate, air quality and health for future years. [Ranjeet Sokhi, United Kingdom (of Great Britain and Northern Ireland)]	Noted. There is a discussion of the regional surface ozone trends within this sub-section based on observations and a Figure has been introduced to show these trends. This paragraph discusses the model uncertainties in reproducing model ozone trends. Furthermore it should be taken into consideration that WGI is focused on the physical science basis for climate change while WGII is focusing on impacts such health impact from air quality.
24796	31	19	31	33	What is the message here? This paragraph could be reduced. [William Collins, United Kingdom (of Great Britain and Northern Ireland)]	Taken into consideration and the paragraph has been reduced. The message from this paragraph is the discussion of model uncertainties to reproduce ozone trends.
12694	31	25	32	18	Section 6.2.2.5.2 should include that the success of the Montreal Protocol has put the ozone layer on the path to recovery. World Meteorological Organization (WMO) (2018) SCIENTIFIC ASSESSMENT OF OZONE DEPLETION: 2018, Global Ozone Research and Monitoring Project-Report No. 58. [Kristin Campbell, United States of America]	Accepted and revised accordingly.
16684	31	35	31	35	Change to Pre-Industrial [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Editorial -Copyedit to be completed prior to publication
27836	31	35	31	35	attend the placeholders [Poot Delgado Carlos Antonio, Mexico]	Noted
55664	31	36	31	36	Add "of tropospheric O3 precursors (NOx, CO, NMVOC)" after "increasing emissions." [Larry Horowitz, United States of America]	Accepted
16686	31	38	31	38	Change' to '20th Century' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted
24798	31	38	31	38	What has led to this increased confidence in the observed trend? [William Collins, United Kingdom (of Great Britain and Northern Ireland)]	Accepted and revised accordingly.
52002	31	38	31	41	Other chapters have knowledge gaps exclusively at the chapter end. Is this required here for consistency across the report as a whole? [Peter Thorne, Ireland]	Noted. Indeed, the knowledge gap section at the end of the chapter summarizes the knowledge gaps articulated in earlier sections of the chapter.

16688	31	39	31	39	Change to Pre-Industrial [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Editorial -Copyedit to be completed prior to publication
28928	31	44	32	18	Maybe there is a reason for this but if so, it should be explained. Why are you only considering 60S-60N in this section when it is clear throughout the whole report that Antarctic ozone depletion has had a much bigger effect on surface climate than elsewhere. [Matt Tully, Australia]	Accepted and revised accordingly by adding statements for polar ozone changes.
41026	31	44	32	18	This is another example of poor coordination with Chapter 2. Apart from the link provided in the first sentence there seems to have been little exchange between the authors to ensure consistency of messages and as little repetition as possible. [Johannes Laube, Germany]	Taken into consideration and revised accordingly to ensure consistency.
24812	31	44			Section 6.2.2.5.2. should assess to what extent these changes are due to ODSs. How much have tropospheric ozone precursors affected the stratosphere? [William Collins, United Kingdom (of Great Britain and Northern Ireland)]	Taken into consideration and revised accordingly.
24800	31	45	31	45	This should cite the specific section in chapter 2 (2.2.5.2) and doesn't need to cite WMO (2018) since the numbers come from chapter 2. [William Collins, United Kingdom (of Great Britain and Northern Ireland)]	Accepted and revised accordingly.
12862	31	45	32	18	Section 6.2.2.5.2 should include that the success of the Montreal Protocol has put the ozone layer on the path to recovery. World Meteorological Organization (WMO) (2018) SCIENTIFIC ASSESSMENT OF OZONE DEPLETION: 2018, Global Ozone Research and Monitoring Project-Report No. 58. [Durwood Zaelke, United States of America]	Accepted and revised accordingly.
41566	31	49	31	49	suggest here and elsewhere that references to 2018 Ozone Assessment Report as WMO (2018) are replaced with citations to the relevant chapters within that assessment [Amanda Maycock, United Kingdom (of Great Britain and Northern Ireland)]	Accepted and revised accordingly.
24802	31	51	32	3	Are these changes different or more certain than AR5? [William Collins, United Kingdom (of Great Britain and Northern Ireland)]	For the recent period there are updates due to the extension of the time period. In the upper stratosphere for the period through the 1980s and middle 1990s the trends are slightly lower than reported in AR6 (5-7% here based on WMO 2018 while 10% in AR5). In the recent period the results are qualitatively similar but now in AR6 a quantitative estimate is reported (1-3% is referred here and a slight increase is referred in AR5). For the lower stratosphere there are updates concerning the trends in the recent period (after 2000). In AR5 it is reported a period of stabilization or a slight (2 to 3%) ozone increase. Here it is reported that there is some evidence for a decrease in lower stratospheric ozone from 2000 – 2016 which is most consistent across datasets in the tropics, but is not statistically significant in most analyses.

41568	32	1	32	3	the references given for upper stratospheric cooling and ozone increase are not the original ones that showed this effect which has been known for a long time, see e.g. Haigh and Pyle 1982. Moreover, Polvani et al (2017) do not even consider upper stratospheric temperature change so this is not an appropriate reference here. Also it should be mentioned here that ozone depletion itself cools the upper stratosphere and hence contributes to observed stratospheric temperature trends (e.g. Maycock et al 2018; doi: 10.1029/2018GL078035) [Amanda Maycock, United Kingdom (of Great Britain and Northern Ireland)]	Accepted and revised accordingly.
27272	32	5	32	7	Ball et al., 2018 should be cited after 'decrease in lower stratosphere', not at the end of the sentence, because Ball et al., 2018 provides evidence for decreases. Please move this reference to earlier to avoid confusion. (The 1998 you replace for 2000 is also why the reference should be moved; the WMO focuses on 2000+, while Ball et al., 2018 focuses on 1998+) [Gabriel Chiodo, Switzerland]	Accepted and revised accordingly.
56130	32	6	32	6	Ball et al. ACP 2018 is discussed here; this discussion needs to be consistent with the one in Chapter 1 (this is not the case currently) [Rolf Müller, Germany]	Rejected. There is no place in Chapter 1 that stratospheric ozone trends are discussed. There is also consistency in the discussion of stratospheric ozone trends between Chapter 2 and Chapter 6.
27276	32	6	32	6	Please note that Ball et al., 2018 has been updated, using more recent data, confirming the negative trends and their significance. The paper is currently in discussion on ACP (Ball et al., ACPD 2019 "Stratospheric ozone trends for 1985-2018: sensitivity to recent large variability") [Gabriel Chiodo, Switzerland]	Accepted and the reference has been added.
24804	32	7	32	8	Is this further detail on the trends necessary? [William Collins, United Kingdom (of Great Britain and Northern Ireland)]	It provides some justification that the observed ozone decrease in the tropical lower stratosphere is plausibly dynamically driven according to CTMs and that CCMs cannot represent consistently this decrease.
16690	32	9	32	9	Change reference to Stone et al. [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Noted. This is shown from the Mendeley Library.
27274	32	9	32	11	It is important that the point raised by Stone et al., 2018 refers specifically, and only, to the *tropical* lower stratosphere. The 9-ensemble set of simulations do not show the widespread decreases throughout the tropical lower stratosphere, and out to mid-latitudes, that Ball et al., 2018 show. Please insert 'tropical' before 'lower stratosphere' in this sentence. [Gabriel Chiodo, Switzerland]	Accepted and revised accordingly.
16692	32	16	32	16	Insert 'the' after 'in' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted
27838	32	16	32	16	attend the placeholders [Poot Delgado Carlos Antonio, Mexico]	Noted
24806	32	16	32	18	Chapter 7 (7.3.2.5) assesses the stratospheric ozone ERF to be 50% greater than the AR5 assessment. Sections 6.2.2.5.2 and 7.3.2.5 need to be consistent. [William Collins, United Kingdom (of Great Britain and Northern Ireland)]	Noted. It has been revised in order to be consistent with Chapter 7.
55666	32	17	32	17	Change to "during the *period unperturbed by ODS*." [Larry Horowitz, United States of America]	Accepted
16694	32	18	32	18	Change to Pre-Industrial value [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Editorial -Copyedit to be completed prior to publication

14694	32	21	32	21	As stated earlier, we should probably move away from the concept of suggesting that there exist such as thing such as sulfate, nitrate and OM, BC aerosol, as almost always aerosol particles have a mixed composition. Suggest changing the title in: Sulphur dioxide and sulfate aerosol component (or aerosol sulphate mass). Also for subsequent sections. [Frank Dentener, Italy]	Taken into account - heading revised to "Sulphur Dioxide (SO2) and Sulphate Aerosol (SO42-) Components"
38234	32	21	33	39	The trend of SO2/SO4 is important, but the burden and lifetime of them should also be described in this section (6.2.2.6). I think descriptions on processes are not enough. [Hitoshi Matsui, Japan]	Rejected - the burden (emissions) and lifetimes are described in separate chapter.
38258	32	21	36	33	I cannot find descriptions on new particle formation and ice nucleating particles (including primary biological aerosol particles) in section 6.2.2. These are important processes/properties/species of aerosols (especially for aerosol-cloud interactions) and there are many new findings after AR5. I think they should be described in this section. [Hitoshi Matsui, Japan]	Noted - Certainly important, though think this is covered elsewhere, i.e. in chapter 6.3
38260	32	21	36	33	Descriptions on natural aerosols are lacking in section 6.2.2. Since these species are described in 6.2.1 (emissions), please add descriptions on their processes and abundances also. [Hitoshi Matsui, Japan]	Noted -not relevant for the sulphur chapter 6.2.2.2
31048	32	21	36	34	Sections 6.2.2.6 to 6.2.2.8: it would be great if figure 7.13 of AR5, which showed the global distribution of aerosol chemical composition, could be updated. It was a great way to show the variety of compositions without long text, and would help interpret regional trend studies. [Nicolas Bellouin, United Kingdom (of Great Britain and Northern Ireland)]	Accepted. Figure 6.8 has been added.
24814	32	23	32	25	This section seems to dive in straight to the chemistry and physics of SO2, maybe a couple of lines of motivation first would help introduce the topic. [William Collins, United Kingdom (of Great Britain and Northern Ireland)]	Rejected. The first paragraph include the motivation "sulphate aerosols that influence climate forcing"
40556	32	23	36	33	Sections 6.2.2.6-8 should include an assessment of recent studies with on-line ACSM or AMS instruments for evaluation of sources, and diurnal, seasonal, and spatial variations of sulfate, nitrate, and organic aerosol at high time resolution. Examples of these studies are Rivellini et al., (2017) ACP, 17, 10291-10314; Sun et al., (2015) ACP, 15, 10149-10165; Fountoukis et al., (2014) ACP, 14, 9061-9076; Petit et al., (2015) ACP, 2985-3005; Minguillon et al., (2015) ACP, 15, 6379-6391. [Rosa Flores, Turkey]	Rejected - For the sulphur chapter 6.2.2.2 the ACSM and AMS is not that relevant. The sources of sulphur is well known, and more traditional instrumentation have a better spatial resolution and used for long term monitoring. The uncertainties in the ACSM and AMS measurements are also higher, and they only measured fine fraction and non refractory aerosols. The main advantage these instruments have compared to the more traditional are the higher time resolution (which is also possible for some other instrument), but I don't find any specific new information in the reference given on sulphur. For organics I do agree, these instruments combined with statistical analysis (PMF) have given much new insight into the sources and distribution of organic aerosols.
16696	32	25	32	25	Insert full stop [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted -added
53566	32	25	32	25	Strange to refer to a quite recent paper on this. You may refer to AR5, ch 7 (Boucher et al 2013) and ch 8 (Myhre et al, 2013) [Jan Fuglestvedt, Norway]	Accepted -Changed reference Myhre 2017 with the two AR5 chapters
24816	32	25	32	25	I'm not sure Myhre et al. 2017 is the best reference for direct and indirect forcing. [William Collins, United Kingdom (of Great Britain and Northern Ireland)]	Taken into account -see comment 53566

16698	32	31	32	31	Insert , after 'However' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted -added
24818	32	33	32	35	It might be helpful to say what the role of pH is here and how Freedman et al. advances knowledge over AR5. [William Collins, United Kingdom (of Great Britain and Northern Ireland)]	Taken into account -included also mineral dust since that also is important. And added the following text: "However, there are quite large differences in the models' distribution of the concentration fields of sulphate, thus considerable uncertainties in the magnitudes of the regional forcing estimates (Kasoar, 2016a)" I included two more references (Cheng et al. 2016, He et al. 2014) which I think is relevant in this context
24820	32	37	32	37	Maybe move this first sentence on no AR5 SO2 concentrations to later in the paragraph where SO2 is discussed. [William Collins, United Kingdom (of Great Britain and Northern Ireland)]	Accepted - moved
16700	32	38	32	38	Delete 'the' after 'over' and 'period' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Taken into account - deleted
31050	32	41	32	44	Are those findings, and especially the explanation of the different trends, really robust? [Nicolas Bellouin, United Kingdom (of Great Britain and Northern Ireland)]	Rejected - yes the trends in North America and Europe are robust. Good coverage of sites and many studies confirm the trends. The reason for difference in SO2 and SO4 trends are due to both changes in oxidation capacity and higher dry deposition rates, due to increased availability of oxidants (H2O2, OH and O3less acidic clouds and droplets. This is documented in several model studies, but their relative importance is difficult to quantify, and it is probably regional variabilities.
24822	32	44	32	55	Is is this detail on specific changes in specific regions necessary? If these percentages really are deemed valuable maybe they should go in a table? [William Collins, United Kingdom (of Great Britain and Northern Ireland)]	The text has been shorten but since there are regional differences in the trends it is important to document this since it impact the regional forcing.
16702	32	50	32	50	Change 'was' to 'were' and isnerta space [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted -changed to were
16704	32	50	32	51	Don't split units across a line. [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Taken into account .included nonbreaking space between all % and yr
16706	32	55	32	55	Delete 'time' to remove a tautology [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Taken into account - deleted

24824	33	1	33	2	There are very large differences in the concentrations, and radiative forcing derived from these models, see eg Kasoar papers, also Westerveld. It seems overoptimistic to say we have confidence in these relationships. [William Collins, United Kingdom (of Great Britain and Northern Ireland)]	Taken into account- the models are able to predict the change over the 1990-2015 period in North America and Europe, and I therefore don't think it is overoptimistic to say" building confidence". Nevertheless, yes there are difference in concentrations fields between the models. To avoid misunderstand, and to emphasise that there are quite large regional uncertainties, even the overall picture gives confident in he forcing estimates, I suggest adding the following sentence: However, it is quite large differences in the models' distribution of the concentration fields of sulphate, thus considerable uncertainties in the magnitudes of the regional forcing estimates (Kasoar, 2016a)
16708	33	4	33	4	Change 'world' to 'World' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted - changed
44464	33	6	33	10	Krotkov et al., 2016 examined changes in both SO2 and NO2 over the world's most polluted regions for the period 2005-2014 and found the growth rates of (200 ± 50%) in OMI-observed SO2 columns during 2005–2014 particularly over the industrial regions in Chhattisgarh and Odisha. The study is based on particular region of a country and not whole country specific. The complete para needs to be rewritten. [VIJAY SONI, India]	Rejected - the emissions in India have increased similar as what is observed by the OMI satellite. Even though the study focus on polluted regions. The 100% increase of SO2 over these regions in India is applicable for India in general.
16710	33	7	33	7	Subscript 2 in chemical formulae [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted -corrected
50008	33	7			This sentence makes it sound like the satellite observations have only shown a decrease in SO2 above China since 2012. But Krotkov et al [2016] clearly show that SO2 has decreased since at least 2007 when SO2 was at its peak. [Owen Cooper, United States of America]	Taken into account - rewrote: "...around 2005 and then a decline (Aas et al., 2019), this is confirmed by satellite observations (Krotkov et al., 2016), which further reveal a rapid decline in SO2 since 2012 to 2013 (Krotkov et al., 2016; Zheng et al., 2018b).
16712	33	8	33	8	delete 'the' and 'period' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted - changed as suggested
46142	33	11	33	11	What are the Global Earth Systems? Elaborate on this sentence, please, especially the use of reanalyses in trend analysis. [Cynthia Randles, United States of America]	Taken into account - Rewritten to " Further improvements in global trend assessments are expected with new integrated reanalysis products from the Earth-system data assimilation projects"
14696	33	11	33	11	earth system models? [Frank Dentener, Italy]	Taken into account - changed to Earth-system data assimilation projects.
37786	33	11			"integrated reanalysis products" would be better than "reanalysed integrated products". "the Global Earth Systems" must be changed to "Earth-system data assimilation" or something similar. [Adrian Simmons, United Kingdom (of Great Britain and Northern Ireland)]	Accepted - changed to: " Further improvements in global trend assessments are expected with new integrated reanalysis products from the Earth-system data assimilation projects"

24826	33	13	33	19	Should the description of ice-core data be moved to chapter 2? [William Collins, United Kingdom (of Great Britain and Northern Ireland)]	Rejected - ice core data are necessary to assess the historical trends and that fits in this chapter
16714	33	16	33	16	Change to '19th Century' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted - changed
24828	33	23	33	24	Could clarify that there are only regional differences in the *magnitude* of the burden increase. There is no region where the 2005 burden is less than 1850. [William Collins, United Kingdom (of Great Britain and Northern Ireland)]	Taken into account -added and changed to:".. large regional differences in the magnitude
14692	33	23	33	29	There is a small paragraph in section 2 as well on past changes with a figure, and partly the same references. We would be happy to integrate this paragraph in section 2 (contact Johannes Quaas) or visa versa. [Frank Dentener, Italy]	Noted -consistency/overlaps with chapter 2 have been fixed.
16716	33	25	33	25	delete 'the' and 'period' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted - changed as suggested
16718	33	26	33	26	delete 'the' and 'period' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted - changed as suggested
16720	33	26	33	27	Sense unclear, there is overlap between the decades as both are noted to include 2000. Do you mean 2001-2015? [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Rejected - the trend estimates are based on overlapping years
44466	33	27	33	29	Based on above two comments, this para also needs to be revised. [VIJAY SONI, India]	Rejected - see above
14698	33	32	33	32	nitrate aerosol component. Should also talk about ammonium component [Frank Dentener, Italy]	taken into account. The title has been revised to include ammonium
53572	33	32	34	42	More assessment is needed [Jan Fuglestvedt, Norway]	rejected. not specific enough
38236	33	32			The title should be revised. Please include NH4 and HNO3. [Hitoshi Matsui, Japan]	taken into account. The title has been revised to include ammonium. We have not added HNO3 as it is not discussed in details in this subsection
40682	33	39	34	3	Given that ammonia has little direct radiative importance, this paragraph should be shortened. NHx, as discussed on page 34, is probably a better parameter than NH3. One suggestion is simply to delete everything after the Van Damme reference in line 45. [Daniel Murphy, United States of America]	rejected. NH3 contributes to the production of ammonium nitrate and ammonium sulphate. Therefore, we believe it is important to highlight recent advances and gaps in our understanding of NH3 trends
24830	33	39	34	3	This is a nice assessment of the change in knowledge in ammonia since AR5. [William Collins, United Kingdom (of Great Britain and Northern Ireland)]	thanks
56126	33	40	33	40	Van Damme 2018 should be mentioned here as well [Rolf Müller, Germany]	accepted
16722	33	46	33	46	Insert 'a' after 'with' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	accepted
56128	33	49	33	50	It has recently been found (Höpfner et al., Nature Geosci., 2019) that both ammonia and ammonium nitrate can be found at high altitudes (above 10 km) in te region of the Asiam monsoon. This importnat finding is relevant here. [Rolf Müller, Germany]	accepted. We have added a reference to Höpfner et al. (2019)
50010	33	50	34	3	It's not clear how the observational trends differ from the bottom-up emissions trends. Which one is increasing faster? [Owen Cooper, United States of America]	taken into account. the text has been revised to emphasize that the decrease in the NH4:NH3 ratio has contributed to the observed increase in NH3 concentrations
14700	33	51	33	51	Are these surface observations? [Frank Dentener, Italy]	taken into account. The text was revised to clarify that this is both from ground-based and space-borne platforms

16724	34	5	34	5	Insert 'the' after 'that' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	accepted
55854	34	5	34	6	Also NHx deposition has incresed by a factor of about 3 driven by anthropogenic emissions (ref: 100. Kanakidou M., S. Myriokefalitakis, N. Daskalakis, G. Fanourgakis, A. Nenes, A. Baker, K. Tsigaridis, N. Mihalopoulos, Past, Present and Future Atmospheric Nitrogen Deposition, Journal of the Atmospheric Sciences (JAS-D-15-0278) Vol 73, 2039-2047, 2016) [MARIA KANAKIDOU, Greece]	rejected. This sections is devoted to changes in the atmospheric concentrations of NH4, NH3, aerosol NO3. N deposition is an important proxy for such changes and we already refer to studies that focus on observed trends in ice cores and US-NADP network. Therefore we have not added this reference.
24832	34	6	34	6	How robust is this single model (Hauglustaine) study? Surely there have been other models including ammonium? [William Collins, United Kingdom (of Great Britain and Northern Ireland)]	taken into account. For historical trends, we have added Xu and Penner (2012). For present-day, we have added a reference to a recent AEROCOM multimodel evaluation (Bian 2017)
31052	34	6	34	6	Having a single reference probably means that the statement should be more cautious. [Nicolas Bellouin, United Kingdom (of Great Britain and Northern Ireland)]	taken into account. We have revised this statement to emphasize the uncertainty in the magnitude of changes (but not the sign)
24834	34	12	34	12	What does it mean to say "The overall distribution of ammonia column is well understood."? Modelling ammonia is very tricky - see eg. Papers by Mark Sutton. [William Collins, United Kingdom (of Great Britain and Northern Ireland)]	Taken into account. This statement has been removed. We have clarified that the simulation of NH4NO3 remains challenging in part because of biases in the simulation of its precursor.
16726	34	12	34	12	Insert 'the' after 'of' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	accepted
16728	34	17	34	17	Change 'favored' to 'favoured' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	accepted
40684	34	26	34	42	This section confuses nitrate aerosol with ammonium nitrate aerosol. In much of the world the majority of nitrate aerosol is formed from HNO3 reacting on dust. In other places (e.g. Los Angeles) the majority of nitrate aerosol is from HNO3 reacting with sea salt. [Daniel Murphy, United States of America]	taken into account. We have clarified that our focus is on ammonium nitrate and that its formation accounts for 10-20% of the overall production of NO3 (Bian et al., 2017).
16730	34	28	34	28	Capital V for 'valley' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	accepted
24836	34	29	34	33	This section on interactions between NO, SO2 and NH3 needs to be expanded considerably. For attribution purposes or future mitigation it is essential to understand the relative contributions to the different precursors to past and future sulphate/nitrate burdens. [William Collins, United Kingdom (of Great Britain and Northern Ireland)]	taken into account. This section is devoted to historical trends. Future scenarios are tackled in 6.6.1.1. We have expanded the discussion of the importance of aerosol pH in determining the partitioning of NH3
24838	34	35	34	35	How does this factor of 5 increase in ammonium nitrate relate to the factor of 2 increase in ammonium? What causes the amplification? How robust is this single model study? [William Collins, United Kingdom (of Great Britain and Northern Ireland)]	taken into account. Changes in ammonium burden are dominated by the reaction of NH3 with SO4. This has been clarified. We have added another study (Xu and Penner, 2012), which report the change in the NHx budget.

14702	34	35	34	38	I guess a major issue is the use of coarse resolution models for aerosol formation, which is essentially driven by higjly heterogenous NH3 emissions [Frank Dentener, Italy]	taken into account. We have highlighted that uncertainties in the representation of NH3 emissions (including its spatial heterogeneity) contribute to uncertainty in the representation of ammonium nitrate
16732	34	37	34	37	Insert , after 'However' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	accepted
24840	34	38	34	38	Explain how biases in pH etc significantly skew the trends. [William Collins, United Kingdom (of Great Britain and Northern Ireland)]	taken into account. this section has been removed
46144	34	40	34	42	Please add some detail on what would be needed to better understand the evolution of aerosol pH over time. [Cynthia Randles, United States of America]	taken into account. We have added that comprehensive measurements of aerosol and gas-phase composition have helped better understand aerosol pH and its impact on ammonium partitioning
24842	34	41	34	41	What aspect of the nitrate evolution is there low confidence in? Presumably we know the sign? How poorly do we know the magnitude? [William Collins, United Kingdom (of Great Britain and Northern Ireland)]	taken into account. We have revised the text to emphasize that the sign of the trend is well know but the magnitude is very uncertain
31054	34	45	34	45	Section 6.2.2.8 is heavily skewed towards mass budgets, in contrast to the previous two sections, which were more about trends. That needs to be harmonised. I like the (ambitious) idea of trying to assess the mass budget of aerosol species, but that needs to be done for all species and from a wide range of studies, including multi-model studies, especially AeroCom. [Nicolas Bellouin, United Kingdom (of Great Britain and Northern Ireland)]	Taken into account - Revised the section to assess trends from models and observations
53574	34	45	36	33	I look forward to more assessment in next draft [Jan Fuglestvedt, Norway]	Taken into account - Newer results have been assessed
38254	34	45	36	33	Currently, recent findings/advancements on BrC are lacking in this section (6.2.2.8). [Hitoshi Matsui, Japan]	Taken into account - text revised
44546	34	45			This section is nice and comprehensive, but seems to delve into some aspects that are covered by the later sections (e.g. the points on BC lifetime, which comes again in section 6.3.2 (p 47), and the statement on warming by BC, which is covered/assesed in section 6.3.4.3. [Bjorn Samset, Norway]	Accepted- This section deals with emissions, abundances and lifetimes so the lines have revised in 6.3.2 . This section has removed the sentences about warming. See response to comment 38242
38238	34	45			"BC, OC, SOA" --> "BC, OA", or "BC, OC, SOA" --> "BC, POA, SOA" [Hitoshi Matsui, Japan]	Accepted - text revised
14704	34	47	34	47	As there was a whole Chapter in AR5 on these issues, I am somewhat missing the AR5 starting point. Surprisingly no mentioning of BC vs EC according to operational defintions/uncertainties etc. On page 35 l. 48 EC pops up. Likewise l. 35/40 A discussion on OA, OC. What is the assessment of IPCC what should be used. [Frank Dentener, Italy]	Accepted - Text revised, definition added and progress since AR5 reported
38240	34	48			"OC" --> "OA" [Hitoshi Matsui, Japan]	Accepted-text revised
24844	34	51	34	52	Is Bond et al. assessed here as being robust? Not all the Bond findings were accepted in AR5 Ch7. There have been papers critical of Bond since AR5. [William Collins, United Kingdom (of Great Britain and Northern Ireland)]	Accepted - text revised to point out the limitation assessing BC burden as discussed by Bond et al. This section is discussing atmospheric abundances only and not radiative forcing which is discussed further in section 6.3.

24846	34	52	35	2	This assessment of the effects of BC on temperature and precipitation needs to be expanded considerably to describe the new knowledge since AR5. What do we now know about the temperature response. What do we now know about how BC affects precipitation. [William Collins, United Kingdom (of Great Britain and Northern Ireland)]	Rejected - This section deals only with emissions, abundances and lifetimes. See comment 38242. Further, please see section 6.3.4.3 additional information about effects on temperature and precipitation
38242	34	52	35	2	These two sentences should be described in 6.3. Impact on temperature and precipitation should not be described in this section (6.2). [Hitoshi Matsui, Japan]	Accepted-text revised
46146	35	1	35	2	BC is a weaker warming compared to what? AR5 estimates, I assume, but unclear. [Cynthia Randles, United States of America]	Not Applicable -text is now removed - see comment 38242
53568	35	2	35	2	Insert "surface" before "warming" [Jan Fuglestvedt, Norway]	Not applicable - please see comment 38242
31056	35	2	35	2	weaker warming than expected from its instantaneous radiative forcing [Nicolas Bellouin, United Kingdom (of Great Britain and Northern Ireland)]	Not applicable -text is now removed - see comment 38242
24848	35	5	35	5	There must be more studies/models of the BC burden available than the single model in Huang et al. 2013. AR6 needs to make a thorough assessment of the BC (and other aerosol) burdens. [William Collins, United Kingdom (of Great Britain and Northern Ireland)]	Accepted - text revised with additional citations.
16734	35	6	35	6	Insert 'the' after 'both' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted -text revised
16736	35	7	35	7	Change to '..from historical times to the modern day..' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted -text revised
16738	35	7	35	7	Insert , after 'doubled' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted -text revised
16740	35	9	35	9	Insert full stop after 'observation' and insert 'A' before 'few' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted -text revised
40592	35	9	35	10	Period of study [Chaitri Roy, India]	Accepted - Text revised
16742	35	11	35	11	Change 'network' to 'networks' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted -text revised
16744	35	12	35	12	Change 'does' to 'do' and hyphen after 'satellite' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted -text revised
40686	35	12	35	14	The Li et al. paper about a satellite surrogate for BC is too speculative for this assessment. Also lines 18 to 20. [Daniel Murphy, United States of America]	Taken into account - Lines 12 to 14 is revised for advances in techniques and knowledge. Lines 18-20 removed.
16746	35	13	35	13	Insert 'the' after 'over' and capitalise pacific [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted -text revised
16748	35	15	35	15	Insert 'a' after 'to' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted -text revised
38244	35	15	35	17	The performance of current aerosol models can be added here. Most models overestimate BC mass in the upper troposphere, while they underestimate BC near surface (especially remote regions). There remain large uncertainties (or large spread between models) in BC simulations especially at high-latitudes. [Hitoshi Matsui, Japan]	Taken into account - observations and model performance in the vertical is assessed.
16750	35	16	35	16	Change 'on' to 'of' and insert 'the' after 'of' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted -text revised

11678	35	17	35	17	Add reference to Allen et al. (2019) Allen, R. J., Amiri-Farahani, A., Lamarque, J.-L., Smith, C., Shindell, D., Hassan, T., Chung, C. E.: Observationally constrained aerosol-cloud semi-direct effects. Npj Climate and Atmospheric Science 2, 2019. https://doi.org/10.1038/s41612-019-0073-9 [David Neubauer, Switzerland]	Taken into account- Allen et al cited in section 6.3
38248	35	22	35	38	Recent understandings on absorption enhancement and mass absorption cross section should be added to this paragraph. [Hitoshi Matsui, Japan]	Rejected - This section deals only with emissions, abundances and lifetimes. Please see section 6.3 on absorption enhancements and mass absorption cross section discussion
40688	35	22	35	38	This paragraph is more literature review than assessment. Much could be deleted. I would note that this section 6.2.2.8 about BC and OA has about 1/3 of the text devoted to BC and 2/3 to OA. Yet BC is far more important to anthropogenic climate forcing. [Daniel Murphy, United States of America]	Taken into account - Text cleaned up in SOD. However, please note the Organic Aerosols are important from Air quality perspective given their large mass fraction in PM
24850	35	22	35	39	This paragraph contains a lot of statements and values. It would be good to structure it to make it clearer what the AR6 assessment of our scientific understanding is. Maybe the values could go in a table. [William Collins, United Kingdom (of Great Britain and Northern Ireland)]	Taken into account - text cleaned up.
38246	35	23	35	24	Please add Stevens and Dastoor (2019, Atmosphere, https://doi.org/10.3390/atmos10040168) and Matsui et al. (2018, ncomms, https://doi.org/10.1038/s41467-018-05635-1) as references here. [Hitoshi Matsui, Japan]	Rejected - adequate citations have been provided for the statement.
16752	35	25	35	25	Edit to '..aerosol ageing, although they show similar global lifetimes (several days) as constant ageing schemes' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted - text revised
16754	35	27	35	27	Insert 'the' after 'for' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted -text revised
16756	35	32	35	32	Reference required [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Not applicable - text revised and sentence no longer present.
16758	35	33	35	33	Insert , after 'scale' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted -text revised
53570	35	34	35	34	typo: preiod --> period [Jan Fuglestvedt, Norway]	Accepted -text revised
16760	35	34	35	34	Change to 'estimates of' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted -text revised
16762	35	35	35	35	Change 'rate' to 'rates' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted -text revised
16764	35	36	35	36	Insert , after 'higher' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted -text revised
43386	35	40	35	42	Up until this point (e.g. p. 10, 11), the terms OC and OA (POA, SOA) appeared to be used interchangeably, but not here later in the text. OC is often used to mean OA; I think this section on p. 35 intends to say organic mass (OM) versus OC, but the earlier instances could also be clarified to use only one or the other. [Kristina Pistone, United States of America]	Taken into account - definitions added in this section, prior section revised significantly
24852	35	40	35	46	This paragraph needs a couple of lines to introduce why OA and OC are different. [William Collins, United Kingdom (of Great Britain and Northern Ireland)]	Taken into account- definitions added for OA and OC

43388	35	48	35	49	Similarly, it's not clear whether BC and EC are being used interchangeably in this text. I'd recommend either defining them, or pick one or the other. [Kristina Pistone, United States of America]	Taken into account - definition for EC and BC added
55802	35	49	35	49	EC should be BC? Just checking. I have seen EC mentioned in other places too. It may have been formally defined and I have missed it, in which case ignore. [Christopher Smith, United Kingdom (of Great Britain and Northern Ireland)]	Accepted -text revised
16766	35	52	35	52	Change 'environment' to 'enviroments' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted -text revised
16768	35	53	35	53	Examples of data gap regions? [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Not applicable - text cleaned up and revised significantly and the exact line is deleted
40594	35	53	35	55	Period of study [Chaitri Roy, India]	Accepted - text revised. Period explicitly defined
24854	35	53	36	1	Are PAH important? If so, does it matter than observations and models dissagree? [William Collins, United Kingdom (of Great Britain and Northern Ireland)]	Accepted - text revised to put PAHs (a subset of OA) observation data in context with Organic Aerosols simulated by models. However, separate PAH assessment will not be carried out.
55856	36	3	36	3	In agreement with Naik et al (2013) the GISS-E2-R CMIP5 simulations show a OA global burden of 1.6 Tg in 2010 and 0.6 Tg in 1850 (Tsigaridis and Kanakidou, 2018, Present and Future of Secondary Organic Aerosol Direct Forcing on Climate, Current Climate Change Reports ,https://doi.org/10.1007/s40641-018-0092-3). [MARIA KANAKIDOU, Greece]	Noted - Multimodel estimates from Tsigaridis already reported.
16770	36	3	36	3	Change to Pre-Industrial [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted -text revised
16772	36	3	36	3	Edit reference to (Nail et al., 2013) [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted -text revised
16774	36	4	36	5	Don't split units across a line. [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted -text revised
38250	36	6			“higher” --> “lower” [Hitoshi Matsui, Japan]	Accepted -text revised
16776	36	8	36	9	Don't split units across a line. [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted -text revised
40690	36	11	35	25	This paragraph is also more literature review than assessment. Much could be deleted. This paragraph also strays into a general discussion of SOA without distinguishing what is natural and what is anthropogenic, surely a necessary distinction for this report. [Daniel Murphy, United States of America]	Accepted - Text revised and deleted.
52004	36	11	36	13	Is there one or more references that can support this assertion? Otherwise it should likely be deleted as it risks being seen as an unsupported assertion on the part of the authors. [Peter Thorne, Ireland]	Taken into account - the sentence removed

43132	36	11	36	13	It is worth noting that observation by Volkamer et al. (2006) during MCMA-2003 field study in the Mexico City Metropolitan Area showed that SOA production was faster and higher than explained by traditional atmospheric models or laboratory chamber simulation experiments. This was supported by subsequent field measurement campaign, MILAGRO in Mexico City, and updated SOA modeling studies, indicating that SOA formation from primary semivolatile and intermediate volatility precursors has the potential to close the gap in predicted vs. measured SOA (Molina et al., 2010 and references therein). Since then, there has been additional information from observation and modeling studies; nevertheless, the formation and evolution of SOA, which accounts for a large fraction of the OA burden, remains one of the least understood aspects in atmospheric science. (references provided in the next row). [Luisa Molina, United States of America]	noted
43134	36	11	36	13	Volkamer, R., Jimenez, J. L., San Martini, F., Dzepina, K., Zhang, Q., Salcedo, D., Molina, L. T., Worsnop, D. R., and Molina, M. J.: Secondary Organic Aerosol Formation from Anthropogenic Air Pollution: Rapid and Higher than Expected. Geophys. Res. Lett., 33, L17811, doi: 10.1029/2006GL026899 (2006). Molina, L. T., Madronich, S., Gaffney, J. S., Apel, E., de Foy, B., Fast, J., Ferrare, R., Herndon, S., Jimenez, J. L., Lamb, B., Osornio-Vargas, A. R., Russell, P., Schauer, J. J., Stevens, P. S., Volkamer, R., and Zavala, M.: An overview of the MILAGRO 2006 Campaign: Mexico City emissions and their transport and transformation, Atmos. Chem. Phys., 10, 8697-8760, https://doi.org/10.5194/acp-10-8697-2010 (2010). [Luisa Molina, United States of America]	taken into account- However reference before AR5 and also see comment 40690
38252	36	11	36	25	Please add Shrivastava et al. (2017, RG, https://doi.org/10.1002/2016RG000540) to this paragraph as a reference. [Hitoshi Matsui, Japan]	taken into account - SOA section revised please also see comment 40690
44212	36	11	36	25	Indeed, there should be a paragraph to summarize the recent progress on our understanding of SOA formation. First of all, it is now well established that isoprene oxidation products make a significant contribution to biogenic SOA through reactive uptake of Isoprene Expoxydiols (IEPOX) (high confidence). Given the dominant role of isoprene in global VOC emissions, isoprene may serve as an important precursor to SOA on a global scale. Second, both field measurements and recent laboratory studies have indicated that SOA formation from terpene oxidation can be as important as isoprene SOA in forested regions (medium confidence). Future SOA burden would largely depend on biogenic VOC emissions, oxidant level and related aerosol chemistry. [Jingqiu Mao, United States of America]	taken into account -VOC emissions are discussed in 6.2.1.2. Please also see comment 40690.
16778	36	14	36	14	Insert) after HOM and delete , and insertspace [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted -text revised
16780	36	18	36	18	Don't italicise et al. [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted -text revised
16782	36	21	36	21	Change al to al' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted -text revised
16784	36	22	36	22	move 'also' to before 'implying' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted -text revised
16786	36	23	36	23	Delete , after al. [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted -text revised
16788	36	24	36	25	Exponentials required for rates [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted - text revised

14706	36	30	36	33	The surface warming conclusion is poorly supported in the text. I agree that global carbonaceous budget is poorly quantified, but it less clear what this means for the uncertainty in radiative forcing. It is not only limited observations, but also diverse observational methodologies, that mostly pertain to surface observations. [Frank Dentener, Italy]	Accepted -text removed see comment 38242
38256	36	31	36	33	This sentence should be moved to section 6.3. [Hitoshi Matsui, Japan]	Accepted - text removed see comment 38242
40558	36	36	36	36	Section 6.2.2.9 (Short-lived halogenated species) should mention the identification of new emissions sources of CFC-11 (CCl3F) in eastern China. The change in abundances (1995-2018) should be also discussed (see e.g., Rigby et al., (2019), Nature, 569, 546-550; Montzka et al., (2018) Nature, 557, 413-417). [Rosa Flores, Turkey]	A sentence has been added to clarify that in this sub-section emphasis is given on the short-lived halogenated species classified as SLCFs, with lifetimes from days to a decadal time scale. CFC-11 is not considered as a SLCF because of its longer lifetime. Generally CFCs are not discussed in this sub-section. Their abundances are discussed in 2.2.4.3.1 of Chapter 2.
29044	36	36	36	36	It would help the reader if it was clear where the CFCs and non-short-lived HFCs etc are discussed in the report [Keith Shine, United Kingdom (of Great Britain and Northern Ireland)]	Accepted. A sentence has been added to clarify this issue.
14708	36	36	37	29	There is some overlap section 2.2.4.3 Synthetic Greenhouse Gases (CFCs, HCFCs, HFCs, PFCs, SF6 and others)- which was provided by CA Bradley Hall. Willing to discuss streamlining of the 2 sections. [Frank Dentener, Italy]	The text has been revised making the proper references to chapter 2 when discussing abundances and to chapter 7 when discussing the radiative forcing of the short-lived halogenated species.
24856	36	36			Are all HCFCs/HFCs considered here, or only those with a short lifetime? How is "short" defined? [William Collins, United Kingdom (of Great Britain and Northern Ireland)]	A sentence has been added to clarify this issue. Emphasis is given on the short-lived halogenated species classified as SLCFs, with lifetimes from days to a decadal time scale.
24858	36	39	36	52	This section could do with a short explaination of HCFCs (as is done for HFCs). Should cite Chapter 2 for the abundances here, rather than original sources, to ensure consistency. [William Collins, United Kingdom (of Great Britain and Northern Ireland)]	Accepted and revised accordingly.
16790	36	41	36	41	Text missing [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Noted. There is no text missing.
29046	36	43	36	43	"higher" by how much? [Keith Shine, United Kingdom (of Great Britain and Northern Ireland)]	Accepted. The respective value for 2011 reported in AR5 is 213 pptv.
41028	36	47	36	47	“—“? [Johannes Laube, Germany]	Accepted.
16792	36	50	36	50	Don't italicise reference [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted.
41570	36	51	36	51	make sure references to WMO (2018) are consistent [Amanda Maycock, United Kingdom (of Great Britain and Northern Ireland)]	Noted.
41030	36	51	36	52	The last sentence is incorrect: HCFC-124 has a dry air mole fraction (not concentration) of > 1 ppt (Simmonds et al., ACP, 2017). [Johannes Laube, Germany]	Accepted and revised accordingly.
24860	36	55	37	28	This seem too detailed a description of HFCs, far longer than for HCFCs and halons. The abundances should cite chapter 2, the radiative forcings should cite chapter 7. [William Collins, United Kingdom (of Great Britain and Northern Ireland)]	Accepted and revised accordingly.

12864	36	55	37	28	Note that HFC-23 is not included in the SAP calculations, and in 2016, HFC-23 contributed 0.005 W/m2 forcing, approximately 17% of the total forcing from HFCs. World Meteorological Organization (WMO) (2018) EXECUTIVE SUMMARY: SCIENTIFI¬C ASSESSMENT OF OZONE DEPLETION: 2018, Global Ozone Research and Monitoring Project-Report No. 58, ES.39 ("The 2016 Kigali Amendment to the Montreal Protocol, assuming global compliance, is expected to reduce future radiative forcing due to HFCs by about 50% in 2050 compared to the forcing from HFCs in the baseline scenario. Currently (in 2016), HFCs account for a forcing of 0.025 W m−2 not including 0.005 from HFC-23; forcing from these HFCs was projected to increase up to 0.25 W m−2 by 2050 (excluding a contribution from HFC-23) with projected increased use and emissions in the absence of controls. With the adoption of the Kigali Amendment, a phasedown schedule has been agreed for HFC production and consumption in developed and developing countries under the Montreal Protocol. With global adherence to this Amendment in combination with national and regional regulations that were already in place in, e.g., Europe, the USA, and Japan, along with additional recent controls in other countries, future radiative forcing from HFCs is projected to reach 0.13 W m−2 by 2050 (excluding HFC-23), or about half the forcing projected in the absence of these controls."). [Durwood Zaelke, United States of America]	HFC-23 has a long lifetime and has been excluded from the discussion of SLCFs. This is mentioned in the sub-section about HFCs. The effect of Kigali Amendment on projected radiative forcing by HFCs is discussed in the revised version.
12866	36	55	37	28	The Montreal Protocol's Quadrennial Assessment calculates that energy efficiency improvements of cooling equipment alongside the transition to low-GWP alternative refrigerants for refrigeration and air-conditioner equipment could double the climate benefits from the HFC phasedown under the Kigali Amendment. As an example, the Assessment notes that improving energy efficiency of mini-split air conditioners by 30% is technical and economically feasible and would provide significant climate benefits. Efficiency gains will reduce the energy needed to power cooling equipment, which today remains largely powered by fossil fuels. World Meteorological Organization (WMO) (2018) EXECUTIVE SUMMARY: SCIENTIFI¬C ASSESSMENT OF OZONE DEPLETION: 2018, Global Ozone Research and Monitoring Project-Report No. 58, ES.31 ("Improvements in energy efficiency in refrigeration and air-conditioner equipment during the transition to low-GWP alternative refrigerants can potentially double the climate benefits of the HFC phasedown of the Kigali Amendment."); WMO (2019) SCIENTIFIC ASSESSMENT OF OZONE DEPLETION: 2018, Global Ozone Research and Monitoring Project-Report No. 58, 2.3 ("Improvements in energy efficiency in refrigeration and air-conditioning equipment during the transition to low-GWP alternative refrigerants can potentially double the climate benefits of the HFC phasedown of the Kigali Amendment. The conversion from equipment using HFC refrigerants with high GWPs to refrigerants with lower GWPs, which will most likely result from the Kigali Amendment, provides an opportunity to consider other technological improvements that offer additional climate benefits. The total climate impact related to refrigerant use and associated emissions is not only associated with the radiative properties and lifetime of the refrigerant, but also with CO2 emissions resulting from the energy used by the equipment over its entire life cycle. The use of a refrigerant with a lower GWP than the currently-used HFCs (i.e., following the Kigali Amendment) offers the opportunity to redesign equipment and improve its energy efficiency. For example, a 30% improvement in the energy efficiency of the global stock of mini-split air conditioners (the most widely used air conditioning systems	Accepted. The text has been revised and a sentence about the climate benefits by improvements in energy efficiency in refrigeration and air-conditioner equipment has been added with the relevant references.

12868	36	55	37	28	There is the potential for even greater avoided warming from HFCs by ramping up the phasedown schedule outlined in the Kigali Amendment to require a faster phasedown. Past amendments to the Montreal Protocol, however, have allowed for a revision of the initial phasedown schedule, furthering the idea that the Montreal Protocol "start-and-strengthen" treaty that is amenable to increasing the mandated reductions. Zaelke, Andersen, & Borgford-Parnell (2012) Strengthening Ambition for Climate Mitigation: The Role of the Montreal Protocol in Reducing Short-lived Climate Pollutants, RECIEL doi: 10.1111/reel.12010 ("Another important feature is the treaty's 'start and strengthen' philosophy. Throughout its 25-year history, the Montreal Protocol has started by addressing a problem, learned by doing, gained experience and confidence, and then done more. This philosophy has allowed the Protocol to build confidence in the parties and their industries that progress is possible, to facilitate the fast development and deployment of technologies that make action easier and cheaper, and to build the ambition, momentum and political courage to do more."). Also, replacing high-GWP HFCs under the Kigali Amendment provides an opportunity to increase the energy efficiency of appliances utilizing refrigerants. Improving air conditioner energy efficiency and switching to lower GWP refrigerants as required by the Kigali Amendment to the Montreal Protocol could avoid even more warming, up to 100 Gt CO2-eq cumulatively through 2050 (Shah et al., 2015; Purohit and Höglund-Isaksson, 2017). Shah et al. (2015), Benefits of Leapfrogging to Superefficiency and Low Global Warming Potential Refrigerants in Room Air Conditioning. Berkeley, CA, USA. ("While there is some uncertainty associated with emissions and growth projections, moving to efficient room air conditioning (~30% more efficient than current technology) in parallel with low-GWP refrigerants in room air conditioning could avoid up to ~25 billion tonnes of CO2 in 2030, ~33billion in 2040, and ~40 billion in 2050, i.e. cumulative savings up to 98 billion tonnes of CO2 by 2050."). [Durwood Zaelke, United States of America]	Accepted. The text has been revised and a sentence about the climate benefits by improvements in energy efficiency in refrigeration and air-conditioner equipment has been added with the relevant references.
12870	36	55	37	28	Demand for space cooling is expected to increase due to increased population, GDP, and warming conditions, more than tripling in cooling capacity by 2050 according to the IEA Future of Cooling (2018) p. 59 ("The total space-cooling output capacity of residential ACs worldwide increases in line with the number of units brought into service over the projection period, growing from around 6 200 gigawatts (GW) in 2016 to nearly 23 000 GW in 2050."). Purohit and Hoglund-Isaksson 2017 likely underestimate future demand for cooling and certainly don't allow for meeting SDGs by providing cooling for all (per SE4All definition). Only Velders et al. (2009) implicitly accounts for meeting SDG by assuming that developing country demand for HFCs achieve levels projected for the US in 2020: "The resulting HFC consumption is limited, per application, to the per capita consumption of HFCs projected for the USA in 2020, the year in which the developed country HCFC phaseout is virtually complete."). Further, neither Velders et al. (2009), Velders et al. (2015), nor does Purohit and Hoglund-Isaksson (2017) consider the effect of warming conditions on demand for cooling and refrigeration services. [Durwood Zaelke, United States of America]	A sentence has been added to show that the increase of HFCs in future could be higher if considering the effect of warming conditions on demand for cooling and refrigeration services .

42344	36	55	37	28	Demand for space cooling is expected to increase due to increased population, GDP, and warming conditions, more than tripling in cooling capacity by 2050 according to the IEA Future of Cooling (2018) p. 59 ("The total space-cooling output capacity of residential ACs worldwide increases in line with the number of units brought into service over the projection period, growing from around 6 200 gigawatts (GW) in 2016 to nearly 23 000 GW in 2050."). Purohit and Hoglund-Isaksson 2017 likely underestimate future demand for cooling and certainly don't allow for meeting SDGs by providing cooling for all (per SE4All definition). Only Velders et al. (2009) implicitly accounts for meeting SDG by assuming that developing country demand for HFCs achieve levels projected for the US in 2020: "The resulting HFC consumption is limited, per application, to the per capita consumption of HFCs projected for the USA in 2020, the year in which the developed country HCFC phaseout is virtually complete."). Further, neither Velders et al. (2009), Velders et al. (2015), nor does Purohit and Hoglund-Isaksson (2017) consider the effect of warming conditions on demand for cooling and refrigeration services. [Gabrielle Dreyfus, United States of America]	A sentence has been added to show that the increase of HFCs in future could be higher if considering the effect of warming conditions on demand for cooling and refrigeration services .
12696	36	55	37	28	Note that HFC-23 is not included in the SAP calculations, and in 2016, HFC-23 contributed 0.005 W/m2 forcing, approximately 17% of the total forcing from HFCs. World Meteorological Organization (WMO) (2018) EXECUTIVE SUMMARY: SCIENTIFI¬C ASSESSMENT OF OZONE DEPLETION: 2018, Global Ozone Research and Monitoring Project-Report No. 58, ES.39 ("The 2016 Kigali Amendment to the Montreal Protocol, assuming global compliance, is expected to reduce future radiative forcing due to HFCs by about 50% in 2050 compared to the forcing from HFCs in the baseline scenario. Currently (in 2016), HFCs account for a forcing of 0.025 W m−2 not including 0.005 from HFC-23; forcing from these HFCs was projected to increase up to 0.25 W m−2 by 2050 (excluding a contribution from HFC-23) with projected increased use and emissions in the absence of controls. With the adoption of the Kigali Amendment, a phasedown schedule has been agreed for HFC production and consumption in developed and developing countries under the Montreal Protocol. With global adherence to this Amendment in combination with national and regional regulations that were already in place in, e.g., Europe, the USA, and Japan, along with additional recent controls in other countries, future radiative forcing from HFCs is projected to reach 0.13 W m−2 by 2050 (excluding HFC-23), or about half the forcing projected in the absence of these controls."). [Kristin Campbell, United States of America]	HFC-23 has a long lifetime and has been excluded from the discussion of SLCFs. This is mentioned in the sub-section about HFCs. The effect of Kigali Amendment on projected radiative forcing by HFCs is discussed in the revised version.

12698	36	55	37	28	The Quadrennial Assessment calculates that energy efficiency improvements of cooling equipment alongside the transition to low-GWP alternative refrigerants for refrigeration and air-conditioner equipment could double the climate benefits from the HFC phasedown under the Kigali Amendment. As an example, the Assessment notes that improving energy efficiency of mini-split air conditioners by 30% is technical and economically feasible and would provide significant climate benefits. Efficiency gains will reduce the energy needed to power cooling equipment, which today remains largely powered by fossil fuels. World Meteorological Organization (WMO) (2018) EXECUTIVE SUMMARY: SCIENTIFI¬C ASSESSMENT OF OZONE DEPLETION: 2018, Global Ozone Research and Monitoring Project-Report No. 58, ES.31 (“Improvements in energy efficiency in refrigeration and air-conditioner equipment during the transition to low-GWP alternative refrigerants can potentially double the climate benefits of the HFC phasedown of the Kigali Amendment.”); WMO (2019) SCIENTIFIC ASSESSMENT OF OZONE DEPLETION: 2018, Global Ozone Research and Monitoring Project-Report No. 58, 2.3 (“Improvements in energy efficiency in refrigeration and air-conditioning equipment during the transition to low-GWP alternative refrigerants can potentially double the climate benefits of the HFC phasedown of the Kigali Amendment. The conversion from equipment using HFC refrigerants with high GWPs to refrigerants with lower GWPs, which will most likely result from the Kigali Amendment, provides an opportunity to consider other technological improvements that offer additional climate benefits. The total climate impact related to refrigerant use and associated emissions is not only associated with the radiative properties and lifetime of the refrigerant, but also with CO2 emissions resulting from the energy used by the equipment over its entire life cycle. The use of a refrigerant with a lower GWP than the currently-used HFCs (i.e., following the Kigali Amendment) offers the opportunity to redesign equipment and improve its energy efficiency. For example, a 30% improvement in the energy efficiency of the global stock of mini-split air conditioners (the most widely used air conditioning systems today) in 2030 would	Accepted. The text has been revised and a sentence about the climate benefits by improvements in energy efficiency in refrigeration and air-conditioner equipment has been added with the relevant references.

12700	36	55	37	28	There is the potential for even greater avoided warming from HFCs by ramping up the phasedown schedule outlined in the Kigali Amendment to require a faster phasedown. Past amendments to the Montreal Protocol, however, have allowed for a revision of the initial phasedown schedule, furthering the idea that the Montreal Protocol "start-and-strengthen" treaty that is amenable to increasing the mandated reductions. Zaelke, Andersen, & Borgford-Parnell (2012) Strengthening Ambition for Climate Mitigation: The Role of the Montreal Protocol in Reducing Short-lived Climate Pollutants, RECIEL doi: 10.1111/reel.12010 ("Another important feature is the treaty's 'start and strengthen' philosophy. Throughout its 25-year history, the Montreal Protocol has started by addressing a problem, learned by doing, gained experience and confidence, and then done more. This philosophy has allowed the Protocol to build confidence in the parties and their industries that progress is possible, to facilitate the fast development and deployment of technologies that make action easier and cheaper, and to build the ambition, momentum and political courage to do more."). Also, replacing high-GWP HFCs under the Kigali Amendment provides an opportunity to increase the energy efficiency of appliances utilizing refrigerants. Improving air conditioner energy efficiency and switching to lower GWP refrigerants as required by the Kigali Amendment to the Montreal Protocol could avoid even more warming, up to 100 Gt CO2-eq cumulatively through 2050 (Shah et al., 2015; Purohit and Höglund-Isaksson, 2017). Shah et al. (2015), Benefits of Leapfrogging to Superefficiency and Low Global Warming Potential Refrigerants in Room Air Conditioning. Berkeley, CA, USA. ("While there is some uncertainty associated with emissions and growth projections, moving to efficient room air conditioning (~30% more efficient than current technology) in parallel with low-GWP refrigerants in room air conditioning could avoid up to ~25 billion tonnes of CO2 in 2030, ~33billion in 2040, and ~40 billion in 2050, i.e. cumulative savings up to 98 billion tonnes of CO2 by 2050."). [Kristin Campbell, United States of America]	Accepted. The text has been revised and a sentence about the climate benefits by improvements in energy efficiency in refrigeration and air-conditioner equipment has been added with the relevant references.
29048	37	4	37	4	"accounting totally" needs a reference [Keith Shine, United Kingdom (of Great Britain and Northern Ireland)]	Accepted. A reference to Table 7.2 of Chapter was added.
16794	37	4	37	4	Insert 'for' after 'totally and give rate as exponential [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted and corrected accordingly.
16796	37	5	37	5	Subscript for numbers in chemical formulae [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted and corrected accordingly.
29050	37	9	37	9	HFC-23 has a 200+ year lifetime so a discussion doesnt really belong here. This exposes a difficulty in the assessment's structure. It would seem to make sense, from a coherence point of view to discuss all halogenated substances in one place, or at least to include cross-references. [Keith Shine, United Kingdom (of Great Britain and Northern Ireland)]	Accepted. HFC-23 has a long lifetime and has been excluded from the discussion of SLCFs. This is mentioned in the sub-section about HFCs.
41032	37	9	37	10	The numbers in the formulas should be subscript and the formula given for HFC-143a is ambiguous as its isomer has the same sum formula (better to state CH3CF3 instead). [Johannes Laube, Germany]	Accepted and corrected accordingly.
16798	37	12	37	12	Insert 'for' after 'account' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted and corrected accordingly.
41034	37	14	37	14	Do the authors mean "multiply HFC emissions" here? [Johannes Laube, Germany]	Yes, multiple HFC emissions.
52546	37	17	37	23	Velders 2015 predates the Kigali Amendment and should not be compared directly with the KA mitigation scenario in Purohit and Hoglund 2017. Purohit and Hoglund also contains a maximum feasible reduction scenario which would be more accurate to comapre with Velders 2015. [Nathan Borgford-Parnell, Switzerland]	Not applicable. The text has been revised and the sentence has been removed.

52548	37	17	37	23	If the KA is going to be referenced here, it could be worth noting that most climate scenarios assume much deeper HFC mitigation by 2050 than is currently mandated by the KA phase down schedule. [Nathan Borgford-Parnell, Switzerland]	Not applicable. The text has been revised and the commented sentence has been removed.
24862	37	18	37	18	Chapter 7, section 7.7 specifically discourages the use of CO2e for SLCFs and there is no preferred way of detemining equivalance. Suggest removing discussion of CO2e here. [William Collins, United Kingdom (of Great Britain and Northern Ireland)]	Accepted. The text has been revised and the discussion of CO2e has been removed.
53576	37	18	37	18	Re "compared to a reference scenario": Please make clear what reference scenario this is? [Jan Fuglestvedt, Norway]	Not applicable. The text has been revised and the sentence has been removed.
29052	37	18	37	18	I think it would be more accurate to refer to Velders et al's scenario as a "fictional reference scenario". This will, I know, be contentious, but the idea that were were committed to that reference scenario prior to Kigali, given the various legislations already in place before Kigali, is very hard to believe. [Keith Shine, United Kingdom (of Great Britain and Northern Ireland)]	Not applicable. The text has been revised and the sentence has been removed.
16800	37	18	37	18	Subscript 2 for numbers [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Corrected.
53578	37	20	37	20	Re "revised reference": Some more info would be good. [Jan Fuglestvedt, Norway]	Not applicable. The text has been revised and the sentence has been removed.
16802	37	21	37	22	Subscript 2 for numbers [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Corrected.
16804	37	22	37	22	Insert 'a' after 'achieving' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Corrected.

29054	37	23	37	24	I would delete this sentence. I don't believe the reduction in temperature is referenced to a credible baseline scenario. You could essentially get any number you want if you choose your baseline carefully/carelessly enough [Keith Shine, United Kingdom (of Great Britain and Northern Ireland)]	Noted. However this sentence refers to one of the key statement in the executive summary of the Ozone Assessment 2018. The effects of the Amendment can be viewed relative to HFC baseline scenarios that were constructed in the past without including specific global control measures on HFC production or consumption. A baseline scenario created nearly a decade ago based on an analysis of atmospheric data and market trends through 2006 (Velders et al., 2009). This baseline scenario has been updated to include data through 2012 (Velders et al., 2015). The HFC emissions in Velders et al. (2015) are similar to those in UNEP (2014); they are slightly higher than projected in other sector-specific scenarios (Gschrey et al., 2011; Purohit and Hoglund-Isaksson, 2017; Hoglund-Isaksson et al., 2017); and they are significantly higher than in the Representative Concentration Pathways (RCPs) scenarios (Meinshausen et al., 2011). The scenarios used for calculating the climate impact of HFCs without the measures are based on Xu et al. (2013) and Velders et al. (2015) which differ in their assumptions for the projections of the demand for HFCs past 2050. The surface
53580	37	24	37	24	What baseline? [Jan Fuglestvedt, Norway]	The baseline scenario projects increased use and emissions of HFCs in the absence of controls (see sub-section 2.5.1.1 of WMO, 2018). This is added in the text.
16806	37	24	37	24	Subscripts for degree symbols [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Corrected.
50798	37	24	37	28	It would be useful to also mention that HFO are a source of trifluoroacetic acid (TFA) when decomposed. See https://www.miljodirektoratet.no/globalassets/publikasjoner/M917/M917.pdf for relevant references. [Ole-Kristian Kvissel, Norway]	Thanks for the comment but a discussion of the degradation products of HFOs is beyond the scope of this section which gives emphasis on the climate relevance of the species and also taking into account the limitations in the text length of the sub-section.
16808	37	25	37	25	Insert , after) [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Corrected.
24864	37	31	37	41	Aboundances should be taken from chapter 2. [William Collins, United Kingdom (of Great Britain and Northern Ireland)]	The abundance of halon-1211 was reported according to Table 2.2 of Chapter 2. For methyl bromide and halon-1202 there is no reference in chapter 2 and hence the Ozone Assessment of 2018 has been used for reference.

16810	37	32	37	32	Subscript 3 for number in chemcial formula [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Corrected.
16812	37	34	37	34	Delete 'the recent period' and space required after full stop [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted and corrected accordingly.
16814	37	34	37	35	Subscript for 2 in chemical formulae [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Corrected.
41036	37	38	37	38	This is the wrong reference as these numbers come from the WMO SOAD 2018. Also, why is the second most important halon (1301) not even mentioned? [Johannes Laube, Germany]	Accepted and revised accordingly. The halon-1301 is not classified in SLCFs due to the longer lifetime and hence it is not discussed in this chapter.
41038	37	45	37	46	I suggest adding a justification for including them, e.g. because of their radiative impact through ozone depletion in the lower stratosphere as demonstrated by Hossaini et al., 2015. [Johannes Laube, Germany]	Accepted. A sentence has been added in the text indicating their radiative impact through ozone depletion.
16816	38	5	37	6	Capitalsie northern hemisphere and southern hemisphere [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted and corrected accordingly.
41040	38	8	38	8	Leedham Elvidge et al., 2015 is about dichloromethane from aircraft observations so this is the wrong reference again. I suggest checking the references in the entire section 6.2.2.9. [Johannes Laube, Germany]	The reference used here is actually "Leedam Elvidge, E.C., S.M. Phang, W.T. Sturges, and G. Malin, The effect of desiccation on the emission of volatile bromocarbons from two common temperate macroalgae, Biogeosci., 12(2), 387–398, doi:10.5194/bg-12-387-2015, 2015b." It has been added to Mendeley library of the Chapter.
16818	38	8	38	8	Insert 'is' after 'There' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted and corrected accordingly.
47292	38	11	38	11	Suggest to rephrase the sentence, for example, as "The impact of bromine, chlorine, and iodine chemistry in global troposphric models has been increasingly investigated" [Guang Zeng, New Zealand]	Accepted and corrected accordingly.
47294	38	11	38	12	Regarding "This chemistry significantly reduce the tropospheric ozone burden and lifetime", I think the impact of halogen chemistry on global ozone should be stated with caution. These are very short-lived species and their source distributions are very uncertain. The impact on ozone are more likely limited to the source regions. Should comment on the confidence level. [Guang Zeng, New Zealand]	Accepted and revised accordingly.
16820	38	12	38	12	Change 'reduce' to 'reduces' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Corrected.
16822	38	13	38	13	Change , to full stop [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Corrected.
14710	38	16	38	18	Statement could include the climate impact of the aggregrated ODS (RF). [Frank Dentener, Italy]	Accepted. A statement has been added in accordance with Chapter 7.
55672	38	23	38	25	"oxidizing" --> "oxidising" [Larry Horowitz, United States of America]	Accepted. Text revised
14714	38	23	40	11	It is a nice overview, although some of it reads textbook and not assessment=>some potential to reduce. Also there is some duplication with the box in Chapter 5. [Frank Dentener, Italy]	Taken into account. Text has been revised considerably.

24866	38	25	38	31	This should also mention that oxidizing capacity determines the conversion of SO2 to SO4, NO to NO3 and VOCs to SOA. [William Collins, United Kingdom (of Great Britain and Northern Ireland)]	Taken into account. Text is revised to explicitly indicate that OH also contributes to the formation of aerosols from oxidation of SO2 to sulphate and VOCs to secondary organic aerosols. Formation of nitrate aerosols (both organic and inorganic) is more complex than just the oxidation of NO2 with OH.
14712	38	25	38	31	OH formation is also intimately connected to another SLCF: tropospheric ozone. [Frank Dentener, Italy]	Accepted. Text added - OH initiated loss of methane, CO and NMVOCs in the presence of NOx leads to the production of tropospheric ozone.
16824	38	29	38	29	Insert 'the' after 'how' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted. Text revised
16826	38	33	38	33	Change 'vapor' to 'vapour' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted. Text revised
39064	38	33	38	48	Nice discussion, but we know the global chemistry-transport models overestimate OH in the NH relatitve to the the SH, which produced NH/SH ratio of about 1.2. The CH3CCl3 based calculation produces NH/SH OH ratio to be 1, provided the inter-hemispheric exchange rate is realistic for model transport (Patra et al., Nature, 2014). Also most models simulate global mean OH concentration to be greater than that is determined from CH3CCl3 decay rate or CH4 lifeteime (Naik et al., ACP, 2013). Given these observations, the OH production in the NOx dominated region has to be lower than what is simulated by the global models now (to get a consisten NH/SH OH ratio). Although one would argue that we should increase OH production in the high VOCs and low NOx regions for getting the NH/SH OH ratio right, that would further increase OH concentration which is not desirable. [Prabir Patra, Japan]	Noted. There is no literature on the impact of accounting for OH production in low NOx high BVOC regions in global models on NH/SH OH.
11680	38	33	38	48	The atmospheric oxidation capacity is also relevant for the formation of secondary aerosol and therefore ERFari and ERFaci (Karset et al., 2018). Karset, I. H. H., Berntsen, T. K., Storelvmo, T., Alterskjær, K., Grini, A., Olivié, D., Kirkevåg, A., Seland, Ø., Iversen, T., and Schulz, M.: Strong impacts on aerosol indirect effects from historical oxidant changes, Atmos. Chem. Phys., 18, 7669-7690, https://doi.org/10.5194/acp-18-7669-2018, 2018. [David Neubauer, Switzerland]	Taken into account. While not relevant to this paragraph, the relevance of OH for climate via its role in aerosol formation is clarified in the first paragraph of this section
16828	38	35	38	35	Delete , after CO [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted. Text revised
16830	38	36	38	36	Change to 'Secondary' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted. Text revised
16832	38	38	38	38	Delete , after 'air' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted. Text revised
24872	38	50	38	52	The effects of anthropogenic drivers on OH through NOX, CH4 and VOC emissions needs to be expanded. There are at least modelling results available for this. Which drivers are most important? What is the sign of their impact on OH? [William Collins, United Kingdom (of Great Britain and Northern Ireland)]	Taken into account. Text has been revised to indicate the sign of OH change in response to the individual drivers and their importance

55858	38	50	39	39	There is need to clarify to what you refer as 'mean' global OH. Is this based on the CH4 loss rate or the methylcholoform loss rate? Or you refer to a simple mean concentration in the troposphere? Changes in OH are not spatially (and seasonally/temporally) uniform, and the overall significance of these changes for GHG and SLCF lifetimes will depend on the spatiotemporal pattern of the OH changes. Some dicussion on this is needed. [MARIA KANAKIDOU, Greece]	Taken into account. We have clarified it is airmass weighted global average OH we refer to here. A detailed discussion of the significance of different methods of averaging would be out of scope
16834	38	52	38	52	Delete , after 'temperature' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted. Text revised
40596	38		38		The trends can be better understood if presented in a tabular form with species, period of study, value, reference, etc. [Chaitri Roy, India]	Thanks for the suggestion but it would be a repetition to add a Table showing the changes of the most important halogenated species. There is already Table 2.2 in Chapter 2 showing their changes in abundances and there is also Table 7.2 in Chapter 7 showing their radiative forcing.
24868	39	9	39	23	How much of this is already in Chapter 5 or in 6.2.2.4? This should at least be consistent, or explain how it goes beyond chapter 5 or section 6.2.2.4. [William Collins, United Kingdom (of Great Britain and Northern Ireland)]	Taken into account. Section 6.2.2.4 has been modified to minimize overlap
16836	39	15	39	21	Quantifications required. [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted. Numbers added
16838	39	18	39	18	Change 'vapor' to 'vapour' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted. Text revised
16840	39	21	39	21	Delete 'time' to remove a tautology [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted. Text revised
29056	39	22	39	22	"increasing OH trend" is ambiguous. Is OH increasing and/or the trend in OH increasing [Keith Shine, United Kingdom (of Great Britain and Northern Ireland)]	Accepted. Text revised to "….OH increases over the same period…"
16842	39	22	39	22	Delete 'time' to remove a tautology [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted. Text revised
47296	39	27	39	29	Suggest to change "in matching different observation constraint" to "in matching different observation (sometimes indirect) constraint.". Please note that Lopez Comi et al. (2016) use observations of variables that are essential to OH chemistry (O3, CO, CH4, H2O, temperature) to derive OH. [Guang Zeng, New Zealand]	Not relevant as text has been revised.
14716	39	36	39	39	remained constant: I suggest to rephrase this into 'absence of long-term trend' or similar. I think there is sufficient (modelling) evidence that there is interannual variability in OH- but the magnitude is disputed (as is evidenced in the 2nd sentence). [Frank Dentener, Italy]	Accepted. Thank you, text has been revised as suggested
24870	39	37	39	37	This repeats a statement in 6.2.2.4. The "remained constant" needs to have a range, otherwise it is "exceptionally unlikely" that OH has remained exactly constant. [William Collins, United Kingdom (of Great Britain and Northern Ireland)]	Accepted. Text revised
16844	39	41	39	42	Chanbge 'paleo' to 'palaeo' for cosntnecy elsewhere in the Report [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted. Text revised
16846	39	43	39	43	Change to Pre-Industrial [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Noted. All references to 'pre-industrial' follow IPCC conventions

47298	39	45	39	45	"CCMs and CTMs disagree on …" - what causes the difference between these two types of models in simulating OH trends? Please clarify. [Guang Zeng, New Zealand]	Take into account. The diversity in OH trends in ACCMIP models has been found to be related to disparate implementation of chemical and physical processes that affect NOx and VOCs (Murray et al. submitted PNAS, 2019)
14718	39	51	39	51	Is this the overall asssessment of the evidence in this paragraph? I don't see much discussion on the 'competing influences'- although there have been papers on the 'buffering' capacity of OH (but not for paleo situations). [Frank Dentener, Italy]	Taken into account. Text revised to include discussion of buffering.
16848	39	51	39	51	Change 'vapor' to 'vapour' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted. Text revised
50012	39	51	39	53	This sentence does not seem consistent with the preceding text of the paragraph. Most of the paragraph is about large OH changes over the past 20000 years or so (but the time period is not clearly stated), and it also talks about very high uncertainty in the OH response to to changes in SLCF. But then the paragraph concludes (without any references) that over even longer time periods (which are not specified) OH remained nearly constant despite changes in SLCF and climate. This is confusing and needs a lot more context and references. [Owen Cooper, United States of America]	Accepted. Text has been revised to focus the discussion on the preindustrial to present day changes in OH in response to SLCF changes derived from modelling studies.
16850	40	3	40	3	Change 'vapor' to 'vapour' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted. Text revised
16852	40	5	40	5	Insert 'an' after 'predict' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted. Text revised
16854	40	5	40	6	This is a poor expression, and also poor science (although becoming increasingly common in the media!). Temperatures cannot warm, they increase/decrease or it gets warmer/cooler. I suggest replacing ‘warmer’ with ‘increasing' (and consider quantifying) [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted. Text has been revised
16856	40	6	40	6	Change to Pre-Industrial [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted. Text revised
8208	40	10	40	10	In support of Clark et al., 2017, I have two papers which show the uncertainty in climate change impact on lightning NOx (already referenced in the chapter, Finney2016b and Finney2018). In addition, the latter reference shows the impacts on methane lifetime and therefore indirectly demonstrates the impact on OH. Using two lightning schemes (one with a positive response, and one with a negative response, to climate change), shows a range in reductions of methane lifetime from 2.4 to 1.8 years, respectively. [Declan Finney, United Kingdom (of Great Britain and Northern Ireland)]	Taken into account. Finney et al 2018 has been added
27840	40	14	40	14	attend the placeholders [Poot Delgado Carlos Antonio, Mexico]	Accepted. Placeholders have been replaced
55042	40	19	40	19	This section hould be harmonized with Chapter 7 [Ina Tegen, Germany]	Accepted -- Section 6.3 has been harmonized with chapter 7
31058	40	19	40	19	Throughout section 6.3 it is often unclear what line of evidence is represented by the studies quoted. It should always be clear whether a study uses observations (aircraft, in-situ, satellite remote sensing) or models (LES, cloud resolving models, large-scale models), because the strength of evidence is not the same. [Nicolas Bellouin, United Kingdom (of Great Britain and Northern Ireland)]	Accepted -- sources of the evidence have been explicitly quoted in order to clarify the strength of that evidence
14720	40	21	41	38	6.3/6.3.1 and 6.3.1.1 read as 3 introductions after each other, this could perhaps be streamlined. Not sure if we need again to discuss what are the sources of aerosol and how ozone is formed? See earlier sections. [Frank Dentener, Italy]	accepted -- text revised and introductory material streamlined. 6.3.1.1 has been rewritten in assessment form

37788	40	21			Methane is described as a WMGHG in many places in the FOD, yet here it is by implication an SLCF not a WMGHG. As noted in comment 2 of the entire report, the treatment of methane needs rationalization. [Adrian Simmons, United Kingdom (of Great Britain and Northern Ireland)]	Accepted -- this chapter categories forcing agents by their chemical lifetime, and treats methane as one of the SLCFs consistent with SR15.
16858	40	22	40	22	Capital C for Chapter [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted - text revised
16860	40	26	40	26	Capital S for section [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted - text revised
16862	40	28	40	32	Capital S for section [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted - text revised
53582	40	31	40	32	This is connected to several chapters and sections, chapter 4 (4.4.4), chapter 8 and potentially chapter 10 (10.4). [Jan Fuglestvedt, Norway]	Noted -- section 6.3 has been harmonized with chapters 4 and 8
55668	40	35	40	48	Be specific about which metric(s) of RF is (are) used in this section. [Larry Horowitz, United States of America]	Accepted -- the type(s) of RF cited have been clarified throughout 6.3 and assessed in 6.3.1.2
47684	40	37	40	48	What is missing is the recognition in this section that emissions of SLCFs in particular aerosol species exhibit spatial heterogeneous behaviour and more so as we go towards urban scales. Some of the conclusions may well be challenged as we move to finer scales. [Ranjeet Sokhi, United Kingdom (of Great Britain and Northern Ireland)]	Noted -- impacts of megacities are described later in the chapter (e.g. 6.4.2.4, impacts of SLCF emissions from megacities on climate)
16864	40	39	40	39	Capital S for section [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted - text revised
16866	40	42	40	42	Capital S for section [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted - text revised
43390	40	42	40	44	This sentence seems to be missing some words. Knowledge of effects… on the productivity of vegetation and how this affects storage…" maybe? [Kristina Pistone, United States of America]	Accepted - text clarified
55670	40	43	40	43	"affects" --> "and on" [Larry Horowitz, United States of America]	Taken into account--combined with comment 55670
16868	40	44	40	44	Capital S for section [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted - text revised
11682	40	44	40	47	LAPs also impact the temperature (structure) in the atmosphere (semi-direct aerosol effect). [David Neubauer, Switzerland]	Not applicable -- text no longer included in chapter
52550	40	45	40	45	this is the first time that brown carbon is mentioned and it deserves some explantation. [Nathan Borgford-Parnell, Switzerland]	Not applicable -- text no longer included in chapter
16870	40	48	40	48	Capital S for section [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted - text revised
7758	40	51	40	51	While water vapour is not considered an anthropogenic factor or a SLCF in this chapter, this section covers “indirect forcers.” Beyond the warming provided by water vapour, its positive feedback properties alone can at least be described as indirect. In AR5, the IPCC correctly describes water vapour as the “largest contributor to the natural greenhouse effect” and “Water vapour is the most important greenhouse gas.” Thus, is not water vapour worthy of mention in at least this section? If not here, please add a new section. Skeptics have long criticized the IPCC’s failure to more fully acknowledge the role of water vapour in climate change. A scientific report as influential as this one simply must include space for water vapour, especially since the IPCC’s rules require its assessment reports to be “comprehensive, objective, open and transparent.” [Forrest Mims, United States of America]	Noted -- water vapor is dealt with in detail elsewhere in the assessment, e.g. chapter 2 on observed changes in the state of the climate system.

24874	40	51			Nearly all of section 6.3.1.1 repeats earlier text from 6.2 [William Collins, United Kingdom (of Great Britain and Northern Ireland)]	Accepted -- the redundancies in 6.3.1.1 relative to 6.2 have been removed.
38262	40	51			Currently, direct effects (aerosol-radiation interactions) of LAP (BC, BrC, dust) and inorganic aerosols are not described in this section (6.3.1.1). They should be added here or in 6.3.1.4. [Hitoshi Matsui, Japan]	Not applicable -- text no longer included in chapter
44538	40	51			Chapter 7 makes some heavy statements on the state of the aerosol indirect effect and its impacts for ERF. (From their Executive Summary: "Compared to AR5, there has been a ~100% upward revision to the magnitude of ERF due to aerosol-cloud interactions, and a ~50% downward revision of the magnitude of ERF due to aerosol-radiation interactions." However they don't, as far as I can see, fully assess the supporting litterature down to a process level. Would that fit in this section? Some of it is currently in sections 6.3.1.2, but under the header of impacts on the hydrological cycle, and then in section 6.3.3.2, where ERF numbers are discussed but not fully assessed. [Bjorn Samset, Norway]	Noted -- Chapter 6 and 7 have agreed that an assessment of the global ERFari and ERFaci would appear in their chapter
47910	40		56		Assessment Structure: If possible, assessment conclusions should be provided in a structured traceable account of how these statements were derived. For example, sections / subsections can start with previous IPCC report conclusions (AR5 or AR6 Special Reports) and then provide an update of the more recent literature, clearly laying out the lines of evidence. Each section / subsection can then conclude with assessment statements. This section currently reads more as a review than an assessment. In addition, please make sure the ES uncertainty language is clearly tracable to the underlying chapter text. [WGI TSU, France]	Taken into account -- please see response to comment 41514.
47894	40		57		There is potential overlap in ERF topics between chapter 6 (Section 6.3, Section 6.3.1.4) and Chapter 7 (Section 7.3, Section 7.3.3), for example, methods of ERF, emergent constraints, SO2, methane, aerosols. Could all outs / cross references to each seciton be included. Furthermore chapter 7 hold the main assessment of ERF, including th indepth introduction, but ch6 comes before chapter 7. Could chapter 6 refer to chapter 7 with respect to this? Could assessments on ERF in both chapters be systemised to have similar approaches? This would make it easier for the reader. [WGI TSU, France]	Taken into account -- see response to comment 28832
51818	41	4	41	12	It seems that the description on SOA RF is inadequate. The uncertainty on SOA RF is large, due to lack of mechanistic understanding on SOA formation, and the role of anthropogenic emissions on SOA formation (through SO2 and NOx). [Jingqiu Mao, United States of America]	Not applicable -- text no longer included in chapter
41576	41	4	41	38	there is quite some overlap here of the description of key processes with the sections on processes for each SLCF component earlier in the chapter [Amanda Maycock, United Kingdom (of Great Britain and Northern Ireland)]	Accepted -- overlaps have been trimmed
16872	41	6	41	6	Insert 'an' after 'making' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted - text revised
41572	41	13	41	13	Need to quote time period for stated RFs (1750-2011?) and also W m-2 has typos [Amanda Maycock, United Kingdom (of Great Britain and Northern Ireland)]	Not applicable -- text no longer included in chapter
11684	41	13	41	13	Does RF refer to the radiative forcing due to the direct and/or semi-direct and/or indirect effect? [David Neubauer, Switzerland]	Not applicable -- text no longer included in chapter
16874	41	13	41	13	Superscipt - required [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted - text revised
38264	41	15	41	21	This paragraph should be moved to section 6.2.2 because these sentences focus on processes rather than forcing/impact. [Hitoshi Matsui, Japan]	Not applicable -- text no longer included in chapter

55860	41	15	41	23	The potentially significant of combustion sources, including biomass burning, on aerosol and contained Fe over the remote ocean has been recently shown based on a compilation of global models of the atmospheric iron cycle and available observations (Myriokefalitakis, S.,et al. The GESAMP atmospheric iron deposition model intercomparison study, Biogeosciences, https://doi.org/10.5194/ bg-2018-285, 2018.Biogeoscience, 2018 and Pyrogenic iron: The missing link to high iron solubility in aerosols, Science Advances, 5: eaau7671 2019). [MARIA KANAKIDOU, Greece]	Not applicable -- text no longer included in chapter
55862	41	15	41	23	A comment on the importance of biomass burning as a source of brown carbon and the impact this has on the forcing estimates is missing here [MARIA KANAKIDOU, Greece]	Not applicable -- text no longer included in chapter
41574	41	16	41	16	typo or --> of [Amanda Maycock, United Kingdom (of Great Britain and Northern Ireland)]	Accepted - text revised
50116	41	18	41	18	"get coated with organics and sulfate vapours (see Zhu et al., PNAS, 114, 12685-12690, 2017) [Joyce Penner, United States of America]	Noted
55674	41	23	41	23	Change to "that is not directly emitted, but is …." [Larry Horowitz, United States of America]	Accepted - text revised
43136	41	23	41	38	Suggest to shorten this paragraph; ozone has been discussed already extensively above, see e.g., section 6.2.2.5; also 6.1.2. Regarding the sensitivity of ozone to precursors (NOx and VOCs) – as noted in the document, the atmospheric chemistry has become more complex due to several factors, including emissions changes resulting from technological and regulatory changes (e.g., emerging pollutants such as volatile chemical products and intermediate volatility compounds, the electrification and continued NOx controls) coupled with other parameters (e.g., meteorology, etc.) [Luisa Molina, United States of America]	Accepted -- the redundancies with respect to 6.2.2.5 have been removed
16876	41	23	41	38	This seems to duplicate in part what is in Section 6.2.2.5. [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted -- the redundancies with respect to 6.2.2.5 have been removed
50014	41	24			The Tropospheric Ozone Assessment Report (TOAR) has produced some very informative review papers but the TOAR papers by Lefohn et al. [2018] and Schultz et al. [2017] are not the appropriate references for the statements in this sentence. Neither of these papers provide an authoritative review of ozone photochemistry. A paper that is appropriate for this sentence is Monks et al. 2015a. [Owen Cooper, United States of America]	Not applicable -- text no longer included in chapter
50016	41	25			Here again the TOAR paper by Schultz et al. [2017] which describes the TOAR ozone database is not a good reference for ozone being a greenhouse gas or an air pollutant. Better TOAR papers are Gaudel et al. [2018] which describes ozone's global distribution and trends from a climate perspective, and Fleming et al. [2018] which describes ozone's global distribution and trends from a human health/air pollution perspective. [Owen Cooper, United States of America]	Taken into account -- dealt with in comment 50018
50018	41	34			Here Schultz et al [2017] is an appropriate reference because it does provide an overview of ozone's general global distribution, but it doesn't provide any information on ozone's radiative forcing. Gaudel et al. [2018] provide a nice figure that shows ozone's global distribution in terms of its greenhouse effect. For figures that show the global distribution of ozone's radiative forcing, cite Stevenson et al., 2013. Stevenson, D. S., et al., Tropospheric ozone changes, radiative forcing and attribution to emissions in the Atmospheric Chemistry and Climate Model Intercomparison Project (ACCMIP), Atmos. Chem. Phys., 13, 3063–3085, doi:10.5194/acp-13-3063-2013, 2013. [Owen Cooper, United States of America]	Not applicable -- text no longer included in chapter

29058	41	35	41	35	Sentence needs references [Keith Shine, United Kingdom (of Great Britain and Northern Ireland)]	Not applicable -- text no longer included in chapter
16878	41	35	41	38	Subscript 2 required in chemical formulae [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted - text revised
40692	41	35	41	38	A good thought about ozone linked to CO2 uptake, needs a reference. [Daniel Murphy, United States of America]	Not applicable -- text no longer included in chapter
38266	41	38			Please add 1 or 2 references here. [Hitoshi Matsui, Japan]	Not applicable -- text no longer included in chapter
29060	41	41	41	41	I found Section 6.3.1.2 to be particularly too close to being a text book introduction and suggest it could be shortened somewhat. [Keith Shine, United Kingdom (of Great Britain and Northern Ireland)]	Not applicable -- text no longer included in chapter
47888	41	41	43	9	Section 8.2.2.2.1.1 and Section 8.5.1.1.2 cover aerosols and the water cycle. Please ensure consistency and cross-reference where appropriate. Is duplication needed? [WGI TSU, France]	Accepted -- duplication relative to chapter 8 has been minimized in this section.
47900	41	41	43	9	There are overlaps on SLCF (inc aerosols) and the hydrological cycle in Chapter 6 (both sections 6.3.4.3 and 6.3.1.2 overlap with each other) and with chapter 8 (e.g. in Section 8.2.2) and with chapter 7 (7.3.3.1 - aerosol cloud interactions) [WGI TSU, France]	Accepted -- we have resolved the overlaps with those chapters
14722	41	41	43	9	It is a great section, but has somewhat a textbook look and feel with about half the reference dating before AR5. The section could assess to what the extent the opening statement (41/43 to 41/45) presumably from AR5 is modified by a summary statement at the end of the section. Do aerosol cloud interactions remain the largest source of uncertainty. I didn't read about other constraints, i.e. from satellite observations, but maybe that is in a different section? [Frank Dentener, Italy]	Accepted -- this section has been shortened consistently by referencing more detailed assessments of these interactions in Chapter 8. Section 6.3.1 has been rewritten to start with assessment as of AR5, then references updates in SRCCL/SROCC/SR1.5, then links to other parts of AR6 WGI report with pertinent material
50434	41	41			It would be helpful to include a discussion of the inhibition of cloud droplet growth by the hygroscopicity of sulfate and other aerosols rather than just radiative effects inhibiting cloud formation. Overlap with 6.3.1.4 needs to be clarified in this aspect [Harald Sodemann, Norway]	Taken into account -- this section has been revised as an assessment, and discussion of processes has been removed in favour of assessment of understanding of these processes in chapter 8
44536	41	41			Many recent developments are missing from this section. E.g. much of the output from PDRMIP would fit here, in particular the multi-model estimates of hydrological sensitivities (doi:10.1038/s41612-017-0005-5), and the subsequent breakdown of the responses into energy balance components (https://doi.org/10.1175/JCLI-D-17-0240.1, https://doi.org/10.1029/2018GL079826). (For a full overview, see https://www.cicero.oslo.no/en/PDRMIP/PDRMIP-publications) Some of it gets discussed later, under 6.3.4.3, but there as total impacts and not on a per-process or per-forcer level. The impacts of rapid adjustments from LAPs (aerosol absorption in general) is another key developent that should be covered either here or in section 6.3.1.5. See e.g. doi: 10.1002/2017JD027326, which deals with precip too even though the title is on temperatures. There's also a major review coming up led by Philip Stier and many others, covering many topics relevant to this section. If you're not already in touch with him I encourage asking for input from there. I'm also happy to help if you wish (as a coauthor of the review). [Bjorn Samset, Norway]	Accepted -- references to and assessment of PDRMIP and Philip Stier's articles have been added here

53584	41	43	41	45	Statements on uncertainty related to role of clouds should be coordinated with ch 4 and 7 (and 8) [Jan Fuglestvedt, Norway]	Not applicable -- text no longer included in chapter
16880	41	44	41	44	Delete full stop and change 'But' to 'but' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted - text revised
49308	41	46	41	46	After "relationships", add the citations of Li et al. (2017): Li, Z., D. Rosenfeld, and J. Fan, 2017a: Aerosols and their impact on radiation, clouds, precipitation, and severe weather events, Oxford Research Encyclopedias, doi:10.1093/acrefore/9780199389414.013.126. [Zhanqing Li, United States of America]	Not applicable -- text no longer included in chapter
16882	41	51	41	51	Delete , after 'dynamics' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted - text revised
41578	41	52	41	52	typo ally --> all [Amanda Maycock, United Kingdom (of Great Britain and Northern Ireland)]	Accepted - text revised
16884	41	52	41	52	Not clear what 'ally' means [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Not applicable -- text no longer included in chapter
16886	42	1	42	1	Insert hyphen between synoptic and scale [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted - text revised
16888	42	3	42	3	Delete , after 'dynamics' and delete first 'and' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted - text revised
55864	42	6	42	16	During a recent global model intercomaprison, the hygroscopicty of organic aerosol (OA), the formation of OA from biogenic volatile organic compounds oxidation as well as the deposition processes have been identified as major uncertainty factors in global model simulations of CCN (Fanourgakis et al., https://doi.org/10.5194/acp-2018-1340, and ACP paper in press, 2019- proofs under correction). That study has also shown reduced spread of cloud droplet number concentration (CDNC) simulations compared to that of CCN that is attributed to the sublinear response of CDNC to aerosol particle number variations and the negative correlation between the sensitivities of CDNC to aerosol particle number concentration and to updraft velocity. Overall, while CCN is controlled by both aerosol particle number and composition, CDNC is sensitive to CCN at low and moderate CCN concentrations and to the updraft velocity when CCN levels are high.' [MARIA KANAKIDOU, Greece]	Noted
40694	42	9	42	13	The paragraph says size and chemical composition matter, then talks only about chemical composition (hygroscopicity). In fact size is more important, with multiple references such as Dusek et al. mentioned in an earlier comment. I feel the literature is a little biased with an overemphasis on topics like hygroscopicity of OA that are interesting but not all that crucial to climate effects. This assessment is a good place to keep a focus on important parameters. [Daniel Murphy, United States of America]	Not applicable -- text no longer included in chapter
40696	42	14	42	16	This comment about in-cloud heating should either be deleted or expanded. In fact there are at least three distinct effects of aerosol absorption on clouds. Heating in clouds and close to clouds, as mentioned, decreases cloud cover. Heating below clouds invigorates convection and increases cloud cover. Heating above clouds is complex and not as well studied; on balance it probably increases cloud cover by decreasing entrainment at cloud tops (because of the change in lapse rate). One reference is Samset GRL 2011 L24802, also Samset 2015 JGR, 120, 2913. [Daniel Murphy, United States of America]	Not applicable -- text no longer included in chapter

11694	42	18	42	18	IN is defined as the process of ice nucleation whereas in the following text it refers to ice nuclei (IN) also called ice nucelating particles (INP). This has to be clarifed. IN refers to the particles, not to the process. In section 6.3.1.4 the abbreviation INP is used. [David Neubauer, Switzerland]	Not applicable -- text no longer included in chapter
52006	42	18	42	28	This paragraph contains no new literature since AR5. Is there really no new literature in this area? If so, why does it constitute part of the AR6 assessment? Otherwise newer references should be included and the new insights stressed. [Peter Thorne, Ireland]	Not applicable -- text no longer included in chapter
38268	42	18	42	28	These are descriptions on INP properties (not forcing/impact) and should be moved to section 6.2.2. [Hitoshi Matsui, Japan]	Not applicable -- text no longer included in chapter
38270	42	18	42	28	All studies cited here are studies before AR5. Please add recent papers (e.g. Atkinson et al. (2013, Nature, https://doi.org/10.1038/nature12278), Vergara-Temprado et al. (2018, PNAS, https://doi.org/10.1073/pnas.1721627115)) [Hitoshi Matsui, Japan]	Not applicable -- text no longer included in chapter
11692	42	18	42	28	A key point is that IN can lead to freezing also at lower supersaturation (with respect to ice) than homogeneous freezing. This can have an impact at which altitudes cirrus clouds form. [David Neubauer, Switzerland]	Noted
11696	42	18	42	28	Heterogeneous freezing in mixed-phase clouds (as well as cirrus (ice) clouds) will have an impact on cloud radiative properties and cloud lifetime. Either this is mentioned here or references to the respective (sub)sections in Chapter 7 need to be included [David Neubauer, Switzerland]	Not applicable -- text no longer included in chapter
16890	42	19	42	23	References required [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Not applicable -- text no longer included in chapter
50118	42	21	42	21	This can occur at temperatures below about ….(not only at temperatures of -36 to -38) [Joyce Penner, United States of America]	Not applicable -- text no longer included in chapter
16892	42	25	42	25	Replace 'as' with 'in' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted - text revised
31060	42	25	42	26	More recent references on both sides of the debate: Mahrt et al., 2018 10.5194/acp-18-13363-2018; Kanji et al., 2017 10.1175/AMSMONOGRAPHS-D-16-0006.1. [Nicolas Bellouin, United Kingdom (of Great Britain and Northern Ireland)]	Not applicable -- text no longer included in chapter
11698	42	25	42	26	Add references for Kanji et al. (2017), Hoose and Möhler (2012) and Mahrt et al. (2018). Kanji, Z. A., Ladino, L. A., Wex, H., Boose, Y., Burkert-Kohn, M., Cziczo, D. J., et al. (2017). Overview of Ice Nucleating Particles. Meteorol. Monogr. 58, 1.1-1.33. doi:10.1175/AMSMONOGRAPHS-D-16-0006.1. Mahrt, F., Marcolli, C., David, R. O., Grönquist, P., Barthazy Meier, E. J., Lohmann, U., and Kanji, Z. A.: Ice nucleation abilities of soot particles determined with the Horizontal Ice Nucleation Chamber, Atmos. Chem. Phys., 18, 13363-13392, https://doi.org/10.5194/acp-18-13363-2018, 2018. [David Neubauer, Switzerland]	Not applicable -- text no longer included in chapter
16894	42	27	42	27	Edit for exponential style [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted - text revised

54694	42	31	42	31	after "Tao et al. (2012).", add "especially in Asia where the dominant monsoon rainfall and heavy pollution interact in a much more complex manner to mutually affect each other (Lau, 2016; Li et al., 2016 & 2019). Lau, K. M. (2016), The aerosol-monsoon climate system of Asia: A new paradigm, J. Meteorol. Res., 29(6), 1–11, doi:10.1007/s13351-015-5999-1. Li, Z., et al., 2016: Aerosol and monsoon interactions in Asia, Rev. Geophys., 10.1002/2015 RG000500. Li, Z., et al. (2019), East Asian Study of Tropospheric Aerosols and Impact on Regional Cloud, Precipitation, and Climate (EAST-AIRCPC), J. Geophy. Res., revised. [Zhanqing Li, United States of America]	Not applicable -- text no longer included in chapter
54696	42	33	42	33	after "loading, ", add a citation (Li et al., 2011, 2017). Li, Z., F. Niu, J. Fan, Y. Liu, D. Rosenfeld, and Y. Ding, 2011: The long-term impacts of aerosols on the vertical development of clouds and precipitation, Nature Geoscience, 4, doi: 10.1038/NGEO1313. Li, Z., D. Rosenfeld, and J. Fan, 2017a: Aerosols and their impact on radiation, clouds, precipitation, and severe weather events, Oxford Research Encyclopedias, doi:10.1093/acrefore/9780199389414.013.126. [Zhanqing Li, United States of America]	Not applicable -- text no longer included in chapter
31062	42	34	42	34	need to clarify what is meant by "reported". Models? Observations? [Nicolas Bellouin, United Kingdom (of Great Britain and Northern Ireland)]	Not applicable -- text no longer included in chapter
54698	42	35	42	35	after t "Wang et al., 2015)", add "leading to sysmatic bias errors even in precipitation by the NOAA's global forcase system (Jiang et al., 2017) that are significantly associated with aerosol loading." Jiang, M., J. Feng, Z. Li, R. Sun, Y.-T. Hou, Y. Zhu, B. Wan, J. Guo, and M. Cribb, 2017: Potential influences of neglecting aerosol effects on the NCEP GFS precipitation forecast, Atmos. Chem. Phys., 17, 13,967-13,982, doi:10.5194/acp-17-13967-2017. [Zhanqing Li, United States of America]	Not applicable -- text no longer included in chapter
40698	42	35	62	37	The study by Fan et al. is interesting but requires very special conditions and so is not suitable for the assessment. [Daniel Murphy, United States of America]	Not applicable -- text no longer included in chapter
41580	42	39	42	39	This paragraph could better assess the new information about aerosol effects on precipitation derived through the Precipitation Driver and Response Model Intercomparison Project, e.g. Richardson et al (2018) separating adjustments and feedbacks on precipitation doi:10.1175/JCLI-D-17-0240.1 [Amanda Maycock, United Kingdom (of Great Britain and Northern Ireland)]	Accepted -- assessment of PDRMIP results added
52010	42	39	42	40	Chapter 4 takes a substantive assessment of this so rather than relying on a single paper it would be better to refer to chapter 4 for the substantive assessment? [Peter Thorne, Ireland]	Accepted -- text revised to reference chapter 4's discussion of the rate of change in global mean precipitation with global mean surface temperature increase
40700	42	39	43	2	This paragraph needs reorganization. It does not clearly distinguish between three levels of aerosol effects on global mean precipitation: 1) To the extent that aerosols change overall warming, they change the 1 to 2% per K increase mentioned in the first sentence. 2) Decreases in surface insolation lead to reductions in precipitation at constant temperature, as examined in recent papers on precipitation changes under SRM climate modification. 3) Aerosol effects on microphysics can change the types, locations, and timing of precipitation but because of the closed water mass budget (lines 53-55) changes on global net precipitation tend to be small. The concepts are there in this paragraph, it just skips back and forth and half-contradicts itself before getting things right. [Daniel Murphy, United States of America]	Not applicable -- text no longer included in chapter

55018	42	42	42	42	after "2013", add Jiang et al., 2017). Jiang, M., J. Feng, Z. Li, R. Sun, Y.-T. Hou, Y. Zhu, B. Wan, J. Guo, and M. Cribb, 2017: Potential influences of neglecting aerosol effects on the NCEP GFS precipitation forecast, Atmos. Chem. Phys., 17, 13,967-13,982, doi:10.5194/acp-17-13967-2017. [Zhanqing Li, United States of America]	Accepted -- references added
50436	42	42			Mention here wether trends are increasing or decreasing. Split sentence in two. Is this text writing about present-day or future projections? [Harald Sodemann, Norway]	Not applicable -- text no longer included in chapter
50438	42	43			Would be useful to explain in the beginning of the section how the delay happens, and refer back to this here. [Harald Sodemann, Norway]	Taken into account -- section has been heavily revised, and textbook material removed
31064	42	44	42	45	Need to make the language more caution. Albrecht (1989) is a hypothesis, and it is now clear that clouds exhibit a large range of responses, some of which are not consistent with the Albrecht hypothesis -- e.g. Stevens and Feingold 2009. [Nicolas Bellouin, United Kingdom (of Great Britain and Northern Ireland)]	Not applicable -- text no longer included in chapter
50440	42	44			The writing is not fully clear here. Does the effect on individual clouds not scale up to larger scales? Is it really a question of scale, or is it a question of process? [Harald Sodemann, Norway]	Taken into account -- see response to comment 50438
55020	42	47	42	47	after "Koren et al.2005)", add "Significant delay and intensification of heavy rainfall and lightening by aerosol were also reported for deep convective clouds in China based on analyses of large amounts of data together with modeling (Fan et al., 2015; Guo et al., 2016; Lee et al., 2016; Li et al., 2019). Fan, J., D. Rosenfeld, Y. Yang, C. Zhao, L. R. Leung, and Z. Li, 2015: Substantial contribution of anthropogenic air pollution to catastrophic floods in Southwest China, Geophys. Res. Lett., 42, doi:10.1002/2015GL064479. Guo, J., M. Deng, S. S. Lee, F. Wang, Z. Li, P. Zhai, H. Liu, W. Lv, W. Yao, and X. Li, 2016: Delaying precipitation and lightning by air pollution over the Pearl River Delta. Part I: Observational analyses, J. Geophys. Res. Atmos., 121, 6472-6488, doi:10.1002/2015JD023257. Lee, S.-S., J. Guo, and Z. Li, 2016: Delaying precipitation by air pollution over the Pearl River Delta. Part II: Model simulations, J. Geophys. Res. – Atmos., doi/10.1002/2015JD024362. Li, Z., et al. (2019), East Asian Study of Tropospheric Aerosols and Impact on Regional Cloud, Precipitation, and Climate (EAST-AIRCPC), J. Geophy. Res., revised. [Zhanqing Li, United States of America]	Accepted -- references added
16896	42	48	42	48	Reference required [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Not applicable -- text no longer included in chapter
16898	42	49	42	49	Define ERFaci and write 'faci' in subscript for consistency elsewhere [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Not applicable -- text no longer included in chapter
50442	42	49			ERFaci - something wrong with sentence/grammar? [Harald Sodemann, Norway]	Accepted - text clarified
50444	42	50			demonstrates - If it is a postulation, it can not demonstrate - rephrase [Harald Sodemann, Norway]	Accepted - text revised
54672	42	52	42	52	another reference possible relevant in addition to Booth et al., 2012: Undorf, S., Bollasina, M. A., Booth, B. B. B., & Hegerl, G. C. (2018). Contrasting the effects of the 1850-1975 increase in sulphate aerosols from North America and Europe on the Atlantic in the CESM. Geophys Res Lett, 45, 11,930–11,940. Retrieved from https://doi.org/10.1029/2018GL079970. [Sabine Undorf, United Kingdom (of Great Britain and Northern Ireland)]	Accepted -- references added

29062	42	53	42	55	I found this sentence hard to digest. The water mass budget is only closed to the extent that precip and evap must balance on large scales, but that doesnt mean that neither of these can change. You could equally argue that the energy budget (since to first order radiative cooling and latent heating must balance, on large scales). [Keith Shine, United Kingdom (of Great Britain and Northern Ireland)]	Not applicable -- text no longer included in chapter
16900	42	54	42	54	delete hyphens, replace with commas (avoids confusion with negatives) [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted - text revised
31066	42	55	42	55	Could point out that this means that it is possible to have energetic constraints on aerosol-precipitation interactions, e.g. Richardson et al. 2016 doi:10.1175/JCLI-D-15-0174.1 -- an important progress since AR5. [Nicolas Bellouin, United Kingdom (of Great Britain and Northern Ireland)]	Not applicable -- text no longer included in chapter
16902	43	1	43	1	Delete , after 'spectrum' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted - text revised
55022	43	7	43	7	after "spatial scales", add "(Li et al., 2016, 2019)'. Li, Z., et al., 2016: Aerosol and monsoon interactions in Asia, Rev. Geophys., 10.1002/2015 RG000500. Li, Z., et al. (2019), East Asian Study of Tropospheric Aerosols and Impact on Regional Cloud, Precipitation, and Climate (EAST-AIRCPC), J. Geophy. Res., revised. [Zhanqing Li, United States of America]	Not applicable -- text no longer included in chapter
38272	43	9			Rosenfeld et al. (2019, Science, https://doi.org/10.1126/science.aav0566) can be added as a reference here. [Hitoshi Matsui, Japan]	Accepted -- references added
53666	43	12	43	12	6.3.1.3. check interface with WGII [Jan Fuglestvedt, Norway]	Accepted - text revised. Section 6.3.5 "Indirect radiative forcing through impacts on the carbon cycle" does not discuss impacts of SLCFs on food crops.
38274	43	12	44	10	I think impacts of aerosol deposition on ocean and land biogeochemisty (as nutrient inputs) can be mentioned in this section (6.3.1.3). If they are described in another chapter, I suggest adding a short paragraph (or sentence) which shows the information on the chapter/section. [Hitoshi Matsui, Japan]	Accepted - text revised. Impacts of aerosol deposition on carbon cycle through changing nutrient inputs are now assessed in Section 6.3.5.
38276	43	13			Aerosol-radiation interactions for each aerosol species should be added to this section (6.3.1.4). [Hitoshi Matsui, Japan]	Rejected. Discussed in Section 6.3.1.
16904	43	14	43	14	certain' should be in italics, but this text repeats earlier text (and see earlier comment regarding photosynthesis). Delete , after 'growth' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted - italicization. Section 6.3.5 "Indirect radiative forcing through impacts on the carbon cycle" does not repeat any earlier text.
44258	43	16	43	18	In addition to ambient aerosol affecting plants via scattering or absorption, deposited aerosol can also affect plants and is probably worth mentioning here (e.g. Greenwald, R., Bergin, M.H., Xu, J., Cohan, D., Hoogenboom, G. and Chameides, W.L., 2006. The influence of aerosols on crop production: A study using the CERES crop model. Agricultural systems, 89(2-3), pp.390-413). [Drew Shindell, United States of America]	Not Applicable - impacts of SLCFs on food crops not discussion in Section 6.3.5 "Indirect radiative forcing through impacts on the carbon cycle"
55866	43	18	43	20	SLCFs also affect the carbon cycle through atmospheric deposition of nutrients and toxic substanecs that they carry and changes in the associated biogeochemical cycles (Kanakidou et al. 2018, Aerosols in atmospheric chemistry and biogeochemical cycles of nutrients, Environ. Res. Lett. 13 063004, 2018. https://doi.org/10.1088/1748-9326/aabcdb). This indirect impact of aerosols on the carbon cycle and climate is not sufficiently explored and not yet included in climate estimates. [MARIA KANAKIDOU, Greece]	Accepted - text revised. Section 6.3.5. now assesses aerosol impacts on carbon cycle through deposition of nutrients with this citation included.
16906	43	21	43	21	Reference required [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Not Applicable. Sentence no longer included in section.

14724	43	21	43	21	SLCF A source of carbon? Probably it meant, is an anthropogenic process affecting the carbon cycle? [Frank Dentener, Italy]	Accepted - text revised to "The effect of ozone damage on plant physiology is a source of anthropogenic carbon not accounted for in regional or global carbon cycle assessments."
16908	43	26	43	26	Date mising from reference [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted - text revised
16910	43	28	43	28	Change 'influences' to 'influence' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted - text revised
14726	43	34	43	41	It is a bit strange to be so specific about on set of scenarios- while there are many more. Try to generalize. [Frank Dentener, Italy]	Accepted - text revised. Removed discussion of specific scenarios.
16912	43	36	43	36	Reference required [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Not Applicable. Sentence no longer included in section.
16914	43	40	43	40	Define IIASA ECLIPSE [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Not Applicable. Sentence and reference no longer included in this Section.
16916	43	40	43	40	Insert 'can' after 'but' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted - text revised
29064	43	44	32	44	This paragraph seems more appropriate to WG2 - or at least it could be shortened [Keith Shine, United Kingdom (of Great Britain and Northern Ireland)]	Accepted - text revised. Section 6.3.5 "Indirect radiative forcing through impacts on the carbon cycle" does not discuss impacts of SLCFs on food crops.
44260	43	48	43	50	It reads weirdly to list crops that are sensitive and then other crops that are moderately sensitive - should be an adjective for how sensitive are the first batch (i.e. something more than moderately). [Drew Shindell, United States of America]	Not Applicable. SLCF impacts on food crops not included in this Chapter 6 AR6 WG1.
16918	43	50	43	50	Delete space after) [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted - text revised
47878	43		43		Please see if this paper is relevant for this section: https://www.atmos-chem-phys.net/15/5123/2015/acp-15-5123-2015.html [WGI TSU, France]	Not applicable -- text no longer included in chapter
47884	43		43		Impacts on human health and crops are WG2 assessment areas and go beyond the mandate of the WG1, specifically the CH6 outline. [WGI TSU, France]	Accepted -- discussion of these impacts have been removed
41230	44	1	44	52	there does not seem to be much use of model results in this section [Jean-Francois Lamarque, United States of America]	Not applicable -- text no longer included in chapter
44262	44	5	44	6	I made a comment regarding page 15 on a similar theme, but although AgMIP doesn't have air pollution, we studied this in a recent analysis and found that as CO2 has a fertilization effect whereas HFCs do not and methane not only doesn't fertilize but makes ozone, the net impact of SLCFs from climate and ozone could be as large or larger (or even the opposite sign) to that of CO2 and so SLCFs might be extremely important to crop yields, much more so than their relative impact on global mean temperatures would suggest. If you wanted to discuss that here, the citation is: Shindell, D., G. Faluvegi, P. Kasibhatla, R. Van Dingenen, Spatial patterns of crop yield change by emitted pollutant, Earth's Future, 7, 101-112, doi:10.1029/2018EF001030, 2019. [Drew Shindell, United States of America]	Not Applicable. Thank you for important point & reference. Impacts of SLCFs on food crops is no longer included in Chapter 6 AR6 WG1 (WGII topic coverage).

14728	44	6	44	6	The section should probably discuss the issue of interaction of O3, CO2 and Nitrogen. Like for CO2, other limiting factors may dominate O3 effects in specific regions (… llimited evidence). [Frank Dentener, Italy]	Accepted. Thank you for excellent point. We have included assessment of the interactions in Section 6.3.5: "There are complex interactions between ozone and reactive nitrogen deposition to ecosystems. For some plants, the effects of increasing O3 on root biomass become more pronounced as reactive nitrogen deposition increased, and the beneficial effects of reactive nitrogen on root development were lost at higher O3 treatments (Mills et al., 2016)."
14730	44	6	44	6	AgMIP is working on including it, but the crux is that including ozone effects in crop models, will allow to evaluate effects throughout the growth cycle and interactions with other limiting factors, while most effects have measured in laboratory conditions without confounding factors. [Frank Dentener, Italy]	Not Applicable. SLCF impacts on food crops not included in this Chapter 6 AR6 WG1.
55044	44	11	44	11	What about impact of increased diffuse radiation by aerosol on plant productivity? (Kanniah, K. D., Beringer, J., North, P., & Hutley, L. (2012). Control of atmospheric particles on diffuse radiation and terrestrial plant productivity: A review. Progress in Physical Geography: Earth and Environment, 36(2), 209–237. https://doi.org/10.1177/0309133311434244) [Ina Tegen, Germany]	Noted. New knowledge since AR5 indicates that aerosol impacts on carbon cycle through altered meteorology are larger than aerosol diffuse radiation fertilization. We assess that all aerosol processes on carbon cycle are important but currently too uncertain to constrain quantitatively the indirect CO2 RF.
31068	44	13	44	13	Section 6.3.1.4 includes some repetitions of 6.3.1.2. [Nicolas Bellouin, United Kingdom (of Great Britain and Northern Ireland)]	Accepted -- 6.3.1.4 has been moved to before 6.3.1.2 and the repetitive material removed
41584	44	13	44	13	Section 6.3.1.4. To my mind it would be more logical to discuss ERF before precipitation, as the latter is partly related to the former through global energetic constraints [Amanda Maycock, United Kingdom (of Great Britain and Northern Ireland)]	Accepted -- ERF is now discussed before the precipitation effects
50446	44	13			It appears that the order of Sec. 6.3.1.2 and 6.3.1.4 may be clearer if both sections appear in reverse order (Sec. 6.3.1.4 first) [Harald Sodemann, Norway]	Accepted -- the sequence of these subsections has been swapped (as requested by another reviewer)
14732	44	15	45	26	A good section, but a bit textbook. The section misses a summary statement, what is the overall key point? [Frank Dentener, Italy]	Accepted -- this section has been revised to serve as an assessment rather than a review. Assessment as of AR5 and links to Chapter 7 now included
41582	44	21	44	21	"and subsequent adjustment processes on the other hand" can you give a specific example here to help distinguish the two components of ERF_aci? [Amanda Maycock, United Kingdom (of Great Britain and Northern Ireland)]	Not applicable -- text no longer included in chapter
29066	44	30	44	33	Given the large literature on the topic, I think mixed-phase clouds and the partitioning of the ice and liquid components, should be mentioned too. [Keith Shine, United Kingdom (of Great Britain and Northern Ireland)]	Not applicable -- text no longer included in chapter
16922	44	32	44	32	Delete , after) and remove hyphens: replace with , [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted - text revised
16924	44	33	44	33	Change 'cloud top' to 'cloud-top' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted - text revised

29068	44	33	44	33	Cloud height (and hence temperature) is important for SW because of WV absorption, and degree of overlap between different cloud layers. A cloud with heavy overcast above it, has almost no impact. And I would say it is the difference between surface temperature and cloud top height that is more important than the cloud top temperature per se (consider low altitude clouds in the polar regions) [Keith Shine, United Kingdom (of Great Britain and Northern Ireland)]	Not applicable -- text no longer included in chapter
11700	44	41	44	41	You mean that the impact of anthropogenic aerosol, via anthropogenic CCN or INP, on longwave cloud radiative effect (LW CRE) is small. All clouds form on natural or anthropogenic aerosol particles and the global mean LW CRE of ~28 W m-2 is substantial. This sentence is out of context. It needs to be better motivated, moved or removed. [David Neubauer, Switzerland]	Not applicable -- text no longer included in chapter
50120	44	43	44	47	Heterogeneous nucleation also occurs below -38 C, not just homogeneous nucleation, and can cause a decrease in crystal number [Joyce Penner, United States of America]	Not applicable -- text no longer included in chapter
16926	44	45	44	45	Delete , [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted - text revised
38278	44	47	44	52	INP is described at Page 42, Lines 18-28 (6.3.1.2). This paragraph can be removed or shortened (and then combined to the INP paragraph in 6.3.1.2). [Hitoshi Matsui, Japan]	Not applicable -- text no longer included in chapter
16920	44		44		Ignore, line inserted in error [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Noted
47892	44		45		There is potential overlap in ERF topics between chapter 6 (Section 6.3, Section 6.3.1.4) and Chapter 7 (Section 7.3, Section 7.3.3), for example, methods of ERF, emergent constraints, SO2, methane, aerosols. Could all outs / cross references to each seciton be included. Furthermore chapter 7 hold the main assessment of ERF, including th indepth introduction, but ch6 comes before chapter 7. Could chapter 6 refer to chapter 7 with respect to this? Could assessments on ERF in both chapters be systemised to have similar approaches? This would make it easier for the reader. [WGI TSU, France]	Issues from LAM3 BOG on x-chapter topics between Chapter 6 and 7 have been worked out.
11702	45	6	45	21	Also mesocale cloud organization (e.g. open-cell vs. closed-cell stratocumulus clouds) could be important and is discussed in the literature. [David Neubauer, Switzerland]	Not applicable -- text no longer included in chapter
11704	45	6	45	21	References to the respective (sub)sections in Chapter 7 need to be included [David Neubauer, Switzerland]	Accepted -- references to the respective sections in chapter 7 have been added
16928	45	12	45	12	Insert 'a' after 'implying' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted - text revised
38280	45	12	45	17	Similar descriptions are already given in 6.3.1.2. This paragraph can be removed. [Hitoshi Matsui, Japan]	Accepted - 6.3.1.2 and 6.3.1.4 have been harmonized (and 6.3.1.4 has been moved before 6.3.1.2)
40702	45	25	45	26	This statement about small thermodynamic adjustments is true (in the vertical but not the horizontal) for reflective aerosols. It is not true for black carbon and other absorbing aerosols. The thermodynamic adjustments are large for BC. They have to be, because BC acts to heat whatever layer of air it is in. The statement is also not true for the stratosphere, where infrared absorption by aerosols changes stratospheric circulation (Lacis et al., 1992, GRL, 1607). [Daniel Murphy, United States of America]	Not applicable -- text no longer included in chapter

44540	45	29			This section is introduced on page 40 line 47 as being about the impacts of light absorbing particles, but currently it only deals with cryosphere/deposition on snow. That's certainly one aspect, but I would also expect the new litterature on absorption by brown carbon, the rapid adustments to lapse rates and clouds (i.e. semidirect effects), optical properties of dust etc. to go here. (Some of this is mentioned later in section 6.3.2, but then in the context of observations and not as processes to be understood.) See e.g. https://doi.org/10.1007/s40641-018-0091-4 for an overview of some of the topics. [Bjorn Samset, Norway]	Noted
38282	45	33	45	34	“aerosol-radiation interactions (ERFari; Section 6.3.1.4)”: aerosol-radiation interactions are not discussed in 6.3.1.4 in the current draft. They should be added to 6.3.1.4. [Hitoshi Matsui, Japan]	Noted
14734	45	39	45	39	defintely: in uncertainty language 'certain'? What is snow ageing. [Frank Dentener, Italy]	Noted and modified.
24876	45	41	45	41	References are needed for this factor of 3. It's also not clear from Sand et al. whether the factor of 3 is an increase in effective radiative forcing, or an increase in the efficacy. [William Collins, United Kingdom (of Great Britain and Northern Ireland)]	Noted
16930	45	47	45	47	Change 'Artic' to 'Arctic' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted
27844	46	8	46	8	attend the placeholders [Poot Delgado Carlos Antonio, Mexico]	Noted
47934	46	9	46	9	Please check the use of this IPCC uncertainty language term. Are you able to provide a traceable account to assigning this uncertainty statement? Note that likelihood statements are quantified terms - phrases like likely and very likely have quantifiable probabilities associated with them. Please check it has been used correctly here. Please refer to the IPCC guidance note on uncertainty: https://wg1.ipcc.ch/SR/documents/ar5_uncertainty-guidance-note.pdf [WGI TSU, France]	Noted
16932	46	9	46	10	Subscripts required [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Noted
31070	46	15	46	15	Could be noted that many CMIP and AeroCom models do not include that mechanism at all. [Nicolas Bellouin, United Kingdom (of Great Britain and Northern Ireland)]	Noted
16934	46	24	46	24	Capital P for plateau [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted
14736	46	28	46	28	There is no summary assessment on what we know and what it means for forcing. [Frank Dentener, Italy]	Noted
27846	46	28	46	28	attend the placeholders [Poot Delgado Carlos Antonio, Mexico]	Noted
53586	46	31	46	31	Since forcing is not observed I suggest you change "forcing" to "forcers" in this section title [Jan Fuglestvedt, Norway]	Accepted -- Title has been changed as suggested
29070	46	31	46	31	Section title doesn’t really reflect the content of the section [Keith Shine, United Kingdom (of Great Britain and Northern Ireland)]	Accepted -title has been replaced with "Observations of short-lived climate forcers and their radiative effects"
47686	46	31	47	2	Section 6.3.2 makes very important pioints about changes to ERF from new developments. It will help to include how big the changes are. E.g. "Based new observational data on BC (surface and atmospheric profiles) the estimated residence times have been reduced" but by how much and how significant is this change in relation to model and observational uncertainties? [Ranjeet Sokhi, United Kingdom (of Great Britain and Northern Ireland)]	Accepted -- revisions to estimates of ERF from new developments have been quantified

47964	46	31	48	31	LWP is covered in both ch7 and ch6 with respec to aerosol-cloud interactions. Please ensure no inconsistecies and avoid overlap where possible. Please also call out / cross reference to the appropriate sections. (Chapter 6 Section 6.3.2, Chapter 7 Section 7.3.3.2.1) [WGI TSU, France]	Accepted -- overlaps with chapter 7 removed and references to chapter 7 added as appropriate
11658	46	31	48	31	This section is designed to state the observations of regional short-lived climate forcing. But some cited studies (e.g., Yuan et al, 2011), especially for the ERFaci, were only used to state how they studied the ACI processes in different regions, not about how these studies quantified the short-lived climate forcing. [Chuanfeng Zhao, China]	Accepted -- the section is shifted from a discussion of process to an assessment of the observations for ERF
47918	46	31	54	3	Why are there two separate sections on historical and observations of regional SLCForcing? Could these section not be synthesised togehterto create a more robust assessment conclusion? [WGI TSU, France]	Noted -- section 6.3.2 concerns actual observations, whereas 6.3.3 is an assessment of model-based calculations of SLCF ERF
52012	46	31			This section would benefit from greater efforts at synthesis. It reads a little like a review and thus the assessment findings have somewhat unclear provenance. [Peter Thorne, Ireland]	Accepted -- review material removed and provenance of assessment findings have been elevated
38284	46	31			The title should be changed. “Observations of forcing” are difficult (almost impossible). “Constraint of short-lived climate forcing by observations” may be better. [Hitoshi Matsui, Japan]	Accepted -- Title has been changed as suggested
38286	46	31			Many paragraphs in this section (6.3.2) describe findings based on modeling rather than observations. It may be better to revise the title of this section. [Hitoshi Matsui, Japan]	Accepted -- Title has been changed as suggested to "observational constraints on short-lived climate forcers and their radiative effects". The section 6.3.2.2 on emergent constraints is now consistent with that title.
24878	46	42	46	45	This discussion of methane ERF is in Ch 7. [William Collins, United Kingdom (of Great Britain and Northern Ireland)]	Taken into account -- this paragraph has been deleted
41586	46	42	48	7	this section introduces several concepts of how SLCFs relate to ERF but only briefly and no assessment level statements are made. It is too much of a review format at present [Amanda Maycock, United Kingdom (of Great Britain and Northern Ireland)]	Taken into account -- see response to comment 11658
42032	46	43	46	43	This all seems a bit muddled. First, why is this in section entitled "obs of regional SLCF"? This methane forcing is neither observed nor regional. Second, the 25% is not quite correct, although I accept some of the blame for ambiguity in the abstract of that paper. The Etminan work found that, relative to the simple formulae used in AR5, the forcing increased by 25% but "only" 15% was due to methane SW (Section 3.2 of the paper), and Collins et al. (2018) could confirmed the direct SW component (but much of the total SW effect comes from stratospheric T adjustment and teh effect on the IR) [Keith Shine, United Kingdom (of Great Britain and Northern Ireland)]	Taken into account -- this paragraph has been deleted
29072	46	43	46	43	This all seems a bit muddled. First, why is this in section entitled "obs of regional SLCF"? This methane forcing is neither observed nor regional. Second, the 25% is not quite correct, although I accept some of the blame for ambiguity in the abstract of that paper. The Etminan work found that, relative to the simple formulae used in AR5, the forcing increased by 25% but "only" 15% was due to methane SW (Section 3.2 of the paper), and Collins et al. (2018) could confirmed the direct SW component (but much of the total SW effect comes from stratospheric T adjustment and the effect on the IR) [Keith Shine, United Kingdom (of Great Britain and Northern Ireland)]	Taken into account -- see response to comment 42032 above

16936	46	44	46	44	Insert full stop after) and change 'increases' to 'increase' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted - text revised
44264	46	44	46	44	Good to point out here that this is the 'concentration-based' methane forcing, as distinct from the 'emissions-based' value which is quite different. [Drew Shindell, United States of America]	Taken into account -- see response to comment 42032 above
29074	46	45	46	46	This seems more categorical than the underlying literature, which hypothesises the role of feedbacks rather than establshing them. But I agree it should be mentioned. Also, I think that literature more points to the role of tropical wetlands than thawing permafrost, so perhaps both could be mentioned? [Keith Shine, United Kingdom (of Great Britain and Northern Ireland)]	Taken into account -- see response to comment 42032 above
24880	46	46	46	46	While Saunois et al. may not answer it, AR6 absolutely do need to assess how much of the methane change is anthropogenically driven and how much is a feedback. [William Collins, United Kingdom (of Great Britain and Northern Ireland)]	Taken into account -- see response to comment 42032 above
53588	46	46	46	46	this sentence (incl fotnote) needs further improvement , or should be deleted [Jan Fuglestvedt, Norway]	Taken into account -- see response to comment 42032 above
14738	46	46	46	46	Here a reference can be made to quantitative estimates of increased permafrost emissions, which I believe are still considered to be quite small. [Frank Dentener, Italy]	Taken into account -- see response to comment 42032 above
56310	46	46	46	46	The question in footnote 13 needs to be answered and added to the text [zahrah musa, Netherlands]	Taken into account -- see response to comment 42032 above
38288	46	46			This sentence “Saunois et al. (2016)...” is not meaningful. Should be removed. [Hitoshi Matsui, Japan]	Taken into account -- the paragraph containing this sentence has been entirely deleted
16938	46	49	46	49	Edit reference to He et al. (2018a) [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted - text revised
16940	46	49	46	49	Insert 'the' after 'account' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted - text revised
31072	46	51	46	51	What is the overall impact? [Nicolas Bellouin, United Kingdom (of Great Britain and Northern Ireland)]	Taken into account -- the ambiguity of this sentence has been ameliorated.
14740	46	51	46	51	Can the 'significan't be quantified? What is the overall relevance of the statement? [Frank Dentener, Italy]	Accepted - text revised to say "both significantly altered the effects of BC on snow albedo"
38290	46	53	47	2	This paragraph and the paragraph at Page 47, L20-22 are related. Please combine the two paragraphs. [Hitoshi Matsui, Japan]	Accepted -- these paragraphs have been consolidated into a single level-4 subsection w/in 6.3.2
16942	47	1	47	1	Insert 'on' after 'Based' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted - text revised
24882	47	1	47	55	This list of studies on page 47 will need to be structured into an assessment. [William Collins, United Kingdom (of Great Britain and Northern Ireland)]	Accepted -- list of studies has been restructured as an assessment
31074	47	2	47	2	Need to be more quantitative. [Nicolas Bellouin, United Kingdom (of Great Britain and Northern Ireland)]	Accepted -- this language has been made more quantitative
44542	47	2			Lund 2018 would be a key new reference here: https://doi.org/10.1038/s41612-018-0040-x [Bjorn Samset, Norway]	Accepted -- reference added
16944	47	4	47	4	Edit reference to Samset et al. (2018b) [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted - text revised
14742	47	4	48	31	Section needs to end with clear summary statement. Last paragraph of section is useful, but sentences before look like scattered information. Structure. [Frank Dentener, Italy]	Accepted -- the conclusion to this section has been revised to conclude with a clear summary statement.

27480	47	7	47	7	Aerosol columnar absorption properties, that are needed for any REari calculations (e.g. Single scattering albedo) are currently provided for the visible and infrared range by ground based sun-photometric networks (1). However, for most of the globe the related uncertainty remains high (2,3). In addition, in the UV range there are only case studies that provide such information (4,5). 1. Holben B.N., T.F.Eck, I.Slutsker, D.Tanre, J.P.Buis, A.Setzer, E.Vermote, J.A.Reagan, Y.Kaufman, T.Nakajima, F.Lavenu, I.Jankowiak, and A.Smirnov, 1998: AERONET - A federated instrument network and data archive for aerosol characterization, Rem. Sens. Environ., 66, 1-16. 2. Andrews, E., Ogren, J. A., Kinne, S., and Samset, B.: Comparison of AOD, AAOD and column single scattering albedo from AERONET retrievals and in situ profiling measurements, Atmos. Chem. Phys., 17, 6041-6072, https://doi.org/10.5194/acp-17-6041-2017, 2017 3. Dubovik, O., Smirnov, A., Holben, B.N., King, M.D., Kaufman, Y.J., Eck, T.F. and Slutsker, I., Accuracy assessments of aerosol optical properties retrieved from Aerosol Robotic Network (AERONET) Sun and sky radiance measurements. Journal of Geophysical Research: Atmospheres, 105(D8), pp.9791-9806, 2000. 4. Kazadzis, S., Raptis, P., Kouremeti, N., Amiridis, V., Arola, A., Gerasopoulos, E., and Schuster, G. L.: Aerosol absorption retrieval at ultraviolet wavelengths in a complex environment, Atmos. Meas. Tech., 9, 5997-6011, https://doi.org/10.5194/amt-9-5997-2016, 2016. 5. Corr, C. A., Krotkov, N., Madronich, S., Slusser, J. R., Holben, B., Gao, W., Flynn, J., Lefer, B., and Kreidenweis, S. M.: Retrieval of aerosol single scattering albedo at ultraviolet wavelengths at the T1 site during MILAGRO, Atmos. Chem. Phys., 9, 5813-5827, doi:10.5194/acp-9-5813-2009, 2009 [Vassilis Amiridis, Greece]	Accepted -- several of these references pertinent to quantitative assessment of uncertainty have been added
16948	47	12	47	12	Delete , after July [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted - text revised
16946	47	12	47	15	This does not make sense, the text (line 6) refers to Samset et al. [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	The figure has been removed from the SOD. Similar representation of figure appears in Chapter 2.
53590	47	12	47	15	I assume this figure will be updated [Jan Fuglestvedt, Norway]	The figure has been removed from the SOD. Similar representation of figure appears in Chapter 2.
38292	47	12			Figure 6.5: This figure should be changed to a better figure. The reference is a bit old, and does not match the descriptions in the text. [Hitoshi Matsui, Japan]	The figure has been removed from the SOD. Similar representation of figure appears in Chapter 2.
31076	47	20	47	22	Should come together with previous two paragraphs. [Nicolas Bellouin, United Kingdom (of Great Britain and Northern Ireland)]	Accepted -- this material has been merged with the two previous paragraphs into a new 4th-level subsection of 6.3.2
38294	47	24	47	35	These paragraphs on ozone should be moved to an appropriate place. Currently, before and after these paragraphs are both related to absorbing aerosols. The structure of these paragraphs and their surroundings should be reorganized. [Hitoshi Matsui, Japan]	Accepted -- the paragraphs have been restructured and their surroundings reorganized
16950	47	26	47	26	Change 'a' to 'an' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Noted
16952	47	27	47	27	Replace , with a full stop and edit reference to Rap et al. (2015) [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted - text revised
16954	47	30	47	30	Change to Pre-Industrial [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted - text revised

55048	47	34	47	40	Such heating rate change is expected to lead to changes in atmospheric stability and cloud properties [Ina Tegen, Germany]	Noted
41588	47	35	47	35	I don't agree Rap et al (2015) construct an empirical measure of RF based on observed spectral features. They used a radiative transfer model applied to satellite observed ozone concentrations. [Amanda Maycock, United Kingdom (of Great Britain and Northern Ireland)]	Accepted -- the word "empirical" has been removed and replaced with phraseology indicating that the RF is derived from a model applied to satellite retrievals
29076	47	37	47	37	This sections seems to jump from gases to aerosols back to gases and then back to aerosols, and so could have an improved structure [Keith Shine, United Kingdom (of Great Britain and Northern Ireland)]	Accepted -- the discussions of gases and aerosols have been aggregated and separated in 6.3.2.1
11706	47	37	47	40	Observations of Rfari are discussed in Chapter 7; add reference [David Neubauer, Switzerland]	Accepted -- discussion of RFari has been coordinated with chapter 7
44544	47	37	47	48	Would this fit better under section 6.3.1.5, to bolster the general discussion about the climate interactions of LAPs? [Bjorn Samset, Norway]	Taken into account -- this material has been moved into new level-4 subsections on light-absorbing particles and global dimming
40704	47	37	48	31	Much of this material (several paragraphs) is redundant with other sections in the chapter. [Daniel Murphy, United States of America]	Accepted -- the redundant material has been removed.
38296	47	37			"Absorptive" --> "Absorbing" [Hitoshi Matsui, Japan]	Accepted - text revised
38300	47	42	47	48	This paragraph should be removed. Uncertainties in observations are not important in this section. Findings by observations are more important. [Hitoshi Matsui, Japan]	Accepted -- uncertainty ranges in observations have been removed in favour of assessment of findings
38298	47	42			Defining LAPSI is not necessary. LAP is enough. [Hitoshi Matsui, Japan]	Rejected -- we prefer the specificity of LAPSI
16956	47	44	47	44	Delete , after 'properties' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted - text revised
16958	47	45	47	45	Delete , after 'OC' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted - text revised
16960	47	50	47	50	Delete , after 'water' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted - text revised
38302	47	50	48	7	This paragraph should also be removed. Uncertainties in observations are not important in this section. [Hitoshi Matsui, Japan]	Taken into account -- response to comment 38300
11708	47	50	48	7	Discussion of confounding variables is missing; see Chapter 7 [David Neubauer, Switzerland]	Taken into account -- all this text has been deleted in favour of references to treatment of ACI in chapter 7
11710	47	50	48	7	Progess in observatons of cloud droplet number concentrations and ice crystal number concentrations, which are important for ACI, could be discussed (see Chapter 7). [David Neubauer, Switzerland]	Taken into account -- discussion of aerosol-cloud interactions is now referenced from chapter 7
16962	47	51	47	51	Change 'uncertainties' to 'uncertainty' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted - text revised
16964	47	54	47	54	Change 'coefficient' to 'co-efficient' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Noted
16966	47	55	47	55	Change 'nanometers' to either 'nm' or 'nanometres' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted - text revised
27848	48	2	48	2	complete the information [Poot Delgado Carlos Antonio, Mexico]	Take into account -- the sentence containing the missing information has been removed
16968	48	9	48	9	Delete (i) [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted - text revised
16970	48	12	48	12	Delete , after 'both' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted - text revised

16972	48	13	48	13	Change 'quarter' to 'quarters' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted - text revised
16974	48	19	48	19	Delete (ii) [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted - text revised
31972	48	19	48	31	Volcanic emissions were identified as another source of information'. Here only the satellite observations of volcnoes are exploited. However, this section could interstingly enough also refer to information obtained from paleo-observations. [Marie-France Loutre, Switzerland]	Noted -- the challenge with using paleo observations is that we want to link eruptions to fluctuations in cloud properties, and there are essentially no paleo proxies for these properties
50122	48	20	48	22	This study was not confirmed however, when Malavelle (Nat. 2017) looked at Kilauea [Joyce Penner, United States of America]	Noted -- the Malavelle paper in question is in fact cited in this paragraph
16976	48	21	48	21	Delete , after 'likelihood' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted - text revised
16978	48	22	48	22	Add ', Hawaii, ' after 'volcano' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted -- Hawaii added
16980	48	23	48	23	Delete 'in the' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted - text revised
50124	48	29	48	30	I find this sentence unconvincing. You go through results for LWP of both increases and no increases. Why should no systematic changes be "most plausible"? [Joyce Penner, United States of America]	Taken into account -- this discussion has been removed.
47936	48	30	48	30	Please check the use of this IPCC uncertainty language term. Are you able to provide a traceable account to assigning this uncertainty statement? Note that likelihood statements are quantified terms - phrases like likely and very likely have quantifiable probabilities associated with them. Please check it has been used correctly here. Please refer to the IPCC guidance note on uncertainty: https://wg1.ipcc.ch/SR/documents/ar5_uncertainty-guidance-note.pdf [WGI TSU, France]	Taken into account -- see response to comment 50124
31078	48	30	48	30	On which studies is the statement on cloud fraction adjustments based? The paragraph is mostly on LWP changes. [Nicolas Bellouin, United Kingdom (of Great Britain and Northern Ireland)]	Taken into account -- this material has been removed
40714	48	31	48	31	Section 6.3.2. 1 I disagree with the statement that there is no observational evidence for effects of IN. There may be little or no end-to-end observational evidence, but there is strong evidence for individual steps. First, there is strong evidence that there have been anthropogenic changes in ice nuclei. The most important IN is mineral dust, and dust has changed due to anthropogenic effects. There are global papers by Tegen, strong evidence over the US from the IMPROVE network (Hand et al., 2016 GRL 4001; Hand et al., 2017 JGR 3080; Murphy et al. 2008 ACP 2729). Also, IN concentrations are higher in regions with strong anthropogenic influence (papers by DeMott). Second, there is strong evidence that ice clouds respond to changes in ice nuclei. Evidence over the Southern Ocean includes both in-situ and satellite data (e.g. Vergara-Temprado 2018 PNAS; Hu et al., 2010, JGR, D00H34; Chubb et al. 2013 GRL 5280). I would personally assess medium confidence for the individual steps of anthropogenic IN affecting clouds but low confidence for the overall effect, and no quantitative range. [Daniel Murphy, United States of America]	Taken into account -- this text has been removed
53592	48	34	48	34	I assume the title will be improved [Jan Fuglestvedt, Norway]	Accepted -- Title has been changed
14744	48	34	48	34	Mysterious title: observations of observables. Human experiments. Clarify title to understand what section is about. [Frank Dentener, Italy]	Accepted - text clarified
29090	48	34	48	34	Seems a strange title given the content [Keith Shine, United Kingdom (of Great Britain and Northern Ireland)]	Accepted - text clarified

29890	48	34	48	34	What is "snow dimming"? Never heard, please explain if not wrong at all! [Christoph Marty, Switzerland]	Noted (edited out of title)
38304	48	34	48	35	The title of this section (6.3.2.1) should be revised. [Hitoshi Matsui, Japan]	Accepted -- Title has been changed
44468	48	34	48	35	The title "(recent advances in BC on snow dimming, human experiments in India and China, and volcanoes, dust, methane, ACI)" is not clearly understood. Para 6.3.2.1 is not India and China specific. [VIJAY SONI, India]	Accepted -- this subtitle has been removed
47688	48	34	49	23	This section is a good example of how quantitative information helps to substantiate the message. [Ranjeet Sokhi, United Kingdom (of Great Britain and Northern Ireland)]	Noted
37790	48	34			"Observations of observables" is a strange title, as by definition one cannot have observations of the unobservables. [Adrian Simmons, United Kingdom (of Great Britain and Northern Ireland)]	Accepted -- title has been clarified
14746	48	37	48	45	Can this be organized with earlier evaluation of CH4 on page 46? [Frank Dentener, Italy]	Accepted -- these two discussions of CH4 have been unified in a new level-4 section on ozone and methane
9294	48	41	48	42	The 3.3 figure cannot be a concentration. [philippe waldteufel, France]	Accepted -- "concentrations" was in error, this has been changed to "trends"
44266	48	42	48	45	Maybe this comes later, but if not, this observation begs the question of whether the forcing increase is consistent with theoretical understanding of the impacts of the observed methane abudance (ie. does the value match what our formulas give us?). [Drew Shindell, United States of America]	Noted -- the agreement between models and measurements is discussed in the paper cited.
29078	48	47	48	48	This sentence needs a reference [Keith Shine, United Kingdom (of Great Britain and Northern Ireland)]	Accepted -- reference added
44268	48	47	48	50	This discussion needs to say where these observations and model results are from. It sounds like global mean as written, but I'm pretty sure this is Europe & perhaps N America only, isn't it? [Drew Shindell, United States of America]	Noted -- the GEBA network which informs a large part of the work on global dimming is in fact global -- see Fig. 1 in Wild 2009 cited here
55804	48	48	48	50	The addition of the description of the two models in Turnock here is a bit strange - either remove or at least remove references to the one that didn't include realistic aerosol effects and didn't perform so well. [Christopher Smith, United Kingdom (of Great Britain and Northern Ireland)]	Accepted -- reference to the less realistic model has been removed
29080	48	50	48	50	2001 feels very dated for this assessment [Keith Shine, United Kingdom (of Great Britain and Northern Ireland)]	Accepted -- this reference has been updated
38306	48	50			Please clarify the region this study (Wild, 2009) focused on. [Hitoshi Matsui, Japan]	Taken into account -- the term used "global dimming" and it is meant literally
31080	49	3	49	3	Is saying "extensively measured and characterised" really true? The lone reference to Qian et al. 2015 is not sufficient for such a strong statement. [Nicolas Bellouin, United Kingdom (of Great Britain and Northern Ireland)]	Accepted -- "extensively" has been removed.
38308	49	11	49	13	Volcanic eruptions and their impact on clouds are already described at Page 48 L19-31. This part can be removed. [Hitoshi Matsui, Japan]	Accepted -- the material re volcanoes has been consolidated
16982	49	12	49	12	Insert space betweeen number and unit [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted - text revised
38310	49	13	49	15	A recent study (Vergara-Temprado et al. (2018, PNAS)) showed the treatment of INP in models is important to estimate cloud radiative effect over the Southern Ocean. This study can be added to descriptions here. [Hitoshi Matsui, Japan]	Taken into account -- this material has been removed
16984	49	15	49	15	Change to 'Southern Ocean' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted - text revised
16986	49	17	49	17	Change 'Haze' to 'haze' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted - text revised

16988	49	22	49	22	Insert 'by' after 'caused' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted - text revised
44560	49	26			Emergent constraints are introduced and explained in section 1.4.5.2. It would be good to refer back to that section for consistency. [Bjorn Samset, Norway]	Accepted -- references to section 1.4.5.2 have been added
24884	49	28	49	55	The constraints on aerosol forcing are also discussed in section 7.3.3. These sections should be coordinated between the chapters. [William Collins, United Kingdom (of Great Britain and Northern Ireland)]	Accepted -- the discussions here and in chapter 7 have been harmonized
31082	49	39	49	39	Do you mean "modeled temperature change"? [Nicolas Bellouin, United Kingdom (of Great Britain and Northern Ireland)]	Accepted - text clarified
16990	49	42	49	42	Edit reference to Quaas et al. (2009b) and insert space after) [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted - text revised
16992	49	42	49	42	Change 'coefficient' to 'co-efficient' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Noted
16994	49	44	49	44	Rates as exponentials [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted - text revised
16996	49	45	49	45	delete 'to' and change 'relate' to 'relating' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted - text revised
16998	49	50	49	50	Change 'As' to 'as' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted - text revised
38312	49	50	49	55	Volcanic eruptions and ACI are described at Page 48 L19-31. This part can be removed. [Hitoshi Matsui, Japan]	Taken into account -- see response to comment 38308
38314	50	2	50	11	Recent studies should be added as references. All studies cited here are studies before AR5. [Hitoshi Matsui, Japan]	Accepted -- the set of references assessed has been updated
17000	50	8	50	8	Edit to 'too coarse a' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted - text revised
31084	50	8	50	9	The question is whether there is scale-dependence of the cloud responses to aerosol perturbation. If not, then cities and ship tracks would be useful constraints even at the large scales represented by climate models. [Nicolas Bellouin, United Kingdom (of Great Britain and Northern Ireland)]	Taken into account -- this text has been removed
17002	50	11	50	11	Delete , after 'generations' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted - text revised
50126	50	13	20	14	This statement is not corroborated by the evidence you give. [Joyce Penner, United States of America]	Taken into account -- see response to comment 38308
17004	50	15	50	15	Rates as exponentials [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted - text revised
14748	50	18	51	46	Section title is strange. Do you mean historical estimates? Can the variety of component RF estimates be summarized in a table. Are they RF or ERF? [Frank Dentener, Italy]	Accepted - text clarified
41590	50	18	54	3	Section 6.6.3 again lacks several key assessment level statements and is currently in the form of a review [Amanda Maycock, United Kingdom (of Great Britain and Northern Ireland)]	Taken into account -- see response to 44270
38316	50	18			Many paragraphs in this section (6.3.3) describe on global forcing. Please clarify why the title of this section has “Regional”. [Hitoshi Matsui, Japan]	Accepted -- this section is being revised to have a much stronger regional focus
55676	50	22	50	22	Be consistent in notation. Earlier SLCFs refer to radiatively active species *and precursors*. Change "SLCFs and SLCF precursors" here to "SLCFs." [Larry Horowitz, United States of America]	Accepted - text revised
17006	50	23	50	23	Change to Pre-Industrial [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted - text revised

9296	50	27	50	30	To me this chart depicts zonal or latitudinal averages, rather than meridional ones. [philippe waldteufel, France]	No longer applicable. Figure removed from SOD.
55678	50	28	50	28	Change to "including from stratospheric injection by volcanoes." [Larry Horowitz, United States of America]	No longer applicable. Figure removed from SOD.
55680	50	35	50	35	Tropospheric + stratosphere O3? [Larry Horowitz, United States of America]	Accepted - yes both -- text clarified (reference for ozone is doi:10.5194/acp-11-11267-2011)
44270	50	35	50	36	The prior results from my paper are not those I'd say are the most appropriate to present here. As the paper describes, the CCSM4-CAM3.5 and bcc-csm1-1 models did not include aerosol cloud interactions, so are incomplete. The fields in column one of the figure are aerosols without ozone for some models since several included ozone in their historical GHG simulations, and this figure was trying to compare forcing with response in the given simulations. If you draw instead from the last 2 columns of Table 1 you can get the aerosol+ozone forcing for each model. For the first 7 (that is, exluding the two without aci), the forcing is -0.93 +- 0.36 (where that's one std dev, so you can convert to 90% or 95% CI as you like). Looking forward to seeing how this compares with results from the next generation in AerChemMIP/RFMIP. [Drew Shindell, United States of America]	Taken into account -- section 6.3.3 has been entirely rewritten to focus on regional forcing
24886	50	35	50	41	These Naik et al. results are all from a single model study so should not given this level of prominence here. In particularly citing precise values suggests undue confidence in the results. PFP should be ERF. [William Collins, United Kingdom (of Great Britain and Northern Ireland)]	Taken into account -- see response to 44270
17008	50	36	50	36	Edit reference to Naik et al. (2013a) [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted - text revised
55682	50	38	50	38	Notation: RFP versus ERF? [Larry Horowitz, United States of America]	Accepted - text clarified
38318	50	38			Please clarify whether RFP at L38 and RF at L43 have the same definition or not. [Hitoshi Matsui, Japan]	Accepted -- the term RFP has been changed to ERF
17010	50	39	50	40	Edit reference to Naik et al. (2013a) [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted - text revised
24888	50	43	50	45	This statement on the methane forcing repeats that already been made on page 46. This is covered in more detail in section 7.3.2.2. [William Collins, United Kingdom (of Great Britain and Northern Ireland)]	Accepted -- repetition with earlier statement has been removed, and the earlier statement has been harmonized with chapter 7
31086	50	43	50	45	According to Chapter 7, most of those increases are counteracted by rapid adjustments in the troposphere. [Nicolas Bellouin, United Kingdom (of Great Britain and Northern Ireland)]	Noted -- this paragraph has been removed in SOD to avoid d repetition
29082	50	43	50	45	Some co-ordination with Chapter 7 on the methane forcing is needed. Note that the 25% comes from vaarious updates included in the Etminan study or which the shortwave absorption and its accompanying effect on startospheric adjustemnt are a major part. [Keith Shine, United Kingdom (of Great Britain and Northern Ireland)]	Taken into account -- see response to comment 31086
55806	50	43	50	45	I see the description of the reason for the Etminan methane forcing estimate repeated quite often - is it always necessary? In addition Chapter 7 extensively assesses the effective radiative forcing from methane, including rapid adjustments. [Christopher Smith, United Kingdom (of Great Britain and Northern Ireland)]	Accepted -- the number of references to Etminan et al have been reduced as recommended
17012	50	47	50	48	Edit reference to Rap et al. (2015) [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted - text revised

29084	50	47	51	4	I am not entirely sure of the purpose of introducing the RE here, since it is not forcing (in passing, Chapter 7 may use RE for Radiative Efficiency). We presented updated trop and strat ozone RF estimates here 10.1002/2017GL076770 [Keith Shine, United Kingdom (of Great Britain and Northern Ireland)]	Accepted -- discussion of RE has been dropped
17014	50	51	50	51	Edit reference to Myhre et al. (2017) [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted - text revised
55684	50	51	50	51	"forcing" --> "RF" [Larry Horowitz, United States of America]	Accepted - text revised
17016	50	52	50	52	Edit reference to Hoesly et al. (2018) [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted - text revised
55686	50	53	50	53	Change to "mean ozone forcing change." [Larry Horowitz, United States of America]	Noted (not sure what has to be changed)
55688	51	1	51	1	"Uncertainty range of order 50"? [Larry Horowitz, United States of America]	Accepted - text clarified
24890	51	1	51	4	This description is not clear. Presumably the specific short-lived forcers refered to here are the halogenated species? Is this a reduction in the total ozone forcing (stratospheric and tropospheric) These statements seem very categoric for a single model study. [William Collins, United Kingdom (of Great Britain and Northern Ireland)]	Accepted - these statements have been removed
55690	51	2	51	2	"Short-lived halogen forcers"? [Larry Horowitz, United States of America]	Accepted - text clarified
53594	51	6	51	6	Is this update due to changes in concentrations or in scientific understanding, or both? [Jan Fuglestvedt, Norway]	Taken into account -- see response to 44270
38322	51	6	51	19	RF values in this paragraph should be revised. I think the description that BC forcing could be lower than BrC forcing is not consistent with current understandings. [Hitoshi Matsui, Japan]	Taken into account -- see response to 44270
38324	51	6	51	19	Recent studies (Moteki et al.(2017, ncomms, https://doi.org/10.1038/ncomms15329); Matsui et al. (2018, ncomms, https://doi.org/10.1038/s41467-018-03997-0)) found anthropogenic magnetite (iron oxide) particles contribute to aerosol absorption with direct radiative forcing estimates of 0.021 W m-2 globally and 0.22 W m-2 over East Asia. Since these forcing values are greater than those in the last sentence of this paragraph, these findings should be added here. [Hitoshi Matsui, Japan]	Taken into account -- see response to 44270
38320	51	6			RF values of all SLCFs should be summarized as a figure (and a table). [Hitoshi Matsui, Japan]	Taken into account -- see response to 44270
17018	51	7	51	7	Insert space after second) [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Noted (could not find parenthesis in question)
17020	51	8	51	8	Don't capitalise brown carbon [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted - text revised
55692	51	8	51	9	Brown Carbon is not mentioned previously under carbonaceous aerosols. Mention and define earlier. [Larry Horowitz, United States of America]	Taken into account -- see response to 44270
17022	51	11	51	11	Edit reference to Lin et al. (2014a) [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted - text revised
55046	51	21	51	30	Does this extimate just refer to anthropogenic SOA or does it include natural SOA? The latter would not be a classical 'forcing' [Ina Tegen, Germany]	Taken into account -- see response to 44270
24892	51	21	51	30	There are a lot of studies discussed here. What is the AR6 overall assessment? [William Collins, United Kingdom (of Great Britain and Northern Ireland)]	Taken into account -- see response to 44270
50128	51	22	51	22	Lin et al model has been updated now treating SOA as internally mixed based on mechanim of formation, with SOA direct forcing now -0.38 (tp -0.46 without organic nucleation) and indirect -1.67 W/m2 up to -1.88 W/m2 without organic nucleation) Zhu, Penner et al. (Nat. Comm. 2019). [Joyce Penner, United States of America]	Taken into account -- see response to 44270

17024	51	24	51	24	Edit reference to Scott et al. (2014) [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted - text revised
17026	51	25	51	25	Edit reference to Shrivastava et al. (2015) [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted - text revised
38326	51	25			Please add Shrivastava et al. (2017, RG, https://doi.org/10.1002/2016RG000540) as a reference. [Hitoshi Matsui, Japan]	Taken into account -- see response to 44270
55694	51	26	51	26	First indirect forcings *by SOA*? [Larry Horowitz, United States of America]	Accepted - text clarified
17028	51	28	51	28	Delete " aftre full stop [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted - text revised
17030	51	30	51	30	Remove additional full stop [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted - text revised
24894	51	32	51	36	It is not clear why this single model study of Hauglustaine is given prominence here. What does AR6 assess as the advance in understanding since AR5? [William Collins, United Kingdom (of Great Britain and Northern Ireland)]	Taken into account -- see response to 44270
55696	51	32	51	39	Do more CMIP6 models include nitrate aerosol than in CMIP5? [Larry Horowitz, United States of America]	Taken into account -- see response to 44270
38328	51	38	51	39	I think this paragraph is too short. More descriptions on sulfate and nitrate forcing should be added. [Hitoshi Matsui, Japan]	Taken into account -- see response to 44270
55050	51	41	51	46	Recent aircraft measurements from aircraft of supermicron dust particles in the SAL may make the LW forcing component even higher (Ryder, C. L., Marenco, F., Brooke, J. K., Estelles, V., Cotton, R., Formenti, P., McQuaid, J. B., Price, H. C., Liu, D., Ausset, P., Rosenberg, P. D., Taylor, J. W., Choularton, T., Bower, K., Coe, H., Gallagher, M., Crosier, J., Lloyd, G., Highwood, E. J. and Murray, B. J. (2018) Coarse mode mineral dust size distributions, composition and optical properties from AER-D aircraft measurements over the Tropical Eastern Atlantic. Atmospheric Chemistry and Physics, 18. pp. 17225-17257. ISSN 1680-7316) [Ina Tegen, Germany]	Taken into account -- see response to 44270
55052	51	41	51	46	Overall, minaral dust is hardly discussed at all, given the potential importance of anthropogenic dust and potential change within a changing climate this is regrettable. [Ina Tegen, Germany]	Taken into account -- see response to 44270

13888	51	41	51	46	The range in dust radiative effects does not seem to be coherently reported: the former study indicates the simulated change in in dust DRE from the late 20th century with respect to 2009, while the second paper refers to the overall dust DRE in present-day conditions. It would be more appropriate to distinguish at least the studies focussing on the overall dust DRE in present-day conditions, from those analyzing variations in DRE effects and/or trying to single out anthropogenic contributions. In the second category we can find e.g. Tegen et al. 2004; Mahowald et al. 2010; Ginoux et al. 2012; Stanelle et al. 2014; Webb & Pierre, 2018. For the first category instead, for present day climate, IPCC AR5 estimated net TOA DRE from dust in the range −0.61 to +0.10 W m−2, whereas a recent study re-evaluating some of the former estimates in light of new constraints indicates a range from −0.48 to +0.20 W m−2 (Kok et al., 2017). Model studies for the LGM indicate TOA direct DRE, either instantaneous or effective, in a range between −0.02 and −3.2 W m−2, and between -0.01 and −1.2 W m−2 for the corresponding pre-industrial/current climate control cases (Albani et al., 2018 and references therein). Tegen, I., M. Werner, S. P. Harrison, and K. E. Kohfeld (2004), Relative importance of climate and land use in determining present and future global soil dust emission, Geophys. Res. Lett., 31, L05105, doi:10.1029/2003GL019216. Mahowald N. M., S. Kloster, S. Engelstaedter, J. K. Moore, S. Mukhopadhyay, J. McConnell, S. Albani, S. Doney, A. Bhattacharya, M. A. J. Curran, M. G. Flanner, F. M. Hoffman, D. M. Lawrence, K. Lindsay, P. A. Mayewski, J. Neff, D. Rothenberg, E. Thomas, P. E. Thornton, and C. S. Zender (2010). Observed 20th century desert dust variability: impact on climate and biogeochemistry. Atmospheric Chemistry and Physics, 10, 22, 10875-10893. Ginoux, P., J. M. Prospero, T. E. Gill, N. C. Hsu, and M. Zhao, 2012: Global-scale attribution of anthropogenic and natural dust sources and their emission rates based	Taken into account -- see response to 44270
27482	51	41	51	46	New findings recently reported in ACP by Ryder C. et al. (still on discussions) report new dust RF numbers which are valid also for larger particles that were not taken into account up to now (larger than 15 μm in radius) [Vassilis Amiridis, Greece]	Taken into account -- see response to 44270
38330	51	41	51	46	Recent findings by Kok et al. (2017, ngeo, https://doi.org/10.1038/ngeo2912; 2018 ncomms, https://doi.org/10.1038/s41467-017-02620-y) are important for dust forcing. Their findings should be described in this paragraph. [Hitoshi Matsui, Japan]	Taken into account -- see response to 44270
55698	51	43	51	46	Mention also uncertainties in the anthropogenic changes in dust source. [Larry Horowitz, United States of America]	Taken into account -- see response to 44270
17032	51	45	51	46	I don’t know what you eman by 'with oposite sign' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Taken into account -- see response to 44270
55700	51	49	51	49	Change "ARI" and "forcing" to "ERF_{ari}" [Larry Horowitz, United States of America]	Accepted - text revised
56312	51	49	51	49	This subsection (6.3.3.1) title should be changed to ' Characterization of ARI and its increases' . [zahrah musa, Netherlands]	Taken into account -- see response to 44270
38332	51	55			The value of 0.23-0.57 W m-2 is not consistent with the values in the paragraph at Page 51 L6-19. [Hitoshi Matsui, Japan]	Taken into account -- see response to 44270

6453	51		52		Cross check with the values/comments in Chapter 7. Some estimates from CMIP6 models are already published for both present-day and future ERF of anthropogenic aerosols, e.g., Fiedler et al. (2019). Reference: Fiedler, S., Stevens, B., Gidden, M., Smith, S. J., Riahi, K., and van Vuuren, D.: First forcing estimates from the future CMIP6 scenarios of anthropogenic aerosol optical properties and an associated Twomey effect, Geosci. Model Dev., 12, 989-1007, https://doi.org/10.5194/gmd-12-989-2019, 2019. [Stephanie Fiedler, Germany]	Taken into account -- see response to 44270
38334	52	1			"SO2" --> "sulfate" [Hitoshi Matsui, Japan]	Noted -- changed SO2 to SO4
17034	52	3	52	3	Change coefficient to co-efficient [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Noted
44272	52	3	52	4	Hard to comment on an 'in prep' paper, but I'm guessing Samset is drawing on the PDRMIP modeling that finds a negative rapid adjustment. The authors should be aware of Allen et al, in press, 2019 (in npjCAS) that finds that the BC distribution used In most of the PDRMIP modeling is biased relative to obsservations in its vertical profile, and this leads to a biased rapid adjustment. In simulations constrained to match observed profiles, the rapid adjustment flips sign to positive, so enhances the RF from BC rather than weakening it. PDRMIP may have a lot of models, but if they all (or at least most) have the same bias then the fact that it's multi-model doesn't help. [Drew Shindell, United States of America]	Taken into account -- see response to 44270
55702	52	4	52	5	This value for BC RF isn't consistent with the first sentence of the paragraph. [Larry Horowitz, United States of America]	Taken into account -- see response to 44270
38336	52	5			0.21 W m-2: this value should be consistent with BC forcing values used in other paragraphs. [Hitoshi Matsui, Japan]	Taken into account -- see response to 44270
17036	52	11	52	12	Edit reference to Regayre et al. (2018) [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted - text revised
17038	52	14	52	15	Edit reference to Lund et al. (2018) [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted - text revised
55704	52	19	52	20	Explain why sulphate cooling estimates have decreased. [Larry Horowitz, United States of America]	Taken into account -- see response to 44270
17040	52	25	52	25	Change of to 'by' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted - text revised
47690	52	32	52	39	The discussion of regionally dependent RF and ARI is limited to S Asia. It will be more useful if comparisons are given with other regions of contrasting aerosol loading e.g. S Asia, Europe, N and S America as this will address the key uncertainties in ARI currently. And it has significant implications for policy responses to control in terms of warming and cooling PM species. [Ranjeet Sokhi, United Kingdom (of Great Britain and Northern Ireland)]	Taken into account -- see response to 44270
55706	52	32	52	39	This paragraph doesn't seem useful. Either expand regional forcing discussion or cut. [Larry Horowitz, United States of America]	Taken into account -- see response to 44270
17042	52	37	52	37	Subscript 4 required [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted - text revised
56314	52	42	52	42	Subsection (6.3.3.2) title needs revising. [zahrah musa, Netherlands]	Taken into account -- see response to 44270
38338	53	1	53	6	This paragraph should be removed. Volcanic eruptions and their impact on clouds are already described many times. [Hitoshi Matsui, Japan]	Taken into account -- see response to 44270
17044	53	2	53	2	Change micrometers to micrometres or µm [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted - text revised

11712	53	4	53	6	Other studies find an impact on cloud amount or cloud liquid water path (Andersen et al., 2017; Christensen et al., 2017; Gryspeert et al., 2016; Gryspeerdt et al., 2018; Possner et al., 2018). Andersen, H., J. Cermak, J. Fuchs, R. Knutti, and U. Lohmann (2017), Understanding the drivers of marine liquid-water cloud occurrence and properties with global observations using neural networks, Atmos. Chem. Phys., 17(15), 9535–9546, doi:10.5194/acp-17-9535-2017. Christensen, M. W., Neubauer, D., Poulsen, C. A., Thomas, G. E., McGarragh, G. R., Povey, A. C., et al. (2017). Unveiling aerosol–cloud interactions – Part 1: Cloud contamination in satellite products enhances the aerosol indirect forcing estimate. Atmos. Chem. Phys. 17, 13151–13164. doi:10.5194/acp-17-13151-2017. Gryspeerdt, E., Quaas, J., and Bellouin, N. (2016). Constraining the aerosol influence on cloud fraction. J. Geophys. Res. Atmos. 121, 3566–3583. doi:10.1002/2015JD023744. Gryspeerdt, E., Goren, T., Sourdeval, O., Quaas, J., Mülmenstädt, J., Dipu, S., Unglaub, C., Gettelman, A., and Christensen, M.: Constraining the aerosol influence on cloud liquid water path, Atmos. Chem. Phys., 19, 5331-5347, https://doi.org/10.5194/acp-19-5331-2019, 2019. Possner, A., H. Wang, R. Wood, K. Caldeira, and T. Ackerman (2018), The efficacy of aerosol-cloud-radiative perturbations from near-surface emissions in deep open-cell stratocumulus, Atmos. Chem. Phys. Discuss., 2018, 1–21, doi:10.5194/acp-2018-708. [David Neubauer, Switzerland]	Taken into account -- see response to 44270
17046	53	5	53	5	Reference required for 'other studies' and explain why the changes were undetectable (I presume it is a scale issue) [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Taken into account -- see response to 44270
38340	53	8	53	11	Similar descriptions are already given at Page 49, L13-15. This paragraph can be removed. [Hitoshi Matsui, Japan]	Taken into account -- see response to 44270
17048	53	9	53	9	Capitalise Southern Ocean [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted - text revised
53596	53	14	53	14	This section could use a figure showing time developments [Jan Fuglestvedt, Norway]	Taken into account -- see response to 44270
47674	53	16	53	51	The discussion uncertainty as it pertains to the climate effects of SLCFs needs to discuss potentially problematic representations of radiative forcing, either from a problematic representation of radiative transfer processes, or a problematic parameterization of such processes in climate models. The findings of Collins et al, 2006 (doi:10.1029/2005JD006713), Etminan et al, 2016 (doi:10.1002/2016GL071930) and Jones et al, 2017 (doi:10.1002/2017GL075933) present the latter. [Daniel Feldman, United States of America]	Taken into account -- see response to 44270
38342	53	18	53	19	Please add Stevens and Dastoor (2019, Atmosphere, https://doi.org/10.3390/atmos10040168), Matsui et al. (2018, ncomms, https://doi.org/10.1038/s41467-018-05635-1), and Samset et al. (2018, CCCR, https://doi.org/10.1007/s40641-018-0091-4) as references. [Hitoshi Matsui, Japan]	Taken into account -- see response to 44270
17050	53	25	53	25	Edit reference to Bond et al. (2013) [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted - text revised
17052	53	30	53	30	Change 'are' to 'is' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted - text revised

17054	53	34	53	34	Change dimethysulfide to dimethylsulfide (or dimethylsulphide) [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted - text revised
17056	53	40	53	40	Change to Pre-Industrial period [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted - text revised
17058	53	41	53	41	Change to Pre-Industrial [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted - text revised
17060	53	43	53	43	Change to Industrial [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted - text revised
17062	53	43	53	44	Change to '..in Pre-Industrial times.' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted - text revised
38344	53	48			0.25 to 0.9 W m-2: These values are not consistent with BC forcing values given earlier. [Hitoshi Matsui, Japan]	Taken into account -- see response to 44270
55054	53	51	53	51	In addition to the co-emission of non-absorbing species, also the presence of less absorbing species like natural mineral dust has the potential to significantly modify BC DRF (Tegen, I.; Heinold, B. Large-Scale Modeling of Absorbing Aerosols and Their Semi-Direct Effects. Atmosphere 2018, 9, 380.) [Ina Tegen, Germany]	Taken into account -- see response to 44270
17064	53	54	53	54	Is 'm HIAPER' correct? [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted - text clarified
41232	54	1	54	55	It is not clear at all that transport significantly impacts the forcing. The way to check that is to compare the map distribution of forcing (ERF) with the distribution of aerosols for example. It is not clear from som e of the work we have done (see for example Conley, A. J., D. Westervelt, J.-F. Lamarque, A. M. Fiore, D. Shindell, G. Correa, G. Faluvegi, L.W. Horowitz. Multi-model surface temperature responses to removal of U.S. sulfur dioxide emissions. J. Geophys. Res., 123, 2773–2796. https://doi.org/10.1002/2017JD027411, 2018.) [Jean-Francois Lamarque, United States of America]	Taken into account -- see response to 44270
17066	54	3	54	3	Reference required, and you could also cross-reference Section 6.3.4.1 here as well. [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Taken into account -- see response to 44270
53598	54	6	54	6	Section 6.3.4.: "impacts" is very broad - and also used in a different way in WGII. I suggest changing to "Effects of SLCF" [Jan Fuglestvedt, Norway]	Accepted -- Impacts changed to effects
14750	54	6	54	6	The section could have a summary statement from AR5 and then assess what additional evidence is found since then, possibly for each subsection. [Frank Dentener, Italy]	Noted. Taken into consideration for the revision.
39382	54	6			The subsections 6.3.4.1 and 6.3.4.2 are meaningless because the contents are in confusion between the subsections and moreover included which should be in 6.3.4.3 on temperature and precipitation. [Toshihiko Takemura, Japan]	Taken into consideration for the revision and restructure of the sub-section.
14752	54	8	54	55	Question whether it is useful to separate transport and dynamics, in the second section there is a discussion on transport as well. [Frank Dentener, Italy]	6.3.4.1 and 6.3.4.2 are combined to be one sub-subsection
55808	54	11	54	11	Methane lifetime: several rough estimates are used throughout the chapter (about 11 years; about 10 years I read somewhere else). Table 6.2.2 says 9-12 years. In SOD it would be good to be consistent. I note a formal assessment of methane lifetime is currently a placeholder. [Christopher Smith, United Kingdom (of Great Britain and Northern Ireland)]	Accepted - text revised
37792	54	11	54	13	See comment 265. Even in this chapter, methane is described as well mixed. [Adrian Simmons, United Kingdom (of Great Britain and Northern Ireland)]	Noted -- we are distinguishing lifetime vs. mixing and are emphasizing the lifetimes for the selection criteria for species to address in chapter 6.

37794	54	11	54	13	Though it could be pointed out that the statement here applies to the troposphere but not the stratosphere. [Adrian Simmons, United Kingdom (of Great Britain and Northern Ireland)]	Accepted -- "in the troposphere" has been added.
45704	54	11			Methane lifetime - careful here as there are different definitions and the IPCC reader may not be up to speed with why some people say 9 years and some say 12. Best in a general discussion like this to say 'about a decade' and then be specific if you mean burden/annual input or e-folding or whatever. [Euan Nisbet, United Kingdom (of Great Britain and Northern Ireland)]	Accepted - text revised
12872	54	21	54	26	At the same time, emissions in proximity to snow and ice can have a great impact on the region. With increased transit within the Arctic, there will be increased localized pollution, including of climate-warming agents like black carbon that can further amplify warming by decreasing the albedo of the snow and ice surfaces it settles upon; reducing/eliminating sources of black carbon (e.g., the heavy fuel oil utilized in the shipping industry) are crucial to protecting the region. Stephenson S. R., et al. (2018) Climatic responses to future trans-Arctic shipping, GEOPHYSICAL RESEARCH LETTERS 45:9898–9908; Arctic Monitoring and Assessment Programme (AMAP) (2017) ADAPTATION ACTIONS FOR A CHANGING ARCTIC: PERSPECTIVES FROM THE BARENTS AREA; Arctic Council Secretariat (2017) EXPERT GROUP ON BLACK CARBON AND METHANE: SUMMARY OF PROGRESS AND RECOMMENDATIONS 2017; Sand M., et al. (2013) Arctic surface temperature change to emissions of black carbon within Arctic or midlatitudes, J. GEOPHYSICAL RESEARCH 118(14):7788–7798; see also Stohl A., et al. (2013) Black carbon in the Arctic: the underestimated role of gas flaring and residential combustion emissions, ATMOS. CHEM. PHYS. 13:8833–8855. [Durwood Zaelke, United States of America]	Taken into account -- see comment 12872
12702	54	21	54	26	At the same time, emissions in proximity to snow and ice can have a great impact on the region. With increased transit within the Arctic, there will be increased localized pollution, including of climate-warming agents like black carbon that can further amplify warming by decreasing the albedo of the snow and ice surfaces it settles upon; reducing/eliminating sources of black carbon (e.g., the heavy fuel oil utilized in the shipping industry) are crucial to protecting the region. Stephenson S. R., et al. (2018) Climatic responses to future trans-Arctic shipping, GEOPHYSICAL RESEARCH LETTERS 45:9898–9908; Arctic Monitoring and Assessment Programme (AMAP) (2017) ADAPTATION ACTIONS FOR A CHANGING ARCTIC: PERSPECTIVES FROM THE BARENTS AREA; Arctic Council Secretariat (2017) EXPERT GROUP ON BLACK CARBON AND METHANE: SUMMARY OF PROGRESS AND RECOMMENDATIONS 2017; Sand M., et al. (2013) Arctic surface temperature change to emissions of black carbon within Arctic or midlatitudes, J. GEOPHYSICAL RESEARCH 118(14):7788–7798; see also Stohl A., et al. (2013) Black carbon in the Arctic: the underestimated role of gas flaring and residential combustion emissions, ATMOS. CHEM. PHYS. 13:8833–8855. [Kristin Campbell, United States of America]	Taken into account -- see comment 12872
55710	54	24	54	24	Does *climate sensitivity* of absorbers increase with altitude, or *forcing magnitude (efficiency)*? [Larry Horowitz, United States of America]	Accepted -- what was meant here was forcing efficiency
43138	54	24	54	26	Section 6.3.1.5 Line 14-17 stated that “Despite a growing number of observational and modeling studies…., large uncertainties remain.” -- It is not clear that this implies "ample evidence" as stated here. [Luisa Molina, United States of America]	Rejected. Ample evidence can show large uncertainties.
17068	54	28	54	28	Delete , after interannual [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted - text revised

55824	54	37	55	31	The sub-sections here need to capture the more fuller paradigm of the interhemispheric forcings due to SLCFs (chiefly absorbing and scattering aerosols including the indirect effect), the ITCZ shift, and the resulting precipitation change. This is an important characteristic of the inhomogeneously distributed aerosols and is in fact one of the leading challenges in understanding the anthropogenic climate change. The paragraphs in the two sub-sections do not mention the circulation and climatic effects that have been studied for the Asian monsoon regions with an enunciation of the physics in the phenomena including the ITCZ shift, and how it leads to impacts on precipitation including contrasts in the effects between scattering and absorbing aerosol characteristics and that between aerosols and GHGs. As examples: Bollasina, Massimo, Yi Ming, and V Ramaswamy, 2011: Anthropogenic aerosols and the weakening of the South Asian summer monsoon. Science, 334(6055), DOI:10.1126/science.1204994. Bollasina, Massimo, Yi Ming, and V Ramaswamy, 2013: Earlier onset of the Indian Monsoon in the late 20th century: The role of anthropogenic aerosols. Geophysical Research Letters, 40(14), DOI:10.1002/grl.50719. Ocko, I B., V Ramaswamy, and Yi Ming, 2014: Contrasting Climate Responses to the Scattering and Absorbing Features of Anthropogenic Aerosol Forcings. Journal of Climate, 27(14), DOI:10.1175/JCLI-D-13-00401.1. Bollasina, Massimo, Yi Ming, V Ramaswamy, M Daniel Schwarzkopf, and Vaishali Naik, 2014: Contribution of Local and Remote Anthropogenic Aerosols to the 20th century Weakening of the South Asian Monsoon. Geophysical Research Letters, 41(2), DOI:10.1002/2013GL058183. Persad, Geeta, David J Paynter, Yi Ming, and V Ramaswamy, 2017: Competing Atmospheric and Surface-Driven Impacts of Absorbing Aerosols on the East Asian Summertime Climate. Journal of Climate, 30(22), DOI:10.1175/JCLI-D-16-0860.1. Persad, Geeta, Yi Ming, Zhaoyi Shen, and V Ramaswamy, 2018: Spatially similar surface energy flux perturbations due to greenhouse gases and aerosols. Nature Communications, 9, 3247, DOI:10.1038/s41467-018-05735-y. A theoretical explanation of the impact of the interhemispheric forcing on Sahel rainfall appears in: Hill, S A., Yi Ming, Isaac M Held,	Taken into consideration for the revision of both subsections. The references have been also taken into consideration.
17070	54	39	54	40	Change 'At' to 'On' and insert 'the' after 'On', insert 'are' after predominantly' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted -- changes made
15570	54	39	55	14	6.3.4.2 Effects through atmospheric dynamics: There exist a number of previous studies which showed that the SLCF is able to influence the atmospheric circulation in East Asia through perturbing the radiative forcing as well as the temperature meridional structure. In particular, the SLCF from China significantly influences on the monsoon circulation in East Asia during both winter and summer. This chapter should describe more details for this issue. A current version has no such information and description. [SANG-WOOK YEH, Republic of Korea]	Accepted- monsoon has been added in SOD. This also belongs to cross-chapter issues. Changes in monsoon by aerosols are also covered in Chapter 8.
55712	54	42	54	42	Transport of SLCFs broadens their distribution beyond emission region. Atmospheric circulation adjustments broaden impacts still further. [Larry Horowitz, United States of America]	Accepted -- transport has been added as a mechanism
17072	54	44	54	44	Delete , after 'circulation' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted - text revised
17074	54	50	54	50	Insert space after 'Arctic' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted - text revised
24896	54	55	55	1	Kasoar speculate that the responses are due to teleconnections, but do not show it. What is the AR6 assessment of the causes of long-range impacts? [William Collins, United Kingdom (of Great Britain and Northern Ireland)]	Accepted - more studies have been incorporated to come to an assessment in the SOD.
55708	54		57		This breakdown into sub-sectins doesn't seem very useful/balanced. [Larry Horowitz, United States of America]	6.3.4.1 and 6.3.4.2 are combined to be one sub-subsection

31088	55	5	55	8	Is the level of certainty the same across the chain? Cooling of the NH is virtually certain, but identification of changes in tropical precipitation patterns is more elusive or heavily dependent on models. [Nicolas Bellouin, United Kingdom (of Great Britain and Northern Ireland)]	Accepted - has been reviewed with more studies to have an assessment in SOD.
17076	55	7	55	7	Change 'cell' to 'Cell' and change 'an' to 'a' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted - text revised
53600	55	17	55	17	link to chapter 8? And section 4.4.4.? [Jan Fuglestvedt, Norway]	Taken into consideration.
47898	55	17	57	32	There are overlaps on SLCF (inc aerosols) and the hydrological cycle in Chapter 6 (both sections 6.3.4.3 and 6.3.1.2 overlap with each other) and with chapter 8 (e.g. in Section 8.2.2) and with chapter 7 (7.3.3.1 - aerosol cloud interactions) [WGI TSU, France]	Taken into consideration.
40706	55	17			Section 6.3.4.3 This is one of my more general comments. For page 7 line 32 I recommended more focus on temperature patterns. Here I would expand that recommendation to split this section into separate sections on temperature and precipitation patterns, and really expand the focus on precipitation. Many of my earlier comments have been to delete for brevity, here I think text could be expanded. Precipitation in crucial to agriculture, often more so than temperature. The discussion of regional shifts in precipitation is distinct from changes in global mean precipitation in section 6.3.1. There is a large and I gather contentious literature on shifts in the precipitation (mostly but not exclusively about shifts in the monsoons) as a function of changes in regional forcing. Where else but the chapter on SLCFs to assess it? I am not the expert on just what to say, there are chapter authors who should be able to do a good job. If increases in aerosols over India coupled with decreases over China change the regional patterns of solar heating, does that shift the monsoon? It is an important question. [Daniel Murphy, United States of America]	Taken into consideration for the revision of the sub-section.
24898	55	19	55	31	It is not clear how this paragraph is different from the above subsections. [William Collins, United Kingdom (of Great Britain and Northern Ireland)]	Taken into consideration for the restructuring of the sub-sections 6.3.4.2 and 6.3.4.3.
17078	55	26	55	26	Insert , after 'Therefore' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Noted -- section 6.3.4.3 no longer exists

11714	55	26	55	28	In particular in the Arctic remote changes occur e.g. Navarro et al. (2016), Lewinschal et al. (2019), Abbatt et al. (2019). Abbatt, J. P. D., Leaitch, W. R., Aliabadi, A. A., Bertram, A. K., Blanchet, J.-P., Boivin-Rioux, A., Bozem, H., Burkart, J., Chang, R. Y. W., Charette, J., Chaubey, J. P., Christensen, R. J., Cirisan, A., Collins, D. B., Croft, B., Dionne, J., Evans, G. J., Fletcher, C. G., Galí, M., Ghahremaninezhad, R., Girard, E., Gong, W., Gosselin, M., Gourdal, M., Hanna, S. J., Hayashida, H., Herber, A. B., Hesaraki, S., Hoor, P., Huang, L., Hussherr, R., Irish, V. E., Keita, S. A., Kodros, J. K., Köllner, F., Kolonjari, F., Kunkel, D., Ladino, L. A., Law, K., Levasseur, M., Libois, Q., Liggio, J., Lizotte, M., Macdonald, K. M., Mahmood, R., Martin, R. V., Mason, R. H., Miller, L. A., Moravek, A., Mortenson, E., Mungall, E. L., Murphy, J. G., Namazi, M., Norman, A.-L., O'Neill, N. T., Pierce, J. R., Russell, L. M., Schneider, J., Schulz, H., Sharma, S., Si, M., Staebler, R. M., Steiner, N. S., Thomas, J. L., von Salzen, K., Wentzell, J. J. B., Willis, M. D., Wentworth, G. R., Xu, J.-W., and Yakobi-Hancock, J. D.: Overview paper: New insights into aerosol and climate in the Arctic, Atmos. Chem. Phys., 19, 2527-2560, https://doi.org/10.5194/acp-19-2527-2019, 2019. Lewinschal, A., Ekman, A. M. L., Hansson, H.-C., Sand, M., Berntsen, T. K., and Langner, J.: Local and remote temperature response of regional SO2 emissions, Atmos. Chem. Phys., 19, 2385-2403, https://doi.org/10.5194/acp-19-2385-2019, 2019. Navarro, J. C. A., Varma, V., Riipinen, I., Seland, Ø., Kirkevåg, A., Struthers, H., Iversen, T., Hansson, H.-C., and Ekman, A. M. L.: Amplification of Arctic warming by past air pollution reductions in Europe, Nat. Geosci., 9, 277–281, https://doi.org/10.1038/ngeo2673, 2016. [David Neubauer, Switzerland]	The articles were taken into consideration.
17080	55	38	55	38	rlilpl looks odd (and if it is correct I don't know what it means) [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted -- this is notation for a particular member of an multi-integration ensemble, and has been removed for simplicity
55828	55	51	55	52	The physical processes involved with BC in convective and subsidence regions differ. This is part of the tropospheric adjustment process which has downstream implications for how precipitation would be impacted. See e.g., Persad, Geeta, Yi Ming, and V Ramaswamy, 2012: Tropical tropospheric-only responses to absorbing aerosols. Journal of Climate, 25(7), DOI:10.1175/JCLI-D-11-00122.1. [venkatachalam ramaswamy, United States of America]	The article was taken into consideration.
17082	56	4	56	4	Delete 'has been already pointed' and replace with 'noted' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Noted -- section 6.3.4.3 no longer exists
55826	56	4	56	5	BC may not always stabilize the atmosphere and can exhibit contrasting effects on precipitation. See, for example, Ming, Yi, V Ramaswamy, and Geeta Persad, 2010: Two opposing effects of absorbing aerosols on global-mean precipitation. Journal of Geophysical Research, 37, L13701, DOI:10.1029/2010GL042895. [venkatachalam ramaswamy, United States of America]	The article was taken into consideration.
24900	56	4	56	32	This paragraph can probably be cut down if it were rephrased as an assessment of the science knowledge rather than a list of studies. [William Collins, United Kingdom (of Great Britain and Northern Ireland)]	Taken into consideration. The paragraph was revised accordingly.

47938	56	12	56	12	Please check the use of this IPCC uncertainty language term. Are you able to provide a traceable account to assigning this uncertainty statement? Note that likelihood statements are quantified terms - phrases like likely and very likely have quantifiable probabilities associated with them. Please check it has been used correctly here. Please refer to the IPCC guidance note on uncertainty: https://wg1.ipcc.ch/SR/documents/ar5_uncertainty-guidance-note.pdf [WGI TSU, France]	Noted.
17084	56	15	56	15	Capitalise Northern Hemisphere [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Noted -- section 6.3.4.3 no longer exists
44274	56	18	56	20	Applicable here also is the study of Allen et al, in press, 2019 (in npjCAS) that suggests that the BC distribution used In most of the PDRMIP modeling (all those with prescribed concentrations) is biased relative to obsservations in its vertical profile, and this leads to a biased rapid adjustment. In simulations constrained to match observed profiles, the rapid adjustment flips sign to positive, so enhances the RF from BC rather than weakening it. The fact that there was a large multi-model ensemble doesn't mean either that it's right or that the design really tested the possible range of rapid adjustments (and in this case, we have clear indications it didn't). [Drew Shindell, United States of America]	Taken into consideration for the revision of this sentence.
17086	56	19	56	19	Do you mean responses occurring within or over a week, or is this a typo for 'weak' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted -- typo for "weak"
17088	56	24	56	24	Insert space after full stop [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Noted -- section 6.3.4.3 no longer exists
40708	56	34	56	49	As in my previous comments, this paragraph needs to distinguish temperature patterns that are general to most forcings and those that are specific to particular forcings. [Daniel Murphy, United States of America]	Taken into consideration for the revision of the sub-section.
38346	56	34	56	49	This paragraph and the paragraph at Page 54 L48 – Page 55 L1 discuss the same topic. This part can be removed, shortened, or combined. [Hitoshi Matsui, Japan]	Noted -- earlier paragraph concerned teleconnected temperature response, while this paragraph addresses long-distance impacts of SLCFs on precipitation (mainly)
17090	56	36	56	36	Change to SO2 [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Noted -- section 6.3.4.3 no longer exists
17092	56	41	56	41	Change to SO2 [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Noted -- section 6.3.4.3 no longer exists
17094	56	44	56	44	Change to 'Earth System' for parity with Chapter 5 [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Noted -- section 6.3.4.3 no longer exists
45706	57	1			re comment above - here it says of the order [of] 10 years: missing of, but better to say loosely 'about a decade'. [Euan Nisbet, United Kingdom (of Great Britain and Northern Ireland)]	Noted -- section 6.3.4.3 no longer exists
17096	57	9	57	9	Insert , after 'chemistry' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Noted -- section 6.3.4.3 no longer exists
9298	57	14	57	21	Concluding that single-model studies are estimated less reliable than multi-model ensembles is not a breakthrough. Unless you know of many cases which go the other way around, I suggest removing the last sentence. [philippe waldteufel, France]	Noted -- this is being stated explicitly that overinterpretation of single-model studies is not warranted. We are not claiming this is a breakthrough.

55714	57	15	57	21	Can any statement be made regarding the relative sources of uncertainty from emissions, concentration distributions, and direct/indirect RF/adjustments? [Larry Horowitz, United States of America]	Taken into consideration for the revision by adding discussion on the different kind of uncertainties. AR5 was pointing that models vary considerably in their representation of aerosols and their radiative properties, resulting in a large uncertainty in aerosol radiative forcing. Large uncertainty remains in the simulation of aerosol processes as for example how differently models parameterize aerosol removal processes including both wet and dry removal as well as aerosol-cloud interactions. Large uncertainty and range among model results exists also as to the climate response to removing anthropogenic BC emissions due partly to the different atmospheric BC distributions in the models. When investigating the climate response to regional aerosol emissions, such uncertainties are likely to be confounded even further by the variability between models in regional climate and circulation patterns, and variation in the global and regional climate sensitivity. Large uncertainty exists in the simulation of aerosol processes.
14754	57	15	57	32	The summary cautioning against using single models reads a bit lengthy- and it is probably something that is true for a wider range of model studies not unique to this problem. Can this section say something more quantitative about the possible NO3 feedback when reducing SO2 emissions? [Frank Dentener, Italy]	Noted -- section 6.3.4.3 no longer exists
31090	57	18	57	21	There is the ever-present question of model weighting, though. Not all models are equal in the quality and range of their representation of SLCF forcing mechanisms. [Nicolas Bellouin, United Kingdom (of Great Britain and Northern Ireland)]	Noted -- but this question is beyond the purview of this chapter, as it involves every aspect of an ESM that affects SLCFs: transport, hydrological cycling, emissions, reactive and heterogeneous atmospheric chemistry, aerosol microphysics, aerosol / cloud interactions, and so forth.
9300	57	24	57	27	If I am not mistaken, methane belongs to both categories… [philippe waldteufel, France]	Accepted -- "GHG" has been changed to "LLGHG"
41592	57	29	57	29	"may lead to the strongest response" of what? Climate? All SLCFs? And compared to what? All climate forcings, all SLCFs? [Amanda Maycock, United Kingdom (of Great Britain and Northern Ireland)]	With regard to the reductions in BC and OC. The text has been revised accordingly to clarify this point.
17098	57	29	57	29	Change to SO2 [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Noted -- section 6.3.4.3 no longer exists
17100	57	30	57	30	Capitalise Northern Hemisphere [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Noted -- section 6.3.4.3 no longer exists
53602	57	31	57	32	Can you also say something about temperature signal here (not only foricng) ? [Jan Fuglestvedt, Norway]	Noted -- we discussed the qualitatively similar temperature change patterns in line 29 immediately above.

14758	57	39	58	26	The section contains sentences like 'often perceived', common statement->these have to be underpinned focusing on how approaches to quantify SLCF climate imapcts have changed since AR5. II am confused by the term 'rate of emission' on 58/3. Rate of emission change? Or the amount of emissions? 58/22-26 is a repetition of earlier sections. [Frank Dentener, Italy]	Noted, corrections have been done in FGD
44276	57	40	57	40	It'd be good to use LLGHG or LLCF consistently rather than both terms. [Drew Shindell, United States of America]	In the FGD, LLGHG has been adopted throughout. 'LLCF' is not used anymore
14756	57	43	57	43	whether reductions are sustained over time, will also depend on the development of the economic activities- as is often witnessed in emission scenarios that turn up again if no further emission mitagation is assumed. [Frank Dentener, Italy]	We agree but this is beyond the scope of the discussion in this subsection which is focussed on the response time to arbitrary SLCF reductions
55774	57	49	58	4	Abother interesting study: Krayenhoff, E. S., Moustaoui, M., Broadbent, A. M., Gupta, V., and Georgescu, M (2018). Diurnal interaction between urban expansion, climate change and adaptation in 21st century U.S. cities, Nature Climate Change, 8: 1097–1103. DOI: 10.1038/s41558-018-0320-9. [Ariane Middel, United States of America]	Noted
29086	57	51	57	51	This is a useful plot. Would it be possible to include CO2 on this? [Keith Shine, United Kingdom (of Great Britain and Northern Ireland)]	CO2 added to plot. Currently Figure 6.15 in SOD.
17102	57	52	57	52	Edit reference to Boucher and Reddy (2008) [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	no longer referenced
17104	57	55	57	55	Change 'like' to 'such as' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Editorial
47912	57		62		Assessment Structure: If possible, assessment conclusions should be provided in a structured traceable account of how these statements were derived. For example, sections / subsections can start with previous IPCC report conclusions (AR5 or AR6 Special Reports) and then provide an update of the more recent literature, clearly laying out the lines of evidence. Each section / subsection can then conclude with assessment statements. This section currently reads more as a review than an assessment. In addition, please make sure the ES uncertainty language is clearly tracable to the underlying chapter text. [WGI TSU, France]	Taken into consideration in the revision.
17106	58	1	58	1	Quantify 'first decades' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Rejected. This would based on the schematic of fig 6.9, and can be seen from the figure.
53604	58	1	58	4	I suggest some link to and cooridnation with section 7.7 on this [Jan Fuglestvedt, Norway]	Taken into account - LAM3
17108	58	4	58	4	Change to CO2 [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Editorial
17110	58	7	58	7	Change 'have' to 'has' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Editorial
17112	58	8	58	8	Capital S for section x 2 [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Editorial
53606	58	13	58	17	The figure shows an important point, but may need some improvement in term of color of the cases and overlaps (just remove one case?). Can CO2 be added? [Jan Fuglestvedt, Norway]	Taken into account. The quality of the figure has been improved. CO2 (with appropriate impulse response function for CO2 concentrations) ha been added.

47922	58	13	58	18	Basing this figure off IRF from 2008 seems outaded for a report that will be published in 2021 and which shoudl be an update on the AR5. Could this figure be updated and could CO2 be added as a comparison (to help policymakers get a sense of the differences)? [WGI TSU, France]	Taken into account. The figure uses the same IRF as is used for GTP-values presented in the AR6, including a climate sensitivity that is consistent with the best estimate from Chapter 7. Also CO2 has been added.
17114	58	15	58	15	Change to exponential [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Editorial
17116	58	16	58	17	Sentence ('The calculation…') does not make sense [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Editorial. Changed.
38348	58	22	58	26	The first sentence in this paragraph is almost the same with the first sentence in the previous paragraph (Page 58, L6). [Hitoshi Matsui, Japan]	Accepted. Text has been rewritten to avoid repetition
17118	58	26	58	26	This is misleading, the hydrological cycle is not going to change location, as it is effectively a global system. What I think you mean is that components of the hydrological cycle will change (particularly intensities of evaporation and precipitation). [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted. Text has been rewritten to avoid confusion.
53608	58	29	58	29	Aviation and shipping are sectors with important contributions from SLCF. As far as I can see, aviation is not mentioned in the chapter, and shipping only a couple of times. The authors may consider including some material on these sectors. (Shipping and aviation was suggested as topics for a Special Report. Themes not selected would be adressed in the main reports) [Jan Fuglestvedt, Norway]	Accepted - text revised. Now include Section 6.5.2.2 on assessment of Aviation sector post AR5. Shipping is addressed in Section 6.5.3.2.
31092	58	29	58	29	There is no mention of aviation in that section. In fact, none in the whole chapter. That seems like an important sector to discuss. No new studies to assess? [Nicolas Bellouin, United Kingdom (of Great Britain and Northern Ireland)]	Accepted - text revised. Now include Section 6.5.2.2 on assessment of Aviation sector post AR5.
17120	58	37	58	40	Delete hyphens before 'years' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Not Applicable.
17122	58	39	58	39	Change to CO2 [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Not Applicable.
17124	58	41	58	41	Change to CO2 [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Not Applicable.
17126	58	43	58	43	Change to CH4 [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Not Applicable.
24902	58	43	58	45	It would be good to summarise the new knowledge since AR5 here (presumably this is what is discussed in detail in 6.4.2.1-6.4.2.4 [William Collins, United Kingdom (of Great Britain and Northern Ireland)]	Accepted - text revised. Provide an assessment of new knowledge since AR5 throughout now in Section 6.5.2.
14760	58	45	58	45	biomas burning=>large scale biomass burning [Frank Dentener, Italy]	Accepted - text revised. We now refer to "open biomass burning".
17128	58	50	58	50	Insert , after 'Worldwide' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Not Applicable.
14762	58	50	59	4	This is repetition of earlier sections on emissions. Authors need to find a way to avoid duplicating too much. [Frank Dentener, Italy]	Accepted - text revised. Thank you. Emissions are covered in Section 6.2. Impacts of SLCFs on RF and AQ by source sector attribution are discussed in Section 6.4.2. Section 6.4.2. covers some aspects of specific source types with relevance to the RF.
24904	58	50			Section 6.4.2.1 This needs to make an assessment of what the AR6 finds, rather than list studies. [William Collins, United Kingdom (of Great Britain and Northern Ireland)]	Accepted - text revised in now Section 6.5.2. Assessment provided throughout.

17130	58	51	58	51	Quantify 'last decades' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Noted. Text no longer included.
17132	59	6	59	6	low confidence' should be in italics [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted - text revised
14764	59	6	59	13	Would you be able to give a central value of 0 RF (globally), with large uncertainties given by the ranges. It is not clear what to do with this information. "allowing BC to act as CN"=>explain that the previous estimates did not consider the ice nucleation process, inclusion would further increase the uncertainty range. [Frank Dentener, Italy]	Noted. We assess low confidence. Too uncertain to provide a quantitative estimate of net RF.
17134	59	7	59	7	Edit reference to Kodros et al. (2015) [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Editorial. Mendeley formatting issues to be fixed by TSU.
17136	59	8	59	8	Exponentials required for rates [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted - text revised.
17138	59	10	59	10	Edit reference to Butt et al. (2016) [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Editorial. Mendeley formatting issues to be fixed by TSU.
17140	59	11	59	12	Exponentials required for rates and don't split units across line [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted - text revised.
14772	59	11	59	13	There is a short LULUC section in Chapter which could include a forward reference to this section on the role of SLCFs. What is the assessment of 45 of net anthropogenic forcing? It is a large number, can something be said about issues like 'double counting'. I am aware of similar estaimtes for the agricultural sector based on LCA principles that state that 20-30% of the CO2eq emissions are due to agriculture. Chapter 2 mentions the existence of large uncertainties (fast feedbacks) related to the hydrological cycle. I assume that could have repercursions for the SCLFs as well? [Frank Dentener, Italy]	Accepted. See response to #24908.
48126	59	14	59	24	Please check the Special Report on Land for overlap (relevant sections are chapter 2 section 2.5 - particularly section on BVOC emissions, chapter 3 Section 3.3 and 3.4 on desertification and dust emissions on climate) and provide cross-references to the report where appropriate. [WGI TSU, France]	Accepted - text revised. Confirm that assessment provided in Section 6.5.2.5 on Land use change is consistent with SRCCL and Chapter 2 of AR6.
14774	59	15	59	24	I am wondering whether the authors can quantify 'substantial', as the reader is left without any feeling on how large the magnitude/uncertainty of these processes can be? [Frank Dentener, Italy]	Accepted - text clarified with confidence levels. "Substantial" not used in assessment report.
17142	59	17	59	17	high confidence' should be in italics [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted - text italicized.
17144	59	17	59	17	Insert , after 'pollution' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted - text corrected
11716	59	21	59	23	Are there also estimates for burden of disease? [David Neubauer, Switzerland]	Rejected - beyond the mandate of the report. Burden of disease calculations not assessed in AR6 WG1.
14766	59	26	59	36	Can you give forcing numbers like in earlier section? If I remember well large uncertainties were associated with injection heights, and placement of plumes above plumes? I think there is still a large (factor of two) difference in global estimates of large scale biomass burning emissions, so I am wondering how this can lead to high agreement. Is the high agreement also for RF estimates. What are the quantitative health impacts of biomass burning. How does the variety of estimates of the 'anthropogenic' fraction of large scale biomass burning imapct the RF and health impacts. [Frank Dentener, Italy]	Accepted - text revised. Thank you for the helpful and important questions. Summary of the assessment of attribution of RF to open biomass burning (based on new knowledge since AR5) is now included in Section 6.5.2.4. AR6 WG1 does not assess quantitative health effects - beyond the mandate of the report.

54200	59	28	59	31	It might be worth mentioning brown carbon (BrC) as another absorber, related to biomass burning. Biomass burning is considered one of the major sources for BrC, including both primary emissions and secondary formation of humic-like substances (HULIS). In contrast to BC, which absorbs at all visible wavelengths, BrC shows much stronger absorptivity at short visible and ultraviolet wavelengths, posing a strong warming effect at the top of the atmosphere, which could be a significant effect compared to the net positive forcing from BC. [Jingqiu Mao, United States of America]	Noted. No quantitative estimates of BrC global RF from open biomass burning found in climate modelling literature to date. Global RF assessment cannot be included at this stage. BrC is discussed in Section 6.2.2.8.
47942	59	29	59	29	Please check the use of this IPCC uncertainty language term. Are you able to provide a traceable account to assigning this uncertainty statement? Note that likelihood statements are quantified terms - phrases like likely and very likely have quantifiable probabilities associated with them. Please check it has been used correctly here. Please refer to the IPCC guidance note on uncertainty: https://wg1.ipcc.ch/SR/documents/ar5_uncertainty-guidance-note.pdf [WGI TSU, France]	Accepted - text revised. Text is now in Section 6.5.2.4. Assessment refers to confidence level rather than quantitative uncertainty estimate for attribution of sector RFs.
25988	59	33	59	33	I would think that it is well established that biomass burning affects air quality, in which case the evidence is not growing since it already exists. Suggest reconsidering this statement to be for example like that of line 28 (robust evidence/high agreement). [Haroon Kheshgi, United States of America]	Accepted - text revised. "Growing" originally referred to biostatistics/epidemiological/human health effects calculations rather than AQ atmospheric concentrations. Section 6.5.2.4 now assesses RF and AQ impacts on open biomass burning thus: "It is well established that fire emissions influence regional air quality (Knorr et al., 2017; Liu et al., 2017; Reddington et al., 2015; Val Martin et al., 2015) (high agreement, robust evidence)."
14770	59	42	60	24	It may be useful to go back to AR5 and the SR Land, to see what were the key statement, and how they are modified here and if numbers are self-consistent. E.g is the estimate of cropland of 9-10 % consistent with the 34 % of crop+range land? NH3 can probably go to a seperate agriculture section (and mostly associated with animal production sytems). [Frank Dentener, Italy]	Accepted. See revised Section 6.5.2.5 that refers to SRCCL. Consistent land cover change with Chapter 2 and SRCCL.
17146	59	43	59	43	delete , after 'forestry' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted - text corrected.
24906	59	44	59	46	Check these land surface changes are consistent with Ch 2. [William Collins, United Kingdom (of Great Britain and Northern Ireland)]	Accepted. Confirm consistent with Section 2.1.1 and SRCCL.
14768	59	46	59	46	I assume 'can influence emissions, concentrations, and impacts/'> [Frank Dentener, Italy]	Accepted - text clarified.
17148	59	54	59	54	Capital S for 'system' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Rejected.
17150	60	2	60	3	Poorly constructed sentence ('There is no…forcing'). I suggest 'Do you mean 'changes influencing global..'? [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Not Applicable. Sentence no longer in Section 6.5.2.5
17152	60	3	60	3	Overgrasing? Too much grass, or do you mean overgrazing? [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted. Typo corrected to "overgrazing" in Section 6.5.2.5
26978	60	3	60	6	The first sentence is misleading. The activities given there may, alone or in various combiniation, result in desertification, but they must not (as this sentence implies). So, please use the definition of "desertification" as given by the U.N. Convention to Combat Desertification. [Joachim Rock, Germany]	Accepted - text revised in Section 6.5.2.5. No longer discuss desertification in this section.

17154	60	7	60	7	Date missing from reference [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted - corrected.
24908	60	9	60	10	This Ward et al. 2014 study seems to show an extremely high impact of LULCC. How robust this this? How much of this is SLCFs? [William Collins, United Kingdom (of Great Britain and Northern Ireland)]	Accepted - text revised. Thank you for important questions. Ward et al., 2014 estimate Included fire & dust estimates as well as BVOCs. It is a single model study not yet replicated in other ESMs. Ward et al. is cited in Section 6.5.2.5 without the quantitative results. Overall the impact of land use change on SLCFs has been attributed low confidence.
24910	60	10	60	13	The effects of SLCFs will be included for the LUMIP scenarios run with full ESMs. [William Collins, United Kingdom (of Great Britain and Northern Ireland)]	Noted. In fact, we checked with LUMIP and AerChemMIP, and only one model (UKESM1) includes SLCFs in land use change runs. To our knowledge, there are no expected AerChemMIP-LUMIP multi-model assessments of land use change impacts on SLCFs because only one single model has included them. In most AerChemMIP models, the chemistry is not actually coupled dynamically with the climate model's land surface. Oftentimes prescribed offline datasets of e.g. PFTs are used to simulate BVOC emissions, and those could be different from the host climate model.
24912	60	27			It is not obvious why megacities are given such prominence unless megacity emissions behave differently to other emissions. [William Collins, United Kingdom (of Great Britain and Northern Ireland)]	Not applicable, This section about megacities is no longer in the chapter
14776	60	29	61	41	In contrast to the earlier sector, that considers sectors with aggregrated components. The rationale for looking at this could be clarified in the sense that planning and political action on SLCF are typically on national, regional (UNECE!), but potentially also a city level. However, spill-over effects (what emissions are attributed to the city) are increasingly playing a role when refining scales. Like for megacities, a discussion on regional/continental scale emission reduction impacts would be appropriate here. I think the 'annihilation' word is a bit strange- often used are the terms 'zero-out', which gives less the feeling of 'mass-destruction'. [Frank Dentener, Italy]	Not Applicable, section no longer included in the chapter
17156	60	31	60	31	Capital S for 'section' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Editorial

43140	60	31	60	36	It is important to note that this is the UN definition of megacities (10 million or more inhabitants); however, based on this definition, Europe has only three megacities (Moscow, Istanbul and Paris) in 2018. London will make the list in 2030. Also, the city boundary defined in the UN report, in some instances, are different from the country. For example, according to the UN report, there are 6 megacities in China with a metropolitan population in excess of 10 million in 2018, but according to China Statistics Bureau [2017], China has 15 cities with population over 10 M (i.e., megacities). Reference: China Statistics Bureau, 2017, China Statistical Yearbook 2017, http://data.stats.gov.cn/easyquery.htm?cn=C01 Perhaps instead of focusing on megacities (inhabitants of 10M or more), one should include the cities or urban complexes with population of 5 - 10 million, which have all the characteristics of megacities (e.g., Santiago, Chile; Bogota, Colombia). [Luisa Molina, United States of America]	Not applicable, This section about megacities is no longer in the chapter
17158	60	40	60	40	Delete , after 'Bangkok' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Editorial
47692	60	41	60	42	"Modern megacities" is a confusing term and not precise. I assume it means newer megacites in terms of classification i.e. due to increasing populations > 10M. "Modern" can also imply large cities with new technology and innovative urban design. Newly classified megacities may be a more precise term. [Ranjeet Sokhi, United Kingdom (of Great Britain and Northern Ireland)]	Not applicable, This section about megacities is no longer in the chapter
17160	60	49	60	49	Change 'emision' to 'emissions' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Editorial
17162	60	51	60	51	Delete , after Dhaka [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Editorial
45712	60	51			this comment on CO is surely badly outdated. In the rich nations CO emission from petrol vehicles have come right down to very low values, and one of the few good benefits to come from the diesel scandal is that CO emisisons are very low. However in the tropical nations CO emissions are likely extremely high over many explosively growing new megacities, both from biomass cooking and also from poorly regulated petrol vehicles. [Euan Nisbet, United Kingdom (of Great Britain and Northern Ireland)]	Not applicable, This section about megacities is no longer in the chapter
56690	60	53	60	54	The statements on "correlations between emissions and population density" in emission inventories can be considered in the context of publications including Moran et al. (2018) on "Carbon footprints of 13 000 cities" in Environmental Research Letters 13(6): 064041. [Kilkis Siir, Turkey]	Not applicable, This section about megacities is no longer in the chapter but the way urbanization is considered for future projection in SSP is discussed in section 6.6.1.2.
17164	60	54	60	54	Please give more information. What do these hypotheses show, and are they accurate/proven? [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Not applicable, This section about megacities is no longer in the chapter
17166	61	6	61	6	Edit references, remove , after Forberth and replace & with 'and' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Editorial. Mendeley formatting issues to be fixed by TSU.
17168	61	6	61	6	Don't capitalise 'annihilation' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Editorial
24914	61	11	61	41	Do these megacity emissions behave any differently to countrywide emissions i.e. is the radiative forcing per emission any different? If not then it is now obvious that much of this text is needed. [William Collins, United Kingdom (of Great Britain and Northern Ireland)]	Not applicable, This section about megacities is no longer in the chapter

17170	61	15	61	15	Replace & with 'and' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Editorial. Mendeley formatting issues to be fixed by TSU.
17172	61	16	61	16	Delete hyphens before 'year' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Editorial
17174	61	20	61	20	Replace & with 'and' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Editorial. Mendeley formatting issues to be fixed by TSU.
17176	61	31	61	31	Replace) with ; and insert space before Forberth [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Editorial. Mendeley formatting issues to be fixed by TSU.
17178	61	33	61	33	low confidence should be in italics [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Editorial
17180	61	38	61	38	Delete , after 'Stock' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Editorial. Mendeley formatting issues to be fixed by TSU.
47694	61	39	61	41	This is a very important point and needs to be emphasised as reliable qualitification and understanding of RF due to urban areas can not be investigated with current global modelling approaches and higher resolution approaches should be encouraged through collaborative studies. [Ranjeet Sokhi, United Kingdom (of Great Britain and Northern Ireland)]	Noted. But this subsection is no longer in the chapter due to limitations in studies quantify the impact of megacities on climate though SLCF emissions.
50020	61	39			Should “request” be “requires”? [Owen Cooper, United States of America]	Editorial
47924	61	44	63	35	The SR1.5 stated that SLCF mitigation has co benefits with AQ, and that mitigation measures that target SLCFs can also reduced CO2 in some instances. It also stated that global mitigation pathways see a short-term warming from SLCF mitigation strategies. For example please see SPM section C1, Chapter 2 ES, Chapter 4.4.3. Can this section/ chapter build on from the key points from this report and develop this further (from a WGI-type science perspective)? If relevant, please cross-reference or cite this report. [WGI TSU, France]	Not applicable, This section is no longer in the chapter. Elements regarding mitigation of SLCF for air quality purpose and its potential impact on climate are now discussed in 6.5.3
53610	61	46	61	46	the effects of SLCF are often discussed in terms of RF. The regional distribution of RF does not tell the full story due to a different temperaure resposne pattern. I suggets making this very clear, and also have some more focus on temperature pattern of the response. [Jan Fuglestvedt, Norway]	Not applicable, This section is no longer in the chapter. Elements regarding mitigation of SLCF for air quality purpose and its potential impact on climate are now discussed in 6.5.3
14778	61	46	61	46	It would be useful to summarize the starting point from AR5 and then build on it to demonstrate how knowledge has evolved. [Frank Dentener, Italy]	Not Applicable, section no longer included in the chapter
45710	62	5			Very Eurocentric. The big air pollution impacts are in India, China and the huge new African cities where biomass and plastic buring are extreme. [Euan Nisbet, United Kingdom (of Great Britain and Northern Ireland)]	Not applicable, This section is no longer in the chapter. Elements regarding mitigation of SLCF for air quality purpose and its potential impact on climate are now discussed in 6.5.3
17182	62	6	62	6	Change 1970's to 1970s [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Editorial
43142	62	7	62	7	Missing words: "… 71% for and 69.5% for PM2.5" -- 71% for what? [Luisa Molina, United States of America]	Not applicable, This section is no longer in the chapter. Elements regarding mitigation of SLCF for air quality purpose and its potential impact on climate are now discussed in 6.5.3
44280	62	11	62	11	Sign seems wrong on temperature, should be warmer for non-mitigated, not cooler. [Drew Shindell, United States of America]	Not applicable, This section is no longer in the chapter. Elements regarding mitigation of SLCF for air quality purpose and its potential impact on climate are now discussed in 6.5.3

24916	62	12	62	13	If this data is of low confidence then it probably isn't useful to quote values from it, but rather give the overall message. [William Collins, United Kingdom (of Great Britain and Northern Ireland)]	Not applicable, This section is no longer in the chapter. Elements regarding mitigation of SLCF for air quality purpose and its potential impact on climate are now discussed in 6.5.3
50022	62	15			I don’t know what is meant by “Future emission control strategies need of holistic approach to quantify…” Are the authors trying to say that attention needs to be paid to the trade-offs between air quality and climate change benefits when designing emission control strategies? [Owen Cooper, United States of America]	Not applicable, This section is no longer in the chapter. Elements regarding mitigation of SLCF for air quality purpose and its potential impact on climate are now discussed in 6.5.3
17184	62	18	62	18	Insert space between)(and delete , after 'emissions' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Editorial
47516	62	20	62	22	When giving sector specific breakdown of regional emission totals, add regional population or regioan per capita emissions for a fair comparison [Birgit van Munster, United Kingdom (of Great Britain and Northern Ireland)]	Not applicable, This section is no longer in the chapter. Elements regarding mitigation of SLCF for air quality purpose and its potential impact on climate are now discussed in 6.5.3
50024	62	23	62	34	Here the text is straying from the goals of WGI, which is to assess our understanding of the physical science basis for climate change. This paragraph is discussing mitigation strategies and even making recommendations as to which ones would be most effective. The goal of IPCC Working Group III (WGIII) is to assess mitigation response options, and the topic of this paragraph should be covered by WGIII. [Owen Cooper, United States of America]	This paragraph is no longer in the chapter but note that this subject is cross-cutting with WG3 but WG3 does not fully quantify the impact of mitigation on AQ and does not discuss SLCF reduction due to purely air quality oriented policies and their impact on climate. For these reasons chapter 6 tries to compare the impact of SLCF reduction for various purposes.
17186	62	25	62	25	Change to near-term [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Editorial
44282	62	26	62	27	Not so much reduce fossil fuels thembsleves, though that would of course also work, but more to reduce "leakage from" fossil fuel extraction and distribution systems. [Drew Shindell, United States of America]	Not applicable, This section is no longer in the chapter. Elements regarding mitigation of SLCF for air quality purpose and its potential impact on climate are now discussed in 6.5.3
45708	62	27			do you mean reduce fossil fuel extraction? Or reduce emissions from fossil fuel extraction? That's different. I'd like to cut both, but the easy target is stopping emissions - lots of new tech to cut gas leaks and also gas vented from coal. The hard target is shutting down the gas industry altogether, which is what this text currently says. [Euan Nisbet, United Kingdom (of Great Britain and Northern Ireland)]	Not applicable, This section is no longer in the chapter. Elements regarding mitigation of SLCF for air quality purpose and its potential impact on climate are now discussed in 6.5.3
17188	62	30	62	30	Edit reference to Stohl et al. (2015) [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Editorial. Mendeley formatting issues to be fixed by TSU.
17190	62	32	62	32	Better to replace 'this study' with reference details for clarity [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Editorial
24918	62	41	62	43	It is probably not worth quoting specific values from a single study. [William Collins, United Kingdom (of Great Britain and Northern Ireland)]	Not applicable, This section is no longer in the chapter. Elements regarding mitigation of SLCF for air quality purpose and its potential impact on climate are now discussed in 6.5.3

17192	62	42	62	43	Insert space between numbers and units [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Editorial
44286	62	42	62	43	I'd think that it would be more useful to split out the various SLCFs, with probably high confidence in the sign and magnitude of climate effects for methane and F-gases, lower for aerosols & non-methane ozone precursors. [Drew Shindell, United States of America]	Not applicable, This section is no longer in the chapter. Elements regarding mitigation of SLCF for air quality purpose and its potential impact on climate are now discussed in 6.5.3
44284	62	45	62	45	Not just co-emitted OC variations, but also local/regional albedo I believe. Near high albedo regions (snow/ice or deserts), BC tends to outweigh OC, whereas the opposite is true for areas whose emissions get carried out over oceans, etc. [Drew Shindell, United States of America]	Not applicable, This section is no longer in the chapter.
47696	62	52	63	6	It is usueful to consider the impacts of individial SLCF species but given that mitigation affects multiple species it is more important to consider the combined or integrated impacts of SLCP + GHG reductions/mitigation on climate and air quality. [Ranjeet Sokhi, United Kingdom (of Great Britain and Northern Ireland)]	Not applicable, This section is no longer in the chapter. Elements regarding mitigation of SLCF for air quality purpose and its potential impact on climate are now discussed in 6.5.3
47944	62	53	62	53	Please check the use of this IPCC uncertainty language term. Are you able to provide a traceable account to assigning this uncertainty statement? Note that likelihood statements are quantified terms - phrases like likely and very likely have quantifiable probabilities associated with them. Please check it has been used correctly here. Please refer to the IPCC guidance note on uncertainty: https://wg1.ipcc.ch/SR/documents/ar5_uncertainty-guidance-note.pdf [WGI TSU, France]	Not applicable, This section is no longer in the chapter. Elements regarding mitigation of SLCF for air quality purpose and its potential impact on climate are now discussed in 6.5.3
24920	62	53	62	53	Surely reducing CH4 "will" benefit climate and air quality, rather than "likely to". [William Collins, United Kingdom (of Great Britain and Northern Ireland)]	Not applicable, This section is no longer in the chapter. Elements regarding mitigation of SLCF for air quality purpose and its potential impact on climate are now discussed in 6.5.3
24922	63	1	63	6	There has been a lot more literature on BC since Bond et al. 2013. Some of it critical of the Bond et al. study. [William Collins, United Kingdom (of Great Britain and Northern Ireland)]	Not applicable, This section is no longer in the chapter. Elements regarding mitigation of SLCF for air quality purpose and its potential impact on climate are now discussed in 6.5.3
24924	63	4	63	6	The impact of CO2 mitigation on SLCFs is very important and needs to be expanded upon here. [William Collins, United Kingdom (of Great Britain and Northern Ireland)]	Not applicable, This section is no longer in the chapter. Elements regarding mitigation of SLCF for air quality purpose and its potential impact on climate are now discussed in 6.5.3
17194	63	13	63	13	Delete , after al. [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Editorial. Mendeley formatting issues to be fixed by TSU.
53612	63	17	63	17	It is not clear why the overall target is strickter. Would be good if that can be made clear. [Jan Fuglestvedt, Norway]	Not applicable, This section is no longer in the chapter. Elements regarding mitigation of SLCF for air quality purpose and its potential impact on climate are now discussed in 6.5.3
17196	63	19	63	19	Insert 'the' after 'achieving' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Editorial
17198	63	23	63	23	delete space after first 2018 and rep;ace sec onf ; with full stop [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Editorial. Mendeley formatting issues to be fixed by TSU.

50026	63	23	63	26	This sentence is poorly written and I don't understand the description of the trade-offs. [Owen Cooper, United States of America]	Not Applicable, section no longer included in the chapter
50028	63	28	63	35	This paragraph focuses on the need for regional models to assess the relevance of air pollution reduction policies. This is going beyond the scope of WGI which is to assess our understanding of the physical science basis for climate change. [Owen Cooper, United States of America]	This paragraph is no longer in the chapter but note that "connections to air quality" were listed as keywords of the chapter outline defined during the AR6 WG1 scoping meeting.
14780	63	35	63	35	The section misses a clear summary statement with uncertainties. [Frank Dentener, Italy]	Noted but not applicable this section has been totally rewritten
17200	63	45	63	45	Insert , after 'is' and 'however' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Editorial, done
47698	63	49	64	24	There is no mention that climate change will also affect boundary layer evolution and dynamics e.g.through changes in temperature and RH as well as ocurrence of anticyclonic events. Changes in BL will affect AQ directly. There will also be heterogeniety and will require higher resolution models. [Ranjeet Sokhi, United Kingdom (of Great Britain and Northern Ireland)]	Accepted. Boundary layer evolution added. It is not up to IPCC reports to suggest development of new tools.
11718	63	49	64	24	In Chapter 7, subsection 7.4.2.5.1 Non-CO2 biogeochemical feedbacks further feedbacks are discussed [David Neubauer, Switzerland]	Noted.
11720	63	49	64	24	Allen et al. (2019) describe an increase in aerosol due to reduced wet removal associated with reduced precipitation over land in a warmer climate. Allen, R. J., Hassan, T., Randles, C. A., Su, H.: Enhanced land-sea warming contrast elevates aerosol pollution in a warmer world. Nature Climate Change 9, 300-203, 2019. https://doi.org/10.1038/s41558-019-0401-4 [David Neubauer, Switzerland]	Accepted. Specific sentence added.
41234	63	51	64	24	there has also been the discussion that changes in precipitation patterns from climate change affected the global lifetime of aerosols (see https://www.nature.com/articles/nclimate2827). [Jean-Francois Lamarque, United States of America]	Accepted. Specific sentence added.
17202	63	52	63	53	Don't' use etc, give all details [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Rejected. Too complicate to provide a complete list.
24928	63	55	63	55	Silva et al. 2017 DOI: 10.1038/NCLIMATE3354 discuss the impact of climate change on AQ mortality and should be included here. [William Collins, United Kingdom (of Great Britain and Northern Ireland)]	Accepted
48568	63		64		This chapter is very nicely written however I don't find any mention about how climate change will affect boundary layer evolution and dynamics. Please mention this in revised version. [Pushp Raj Tiwari, United Kingdom (of Great Britain and Northern Ireland)]	Noted
47914	63		66		Assessment Structure: If possible, assessment conclusions should be provided in a structured traceable account of how these statements were derived. For example, sections / subsections can start with previous IPCC report conclusions (AR5 or AR6 Special Reports) and then provide an update of the more recent literature, clearly laying out the lines of evidence. Each section / subsection can then conclude with assessment statements. This section currently reads more as a review than an assessment. In addition, please make sure the ES uncertainty language is clearly tracable to the underlying chapter text. [WGI TSU, France]	Not applicable, This section is no longer in the chapter. Elements regarding mitigation of SLCF for air quality purpose and its potential impact on climate are now discussed in 6.5.3
17204	64	1	64	1	Insert 'the' after 'in' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Editorial, done
24930	64	1	64	24	Would it be easier to list all these impacts in a table? [William Collins, United Kingdom (of Great Britain and Northern Ireland)]	Rejected. A table would not allow to describe well the different impacts.

17206	64	16	64	16	Move 'in the atmosphere' to after 'species' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Editorial, done
12874	64	22	64	24	This topic should be included; it is more than just behavioral as it involves the rising demand for electricity for peak power to meet the rising demand of ACs and other cooling equipment. There is an opportunity to improve energy efficiency of cooling equipment as part of the phasedown of HFCs and the phaseout of HCFCs. Replacing high-GWP HFCs under the Kigali Amendment provides an opportunity to increase the energy efficiency of appliances utilizing refrigerants. Improving energy efficiency of only residential air conditioners and switching to lower GWP refrigerants as required by the Kigali Amendment to the Montreal Protocol could avoid up to 100 Gt CO2-eq cumulatively through 2050 compared to up to 167 Gt CO2-eq without policy intervention. Sachar et al. (2018) Solving the Global Cooling Challenge: How to Counter the Climate Threat from Room Air Conditioners. Rocky Mountain Institute, P. 11 (“The Reference Scenario therefore includes the improvements in the grid emission factor worldwide. In this scenario (RS), the cumulative emissions from RACs—calculated for the year 2016 onwards— are estimated to be 132 gigatons by 2050.” (p. 10) and “We also understand that targets could be difficult to sustain as planned policies may not pan out—the withdrawal of the United States from the Paris Agreement being the prime example. Our analysis therefore presents an alternative view maintaining a constant grid emission factor in order to isolate the emission impact of RAC operation. In this scenario (RS-C), the resulting cumulative emissions are estimated to be 167 gigatons of CO2 equivalent (CO2e) by the year 2050.” And “P. 24 (“The 5X solution saves up to 100 gigatons of cumulative emissions by 2050.”); see also IEA (2018) Future of Cooling; Sustainable Energy for All (2018) Chilling Prospects: Providing Sustainable Cooling for All; and Birmingham Energy Institute, University of Birmingham (2018) A Cool World: Defining the Energy Conundrum of Cooling for All. [Durwood Zaelke, United States of America]	Rejected. The issue of air conditioning demand is reported here simply as an example. There is no reason in the report to go more deeply into the issue

42346	64	22	64	24	This topic should be included as air conditioner use increases air pollution associated with electricity generation (see David W. Abel, Tracey Holloway, Monica Harkey, Paul Meier, Doug Ahl, Vijay S. Limaye, Jonathan A. Patz (2018) Air-quality-related health impacts from climate change and from adaptation of cooling demand for buildings in the eastern United States: An interdisciplinary modeling study. https://doi.org/10.1371/journal.pmed.1002599). There is an opportunity to improve energy efficiency of cooling equipment as part of the phasedown of HFCs and the phaseout of HCFCs. Replacing high-GWP HFCs under the Kigali Amendment provides an opportunity to increase the energy efficiency of appliances utilizing refrigerants. Improving energy efficiency of air conditioners and other cooling equipment and switching to lower GWP refrigerants as required by the Kigali Amendment to the Montreal Protocol could avoid even more warming, up to 100 Gt CO2-eq cumulatively through 2050. Sachar et al. (2018) Solving the Global Cooling Challenge: How to Counter the Climate Threat from Room Air Conditioners. Rocky Mountain Institute, P. 24 (“The 5X solution saves up to 100 gigatons of cumulative emissions by 2050.”); Shah et al. (2015), Benefits of Leapfrogging to Superefficiency and Low Global Warming Potential Refrigerants in Room Air Conditioning. Berkeley, CA, USA. (“While there is some uncertainty associated with emissions and growth projections, moving to efficient room air conditioning (~30% more efficient than current technology) in parallel with low-GWP refrigerants in room air conditioning could avoid up to ~25 billion tonnes of CO2 in 2030, ~33billion in 2040, and ~40 billion in 2050, i.e. cumulative savings up to 98 billion tonnes of CO2 by 2050.”). Maintaining cold chains is important to reduce food waste and promote food security; improving cold chains should involve promoting energy efficiency (and efficiency within the system) as well as limiting greenhouse gas emissions through utilizing low-GWP refrigerants. See IEA (2018) Future of Cooling; Sustainable Energy for All (2018) Chilling Prospects: Providing Sustainable Cooling for All; and Birmingham Energy Institute, University of Birmingham (2018) A Cool World: Defining the Energy Conundrum of Cooling for All; see also	Same as comment 1775
12704	64	22	64	24	This topic should be included because it is more than just behavioral because the rising demand for electricity to power the rising demand of ACs and other cooling equipment. There is an opportunity through ongoing efforts to improve energy efficiency of cooling equipment as part of the phasedown of HFCs and the phaseout of HCFCs. Replacing high-GWP HFCs under the Kigali Amendment provides an opportunity to increase the energy efficiency of appliances utilizing refrigerants. Improving air conditioner energy efficiency and switching to lower GWP refrigerants as required by the Kigali Amendment to the Montreal Protocol could avoid even more warming, up to 100 Gt CO2-eq cumulatively through 2050 (Shah et al., 2015; Purohit and Höglund-Isaksson, 2017). Sustainable Energy for All (2018) Chilling Prospects: Providing Sustainable Cooling for All; and Birmingham Energy Institute, University of Birmingham (2018) A Cool World: Defining the Energy Conundrum of Cooling for All; see also Carvalho S., et al. (2014) Alternatives to High-GWP Hydrofluorocarbons; Shah et al. (2015), Benefits of Leapfrogging to Superefficiency and Low Global Warming Potential Refrigerants in Room Air Conditioning. Berkeley, CA, USA. (“While there is some uncertainty associated with emissions and growth projections, moving to efficient room air conditioning (~30% more efficient than current technology) in parallel with low-GWP refrigerants in room air conditioning could avoid up to ~25 billion tonnes of CO2 in 2030, ~33billion in 2040, and ~40 billion in 2050, i.e. cumulative savings up to 98 billion tonnes of CO2 by 2050.”). [Kristin Campbell, United States of America]	Same as comment 1775

24940	64	27			Section 6.5.2 is missing a discussion of the effects of climate change on photochemistry, through changes in reaction rates, water vapour abundance, cloud cover ... [William Collins, United Kingdom (of Great Britain and Northern Ireland)]	Accepted. A short discussion of the effects of climate change on tropospheric chemistry has been added.
24932	64	29	64	48	This paragraph seems to discuss the impact of ozone precursor changes, rather than climate change. Hopefully RCPs will be replace by SSPs for the next draft. [William Collins, United Kingdom (of Great Britain and Northern Ireland)]	Noted. There is a discussion of the impacts of ozone precursor changes versus climate change for comparison reasons. Furthermore a Table has been added showing the level confidence we have for the various processes affected by climate change and impact future near surface ozone concentrations.
17208	64	30	64	30	Repalce 'namely' with : [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Replaced with "such as".
17210	64	32	64	32	Change to '21st Century' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted.
17212	64	46	64	46	Text does not make sense, I suspect you need to delete 'and' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted. The "and" was deleted.
50030	64	50	65	2	Here some mention is made of the potential for stratospheric ozone recovery to increase tropospheric ozone over the 21st century, but no quantitative estimates are provided. Some numbers need to be provided, broken down by hemisphere. The impact of ozone recovery in the Northern Hemisphere must be quite small. Figure ES-1 of the Executive Summary of the latest WMO/UNEP Stratospheric Ozone Assessment shows that globally, total ozone has only decreased by about 3-4% since the 1970s (but of course the decreases are much larger over Antarctica). https://www.esrl.noaa.gov/csd/assessments/ozone/2018/report/ [Owen Cooper, United States of America]	Taken into consideration in the revised version of the sub-section.
55716	64	52	64	52	What is meant by "despite the extended range of model results"? [Larry Horowitz, United States of America]	It means that the different model simulations show a large range of model results on future global tropospheric ozone changes due to enhanced stratospheric ozone influx into the troposphere and stratospheric ozone recovery.
17214	65	2	65	2	Change to '21st Century' and change reference to Hess et al. [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted. The reference format is based on Mendeley.
47300	65	19	65	22	Please rephrase the statement of "Specifically it is concluded that the total ozone column response to the anthropogenic forcings from WMGHGs and ODSs is relatively consistently simulated, but ...". The conclusion of Morgenstern et al. (2018) is not correctly represented here. Instead, the authors state: "We find varying degrees of consistency in the models' responses in ozone to these individual forcings, including some considerable disagreement. In particular, the response of total-column ozone to these forcings is less consistent across the multi-model ensemble than profile comparisons." [Guang Zeng, New Zealand]	Accepted and revised accordingly.

8040	65	19	65	26	Morgenstern et al. (2018) are misquoted here. Their abstract says "In particular, the response of total-column ozone to these forcings is less consistent across the multi-model ensemble than profile intercomparisons." They make the point that in the middle and upper stratosphere the responses to GHG and ODS changes are relatively consistent, because in these regions ozone is predominantly driven by chemistry, whereas in the lower stratosphere, which dominates the total-column, the responses are less consistent because of inconsistent dynamical feedbacks. The response of surface ozone is affected by this via stratosphere-troposphere exchange. Worth mentioning here that the study by Young et al. (2013) included models using prescribed stratospheric ozone; this would have suppressed the stratospheric influence, in contrast to the more recent Morgenstern et al. (2018) study. [Olaf Morgenstern, New Zealand]	Accepted and revised accordingly.
17216	65	23	65	23	delete , after al. [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted.
28930	65	24	65	24	"conclusively" is definitely the wrong word here. [Matt Tully, Australia]	Accepted and replaced with "therefore".
8204	65	28	65	32	Lightning activity is considered to be tightly coupled to climate change. And lightning is a key source of NOx that goes on to produce lightning. It is also the main natural ignition of wildfires. Therefore this should be mentioned in this section. It is not directly a temperature-related factor so it may need to be separate from the identified paragraph. However, Doherty et al., 2013 list lightning as a component coupling climate and ozone so that reference can be used, as well as others already used to discuss lightning in this chapter. The effect of lightning on surface ozone is explicitly discussed in the following reference, which also discusses PM and other pollutants, and I suggest it should be read and incorporated into other parts of section 6.5 https://link.springer.com/content/pdf/10.1007%2Fs40726-016-0031-7.pdf [Declan Finney, United Kingdom (of Great Britain and Northern Ireland)]	Accepted. The role of lightning in future climate change and the and level of confidence we have for its impact on near surface ozone is introduced and discussed.
24934	65	28	65	32	This paragraph need expanding greatly to dicuss the impact of temperature on BVOCs, lightning NOX, wild fires, methane emissions … and the consequences of all these for ozone. [William Collins, United Kingdom (of Great Britain and Northern Ireland)]	Accepted. a Table has been added showing the level confidence we have for the various processes affected by climate change and impact future near surface ozone concentrations.
55718	65	28	65	32	Which is more important, the uncertainty from emission changes, or from the impact of these changes on ozone. [Larry Horowitz, United States of America]	As it is discussed in 6.5.2, changes in the ozone precursor emissions dominate future surface ozone changes when compared to climate-change induced changes. Specifically many recent studies show that future reductions in most precursor emissions drive tropospheric ozone decreases except in RCP8.5 which shows an increase due to much larger methane concentrations. A substantial proportion of the uncertainty in the spatial and temporal distribution of ozone simulated by global models arises from uncertainties in emissions of ozone precursors, which are chiefly NOx, CO, methane, and NMVOCs (e.g., Granier et al., 2011).

17218	65	30	65	31	Change O3 to O3 [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted.
17220	65	41	65	41	Change to mid-latitude [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted.
17222	65	48	65	52	Why is all this text in italics? [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted. It has been changed to normal format.
50032	65	48	65	52	This is a good summary of the impact of climate change on ozone in remote parts of the atmosphere, but it completely ignores the projected increases of ozone in polluted regions where air mass stagnation events are expected to increase. This point was nicely made just above on lines 45-46, and a similar statement needs to be added to this section's summary statement. [Owen Cooper, United States of America]	Accepted and revised accordingly.
14782	65	48	65	52	I don't understand the 'hence' connecting the first sentence with the second. I think it is relatively undisputed that larger water vapor and temperatures will lead to lower ozone, but the question whether and where that will be compensated or even overcompensated by other processes is more uncertain. One of the most uncertain ones is strat-trop exchange, but there are more as duly mentioned in this paragraph. It would be good to get a more quantitative feeling for this. [Frank Dentener, Italy]	Accepted. The sentence has been revised accordingly. Furthermore a Table has been added showing the level confidence we have for the various processes affected by climate change and impact future near surface ozone concentrations.
15572	66	2	67	30	6.5.3 Impact of climate change on PM: The authors should mention about the climate penalty which is not described in the current version. Regarding the impact of climate change on PM, the authors should mention the regional characteristics, in particular, the impact of climate change on PM in East Asia. [SANG-WOOK YEH, Republic of Korea]	Rejected: the climate penalty is discussed in other sections. Also in such a short paragraph it is not possible to discuss all regional aspects that are, however discussed in other paragraphs.
55868	66	3	66	22	Im et al (2012) mesoscale modeling study pointed out the existence of chemical feedback involving OH and induced by changes in biogenic VOC emissions that link sulfate and secondary oranic aerosol prodution that reduce PM changes in a warmer climate. They also pointed out that changes in temperature modify not only the aerosol mass but also its chemical composition. (Im et al., Summertime aerosol chemical composition in the Eastern Mediterranean and its sensitivity to temperature, Atmospheric Environment, 50, 164-173, doi:10.1016/j.atmosenv.2011.12.044, 2012) [MARIA KANAKIDOU, Greece]	Im et al., 2012 Reference included and text changed
24936	66	3			Section 6.5.3 is missing important discussions on impact of climate on dust, sea salt, DMS, fires, BVOCs. Many of these will affect PM, all will affect the AOD. [William Collins, United Kingdom (of Great Britain and Northern Ireland)]	We have incorporated this comment to the text. But other sections deals with changes in PM reflected in changes in AOD
17224	66	12	66	12	Change to SO2 [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted
17226	66	13	66	13	I suggest adding NH4NO3 for style [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Rejected. Not necessary.
50034	66	17			Some additional explanation is required for the projected decrease of wet removal. According to Chapter 2, observed precipitation over land has likely increased. What are the projections for precipitation over the 20th century? If rainfall increases in a more humid world, what is the explanation for a decrease in wet removal? Is it because rainfall will be less widespread, but more intense locally? [Owen Cooper, United States of America]	We made the info on wet removal in this section compatible with findings in Chapter 2 regarding precipitation changes

47946	66	18	66	18	Please check the use of this IPCC uncertainty language term. Are you able to provide a traceable account to assigning this uncertainty statement? Note that likelihood statements are quantified terms - phrases like likely and very likely have quantifiable probabilities associated with them. Please check it has been used correctly here. Please refer to the IPCC guidance note on uncertainty: https://wg1.ipcc.ch/SR/documents/ar5_uncertainty-guidance-note.pdf [WGI TSU, France]	Accepted. Several points modified accordingly.
50036	66	20	66	22	This sentence is not phrased well because it makes it sound like increased ventilation leads to increased PM, whereas the opposite is true. Porter et al. 2015 don't mention the word "ventilation", instead they show how a lower planetary boundary layer height is associated with increased PM. This sentence should be changed to: "…emphasising the importance of stagnation episodes and low planetary boundary layer heights for increasing PM atmospheric concentrations (Porter et al., 2015)." [Owen Cooper, United States of America]	Accepted. Changed to your suggestion
55720	66	25	66	25	Only "long-lived climate forcing agents" evolved in time? [Larry Horowitz, United States of America]	The text is explicit that "all climate forcing agents evolved in time"
55722	66	28	66	32	From LLCF-induced climate change only? [Larry Horowitz, United States of America]	No, from all forcings. Future PM have large uncertainties, not only from SLCF
17228	66	31	66	32	Change to '21st Century' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Rejected, We keep future PM, because the forecast are not only for the 21st century
14784	66	43	66	44	If the conclusions of a small increase in global burden due to climate change is only based on the Westerfelt study, I wouldn't call this medium evidence (there are similar considerations in 6.4.3). But I would be surprised if this was the only study. [Frank Dentener, Italy]	Noted. We revised the confidence level, and look for other references in this area
55056	66	43	66	45	I cannot see how this conclusion (high confidence that PM burden change due to climate change) can be drawn given that the effect of wildfires is potenially large and the effects on dust emission due to desertification and wind changes may be subsantial (even if they are uncertain) [Ina Tegen, Germany]	Accepted, Changed to medium confidence
52016	66	43	66	45	I'm not sure that, based upon a single study it is correct to infer high confidence which requires the use of multiple lines of independent evidence per the guidance note on confidence and likelihood [Peter Thorne, Ireland]	Changed to medium confidence
55724	66	43	66	45	Is this intended to mean that there is a robust (statistically significant, although small) signal of change, or is this just making the point that any PM burden change from climate change is small relative to emission changes. [Larry Horowitz, United States of America]	We changed the text for a clearer statement.
17230	66	44	66	44	Don't italicise 'but' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted
31094	66	44	66	44	Would be useful to quantify what "small" is -- a few percents at most, and probably below interannual variability in primary and precursor emissions. [Nicolas Bellouin, United Kingdom (of Great Britain and Northern Ireland)]	Suggestion incorporated in the text.
55870	66	48	66	48	In the list of few sparse studies investigating possible PM chemical composition changes in a warmer climate, you could add the above mentioend work by Im et al., 2012 (Im et al., Summertime aerosol chemical composition in the Eastern Mediterranean and its sensitivity to temperature, Atmospheric Environment, 50, 164-173, doi:10.1016/j.atmosenv.2011.12.044, 2012) [MARIA KANAKIDOU, Greece]	Done when answering comment 55868
47926	66	51	67	32	Please change this subsection into an assessment style, it currently reads more as a review, for example, 'Some authors have concluded…'. Please provide IPCC uncertianty language with this assessment. [WGI TSU, France]	Accepted. Changes done.

17232	67	1	67	1	Change 'polutant' to '[ollutant' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Editorial, done
47700	67	11	67	32	It is correct to say that the connections between climate and AQ and the related mechanisms are not understood. There is another important if not more important aspect that needs to be investigated which is how climate change will affect exposure to sustained higher levels of air pollution even if peak levels do not increase. If the duration of higher levels of air pollution occur, then this could have a major impact on people's health. It is not only peaks that are important. [Ranjeet Sokhi, United Kingdom (of Great Britain and Northern Ireland)]	Noted. This kind of specific issues are not appropriate for an IPCC report.
14788	67	19	67	27	Give the remit of section 6.6 is that not a more appropriate place for this section? [Frank Dentener, Italy]	Rejected. Section 6.5 is specifically devoted to AQ-CC interaction.
17234	67	20	67	20	Change to '21st Century' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Editorial, done
17236	67	24	67	24	Delete 's' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Editorial, done
14786	67	29	67	29	suggest to use appropriate uncertainty language->there is large uncertainty on the increase of air pollution extreme events with climate extreme events. [Frank Dentener, Italy]	Accepted. Changes done.
53614	67	35	67	35	Looking forward to seeing this section develop when more scenario results are available. Please get in touch with WGIII (ch 3 and 4) on this section in order to coordinate (directly or via the xWG team on scenarios). WGII may also be interested in the material on AQ. [Jan Fuglestvedt, Norway]	Thanks. This section has been developed on results made available recently.
47676	67	35	73	19	Several MIPs are discussed in this chapter including ScenarioMIP and AerChemMIP. This section is incomplete without discussing GeoMIP and associated scenarios, though particular attention must be paid to highlight that this is not an endorsement of geoengineering. [Daniel Feldman, United States of America]	Accepted. Results from GeoMIP has been assessed.
17238	67	37	67	37	Capital C for century [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Editorial -Copyedit to be completed prior to publication
27850	67	40	67	40	check bibliographic citation [Poot Delgado Carlos Antonio, Mexico]	Editorial -Copyedit to be completed prior to publication
53044	67	44	68	37	Here (and elsewhere) please note that the original SSP trajectories (e.g. Rao et al.) are not what is used in climate models. The original SSP emissions were subsequently harmonized to the CMIP6 history, and also adjusted to better take into account recent declines in SO2 from China. For details see Gidden et al. 2019. doi: 10.5194/gmd-12-1443-2019) [Steven Smith, United States of America]	Accepted. The text has been revised accordingly.
24938	67	45	67	45	In Ch 7 biospheric feedbacks are only covered as contributions to the climate feedbacks (i.e. in W/m2/K), not as processes or contributions to SLCF abundances. Apart from carbon-cycle and methane from wetland and permafrost, these processess are not covered anywhere else in the report. [William Collins, United Kingdom (of Great Britain and Northern Ireland)]	Taken into account and discussed in 6.3.6
47916	67		72		Assessment Structure: If possible, assessment conclusions should be provided in a structured traceable account of how these statements were derived. For example, sections / subsections can start with previous IPCC report conclusions (AR5 or AR6 Special Reports) and then provide an update of the more recent literature, clearly laying out the lines of evidence. Each section / subsection can then conclude with assessment statements. This section currently reads more as a review than an assessment. In addition, please make sure the ES uncertainty language is clearly tracable to the underlying chapter text. [WGI TSU, France]	Accepted. The section has been substantially revised as new material have been made available (i.e. MIPS), allowing for a proper assessment.
17240	68	42	68	42	Capital C for century and capital S for section [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Editorial -Copyedit to be completed prior to publication

14790	68	42	69	26	The text is a collection of quite separate statements, with the bigger line hard to discover. Would some table in this and other sections help to organize the material? [Frank Dentener, Italy]	Taken into account. We agree that the section was not very well organized in the FOD. For the SOD the text has been revised to be in accordance the outcome of CMIP6 MIPs (AerChemMip and ScenarioMIP mainly)
50038	68	52			This sentence is poorly phrased and it sounds like ozone will change through 2050 but not afterwards, whereas the sentence is trying to say that the study was only conducted through 2050. Re-phrase to: "A study using a simplified parameterisation approach explores regional surface ozone concentration changes due to precursor emission through the year 2050,…" [Owen Cooper, United States of America]	Taken in to account. The comment has been addressed during the revision for the SOD.
50040	68	53			This summary does not mention the very important influence of increasing methane which allows for ozone increases even in North America and Europe where NOx is projected to decrease strongly through 2050 under SSP3. The sentence also makes it seem like NOx will increase above all regions, when the scenarios call for decreases above North America and Europe. Instead it needs to say that emissions will increase globally, with strong regional variability. I recommend re-writing this sentence to something like the following: "Surface ozone increases of 1 to 5 ppb by 2050 relative to 2010 are predicted for all regions for the SSP3 baseline scenario in which global emissions of all ozone precursors increase. However, ozone precursors will not change uniformly, with strong decrease of NOx above North America and Europe. Despite these decreases, ozone is still projected to increase above North America and Europe due to increases in other regions of the Northern Hemisphere and the strong impact of increasing methane levels." [Owen Cooper, United States of America]	Accepted. Now discussed in 6.6.3 in SOD
41594	69	5	69	11	See also Banerjee et al (2018; doi: 10.5194/acp-18-2899-2018) and Iglesias-Suarez et al (2018; doi 10.5194/acp-18-6121-2018) who evaluate future ozone RF for RCP scenarios and distinguish stratospheric and tropospheric contributions [Amanda Maycock, United Kingdom (of Great Britain and Northern Ireland)]	Taken into account. The future RF by ozone (and other SLCFs) are assessed in Section 6.6.3.
50042	69	11			Here the important influence of methane needs to be mentioned. The increases of ozone under RCP8.5 are mainly driven by methane increases, especially in 2100. [Owen Cooper, United States of America]	Accepted. The role of methane for tropospheric ozone trends is important.
17242	69	18	69	18	Capital S for section [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Editorial -Copyedit to be completed prior to publication
17244	69	25	69	26	Exponential forms required [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Editorial -Copyedit to be completed prior to publication
38350	69	29	70	7	This section (6.6.1.2) currently describes the uncertainties of gas-phase species only. Uncertainties in aerosols should be added to this section. For example, the impact of uncertainties in emission particle sizes on radiative forcing will be important for CRF (e.g. Reddington et al. (2011, ACP, https://doi.org/10.5194/acp-11-12007-2011)), BC (Matsui et al. (2018, ncomms, https://doi.org/10.1038/s41467-018-05635-1)), and mineral dust (Kok et al. (2017, ngeo, https://doi.org/10.1038/ngeo2912)). Model structural uncertainties will also be important because recent findings on new particle formation, organic aerosol formation, ice nucleating particles, absorbing aerosols (BrC, magnetite) are not considered in most aerosol models yet. These uncertainties and importance should also be considered in section 6.7 (Knowledge gaps) as sources of differences between models. [Hitoshi Matsui, Japan]	Taken into account. Thanks for pointing out this important issue. This section builds upon the more general assessment of model uncertainties in previous section. However, issues specifically related to future concentrations are addressed here. This would be impacts (feedbacks) from climate change on the lifecycle of the species and changes in natural emissions .

14792	69	31	70	7	Reads like a section for the knowledge gaps? [Frank Dentener, Italy]	This section has been removed from the second order draft. Parts have been incorporated into later sections, and for some parts there were considerable overlap with previous sections (e.g. on biogeochemical feedbacks).
47668	69	33	69	55	The entire chapter alternates between "parameterise" and "paramterize". [Daniel Feldman, United States of America]	Editorial -Copyedit to be completed prior to publication
24942	69	50	69	53	This paragraph should explicitly discuss that the Finney et al. parameterisation predicts the opposite sign to the standard (Price and Rind based) parameterisations. This could have major consequences for the sign of the climate effect on tropospheric ozone and methane. [William Collins, United Kingdom (of Great Britain and Northern Ireland)]	Not applicable, this section is no longer in the chapter, but discussion on lightning NOx remains in 6.2 and discusses this point
17246	69	54	69	54	Insert 'of' after 'factor' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Editorial -Copyedit to be completed prior to publication
17248	70	3	70	3	Insert . After 'Finally' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Editorial -Copyedit to be completed prior to publication
50044	70	10			It's not clear what the focus of this section should be. There is some commentary on social issues which doesn't fit with this scientific assessment and would be more relevant to topics covered by other IPCC working groups. It seems that the section should clearly state two objectives: 1) describe how the changing densities of megacities affects photochemistry and therefore the lifetime of SLCFs; 2) describe how low model resolution leads to incorrect quantification of the photochemistry and deposition within megacities. [Owen Cooper, United States of America]	Not applicable, subsection content completely restructured
17250	70	12	70	12	Delete space after 'regions' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Editorial
17252	70	12	70	12	Change 'Northern' to North' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Editorial
17254	70	18	70	18	Delete 'While' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Editorial
55872	70	24	70	29	Similar results but on smaller scale have been found by Im and Kanakidou (Atmos. Chem. Phys., 12, 6335-6355, doi:10.5194/acp-12-6335-2012, 2012) with a brut force (zero anthropogenic emissions) scenario from the Istanbul and the Athens extended areas .They evaluated that these megacity and large agglomeration anthropogenic emissions depress surface urban O3 by 30- 60% in winter and 8-20% in summer. On the opposite anthropogenic emissions contribute to the fine particulate matter (PM2.5) levels inside the cities themselves by up to 75% in winter and by 40-50% in summer. [MARIA KANAKIDOU, Greece]	Not applicable, subsection content completely restructured
14794	70	24	70	29	Not sure if I caught the point of this section. Having spatially explicit and correct allocation of SLCF emissions, can have local effects but globally very small. What is the certainty of this statement (one or more studies?). [Frank Dentener, Italy]	Not Applicable, section no longer included in the chapter
41596	70	32	71	21	The section 6.6.3 on SLCF influence on near-term global temperature trends needs to be coordinated with chapter 4 section 4.4.4 who also assess this in relation to near-term projections. Ensure consistency and reduce current overlap. The FAiR results shown at present in 6.6.3 will have to be placed in the context of the ScenarioMIP and AerChemMIP results as they become available. [Amanda Maycock, United Kingdom (of Great Britain and Northern Ireland)]	Agree. During the LAM3 meeting and the preparation of the SOD there has been exchange of text between these two sections to ensure consistency.

12706	70	32	71	21	Time-to-achieve-cooling should be emphasized as an important metric in Section 6.6.3. This info should likely be highlighted in the Exec Summary of the chapter (and also the SPM for the whole report). [Kristin Campbell, United States of America]	We have chosen not to focus on this concept of "Time-to-achieve-cooling" in this section (now 6.6.4 in the SOD). The reason for this is that the section assess the contribution of SLCFs only to temperature change, while this concept should include the impact of all anthropogenic emissions to be sure it is not mis-interpreted. Also, this time-to-achieve-cooling is very dependent on your base year (i.e. 2015 or 2021, as the start of the scenario period and future (wrt to the publication of AR6), respectively).
12876	70	32	71	22	Time-to-achieve-cooling should be emphasized as an important metric. This info should likely be highlighted in the Exec Summary of the chapter (and also the SPM for the whole report). [Durwood Zaelke, United States of America]	See response to comment #12706
14796	70	36	70	36	As I understand this new analysis performed for this report, and it would be good if this work would be published. Suggest to add uncertainty bars if possible, and include some results from individual studies. Legenda's of the lower panels of Figure 6.10 were not readible. [Frank Dentener, Italy]	Taken into account. The version of the figure in the FOD is as stated in the comment a new analysis. This is an example of the use of emulators that are used in several places in the whole AR6 report. The use of emulators is coordinated to ensure consistency within WG1 but also with WG3, and to quantify the uncertainties (through e.g. multimodel results).
55812	70	37	71	17	Pedantic point, sorry: please note the model is spelt FaIR. [Christopher Smith, United Kingdom (of Great Britain and Northern Ireland)]	Editorial -Copyedit to be completed prior to publication
17256	70	54	70	54	Replace 'have' with 'has' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Editorial -Copyedit to be completed prior to publication
17258	70	55	70	55	Replace 'like' with 'such as' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Editorial -Copyedit to be completed prior to publication
17260	71	4	71	4	Capital S for section [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Editorial -Copyedit to be completed prior to publication
24944	71	5	71	5	It should be made clear that this small effect on surface temperature is the result of the cancelation of two large terms. Presumably the uncertainty on this (which needs to be included) is far larger than 0.05K. [William Collins, United Kingdom (of Great Britain and Northern Ireland)]	Noted. The figure 6.10 in the FOD was basically a place-holder for a more comprehensive assessment from the multi-model analysis under the RCMIP. The revised figure includes uncertainty ranges for the temperature responses, so the reader should be able to better understand the relative uncertainties.
53616	71	5	71	5	the statement on temp effects of SLCF needs reference(s). [Jan Fuglestvedt, Norway]	Noted. All numbers in this section (now 6.6.4) are based on simulations derived either from RCMIP (Nicholls et al., submitted) or AerChemMip (Allen et al., submitted)

24946	71	19	71	21	Is the insensitivity to SLCFs intrinsic to the scenarios or is it just a cooincidence of the scenarios shown? To what extend does it rely on a particular aerosol forcing efficiency? [William Collins, United Kingdom (of Great Britain and Northern Ireland)]	Noted. Again, figure 6.10 in the FOD was basically a place-holder for a more comprehensive assessment from the multi-model analysis under the RCMIP. With the new multi-model data the general feature is still there, with compensating effects of warming and cooling SLCFs over the first few decades. However, with more models (with different assumptions about aerosol formation rates, lifetimes, and forcing efficiencies) we are able to span out the uncertainty.
17262	71	27	71	27	Delete , after 'al' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Editorial -Copyedit to be completed prior to publication
17264	71	39	71	39	Change to SO4 [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Editorial -Copyedit to be completed prior to publication
17266	71	46	71	46	Change to SO2 [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Editorial -Copyedit to be completed prior to publication
53618	72	1	72	1	Section 6.6.4; This is an important topic, but i dont think you have to link it so strongly to the SSPs. Can be broader, but with results from SSP runs used. [Jan Fuglestvedt, Norway]	Accepted and revised accordingly the title of the sub-section.
53622	72	1	72	53	Seems to be a contradiction between what is said in the 3rd para (lines 22-33) and the 4th para (35-53) regarding effects of SLCF mitigation. The section is also listing studies rather than assessing. [Jan Fuglestvedt, Norway]	The text of the whole 4th paragraph has been revised accordingly.
44292	72	1	73	2	This section is interesting. It can also be useful to think of the various emissions more by source than by pollutant. In that case, nearly all anthropogenic SO2 and Nox and linked to fossil fuels, but something closer to half the methane, BC, OC and CO. So although these may all decline in the Rogelj et al low carbon scenarios, the SSPs show that indeed this isn't necessarily a foregone conclusion. If one divides by source, then it's clear that a low-C transition away from fossil fuels does automatically bring very large declines in some SLCFs, but not all. This reality underlies calls to focus specifically on those warming SLCFs that won't automatically be reduced in a low-C transition (e.g. methane beyond just fossil sources, and some BC and CO-rich sources, as well as F-gases), hence to my mind is a useful way to think about complementarity between CO2 and SLCF reductions. I find this more useful than say includig SO2 with BC as 'SLCFs' and finding that they largely offset one another if both drop greatly, which may be true but is not particularly poicy relevant if they are dropping for independent reasons. [Drew Shindell, United States of America]	We agree with the comment. The text has been revised to highlight the fact that the climate and SLCF (air quality or sustainable development goals) policies have some important overlap (related to fossil fuel mitigation) but there is a significant portion of SLCF mitigation (both for CH4 - agriculture/waste as well as biofuel use and waste burning for BC) that is not part of the typical CO2 strategy. We expect that more detailed analysis of sectorial and regional mitigation (taking into account technical, economic and political issues) will be done in WGIII.
53620	72	3	72	5	The first sentence is problematic: It is unclear, and it is value based. [Jan Fuglestvedt, Norway]	Accepted and revised accordingly.
17268	72	18	72	18	Change to CO2 [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Corrected.
17270	72	19	72	19	Change to '21st Century' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Corrected.

47948	72	22	72	22	Please check the use of this IPCC uncertainty language term. Are you able to provide a traceable account to assigning this uncertainty statement? Note that likelihood statements are quantified terms - phrases like likely and very likely have quantifiable probabilities associated with them. Please check it has been used correctly here. Please refer to the IPCC guidance note on uncertainty: https://wg1.ipcc.ch/SR/documents/ar5_uncertainty-guidance-note.pdf [WGI TSU, France]	Noted
17272	72	22	72	53	Subscripts required in chemical formulae [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Corrected.
24948	72	25	72	25	Your Hayman et al. 2018 reference is actually Collins et al. ! [William Collins, United Kingdom (of Great Britain and Northern Ireland)]	Corrected.
24950	72	27	72	29	This text on Stoh et al. 2015 is a repeat of the text on page 62. [William Collins, United Kingdom (of Great Britain and Northern Ireland)]	Taken into consideration in the revision to avoid repetition of the text.
45714	72	30			could mention the impact of recent methane growth on the viability of the Paris agreement (Nisbet et al. 2019) [Euan Nisbet, United Kingdom (of Great Britain and Northern Ireland)]	Accepted and revised accordingly.
14798	72	31	72	33	Suggest to use the word CO2 emissions (rather than Carbon). CH4 is also carbon. I didn't understand the sentence on line 32,33 how can delaying emission be a a benefit? [Frank Dentener, Italy]	Accepted and revised accordingly. The second comment is not applicable as the sentence has been deleted.
44288	72	32	72	33	This is too simplistic as written, I feel, and appears to contradict the rest of the paragraph's conclusions about methane. The 'long-term climate benefit' would indeed be comparable large, but not the ozone and near-term climate benefits discussed in this chapter so this misleading implies there's no adverse consequences of waiting to reduce methane a couple decades. [Drew Shindell, United States of America]	Not applicable. The sentence has been removed.
14800	72	35	72	35	Are the author discussing 'remaining carbon budgets'. Try to use exact language. [Frank Dentener, Italy]	Not applicable. The sentence has been removed.
52556	72	35	72	38	The CO2 budget and issue of overestimating the long-term climate impact of SLCFs is only relevant if 1) our primary objective is long-term climate stabilization, and 2) if anyone is advocating that we somehow address SLCFs separately from LLGHGs. On the first point, Article 2 of the Paris Agreement does not contain a long-term climate target and it does not reference 2100 or beyond but it does specifically "aim to strengthen the global response to the threat of climate change, in the context of sustainable development and efforts to eradicate poverty...." Sustainable development and efforts to eradicate poverty are very near-term and very policy relevant objectives and the IPCC SR1.5 report concluded that they are objectives which are inherently linked to both near and long-them climate objectives. Regarding the second point, throughout this chapter it clearly shows that most SLCFs are co-emitted with LLGHGs, so in many relevant cases addressing SLCFs and LLGHGs separately would be impossible. Instead of continuing a largely false narrative about some conflict between action on CO2 and non-CO2 climate forcing emissions - this section (and chapter) could be greatly strengthened by advocating first for a net-forcing integrated analysis which takes into account the changes in all climate forcing emissions of any particular mitigation action and puts it in the context of a changing climate throughout the century - not just on whether it helps up hit a particular temperature endpoint. [Nathan Borgford-Parnell, Switzerland]	Taken into consideration for the revision. The mitigation measures in fossil fuels will lead automatically to large declines in both CO2 and some SLCFs. However this is not entirely true for all SLCFs (e.g. methane and some BC rich sources are beyond just fossil sources). The text has been revised to highlight the fact that the climate and SLCF (AQ or SDG) policies have some important overlap (related to fossil fuel mitigation) but there is a significant portion of SLCF mitigation (both for CH4 - agriculture/waste as well as biofuel use and waste burning for BC) that is not part of the typical CO2 strategy. We expect that more detailed analysis of sectorial and regional mitigation (taking into account technical, economic and political issues) will be done in WGII.

52980	72	35	72	38	The CO2 budget and issue of overestimating the long-term climate impact of SLCFs is only relevant if 1) our primary objective is long-term climate stabilization, and 2) if anyone is advocating that we somehow address SLCFs separately from LLGHGs. On the first point, Article 2 of the Paris Agreement does not contain a long-term climate target and it does not reference 2100 or beyond but it does specifically "aim to strengthen the global response to the threat of climate change, in the context of sustainable development and efforts to eradicate poverty...." Sustainable development and efforts to eradicate poverty are very near-term and very policy relevant objectives and the IPCC SR1.5 report concluded that they are objectives which are inherently linked to both near and long-them climate objectives. Regarding the second point, throughout this chapter it clearly shows that most SLCFs are co-emitted with LLGHGs, so in many relevant cases addressing SLCFs and LLGHGs separately would be impossible. Instead of continuing a largely false narrative about some conflict between action on CO2 and non-CO2 climate forcing emissions - this section (and chapter) could be greatly strengthened by advocating first for a net-forcing integrated analysis which takes into account the changes in all climate forcing emissions of any particular mitigation action and puts it in the context of a changing climate throughout the century - not just on whether it helps us hit a particular temperature endpoint. [Nathan Borgford-Parnell, Switzerland]	Taken into consideration for the revision. The mitigation measures in fossil fuels will lead automatically to large declines in both CO2 and some SLCFs. However this is not entirely true for all SLCFs (e.g. methane and some BC rich sources are beyond just fossil sources). The text has been revised to highlight the fact that the climate and SLCF (AQ or SDG) policies have some important overlap (related to fossil fuel mitigation) but there is a significant portion of SLCF mitigation (both for CH4 - agriculture/waste as well as biofuel use and waste burning for BC) that is not part of the typical CO2 strategy. We expect that more detailed analysis of sectorial and regional mitigation (taking into account technical, economic and political issues) will be done in WGII.
14802	72	35	72	53	This is an potentially important paragraph, but doesn't come out very clear. In line 37 I assume you are talking about CO2-SLCF emission reduction linkages? Would a schematic figure help to make the point? [Frank Dentener, Italy]	Taken into consideration for the revision of the paragraph. This paragraph was aiming to show that mitigation measures in fossil fuels will lead automatically to declines in both CO2 and some SLCFs. These links have to be taken into consideration. However this is not entirely true for all SLCFs as for example methane and some BC rich sources are beyond just fossil sources. A Figure under different SSPs will be added showing the compensating effects of SLCF-CO2 mitigation (in fossil fuels) but also a quantification of SLCF mitigation that is not part of the typical CO2 mitigation.
17274	72	38	72	38	Insert (before 'Rogelj' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Corrected.
44290	72	43	72	46	We reported only modest effects of SLCP reductions in the long term because we were only considering specific measures, not all possible reductions. For example, most of thelong-term impact comes from remaining methane emissions in the 'low CO2 world' and those come from agriculture, which was largely not targeted in our analysis. So of course if one targets fossil methane, there is little additional effect in a world that's phased out fossil fuels! So I think the various studies are consistent, but use both difference referece cases and include different sets of potential reductions. [Drew Shindell, United States of America]	Accepted and revised accordingly.
17276	72	46	72	46	Delete , after second al. [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Corrected.
53624	72	50	72	50	say briefly why "stricter" [Jan Fuglestvedt, Norway]	Not applicable. The sentence has been removed.

52554	72	51	72	51	Shindell 2017 addresses SLCPs, not SLCFs. [Nathan Borgford-Parnell, Switzerland]	Accepted and revised accordingly.
17278	72	52	72	52	Insert 'the' after 'achieving' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Corrected.
17280	72	53	73	2	Why is all this text in italics? [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Corrected.
53626	73	1	73	1	what is "important temperature effect"? I assume you mean "substantial" ? [Jan Fuglestvedt, Norway]	Accepted and revised accordingly.
44294	73	5	73	5	This section in the FOD relies solely on Reis et al (2018) for content. This isn't even in the references, making it impossible for a reviewer to give useful feedback! [Drew Shindell, United States of America]	Accepted - text has been revised and the reference has been corrected
53628	73	5	73	5	I dont think you need to have SSPs in title. There could also be other scenarios [Jan Fuglestvedt, Norway]	Accepted - text revised
24952	73	5			There is also work from Steve Turnock on using parameterised relationships to simulate SSPs [William Collins, United Kingdom (of Great Britain and Northern Ireland)]	Rejected - no publication provided to support the changes suggested by the reviewer
50046	73	5			This section is not well written and I'm not sure what the conclusions are meant to be. The last sentence is particularly confusing. What is the "annual average limit"? Why would a target of 1.5 C prevent regions from exceeding these limits? [Owen Cooper, United States of America]	Accepted - text has been revised in SOD
17282	73	8	73	8	Insert 'on' after 'influence' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted - text revised
17284	73	9	73	9	Delete , after al. [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted - text revised
17286	73	15	73	15	Delete space before full stop [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted - text revised
53630	73	15	73	19	In my view, this is too vague and does not contribute to an assessment. [Jan Fuglestvedt, Norway]	Accepted - text has been revised.
43144	73	18	73	19	This statement needs more clarification -- based on Reis et al. (2018) analysis alone? [Luisa Molina, United States of America]	Noted but not applicable: executive summary fully revised.
47702	73	22	74	54	The key Gaps section is not complete. For example, effects of climate change on AQ is not highlighted. I have summarised some of the key gaps that are missing below: [Ranjeet Sokhi, United Kingdom (of Great Britain and Northern Ireland)]	Some of the comments are accepted. See below for details.
47704	73	22	74	54	(i) Bring together the emission changes and impact of climate processes e.g. changes to RF and co-benefits of SLCFs [Ranjeet Sokhi, United Kingdom (of Great Britain and Northern Ireland)]	Accepted - added in Knowledge Gap
47706	73	22	74	54	(ii) Distinction should be made between ground level and upper level ozone as ground level air pollution is important to assess the impact of future climate change on human health. Examination ground level ozone and its longer term trends on regional scales will provide a more robust analysis of the impacts of interactions between climate, air quality and health for future years. [Ranjeet Sokhi, United Kingdom (of Great Britain and Northern Ireland)]	Accepted - added in Knowledge Gap
47708	73	22	74	54	(iii) Heterogeniety should be spatially resolved or disaggregated for emissions of SLCFs in particular aerosol species which exhibit spatial heterogeneous behaviour and more so as we go towards urban scales. Some of the conclusions may well be challenged as we move to finer scales. [Ranjeet Sokhi, United Kingdom (of Great Britain and Northern Ireland)]	Rejected - This is already covered in Knowledge Gap (lines 29-30 on Page 74 of FOD)

47710	73	22	74	54	(iv) The discussion of regionally dependent RF and ARI is limited to S Asia. It will be more useful if comparisons are given with other regions of contrasting aerosol loading e.g. S Asia, Europe, N and S America as this will address the key uncertainties in ARI currently. And it has significant implications for policy responses to control in terms of warming and cooling PM species. [Ranjeet Sokhi, United Kingdom (of Great Britain and Northern Ireland)]	Rejected - This should be covered in the text but not in Knowledge Gap
47712	73	22	74	54	(v) Reliable qualitification and understanding of RF due to urban areas can not be investigated with current global modelling approaches and higher resolution approaches should be encouraged through collaborative studies. [Ranjeet Sokhi, United Kingdom (of Great Britain and Northern Ireland)]	Rejected - This is already covered in Knowledge Gap (lines 29-34 on Page 74 of FOD)
47714	73	22	74	54	(vi) How climate change will alter boundary layer evolution and dynamics e.g.though changes in temperature and RH as well as ocurrence of anticyclonic events are vital to understand the impact on AQ as changes in BL will affect AQ directly. There will also be heterogeniety and will require higher resolution models. [Ranjeet Sokhi, United Kingdom (of Great Britain and Northern Ireland)]	Rejected - This is too detailed to be covered in Knowledge Gap
47716	73	22	74	54	(vii) Given that the connections between climate and AQ and the related mechanisms are not understood, another important aspect that needs to be investigated is how climate change will affect exposure to sustained higher levels of air pollution even if peak levels do not increase. If the duration of higher levels of air pollution occur, then this could have a major impact on people's health. [Ranjeet Sokhi, United Kingdom (of Great Britain and Northern Ireland)]	Accepted -Added in Knowledge Gap.
52018	73	22			This section is longer and much more detailed than is the case in most remaining chapters where instead a bullet list of c.1-2 pages is presented. Some effort to agree a consistent approach would be advisable. [Peter Thorne, Ireland]	Editorial
43146	73	27	73	49	Based on the discussion, it seems the most important knowledge gap is the availability and quality of the emissions of SLCFs and the co-emitted pollutants. [Luisa Molina, United States of America]	Accepted - text revised
14804	73	29	73	37	This message has some communalities with Chapter 2;p.93 37-44. Chapter 2/6 to discuss further. [Frank Dentener, Italy]	Noted -consistency/overlaps with chapter 2 have been fixed.
50048	73	29			With regards to tropospheric ozone, the most important knowledge gap is the lack of ozone observations from 1850 or earlier, and this knowledge gap should be stated first. Although, a recent paper by Yeung et al. [2019] in Nature uses stable isotopes to draw some broad conclusions regarding hemispheric ozone changes since 1850 and this paper should be discussed in the next draft. Then when discussing historical observations from the 20th century, state that we have some reliable ozone observations in the northern extratropics since the mid 20th century, but in other regions of the world historical (pre-1975) ozone observations are too limited to be able to quantify ozone trends since the mid 20th century. [Owen Cooper, United States of America]	Accepted - text revised
17288	73	30	73	30	Italicise 'low confidence' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Editorial
17290	73	34	73	34	Change to Pre-Industrial [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Editorial
55726	73	39	73	44	Importance of uncertainties in mixing state? [Larry Horowitz, United States of America]	Accepted - the importance of uncertainties in mixing state id added.
14806	73	39	73	44	A section about carbonaceous aerosol is OK, but do we know aerosol components like mineral dust, nitrate aerosol etc so much better? [Frank Dentener, Italy]	Contributing authors for dust (Paul Ginoux) and sea-salt (Jurgita Ovadnevaite) added for discussions in section 6.3.6. Brown carbon discussion added (section 6.2.2.8).

55728	73	52	73	52	Start this section with a broader discussion of efficacy of SLCF forcings in causing surface temperature change (and regional pattern). [Larry Horowitz, United States of America]	Section 6.7 "Knowledge Gaps" removed from SOD.
44570	73	54	74	7	Would the SLCF emissions associated with large scale mitigation or negative emission solutions, such as BECCS, aforestation, merit mention here? (We have a related paper in the works, will send it to you when it is submitted, but the topic will remain a knowledge gap for a while yet I think.) In general there is little mention of SLCFs in the scenario literature (beyond inclusion in the SSPs), so maybe this is a way to frame the gap? [Bjorn Samset, Norway]	Rejected for now - no publication provided to support the changes suggested by the reviewer
53632	74	1	74	1	How is the 45% calculated? RF at a (recent) point in time? Integrated RF or dT. Just a breif explanaition would do. [Jan Fuglestvedt, Norway]	Accepted - Added the number of section to support 45%
14808	74	1	74	7	Recommend to cross-check with land-report on numbers and key-messages. If different, it should be duly explained. [Frank Dentener, Italy]	Noted
17292	74	2	74	2	Italicise 'low confidence' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Editorial
43148	74	9	74	12	As commented before, perhaps instead of focusing on megacities (10 M or more inhabitants), one should include the cities or urban complexes with population of 5 - 10 million. [Luisa Molina, United States of America]	Rejected. Specific definition of megacities should not be given in Knowledge gap
14810	74	9	74	20	I think it could be helpful to clarify why 'megacities' emissions are highlighted as a special category. It is probably related to the larger mitigation opportunities for regions were people and emissions are concentrated. I am also wondering about the specific choice for megacity (>10 million), whereas similar issues and mitigation potential would be present for medium and large cities, say 500.000 upward. There was an IGAC report a number of years ago that would contain useful information for this. [Frank Dentener, Italy]	Defined in section 6.5. Section 6.7 "Knowledge Gaps" removed from SOD.
17294	74	16	74	16	Change 'kilometers' to 'kilometres' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Editorial
41042	74	18	74	19	I suggest rephrasing this sentence as it is currently hard to understand. [Johannes Laube, Germany]	Accepted-text revised.
43150	74	22	74	34	This suggests the importance of capacity building in the rapidly growing urban areas in the developing countries, not just in developing emissions inventory but also air quality monitoring and special field studies to validate the inventory used for modeling and for policy design. [Luisa Molina, United States of America]	Accepted - Added in Knowledge Gap
38352	74	22	74	34	I feel this paragraph is a bit biased to the importance of multi-model approaches. I agree that multi-model approaches are very useful to understand current uncertainties (and causes of uncertainties in some cases) for known (or implemented) processes, but it is usually hard to reduce the uncertainties by model inter-comparisons themselves. Single-model approaches are usually more useful to evaluate the importance of new processes/properties/species, which are not considered in current models, than multi-model approaches. So I suggest describing the importance of both single-model and multi-model approaches in a more balanced way. [Hitoshi Matsui, Japan]	Rejected. We are talking about the uncertainties associated with assessment. While single model is useful, multi-model can give higher confidence

50050	74	37	74	54	Chapter 6 and WGI are not focused on the impacts of SLCFs on human health, material and property. According to Section 1.1 of Chapter 1: "Starting from the work on the First Assessment Report (FAR) published in 1990, the IPCC Assessments have been structured into three Working Groups. Working Group I (WGI) assesses the physical science basis of climate change, Working Group II (WGII) assesses associated impacts, vulnerability and adaptation to climate change, and Working Group III (WGIII) assesses mitigation response options." Given that WGI is charged with focusing on the physical science basis for climate change, and not impacts (purview of WGII), Chapter 6 should not summarize knowledge gaps regarding the impact of SLCFs on human health or on materials or property. However, it is fine to discuss knowledge gaps regarding the impacts of SLCFs on vegetation, because in this case climate-relevant feedbacks are involved. [Owen Cooper, United States of America]	Accepted - text has been removed
14812	74	39	74	46	Recommend to have this health section checked by a person from the health community. Language suggestions: 'based on correlation'=>based on health outcome correlations in epidemiological studies (or something similar). 'Still primarily': still suggest that something else is needed, but there seems to be little evidence for that. [Frank Dentener, Italy]	Not applicable. The assessment of health impact has been removed form the chapter
47950	74	51	74	51	Please check the use of this IPCC uncertainty language term. Are you able to provide a traceable account to assigning this uncertainty statement? Note that likelihood statements are quantified terms - phrases like likely and very likely have quantifiable probabilities associated with them. Please check it has been used correctly here. Please refer to the IPCC guidance note on uncertainty: https://wg1.ipcc.ch/SR/documents/ar5_uncertainty-guidance-note.pdf [WGI TSU, France]	Accepted - 'likely' is removed from the sentence
14814	74	53	74	53	There is work going on in AgMIP. I would suggest something like: There is an urgent need for better understanding of combined climate, CO2 and airpollution effects on crop growth and yields-as is planned in the AgMIP crop modelling activity. [Frank Dentener, Italy]	Accepted-text revised.
53634	74	54	74	54	I think we need to avoid "should" here, but rather say what can be gained by doing that. [Jan Fuglestvedt, Norway]	Accepted - that sentence has been replaced
14816	75	5	75	12	Suggest also to explain the term SLCP- which is used in different communities. Suggest - if possible- to give a succint paragraph on the role (and limitations) of reducing SLCP in reaching short and long term climate targets. [Frank Dentener, Italy]	Taken into account -- suggestion passed on to technical writer.
53636	75	8	75	10	Tautological sentence. Please reword. (you may also mention gases as examples) [Jan Fuglestvedt, Norway]	Not applicable -- FAQ 6.1 has been thoroughly rewritten
9398	75	14	75	14	It might be helpful for the reader to indicate the time period of the term "for long" (e.g. longer than 40 (100) years) [Klaus Radunsky Radunsky, Austria]	Not applicable -- FAQ 6.1 has been thoroughly rewritten
53638	75	15	75	15	"lives" is too sloppy, in my view [Jan Fuglestvedt, Norway]	Accepted -- "lives" has been changed to "persists"
41044	75	15	75	16	This is incorrect as many HFCs and even HCFC-22 have longer lifetimes – although that makes them LLGHGs in my opinion. [Johannes Laube, Germany]	Accepted -- text has been corrected to include short-lived halogenated species
16344	75	18	75	20	The paragraph could be strenghtened by a few examples of anthropogenic sources of SLFC emissions (e.g., what processes lead to SLFC's to be emitted?) [Renee van Diemen, United Kingdom (of Great Britain and Northern Ireland)]	Taken into account -- text revised
53640	75	28	75	30	This is very vague ("expected") [Jan Fuglestvedt, Norway]	Accepted -- text revised to say "Models of the current climate indicate"

31096	75	29	75	29	Why is "expected" in italics? [Nicolas Bellouin, United Kingdom (of Great Britain and Northern Ireland)]	Noted - this word no longer appears in the text.
9400	75	49	75	52	It is suggested to revisit this statement that SLCF are comparable in magnitude compared to LLGHG; because in IPCC reports CH4 is included under WMGHGs and is already part of the Kyoto basket; furtehrmore the impact of areosols and stratospheric ozone is cooling and troposheric ozone is warming. And our problem is warming. [Klaus Radunsky Radunsky, Austria]	Rejected -- the sentence says "magnitude", not "sign", and hence is technically correct as it stands
53642	75	50	75	50	You may insert "mean" after "global" [Jan Fuglestvedt, Norway]	Accepted -- text revised
53644	75	51	75	51	I suggets insert "and regioanl" after "local" [Jan Fuglestvedt, Norway]	Accepted -- text revised
17296	76	1	76	1	Change to '..), but the adverse..' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Accepted - text revised
14818	77	1	78	9	FAQ6.1 and FAQ6.2 are quite similar. Possible to combine? [Frank Dentener, Italy]	There are similarities, but the overall scope of the two questions is different. Rejected
14014	77	12	77	12	Correction required. Please cross-check the data i.e. 4.2 million with what has been quoated at Page:Line-14:35 to 37 "The WHO has attributed 5.5-7 mio premature deaths due to air pollution of which about half from ambient pollution (World Health Organization, 2018)" [Nikhil Kant, India]	Rejected. We confirm that WHO 2016 (see reference list) has the figure 4.2 million deaths for outdoor air pollution. Mentioning indoor air pollution here may induce confusion within the non specialised audience the FAQs are directed to.
53646	77	16	77	16	This is a very strong statement. I suggest delting "All". This is not needed when you give so many examples [Jan Fuglestvedt, Norway]	Rejected. We do not find the statement so strong. The examples are just a list of some major anthropogenic emission sources.
16346	77	16	77	25	The second and third paragraph could be merged to make the FAQ more succint (e.g. 'all anthropogenic activities are responsible for the emission of gaseous and particulate pollutants that modify atmospheric composition, leading to degradation of air quality as well as climate change. While this makes air pollution and climate change two intimately connected issues, air pollutants and climate-forcing agents are often defined and regulated independently of one another in the scientific and policy arena.') [Renee van Diemen, United Kingdom (of Great Britain and Northern Ireland)]	Accepted. Sentence has been modified.
17298	77	17	77	17	Don't use etc, give all details [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Rejected. It is not possible to list all individual anthropogenic pollution sources.
17300	77	35	77	35	vice-versa' is (correctly) italicised here, but none of the other Latin terms elsewhere in the Chapter are (eg et al., per, in-situ) [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Editorial, no action
45716	77	38			simply stopping gas leaks! [Euan Nisbet, United Kingdom (of Great Britain and Northern Ireland)]	The comment is not understandable
17302	77	39	77	39	Don't use etc, give all details [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Rejected. It is not possible to list in detail all possible win-win policy actions.
31098	77	45	77	45	There is no CO2 benefit: you said it was carbon neutral. [Nicolas Bellouin, United Kingdom (of Great Britain and Northern Ireland)]	Accepted. Sentence has been modified.
44566	77	46	77	46	Nice and important FAQ. I would encourage adding a small comment that effects like the unmasked warming mentioned here can be quite substantial regionally, and affect billions (as in Asai currently), even if the global effects look small when compared to CO2. [Bjorn Samset, Norway]	Rejected. While we agree with the reviewer on the substance of the comment, it is felt that adding such a comment may induce confusion within the non specialised audience the FAQs are directed to.

14016	77		78		Either the FAQ 6.2 is misfit for this chapter 6 OR it needs to be customized to include SLCFs sifficiently and suitably in the question as well as answer as there's hardly any relevance of the FAQ 6.2 and the answer provided thereto to the theme of the chapter 6 i.e. SLCFs. The decision accordingly should be taken as regards Figure 6.2 as it is suppmentary to the FAQ 6.2. [Nikhil Kant, India]	Accepted: Reference is now made explicitly to SLCFs to show that SLCFs are not only climate forcers but also the air constituents that affect air quality.
17304	78	4	78	4	Change 'Anyone' to 'Any one' [Peter Burt, United Kingdom (of Great Britain and Northern Ireland)]	Editorial.
43154	79	42	79	44	Reference: "Aleluia Reis" should be "Reis, A." [Luisa Molina, United States of America]	Rejected. The first author in question has been contacted, and the surname "Aleluia Reis" is correct.
47656	123	1	135	23	The figures need to be viewed by individuals who are red-green color blind to ensure that the messages conveyed by the figures are still clear. [Daniel Feldman, United States of America]	Noted. Figure colours conform to IPCC TSU colormaps, which take colour-blindness into account.
39054	123	3	123	13	Fig. 6.1 is nice. It should be reminded to the readers. The clarity of the figure should be improved, say not to draw the lines for minor ticks - just tickmarks for the minor ticks should be good. [Prabir Patra, Japan]	Not applicable. Figure has been removed.
49980	123	5			Figure 6.1 shows that ozone has an average lifetime of about 22 days, which fits with Stevenson et al. 2006 and Young et al., 2013. But it also shows a lifetime as long as 90 days, or 3 months. Where does this number come from? I haven't been able to find any studies that clearly state that ozone's lifetime is as long as 90 days. All I can find are vague statements of several weeks. [Owen Cooper, United States of America]	Not applicable. Figure has been removed.
8206	124	1	124	1	In Fig 6.2 there is not a purple arrow showing climate change feedback on lightning. Lightning also affects and is affected by air pollution and there are no arrows showing that, but I'm not sure whether that something intended to be shown. [Declan Finney, United Kingdom (of Great Britain and Northern Ireland)]	Taken into account, figure revised
47658	124	1	124	16	Both the purpose and message that the Figure 6.2 seeks to convey are unclear. The pictorial representation of processes suggests that the figure is geared principally towards non-scientific audiences, it is presumably is meant to be presented as a background slide for research into SLCFs, and as such, it should be easily accessible, with such purpose clear. However, why is everything arranged in a circle? The caption of the figure needs to explicitly state that processes are being presented in a clockwise manner. Additionally, there are some corrections needed, including (1) lightning may be changing in a changing climate (Romps et al, Science, 2014, doi:10.1126/science.1259100); (2) it appears that there are two images representing "industry" in the outer circle; and (3) the radiative forcing pictures require modification to represent the processes described in the caption, most especially the interaction of SLCFs with IR radiation. [Daniel Feldman, United States of America]	Taken into account, figure revised
44568	124	1			Figure 6.3: Nice and important summary figure. In its present form, however, the viewer will struggle with figuring out where to begin interpreting it. It has no clear starting point to draw the eye, or progression through the concepts shown. Would it be an idea to consult an expert on visual representation here (or the knowledgeable people in the TSU) for ideas on how to structure the information such that it can be made (even) more accessible? I can see using such a figure in talks for many years to come, so it's worth thinking it through thorougly. [Bjorn Samset, Norway]	Taken into account, figure revised

41598	124		124		I'm afraid I don't find this schematic very informative. There appears to be important detail in the small circular images around the edge of the wheel but I can't really tell what these are. E.g. the radiative forcing ones appear to try and capture different aspects of forcing but that is very subtle from the pictures shown. I would suggest the chapter team try to rework this figure so the key points are clearer. [Amanda Maycock, United Kingdom (of Great Britain and Northern Ireland)]	Taken into account, figure revised
43152	125	1	125	3	Box 6.1, Figure 2 -- this should be Figure 1. It is not clear if this figure complements the content of Box 6.1. Suggest to revise this figure or delete it. [Luisa Molina, United States of America]	Noted and fixed.
47660	125	1	125	4	The pictures representing processes should be arranged so that they are contained within the circle entirely. The meaning of the half-circle connector between "anthropogenic and natural sources" and "impacts on weather, ecosystems, and people" at the bottom of the circle is unclear. [Daniel Feldman, United States of America]	Taken into account. This figure has gone through graphics changes for improved messaging.
39060	125	3	125	3	Should there be a Box 6.1, Fig. 1?? [Prabir Patra, Japan]	Editorial-Thank you. The Box 6.1 Figure was mis-numbered.
41046	126	1	126	1	Figure 6.3: What is shown in the last three panels? [Johannes Laube, Germany]	Figure has been updated and is now figure 6.4.
47662	126	1	126	25	The term "global evolution" is imprecise, since what is displayed is a concatenation of historical emissions estimates and emissions from a limited, agreed-upon set of future emissions scenarios. [Daniel Feldman, United States of America]	Noted.
44572	126	1	127	10	Figures 6.3 and 6.4: These should be here, but we should make sure that they are consistent with the scenario presentation in section 1.6 which also contains some similar plots. Please have a look at that section to check for potential issues, and let's coordinate. We're (Chapter 1) are happy to take input from you. [Bjorn Samset, Norway]	Noted - based on the comments the Figures were aggregated into one.
26854	126	8	126	13	When adding CH4 emissions to this figure, consider to add EDGAR emissions, as they are used heavily in Chapter 5. [Ragnhild Bieltvedt Skeie, Norway]	Noted - EDGAR has been added for the FGD version of the figure
41048	127	1	127	1	Figure 6.4: The axis descriptions and numbers are too small. In general, some figures seem to be of rather low resolution. [Johannes Laube, Germany]	Editorial
31100	129	1	129	8	Figure 6.5 is old. To stay with Kahn, perhaps adapt Figure 2 of Kahn and Gaitley 2015 10.1002/2015JD023322? [Nicolas Bellouin, United Kingdom (of Great Britain and Northern Ireland)]	The figure has been removed from the SOD. Similar representation of figure appears in Chapter 2.
8034	130	1	130	1	I think this is a zonal not a meridional average. [Olaf Morgenstern, New Zealand]	Not applicable. Figure removed from SOD
41600	130	1	130	1	Zonally averaged? [Amanda Maycock, United Kingdom (of Great Britain and Northern Ireland)]	No longer applicable. The figure has been removed from the SOD.
40710	130	1	130	6	Figure 6.6 This figure needs to be recalculated from a consistent set of models or at least some indication of statistical significance of the model differences. Surely man-made SCLFs were not causing several W m-2 of warming at 70S in the 1870s. An alternative figure from the same model output would use curves for various latitude bands (-15 to 15, 15N-30N, etc) as a function of the year. [Daniel Murphy, United States of America]	No longer applicable. The figure has been removed from the SOD.
47664	130	1	130	6	Change figure title from "man-made" to "anthropogenic" or "human-made" [Daniel Feldman, United States of America]	Not applicable. Figure removed from SOD

40712	132	1	132	6	Figure 6.8 This figure needs an indication of statistical significance and more explanation. I am guessing most of the details are not statistically significant in a large ensemble or over multiple models. Are warming and cooling patterns over Antarctica statistically significant? I would guess not. Is it statistically significant the northern Australia warms and southern Australia cools? I don't know. Why are there such incredibly sharp changes at coastlines (such as northwest India dark blue and the Arabian sea at zero)? Terms such as "sstClimAerosol" and especially "ensemble r1i1p1" mean nothing to most readers. [Daniel Murphy, United States of America]	Accepted. Figure updated in Figure 6.13 in SOD.
41602	132		132		It should be made clear in the caption that these climate impacts only capture the rapid adjustments and not the fully coupled climate response to aerosols [Amanda Maycock, United Kingdom (of Great Britain and Northern Ireland)]	Accepted. Figure updated in Figure 6.13 in SOD.
55730	132		132		This plot shows results from fixed-SST simulations, so does not reflect the full climate impact of aerosols. Update to use difference between historical and hist-piNTCF (from AerChemMIP/CMIP6). [Larry Horowitz, United States of America]	Accepted. Figure updated in Figure 6.13 in SOD.
56658	133	4			This figure seems prone to misinterpretation as it stands. Why would one assume an ECS value of 1.06C? Second point is just a suggestion: It could be more illustrative to use the combination of actual lifetimes of various SLCF substances plus their actual equilibrium forcing levels (assuming those SLCF were reduced to zero)... [Malte Meinshausen, Australia]	Taken in to account. It is not the ECS (for 2xCO2) that is 1.06K, but the sensitivity parameter (1.06 K/Wm-2). The idea with this figure is to clearly illustrate how the lifetime of an SLCF and the timescales of the climate system interact to determine the response time to emission reductions. As to this and to avoid all kinds of discussions on which lifetimes are correct and what forcing to use for each SLCF, we believe this simpler figure is better.
41604	133	7	133	8	Why was an ECS of 1.06C used here? Whatever ECS is chosen should be consistent with the likely range from chapter 7. [Amanda Maycock, United Kingdom (of Great Britain and Northern Ireland)]	Taken into account. See comment 1887.
55810	133	8	133	8	is the ECS really 1.06 in this plot? [Christopher Smith, United Kingdom (of Great Britain and Northern Ireland)]	Figure has been updated noting a different impulse response function, and is now Figure 6.15.
56660	134	2			Figure 6.10: Yes, the figure caption is correct that those probabilistic results can be provided from MAGICC. I am not closely familiar with how FAIR calculates carbon cycle feedbacks. Are those included and attributed to the individual SLCF emissions? Or are those kept out? Secondly, given that several SLCFs are emission-driven in ScenarioMIPs (BC, Aerosols) (roughly speaking), it would be good to have uncertainties in this graph to consistently comprise all uncertainties from emissions to the temperature response, i.e. not start from the concentration timeseries for CH4. Happy to assist with MAGICC results (in line with Chapter 7 findings). [Malte Meinshausen, Australia]	Accepted. There is on-going work to harmonize the use of simple climate models (emulators) within AR6. The final figure in FGD are based on the consistent use of these models including results from more than one model and with uncertainties.
41606	134		134		Unfortunately the quality of the lower panels in Figure 6.10 was too poor for me to assess the details shown. However, I reiterate an earlier point that this assessment with FaIR will need to be integrated with outputs from ScenarioMIP and AerChemMIP as they become available [Amanda Maycock, United Kingdom (of Great Britain and Northern Ireland)]	Accepted. See comment 56660 above.

55778	135	18	135	25	Light trapping does not cause UHIs. In fact, research suggests that tall buildings create shade and reduce daytime heat in urban areas(example: https://doi.org/10.1016/j.landurbplan.2013.11.004) Line 21: UHI is not associated with elevated surface temperature (that's SUHI), it is associated with elevated air temprature, especially at night. [Ariane Middel, United States of America]	Rejected. Comment does not correspond with indicated page/line numbers.
52552					overall more work needs to be done to differentiate between studies that focus on SLCPs and those that address all SLCFs. [Nathan Borgford-Parnell, Switzerland]	Noted, we tried to made it clearer during SOD consolidation.
37762					Comment 2 on the entire report refers to issues associated with there being extensive discussions of methane in both Chapter 5, where it is referred to as long-lived, and Chapter 6, where it is classed as a short-lived climate forcer. [Adrian Simmons, United Kingdom (of Great Britain and Northern Ireland)]	Noted, CH4 is a cross-chapter issue, cross chapter references have been made clearer in the SOD.
56968					Figure general comments Chapter 6: ideally, figures should be a bit more independent from the caption => Titles can be added to the figure to enhance the understanding at first glance //Figures and caption should be more independent from the main text => spell out acronyms in figure and/or caption wherever possible //units have to be in ( ) and not in [ ] and font is Arial. For more information about Visual guidelines, please refer to the IPCC visual style guide (https://www.ipcc.ch/site/assets/uploads/2019/04/IPCC-visual-style-guide.pdf) [WGI TSU, France]	Noted, we took it into account during SOD consolidation.
56970					Figure 6.1: the figure could be uncluttered for readability (remove grid, plot frame and add secondary ticks marks) // cognitively, there is no need to use both colors and symbols to differenciate the short lived climate forces: except for NH3, NOx, SO2, for which symbols have a classification meanging, colors are sufficient to differenciate them // It would be good to have an indication in the legend that NH3/NOx/SO2 are precursors // SLCFs should be spelled out in the caption. [WGI TSU, France]	No longer applicable. Figure 6.1 has been removed.
56972					Figure 6.2: It take some time to decipher the elements (no labels) in the schematic and understand the connections between different groups. The schematic design could be improved for better readability. For more guidelines, contact the TSU's graphic officer [WGI TSU, France]	Figure 6.2 has been improved, with input from the TSU for messaging.
56974					Figure 6.3: It is unclear what the difference in color (dark blue or green) means. And some elements of the design are unclear too (e.g. are the impacts having an effect on "anthropogenic and natural sources"?). [WGI TSU, France]	Taken into account, figure changed
56976					Figure 6.4: This figure would benefit from a short general title right on top of the panel, if any comes to mind (e.g. Short Life Climate Forces emissions from 1850 to 2100, or something in that line) // BC and OC could be spell out for clarity // it is unclear which SLCF is presented in the 6th panel . [WGI TSU, France]	Editorial
56978					Figure 6.6: TOA and SW could be spell out for clarity [WGI TSU, France]	Editorial. Figure is now 6.10.
56980					Figure 6.7: TOA and SW could be spell out for clarity // "…at the top of the atmosphere of aerosols,…"doesn't read well. Suggestion: "effective radiative SW forcing of aerosols at the top of the atmosphere,…" // is the information of the secondary title "sstclimaerosol…climatology" necessary in the figure or could it be left in the caption only? [WGI TSU, France]	taken in to account. Caption has been updated in figure 6.10
40598					Same as above for radiative forcing. [Chaitri Roy, India]	Editorial. Figure is now 6.10.
56982					Figure 6.8: suggestion for the figure title: "impacts of aerosols" // For clarity, change could be added in secondary titles "Change (Δ) of precipitaion..." "Change (Δ) of near surface..." // "Surface impacts of aerosols in the atmosphere" could be changed into "Surface impacts of atmospheric aerosols" [WGI TSU, France]	No longer applicable. Figure has been changed (Fig 6.13).

56984					Figure 6.10: This figure would benefit from a short general title right on top of the panel, if any comes to mind (e.g. effect of Short Life Climate Forces on Global Mean Surface Temperature, or something in that line) // suggestion: "change in temperature" instead of T [WGI TSU, France]	Addressed. Changed to Figure 6.19 in SOD
56986					Figure 6.11: Short indicative titles could be written next to each plot pannel where applicable // it seems that SSPs anotations belong to plot (a) - more space between panels would increase clarity. // panel (d) reads second after (a) // it is not clear what (d) represents by just looking at the figure - a short title would help as well as explaining that the change in color transparency indicates increase in uncertainty. [WGI TSU, France]	Figure removed from SOD