"*Temperature and radiative responses to anthropogenic aerosols over the Mediterranean based on CMIP6 Earth System models*"

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This manuscript focuses on changes in temperature in response to anthropogenic aerosols (AA) reductions over the Mediterranean region. It includes two metrics of the radiative perturbation by AA, ARC and ERF, to examine the fast and slow temperature response respectively. The analysis is sound and of high quality. The main finding of the manuscript is that the increase in TAS due to AA reductions cannot be solely explained by reductions in AOD, but feedback between aerosol concentrations and circulation have also played a role. However, the manuscript in its current form is difficult to read due to very lengthy paragraphs, and lacking a red thread, without a clear motivation. Still these are issues that can be addressed and a revised version of this manuscript would be a good fit for a future publication in ACP.

Essential comments

Introduction

The introduction gives a good overview of the literature, however, it does not properly introduce the knowledge gaps that are addressed by the study. Accordingly, the motivation for the present study is not entirely apparent.

Line 49 -73: This paragraph lists the finding of several specific studies, however, it is not clear how each of these studies points towards the knowledge gap that the current study addresses, nor are these studies brought up again in the discussion or conclusion. Accordingly this paragraph could likely be shortened and focused toward the knowledge gaps that will be addressed through the objectives defined in the next paragraph. For example; what do the previous studies miss by not examining the fast and slow temperature responses to AA reductions jointly?

Data and Methodology

The data and methodology covers the metrics and datasets used. However, the text could benefit from being more concise and understandable. For instance, rather than citing Eyring et al., 2016 and Collins et al 2017, repeatedly when referring to AerChemMIP and CMIP6, just use the name of the MIP instead of the reference.

When referring to names of the different model experiments, it would be more appropriate to use italic to emphasize the names rather than double quotes.

On line 104-105: It is not necessary to repeat that AerChemMIP has fixed SSTs and sea ice concentration. Just mention this one when the AerChemMIP simulations are introduced on line 100.

On line 126-138: Avoid repeating the definition of ERF several times within the same paragraph.

On line 149: ARC is defined in the manuscript as "*ARC is defined as the net shortwave (SW) and longwave (LW) radiation loss of the atmospheric column*", which is the common definition in the literature. Accordingly, from this definition, ARC should be the difference between the net radiative flux at the top-of-the-atmosphere and surface. However in Eq. 3 the authors introduce a new terminology of ARC_{TOA}^{NET} and ARC_{SURF}^{NET}, which in the manuscript simply refers to the net radiative flux at TOA and surface respectively when calculated from the hist-pier/ historically fully coupled simulations. Using the term ARC in this new context is confusing, since this is not actually radiative loss of the atmosphere. Furthermore, ARC does not strictly imply that it is derived from a coupled fully coupled simulation, as it is common to compare ARC from fSST simulations to examine fast versus slow precipitation responses. Therefore, it would be advisable to use a different terminology than ARC_{TOA}^{NET} and ARC_{SURF}^{NET} referring to radiative perturbations in this manuscript.

Results

Overall the figures and results are well described and of good quality. However, due to very information dense and lengthy paragraphs that often span several figures and sometimes going back and forth between them, the section overall is very challenging to read. This was not helped by several paragraphs ending without any particular conclusion. The authors are advised to closely re-examine each paragraph and provide a red thread for the reader to follow.

3.1 Radiative changes

The title of the subsection is not very informative, so it would be advisable to choose a title that relates to a research question.

Line 180 - 183: ~~*As described earlier,*~~ *AA concentrations peak<u>ed</u> in the late 1970s to early 1980s in Europe and the MED. Consequently, AOD change reaches a maximum during that period (Fig. 1, left column). <u>The AOD maximum</u>* ~~*which is stronger*~~ *is larger in magnitude during the boreal summer (JJA) than the winter (DJF). Likewise, <u>the</u> transient <u>annual mean</u> ERF both at TOA and surface attained its most negative values during the late 1970s - early 1980s* ~~*on an annual basis*~~*, dominated by the evolution of ERF in JJA (Fig. 1, middle column).*

Line 183-185: Not sure what is the new information in this sentence, perhaps remove?

Line 185-189: Here, one example of text that is very difficult for a reader to understand due to jumping between topics within the same sentence, e.g. inter-model spread, temporal evolution, magnitude of the ERF peak and ARC. This makes the paragraph as a whole difficult to comprehend. This could be simplified by for instance only describing the ERF and then in the next paragraph describing ARC.

Line 207-209: The first sentence sets the expectation that the spatial pattern of ERF will be described next, then the reader would expect that the following sentence would build on this. However here the reader gets led astray when this sentence is followed by a listing of more tables and figures.

Line 233 -268: This paragraph needs to be broken down into smaller paragraphs.

3.2 Temperature changes

Again, the title of this section is not very informative. The section is started off by another massive paragraph, which is difficult to navigate. Overall, this section is as challenging to read as the previous section.

It would also benefit more from a discussion that compares the findings of this study with previous studies.

4. Conclusion

The conclusion gives a good summary of the findings of the study, however, what is lacking is the context from the literature.

The conclusion does not fully answer the objective of the manuscript defined in the introduction, in particular with respect to quantifying the fast and total radiative response of global changes in AA emission. If this is written in the introduction, then there is an expectation that this will be brought up again in the conclusions.

Minor typographical comment:

The manuscript uses hyphens in places where an en dash is typographically correct (for example “1980-2000”). Please replace hyphens with en dashes for numeric ranges (1980–2000), similarly hyphens should not be used for minus signs. Use hyphens only for compound words and em dashes for clause breaks.