Review of:

Anthropogenic Aerosol effects on Tropospheric Circulation and Sea Surface Temperature (1980-2020): Separating the role of Zonally Asymmetric Forcings

By Diao et al.

I would like to thank the authors for replying to my comments. I stand by my previous opinion that the new simulations presented here are well executed set of numerical experiments, which presents a valuable contribution to the climate community. In my opinion, the paper now is in a much better shape and should be ready for publication after a minor revision. I have a few comments and suggestions for the authors:

Response:
We really appreciate the reviewer's careful reading and valuable suggestions, which helped us improve our paper's quality. Furthermore, We realized that some parts of the manuscript were hard to read. Therefore, we have updated those parts (e.g., abstract, introduction, and summary parts) to improve the readability and clarify our arguments.
Please check our response to the major comments below.

• I still would like to encourage the authors to conduct a carful re-writing and editing of the paper. I am not an expert myself, but the level of English of this paper is low in many parts.

Response:
Thanks very much for pointing out the language issues. We carefully re-edited our manuscript and corrected many editorial issues.

• L25 (and L221, L318, L392, L424, L437…): I suggest to stick to the IPCC definition of radiative forcing. The decline in aerosol concentration by itself does not cause a positive radiative forcing (comparers to pre-industrial conditions) but rather just a decrease in the value of the negative radiative forcing.

Response:
Thanks for the suggestion. We agree with the reviewer that decline in aerosol causes positive radiation anomaly instead of positive radiative forcing. In the abstract (L25), we changed the

description to: "*weakening negative radiative forcing over WH mid-to-high latitudes and enhancing negative radiative forcing over EH at lower latitudes***"**

We also added a clarification on line 221. For other lines, we now use the "positive radiative forcing anomaly" or "positive trend of radiative forcing".

Line 221 now reads:

"

In Fix_EastFF1920, except for the increasing negative forcing in the lower latitudes of East Asia, Siberia shows a slight weakening of the negative forcing (positive anomaly of radiative forcing) due to the extension of WH aerosol reduction.

"

• L75: I suggest to remove the "subtle". I think that the differences between GHG and aerosol forcing is not subtle.

Response:

Thanks for the suggestion. We have removed the "subtle" in line 75 and many other places as suggested.

• L78: I don't understand how the fact that it was found that the response to GHG forcing (well mixed) is similar to aerosol forcing (heterogenous) "suggesting the importance of the spatial distribution of radiative changes"? If anything, it suggest that the spatial distribution is not that important.

Response:

Thanks for the comment. We have rewritten the paragraph to avoid this issue. It now reads:

"

However, despite the differences between GHGs and aerosols, other studies found similar climate responses to GHGs and aerosols. Xie et al. (2013) found that the 20th century regional temperature and precipitation are similar in response to GHGs and the more spatially heterogeneous aerosol forcing.

"

• L296: why do you call these differences "subtle"? I would remove it.

Response:

Thanks for the correction. We mis-used the “subtle” word. We have changed the “subtle zonal differences” to “significant zonal differences”.

• L313: cloud droplet number concentration is usually denoted by CDNC. I suggest to stick to that and not CDNUMC (I think that it will be easier for most people to follow).

Response:

Thanks for the suggestion. Previously we used the CESM1 model-output name “CDNUMC” to represent the cloud droplet number concentration. Now we have replaced it with “CDNC” in both text and Fig. 4.

• L316: please add a reference for the aerosol first indirect effect.

Response:

Thanks for the suggestion. We have added the reference, and it now reads:

“

In response to WestFF, the north Atlantic region shows strong increases in solar radiations, which is consistent with the significant decrease in cloud droplet number concentration (CDNC, third row of Fig. 3). However, the cloud fractions (fourth row of Fig. 3) show very weak changes over the north Atlantic, which indicates the critical role of the aerosol first indirect effect over the north Atlantic (Penner et al. 2001).

”

Penner, J. E., Andreae, M. O., Annegarn, H., Barrie, L., Feichter, J., Hegg, D., and Pitari, G.: Aerosols, their direct and indirect effects, In Climate Change 2001: The Scientific Basis. Contribution of Working Group I to the Third Assessment Report of the Intergovernmental Panel on Climate Change, Cambridge University Press, 289-348, 2001.

• L393: again, the differences here are also not "subtle".

Response:

Thanks for the correction. We have removed the “subtle” here.

• L410: again, "subtle" in a wrong place. You miss-use and over-use this word. Maybe you meant to say substantial instead?

Response:

Thanks for pointing out the problem. By saying "with both strong zonal contrasts and subtle latitudinal differences", we meant that the latitudinal difference is less obvious than the zonal difference. We realized that the "subtle difference" is very misleading, so we have replaced it with "with both zonal and latitudinal contrasts".

• The paragraph around L560 needs to be re-write. The English level is bad.

Response:

Thanks for the suggestion. We have rewritten the whole paragraph, and it now reads:

"

Over the tropical Pacific region, EastFF induces an El Niño-like SAT pattern with symmetric warming trends (does not pass the 95% significance test, though). The EastFF-induced El Niño-like pattern contradicts some previous studies arguing that Asian aerosols lead to a La Niña-like pattern (Kaufmann et al., 2011; Smith et al., 2016; Kang et al., 2021). On the other hand, WestFF induces an asymmetric SAT pattern over the tropical Pacific, with warming in the north and cooling in the south. The distinct tropical Pacific SAT responses due to EastFF and WestFF may also contribute to the Pacific decadal to multi-decadal variability (PDV) in amplitude and spatial pattern. The question about whether and how regional aerosol forcings affect PDV needs further investigation.

"

• L572: another miss-use of "subtle".

Response:

Thanks for the comment. We have rewritten the sentence, and it now reads:

"

The latitudinal difference between EH and WH forcing distribution plays an important role here.

"

Technical comments:

• L60: missing "and", I think.

Response:

Thanks for the comment. We have added an “and” to the sentence.

• L69: ".."

Response:

Thanks for the comment. We have fixed this.

• L97. Remove "that"

Response:

Thanks for the comment. We have removed the “that” word.

• L 234: missing "or" or "and".

Response:

Thanks for the comment. There should be an “or”. We have rewritten the sentences, and it now reads:

“

The surface temperature responses are also very similar between FF and SUM, except for the central Pacific and part of the Arctic region. The warm bias over the central Pacific in SUM is possibly associated with forcings outside the two focused regions (EH box and WH box in Fig. 2), or it is due to the residual effect of internal variability even after ensemble average due to limited ensemble sizes.

”

• Around L287: stick to either AODAA (underline AA) or AOD_AA

Response:

Thanks for the comment. It is an editing error. We use AOD_AA throughout the manuscript.

• L298: please correct "climate responses in response"

Response:

Thanks for the comment. We have changed it to: “climate responses to aerosol increase over EH and aerosol reduction over WH.”

• L545: "which is mentioned by previous studies that the north Pacific cooling due to Asia aerosol emissions" – the English here needs to be improved.

Response:

Thanks for the suggestion. We have rewritten the related sentences for better readability. It now reads:

“

EastFF induces significant cooling over the western part of the North Pacific at low-to-mid latitudes, which is consistent with previous studies (Dong et al., 2014; Takahashi and Watanabe, 2016; Smith et al., 2016). In contrast, WestFF, with positive forcing anomaly at mid-to-high latitudes (30 ºN–60 ºN; blue oval in Fig. 10), induces large-scale warming locally at North Atlantic and even stronger warming over the entire North Pacific. Thus, the WestFF-induced warming over the North Pacific largely offsets the EastFF-induced cooling in the FF case.

”

• L636: please remove the: ”

Response:

Thanks for the comment. We have fixed this issue.