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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Mechanisms for a remote response to Asian aerosol emissions in boreal winter" *by* Laura Wilcox et al.

Anonymous Referee #1

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The authors present an investigation into the mechanisms behind the climate responses to Asian aerosol emission, based on two quite different climate models. Using the HadGEM3 fully coupled model they simulate a global climate evolution forced by historical and RCP4.5 emission (four member ensemble), and one where Asian aerosol emissions are kept constant (also four ensembles). The results are interpreted separately, and also used as input to the LUMA steady-state model.

The topic of the paper is timely and interesting, and the tools well suited for the investigation. I like what the authors are trying to do, and believe that the paper can make a strong contribution to the field. However, as it stands, there are some key pieces of information missing that make it difficult to judge how much weight can be put on the detailed results in the second half of the paper. (See below.) Once these are added,

and assuming the results hold up, I recommend that the paper be published in ACP.

Comments:

From the present manuscript, it is difficult to know the strength of the perturbation applied, and therefore what amount of signal should be expected. The AOD in Figure 1a gives an indication, but as the authors themselves state there are so many compensating effects and nonlinearities in this region that AOD does not directly translate into a forcing. I would recommend adding 2-3 simple fixed SST calculations to estimate the ERF, e.g. using the mean emissions of the two periods used (1993-2007 and 1979-1993) and the fixed aerosol emission case. This will greatly aid the reader in interpreting the results.

All figures are presented as the difference (1993-2007) - (1979-1993), presumably as means of the four fully coupled ensemble members? It would be good to see some plots of the individual members too, to get a feel for internal variability. And how is significance calculated? This is crucial. Should we e.g. really believe that the small dAOD shown in Figure 1a causes the large and significant (to 10%) change in cloud top effective radius over western Canada in Figure 1b?

Another critical question is how the fixed aerosol case was spun up? And are they of equal length to the transient runs? I assume the transient simulations branch off from a historical run, but if the aerosol emissions are suddenly set to the 1970-1981 mean at the same time then there will be a residual response during the first years. (This is probably not what was done, but the mehtodology isn't currently described.) Also, is the surface temperature of the fixed emission run consistent with the mean point of the transient runs?

Finally, can the authors use their results to discuss the climate implications of the current strong reductions in (some) Asian aerosol emission sources? This would add an extra layer of relevance to the paper.

(I have no minor comments; the paper is really very clearly written and seems thoroughly proofread.)

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