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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 #3

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The goal of this study is to understand the mechanisms by which changes in anthropogenic aerosol and precursor emissions from Asia drive regional responses in temperature and precipitation during boreal winter. The study uses a combination of a fully coupled atmosphere-ocean general circulation model and a steady-state primitive equation model. The topic is of interest to readers of Atmospheric Chemistry and Physics. There are some interesting and informative results in the study; however, some aspects of the analysis in the current version of the manuscript is a bit cursory. I recommend semi-major revisions to the manuscript before publication.

Specific Comments

Section 2 should provide a summary of emissions used in the study, including showing timeseries plots of 1975-2007 emissions from Asia of key species. I am assuming SO2,

NOx, CO, black carbon, and organic carbon emissions were included, but this should be made clear and explicit.

The analysis shown the manuscript is quite cursory. For example, the study does not discuss the difference between aerosol scattering and absorption and how the difference between scattering and absorption may have contributed to the differences in local responses to emissions changes. The distinctions between the impacts of aerosol-radiation interactions vs. those of aerosol-cloud interactions were also not discussed. It may be useful to use the method of Ghan (2013) to calculate direct radiative effect and indirect effect as a way to tease out how different effects of aerosols and differences in spatial distributions of different forcings impact local- and large-scale changes.

The manuscript is unclear on what HadGEM3-GC2 simulation setups were used and how they were analyzed to determine the changes due to anthropogenic aerosol and precursor emissions from Asia. Section 2.1 states "We compare simulations with time-varying anthropogenic aerosol emissions (1975-2007) against simulations where Asian anthropogenic emissions were fixed [at their 1970-1981 mean values]", suggesting that there were two sets of 1975-2007 simulations and that the difference between the two sets were taken as the response to Asian emissions changes. However, the same paragraph also states "Throughout the paper, we define the response to the increase in Asian emissions as the difference between two periods: (1993-2007)-(1979-1993)", suggesting that there was only one set of simulations and that the response was taken as the difference of two time periods from the same set of simulations.

In the captions of Figures 1 to 4 does "not significant at the 10% level" mean "not significant at the 90% confidence level"? The manuscript should indicate how the confidence levels were calculated.

Figure 1b shows that the regions with decrease in cloud top effective radius extend much beyond the West Pacific and the Bay Bengal noted in the text (lines 18-19 of

page 5). What explains such a large extent of decrease in cloud top effective radius in response to emission changes only in Asia? Rather than or in additional to cloud fraction (Figure 2d), it may be useful to examine cloud optical depth.

"...decrease in downwelling shortwave radiation over both India and China" in lines 22-23 of page 5 is mis-leading as Figure 2a shows an increase in downwelling shortwave radiation in large parts of China.

Lines 26 and 32 of page 5: Could the slight decrease in cloud fraction in eastern China be due to semi-direct effect?

Line 2 on page 6: By "southwesterly shift", do you mean "southwestward shift"? Southwesterly means coming from the southwest whereas Figure 3b suggests precipitation zone shifting towards the southwest.

One of the maps in Figure 4 should have 130E labeled (i.e., the longitude shown in Figure 5).

Technical Corrections

- Throughout, "aerosol emissions" should be "aerosol and precursor emissions".
- Page 1, Line 3 (Abstract): For clarity, suggest revising "...to isolate the impact of Asian aerosols on global climate. In boreal winter, it is found..." to "...to isolate the impact of aerosol and precursors emissions from Asia on global climate during boreal winter. It is found..."
- Page 1, Line 9 (Abstract): The meaning of "positive" in "positive-Pacific-North-American circulation pattern is not clear here.
- Page 1, Line 18: "provide additional" → "can act"
- Page 2, Line 7: "of the order of weeks" should be "of orders of a few days to a couple of weeks"

- Page 2, Line 7: "heterogeneous" → "spatially heterogeneous"
- Page 2, Line 19: The meaning of the first sentence of the paragraph is unclear, suggest changing it to "Some studies have shown that the spatial patterns of temperature and precipitation responses are similar regardless of the regional locations of the aerosol and precursor emission changes..."
- Page 3, Line 3: "air quality as declined" → "air pollution has increased"
- Page 3, Line 25: Suggest having "In this study..." be the start of a new paragraph.
- Page 4, Line 26: Explain how the four ensemble members are different.
- Figure 1a should include a box indicating where emissions are considered to be in Asia in the HadGEM3-GC2 simulations.

References

Ghan, S. J.: Technical Note: Estimating aerosol effects on cloud radiative forcing, Atmos. Chem. Phys., 13, 9971–9974, https://doi.org/10.5194/acp-13-9971-2013, 2013.

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