

### **Anonymous Referee #3**

**General comments:** The manuscript submitted by Dong et al. assesses how changes in aerosol emissions in Europe and Russia influences haze events in China, using simulations from the HTAP2 project. Analyses include a thorough model evaluation towards various surface and satellite-based observation data, presentations of the seasonality of the long-range impacts from the two regions on China, evaluation of how the long-range impacts are distributed between within- and above-PBL layers, comparison of results to findings for earlier years, as well as an analysis of estimated horizontal visibility and how this variable is affected by the two source regions. The authors have performed many and rigorous analyses, and the results are likely to be of broad interest to the community. There are, however, some issues that need to be resolved before the paper should be accepted for publishing.

**General comments:** -The language of the manuscript could greatly benefit from a thorough read-through by a person fluent in English. - The manuscript is at times unnecessarily lengthy. I have suggested several sentences that could be removed, but going through the manuscript and removing sentences and statements that contain irrelevant information or information that has already been given, will help the reader.

- In the Introduction, it would be good to see a bit more background on haze in China – for instance, write out in more detail what the references around lines 15-20 find. Do that Wang studies referred to on line 19 look at sources in China only, or is there an element of long-range influences here that could be relevant for this study?

**Response:** We intended to provide a brief introduction of the research topics related with haze in China, so detailed findings of these references are not described. The findings of these publications are not used in our study. We listed them in the “Introduction” section as part of the background information. None of the literatures intended to quantify the contribution of long-range transport to haze in China, and this is why we conduct our study.

- The “Results and Discussion” section is at times too much description of figures and numbers, and too little discussion of results. I believe a lot of the numbers could be put in a table so that more time can be spent on the main highlights and how they agree/differ from other findings. There are several interesting results and features here that deserve to be accentuated.

**Response:** We agree with the referee that language of the original submission shall be greatly improved, and thank the referee for providing other detailed suggestions and comments. We have carefully go through the whole manuscript to improve the writing, by removing some of the descriptions of the numbers and adding more in-depth discussions, such as the possible reason for model diversity.

Specific comments:

1. P1 L37: add “from EUR” after “long-range transport”?

**Response:** It has been added in the revised manuscript.

2. P1 L38: change “aerosol response” to “the aerosol response in EAS”

**Response:** It has been added in the revised manuscript.

3. P1 L44: to compare how much 1-3 days change in haze frequency is to the percentages given above, please consider changing 1-3 days to percent change

**Response:** The percent change has been added in the revised manuscript.

4. P2 L12: It is a bit difficult to catch the meaning of the sentence starting with “Although” – a rewording would be good!

**Response:** The long sentence has been revised as “Some pilot studies have tried to explore the understanding of haze in China.”

5. P2 L28: Not necessary to introduce the AQMEII and MICS-Asia projects, as data from these are not used in the present study? Instead, line 26 could instead start with “One of these is the Task Force on Hemispheric ...”

**Response:** The description of AQMEII and MICS-Asia is removed and the sentence has been revised.

6. P2 L34: These last two sentences are not strictly necessary.

**Response:** These sentences are removed.

7. P3 L27: The first part of this sentence “To quantify ... sensitivity simulations” is superfluous – one could instead start directly at “Emission perturbations are conducted with all..”

**Response:** That sentence is changed according to the comment.

8. P3 L31: Fix reference Guido R. can der Werf?

**Response:** The reference is removed, it shall be: “(1) BASE scenario with all baseline emissions”

9. P3 L41: the sentence starting with “These datasets are essential” can also be removed.

**Response:** The sentence is removed.

10. P4 L2: Here you could stop after “descend into the PBL.” And then start a new sentence motivating the remaining text by stating the relevance of the PBL-analysis to haze (for instance, that pollutants within the PBL give more haze, and therefore it is necessary to understand the contributions of within- and above- PBL).

**Response:** These two sentences have been revised according to the comment, and necessary references are added according to the suggestion of another referee.

11. P4 L37: I may have missed something, but P3 L19 says that all models have resolution of 0.1x0.1 – where does the 2.8x2.8 come from? Please clarify.

**Response:** Page4-Line19 states the resolution of the emission inventory, to avoid misleading, that sentence is changed to “The emissions are compiled from several regional inventories for the year 2010 with monthly temporal resolution and 0.1°x0.1° grid resolution”. Page4-Line37 states that the grid resolution of ensemble mean is 2.8°x2.8°, that sentence is changed to “ ... model ensemble mean, calculated as the average of all participating models at 2.8°x2.8° grid resolution.”

12. P5 L1: Please define MB

**Response:** “MB” refers to “mean bias”, it has been added in the updated version.

13. P5 L5: Please consider replacing all uses of “temporal” in this section with “seasonal”, as the “temporal” gives an impression of temporal (year-to-year) development.

**Response:** It has been replaced in the updated version.

14. P5 L6: you write that models tend to underestimate the high peaks in spring, but Fig. 2d seems to me to show that models overestimate in spring (or at least all models are higher in March, and the observations are in the midst of the models in April)?

**Response:** The referee is correct, we intended to emphasize that “model overestimate high values in spring”, it has been fixed in the updated version.

15. P5 L15: Remove “shows significantly ... than the others”, which is given from the previous sentence.

**Response:** The sentence has been removed.

16. P5 L16: Do you have any data on the occurrence or tendency for wildfires near this specific stations? If not, this comment should perhaps be removed.

**Response:** The sentence has been removed.

17. P9 Section 3.3 heading: I am a bit skeptical to the use of the word “Trend” in this heading and in the section text, as a trend can hardly be quantified based on a comparison between the years 2000 and 2010 (data for years 2008 and 2009 helps, but the data are scarce). Consider changing “trend” to “change” or something similar.

**Response:** It has been changed in Section3.3.

18. P9 L39: Please add a reference after “the past decade.”

**Response:** The reference “Li et al., 2018” is added because it compares emission changes in China.

19. P11 L25: How would the results look if you use CAM-chem only for all the years?

**Response:** The numbers (in Table 2 for RBU scenario in 2008 and 2009 ) are indeed calculated with CAM-chem only.

20. P12 L16: ECE → CEC?

**Response:** Yes, it has been changed to “CEC”

21. P13 L10: “The participating models ... to 5.5%” can be removed as it has just been said above.

**Response:** It has been removed.

22. P13 L14: It says Frequency\_Full\_Impact15 twice :)

**Response:** The second one is removed.

23. P13 L34: Please give this in % change as well.

**Response:** The percent change is added.

24. P14 L37: Please add references after “recent years”.

**Response:** The following references are added:

Chen, Y., Schleicher, N., Fricker, M., Cen, K., Liu, X. L., Kaminski, U., Yu, Y., Wu, X. F., and Norra, S.: Long-term variation of black carbon and PM<sub>2.5</sub> in Beijing, China with respect to meteorological conditions and governmental measures, *Environ Pollut*, 212, 269-278, 10.1016/j.envpol.2016.01.008, 2016.

Feng, J. L., Zhong, M., Xu, B. H., Du, Y., Wu, M. H., Wang, H. L., and Chen, C. H.: Concentrations, seasonal and diurnal variations of black carbon in PM<sub>2.5</sub> in Shanghai, China, *Atmos Res*, 147, 1-9, 10.1016/j.atmosres.2014.04.018, 2014.

Lu, Z., Streets, D. G., Zhang, Q., Wang, S., Carmichael, G. R., Cheng, Y. F., Wei, C., Chin, M., Diehl, T., and Tan, Q.: Sulfur dioxide emissions in China and sulfur trends in East Asia since 2000, *Atmos Chem Phys*, 10, 6311-6331, 10.5194/acp-10-6311-2010, 2010.

Zhu, J. L., Liao, H., and Li, J. P.: Increases in aerosol concentrations over eastern China due to the decadal-scale weakening of the East Asian summer monsoon, *Geophys Res Lett*, 39, L0980910.1029/2012gl051428, 2012.