# Response to Comments of Reviewer B

**Manuscript number**: acp-2019-62

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**Title**: Simulated coordinated impacts of the previous autumn NAO and winter El Niño on the winter aerosol concentrations over eastern China

**General comments:**

*The manuscript presents analysis of the impacts of NAO and El Niño on the anthropogenic aerosols in China. It uses mostly GEOS-Chem model simulations driven by GEOS-4 reanalysis. Understanding the changes in aerosols is a relevant topic for improving our knowledge of relationship between natural cycle and aerosols. Model simulation show the circulation anomalies during the co-occurrence events of negative NAO and El Niño, and therefore influence on aerosol concentrations over eastern China. However, a sole negative NAO is linked with anomalous aerosols over central China. Overall the manuscript is well written and clear, the figures are also appropriate and clear. After addressing the following minor concerns, I suggest publishing this work.*

**Response:**

Thanks to the reviewer for the helpful comments and suggestions. We have revised the manuscript seriously and carefully according to the reviewer's comments and suggestions. The point-to-point responses to the comments are listed as follows.

**Comments:**

1. *I suggest that the authors could also select more sample size (negative NAO + El Niño and El Niño events) from reanalysis data in a longer time, i.e., 1979-2016, and compare the distribution of wind anomalies.*

**Response:**

Thanks for the comment. We have adopted the reviewer's comment by examining the temporal variation of autumn NAO and winter El Niño. Except the cases in the manuscript, there is only one well defined negative NAO event, i.e., 2010, and one El Niño event, i.e., 2015. However, the occurrence of the negative NAO is overlapped

with a La Niña event, and the El Niño event 2015 is along with a neutral NAO event. For the El Niño event 1982, it is along with a positive NAO. That is there is no other proper cases (negative NAO + El Niño) as shown in the manuscript during period 1979-2016.

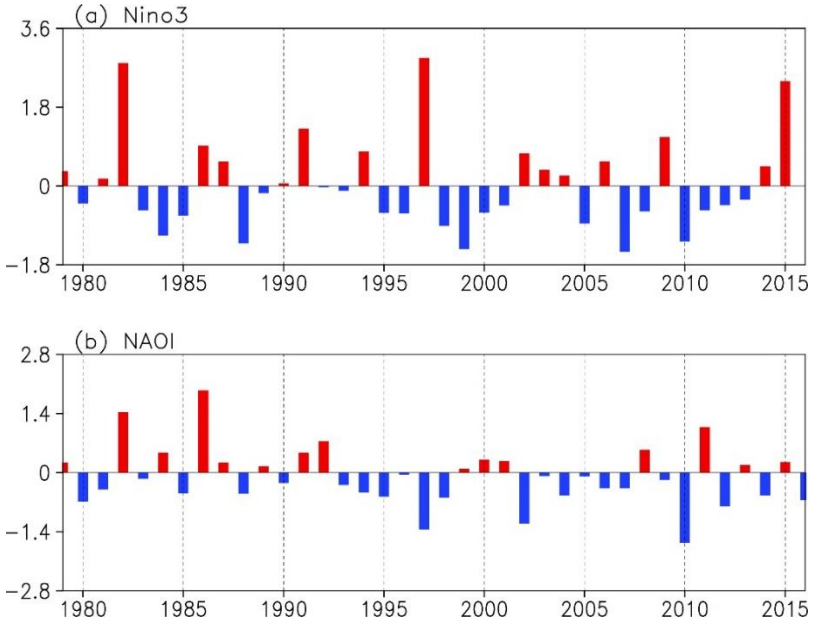


**Figure R1.** (a) The time series of the Niño3 index based on the HadISST during period 1979-2016. (b) The time series of the NAO index based on the NCEP/NCAR reanalysis during period 1979-2016.

2. *Data part. In the whole study, the authors used mostly the model data, even in analyzing the atmospheric circulation, why? And what are the differences between model data and reanalysis data? Can their differences influence the results of the research?*

**Response:**

Thanks to the reviewer for the helpful comments. We would like to clarify the reliability of the datasets used by the following two points:

1) We have shown in the manuscript, the input surface skin temperature of GEOS-Chem is highly correlated with the widely used SST dataset, i.e., HadISST. And the NAOI based on GEOS-Chem is closely correlated with the NAOI based on the NCEP/NCAR reanalysis.
2) The input meteorological fields (GEOS-4), such as winds, temperature, humidity, have been evaluated in Zhu et al. (2012) and Feng et al. (2016), and their result suggested the GEOS-Chem input meteorological fields are highly

consistent with the NCEP/NCAR reanalysis. Besides, the spatial distribution of winds anomalies at 850 hPa during two events, i.e., 1997 and 2002, based on the GEOS-Chem input meteorological fields and those from NCEP/NCAR are computed as shown in Figure R2. We see that the winds show similar spatial structures, implying high consistency between the model meteorological fields and reanalysis. The above results provide confidence for the reliability of the meteorological fields of GEOS-Chem model.

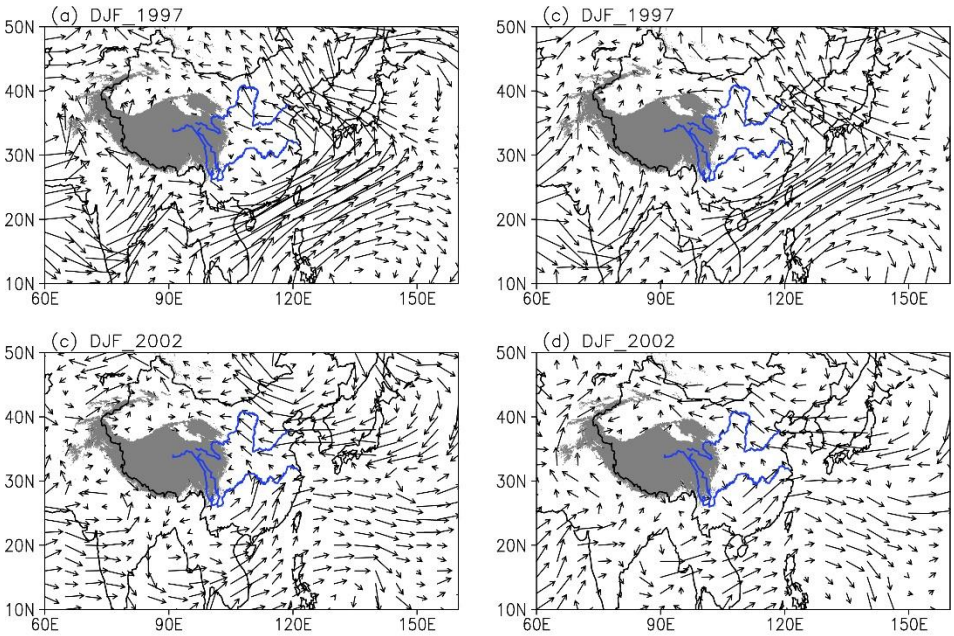


**Figure R2**. The horizontal distribution of wind anomalies at 850 hPa during 1997 and 2002 winters based on the GEOS-Chem input meteorological winds (left panel) and NCEP/NCAR reanalysis (right panel).

The above discussions provide confidence for employing the GEOS-Chem to explore the influences of climatic events on aerosol concentrations, and it is proved to be a useful tool to understand the impacts of climatic event on aerosol concentrations without enough observations.

3. *Figure 11, discuss the contribution from wet deposition, I think the limited role of wet deposit on the aerosol concentrations over central China is partly due to the small amount of rainfall during winter. However, the winter rainfall amount over south China is greater than that over central China. The author should further examine this point.*

**Response:**

We have adopted the reviewer's comment by further examine the climatological winter rainfall distribution over China. The reviewer is right, the amount of winter rainfall over central China is much less than over south China, indicating a less important role of wet deposit on the boreal winter AC over central China than over south China. We have included this point into the revised manuscript.

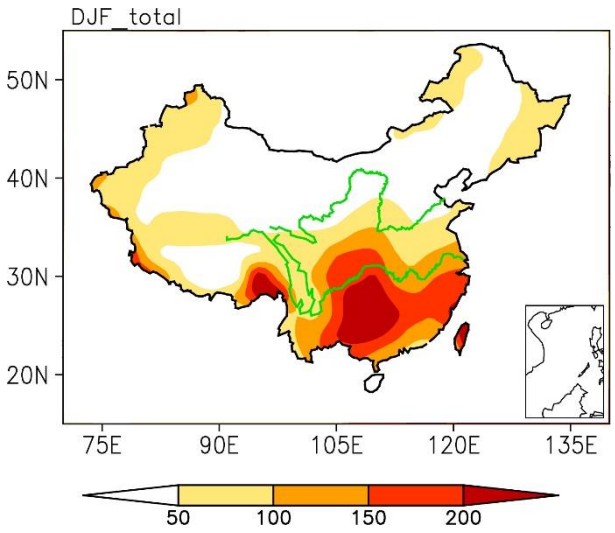


**Figure R3**. The distribution of climatological boreal winter rainfall.

4. *Finally, why the impacts of positive NAO on the aerosol concentrations are insignificant, the authors should shed more light on this issue. The corresponding variations in the underlying thermal and dynamical process should be included to give a full understanding.*

**Response:**

We have adopted the reviewer's comment by further examining the situation during the positive NAO events. During period 1986-2006, there are two well-defined NAO positive events, i.e., 1986 and 1992. The anomalous SST pattern during the two events are shown below. It is seen the anomalous SST tripole pattern is not observed during the positive NAO events, indicating that the air-sea feedback during the positive and negative NAO events is different. Therefore, due to the different anomalous SST pattern, the teleconnection wave train during the positive NAO events are different, without significant impacts on the circulation over eastern China. We have included this point into the revised manuscript.

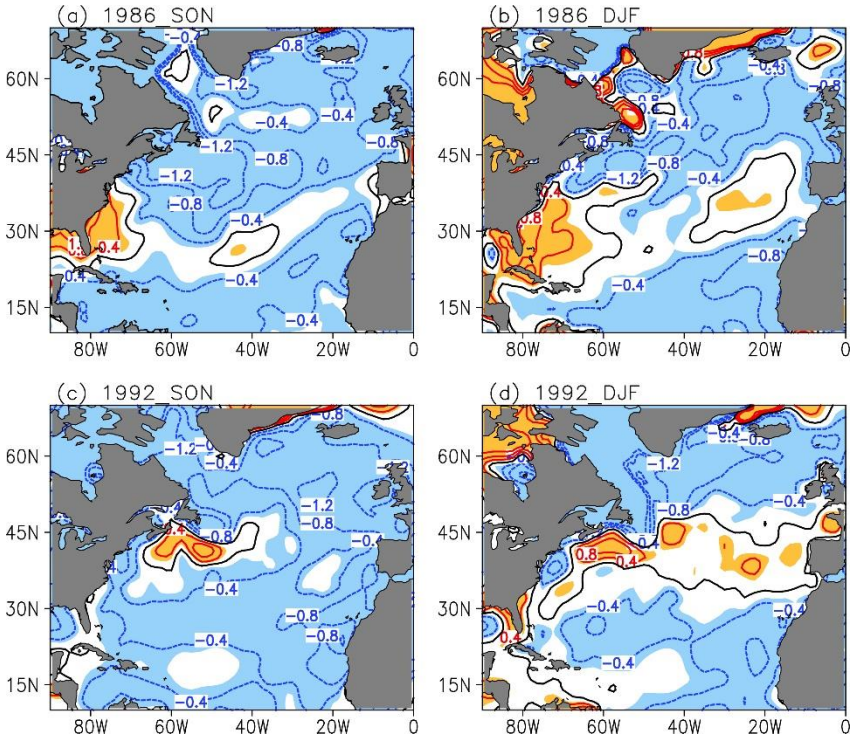


**Figure R4**. The horizontal distribution of skin temperature anomalies (°C) based on the assimilated meteorological data during the (a) autumn and (b) winter of 1986. (c)-(d) As in (a)-(b), but during 1992.

5. *The related reference the authors might be interested in:*

*Li, X., Z. Wu and Y. Li, 2019: A link of China warming hiatus with the winter sea ice loss in Barents–Kara Seas. Clim Dyn., DOI:10.1007/s00382-019-04645-z.*

*Wu, J. and Z. Wu, 2018: Interdecadal change of the spring NAO impact on the summer Pamir-Tienshan Snow Cover. Int.J. Climatol., DOI: 10.1002/joc.5831.*

*Wu, Z., X. Li, Y. Li and Y. Li, 2016: Potential Influence of Arctic Sea Ice to the Inter-annual Variations of East Asian Spring Precipitation. J. Clim., 29, 2797-2813.*

*Wu, Z., J. Li, Z. Jiang and J. He, 2011: Predictable climate dynamics of abnormal East Asian winter monsoon: once-in-a-century snowstorms in 2007/2008 winter. Climate Dyn., 37, 1661-1669.*

*Lyu, M., Z. Wu, X. Shi and M. Wen, 2019: Distinct effects of the MJO and the NAO on cold wave amplitude over China. Quart. J. Roy. Meteor. Soc., DOI: 10.1002/qj.3516.*

*Zhang, P., B. Wang and Z. Wu, 2019: Weak El Niño and Winter Climate in the mid-high latitude Eurasia. J. Climate, 32, 402-421.*

*Zhang, P., Z. Wu and J. Li, 2019: Reexamining the relationship of La Niña and the East Asian winter monsoon. Climate Dyn., DOI: 10.1007/s00382-019-04613-7.*

*Ye, X. and Z. Wu, 2018: Contrasting Impacts of ENSO on the Interannual Variations*

*of Summer Runoff between the Upper and Mid-Lower Reaches of the Yangtze River. Atmosphere, DOI: 10.3390/atmos9120478.*

*Zhang, P., Z. Wu, and H. Chen, 2017: Interdecadal Modulation of mega-ENSO on the North Pacific Atmospheric Circulation in Winter. Atmos. Ocean, 55(2), 110-120.*

*Zhou, Y., and Z. Wu, 2016: Possible impacts of mega-El Niño/Southern Oscillation and Atlantic multidecadal oscillation on Eurasian heat wave frequency variability. Quart. J. Roy. Meteor. Soc., 142, 1647-1661.*

*Wu, Z., and P. Zhang, 2015: Interdecadal Variability of the mega-ENSO-NAO Synchronization in Winter. Climate Dyn., 45, 1117ï˘A 1128.*

*Wu, Z. and H. Lin, 2012: Interdecadal Variability of the ENSO-North Atlantic Oscillation Connection in boreal summer. Quart. J. Roy. Meteor. Soc., 138, 1668-1675, DOI: 10.1002/qj.1889.*

*Wu, Z., J. Li, Z. Jiang, J. He and X. Zhu, 2012: Possible effects of the North Atlantic Oscillation on the strengthening relationship between the East Asian summer monsoon and ENSO. Int. J. Climatol., 32, 794-800. DOI: 10.1002/joc.2309.*

**Response:**

We have updated the references and included the relevant references into the revised manuscript. More details are seen in the revised manuscript.