

Response to Comments of Reviewer A

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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 investigated the impact of atmospheric circulation (NAO and ENSO) on the high aerosol concentration in Eastern China was investigated by using simulations of GOES-4, which can exclude the influence of emission. They found that the asymmetric impact of NAO and ENSO on the AC over central and eastern China, and further discussed the physical mechanism induced the circulation anomalies associated with NAO- and El Nino. In general, I found the paper appropriate for ACP. However, it need to be major revised before accepted this paper for publication in ACP with addressing those comments listed below:

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.

Major Comments:

- 1. The manuscript focus on the winter high aerosol concentration and its interannual variation associated with NAO and El Nino, so I think, it is better to point out the seasonal information and time scale of variation in the title to avoid misleading, such as "Simulated coordinated impacts of the previous autumn NAO and winter El Nino on the interannual variation of winter aerosol concentrations over eastern China.", Certainly, authors can give a better title than this.*

Response:

We have adopted the reviewer's comment and revised the title. Since the El Niño is mainly an interannual variability, we have omitted the interannual variation in the

suggested title.

2. *The introduction mentions that “NAO exhibits significant cross-seasonal impacts on the East Asian climate, ... boreal spring NAO influenced the subsequent intensity of EASM”. However, the manuscript investigates the influence of autumn NAO on winter climate, so I think it is better to providing some references to explain why we should investigate the impact of autumn NAO on winter climate.*

Response:

Thanks to the reviewer for the comments. Previous studies have found that spring (summer) NAO plays important role in impacting the summer (autumn) climate over eastern China, indicating the impact of NAO on the East Asian climate is cross-seasonal. We have examined the role of previous autumn and simultaneous winter NAO on the winter aerosols over eastern China, and it is found the influences of winter NAO on the aerosols are insignificant (Figure R1). Based on the above discussions, the role of previous autumn NAO on the AC over eastern China is discussed in the present work.

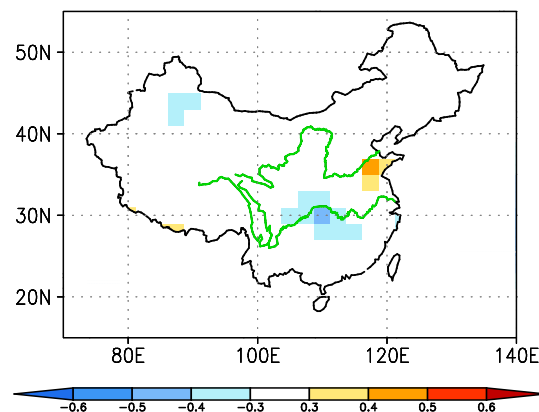


Figure R1. The spatial distribution of the correlation coefficients between surface layer PM_{2.5} concentrations and the winter NAOI.

3. *the time scale of NAO and ENSO are different, the impact of NAO is mainly in decadal time scale, ENSO is mainly in interannual time scale. The time scale should be clarifying clear when authors get the conclusion.*

Response:

The reviewer is right that the NAO exhibits strong decadal variation. For the longer period, for example, 1850-2017, strong decadal variation is observed in the NAOI (Figure R2). However, as shown the NAO in the period 1986-2006 is generally

located in the positive phase, and is characterized by strong interannual variations. We have included the above discussions into the revised manuscript.

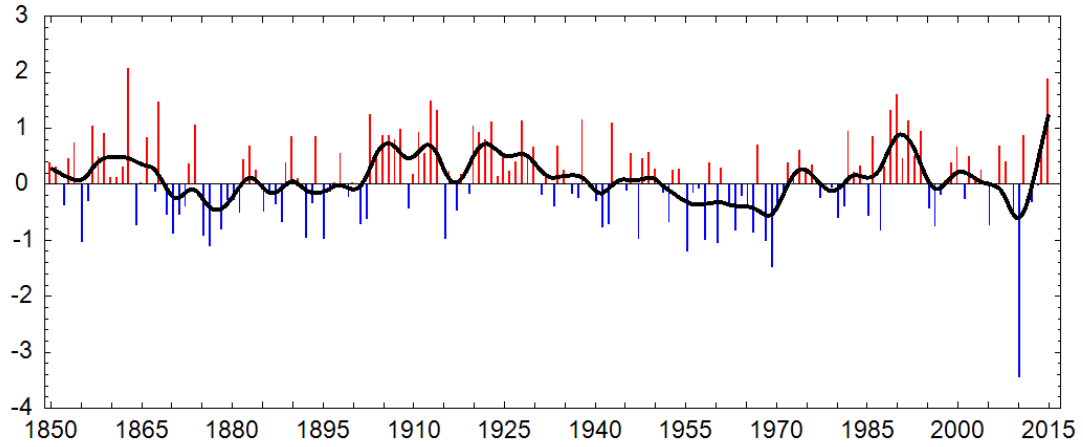


Figure R2. The annual mean NAO index during 1850-2017.

4. as the authors said, although the NAO index are close in 1997 and 2002 (-1.507 in 1997 and -1.510 in 2002), the precise location of anomalous SLP is different, so the difference of AC distribution in 1997 and 2002 (fig. 5a,b) may be caused by the difference of locations of anomalous SLP pattern associated with NAO, the author should give some explain before investigate the impact of NAO & El Nino and solo NAO on the AC.

Response:

Thanks for the comment. From the correlation between the AC and the NAOI during its negative phases, significant negative correlations are seen over central China, indicating a negative NAO is connected with enhanced AC over the central China. However, there is no significant signal over the south China in the correlations between the positive NAOI and AC, indicating the role of positive NAO on the AC over south China is limited. Besides, enhanced AC anomalies are seen over central China in both 1997 and 2002 winters, and similar teleconnection wave train is observed in both winters, suggesting the role of NAO on the AC over central China.

Moreover, the effect of El Niño in impacting the distribution of AC is confirmed for that warm El Niño event is associated with enhanced AC over south China. The influences of El Niño on the circulation and rainfall over south China has been discussed in previous studies (e.g., Weng et al., 2007, 2009; Feng and Li, 2011; Feng et al., 2016). The above discussion provides confidence for the combined role of NAO and El Niño on the boreal AC over eastern China.

As the reviewer pointed that the locations of the anomalous pressure centers in the two negative NAO events show difference, however, it is seen that the two events bear equivalent index values, and with similar anomalous SLP amplitude, i.e., with bigger negative SLP anomalies and the maximum minus center is same. That is the pressure gradient of the two NAO negative events is similar, contributing to the similar anomalous SST pattern and teleconnection wave train as shown in the manuscript.

The above discussions indicate the combined impacts of the NAO and El Niño on the boreal winter AC over eastern China.

Minor Comments:

1. *Line 225 and Fig. 4, the significant level is 0.2 level, which is different with fig. 3 (0.1 level) and it is too lower in the statistical significance. Suggest to use consistent significant level (like 0.1 level).*

Response:

Thanks. Different significance level is shown due to that the sample in Figure 4 is less than that in Figure 3. The possible different impacts between the negative and positive phases of NAO, as well as between the warm and cold events of ENSO are discussed, whereas the whole period. In fact, the color bar 0.35 is for the significance at 0.2 level, and 0.45 is for the significance at 0.1 level, we see that the different significance level would not change the result. We have added the detailed caption into the revised manuscript.

2. *Line 232, like author mentioned in Line406-408, author should point out that “the ENSO affects the distribution of AC in south China and northwest China.” Northwest China is not discussed but should be noted based on the figure.*

Response:

We have revised the relevant description.

3. *Line 248 and the legend in Fig. 5, “column AC anomalies “ in the maintext, however, the legend of Fig. 5 did not point out “anomalies”, which is right? Maybe the main text is right.*

Response:

The reviewer is right, it is for the anomalous aerosol concentrations, and we have revised the relevant description.

4. Line 281: “negative SST “ -> “negative SST anomaly”

Response:

Yes, done.

5. Line 300-301, “Under the influence of the anomalous downstream teleconnection, north China is influenced by convergence anomalies, with the center positioned over central China (Fig. 9).” The Fig. 9 can not fully support this sentence, maybe due to the missing lon information in the Fig. 9 or the country boundaries. I suggest to make the fig. 9 more clear.

Response:

We have adopted the reviewer’s comment and added the longitude and latitude in to the revised Figure 9.

6. “convergence” in Line 308 and “anomalous divergence” in Line 313, which is contrary to the Fig. 10. Generally, the negative values of divergence indicate convergence, positive values indicate divergence. Therefore, Line 308 said “south China was influenced by an evident anomalous convergence at the lower troposphere.” however, I see the positive values (orange color) of divergence in Fig. 10a. please check it.

Response:

Sorry for the typo, the reviewer is right. In winter 1997, there are anomalous divergence over the southeastern coastal regions of China, associated with anticyclonic circulation anomalies. We have revised the description.