

## Response to Comments of Reviewer 2

**Manuscript number:** egosphere-2023-52

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**Title:** Influence of the previous North Atlantic Oscillation (NAO) on the spring dust aerosols over North China

### **General comments:**

This study investigated the relationship between the boreal winter North Atlantic Oscillation (NAO) and the spring dust events (DEs) over North China (30-40 °N, 105-120 °E) during 1980-2020. The authors demonstrated that there is a significant negative relationship between the boreal winter NAO index and the late spring DAs in the North China. The synoptic cause of such relation is characterized as the changes in the tropospheric synoptic situation in the Ural Mountains, DAs source regions in China, and North China during the DEs under the modulation of the NAO negative signal. Further, evolution mechanism of abnormal atmospheric circulation affected by the NAO negative signal is explained by the transient eddy fluxes transport, thermal wind principle, and the quasi-geostrophic theory.

This paper is very meaningful, and a great quantity of previous work has been summarized and cited. The results of this study are interesting and useful to deepen our understanding of formation mechanism of the DEs in east Asia. I would like to recommend this manuscript should be accepted subject to minor revision, for this study fit well with the scope of Atmospheric Chemistry and Physics.

### **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.

**Specific comments are as follows:**

1. Line 85: “it is of important practical”. I suggest deleting “of” in the sentence.

**Response:**

Yes, done.

2. Line 155,450,471: “mechanisms”. I suggest revising it as “mechanism” and pay more attention to tenses of verbs.

**Response:**

Thanks for your suggestion.

We have revised all inappropriate uses (Line 132, 414, 431) and checked the tenses of verbs in the revised manuscript.

3. Line 140: “the DEs in northern China regions”. I suggest deleting “regions”.

**Response:**

Yes, done.

4. Line 192-195: The full name of the ERA5 reanalysis datasets is not correct.

**Response:**

Thanks for your comment.

We have revised this description as “The atmospheric reanalysis data set, including the wind field, geopotential height field, sea level pressure field, temperature field, and vertical velocity field, obtained from the European Center for Medium-Range Weather Forecasts (ECMWF) is the fifth-generation reanalysis global atmosphere (ERA5) data set over the period 1980-2020 (horizontal resolution: 0.25 °x 0.25 °). Compared to its predecessor, ERA-Interim, ERA5 has a modified data assimilation system and improved physical model to achieve reanalysis data information with improved quality (Hersbach et al., 2020)”, as shown in Lines 166-172.

5. Line 208-210: What is the exact definition of selection criteria for the NAO abnormal years? Please describe it specifically.

**Response:**

Thanks for your suggestion.

The selection criteria for the NAO abnormal years is based on the NAOI index averaged over the winter months, then the index is normalized, and the years with a NAOI exceeding 0.5 standard deviations are recorded as NAO anomalous years. The 0.5 standard deviation is used as the criteria for the selection of abnormal years, in order to not filter excessively while retaining the NAO signal to the maximum extent possible.

According to your suggestion, a specific description has been added in Lines 181-184.

6. Line 259: “in DJF, JFM, and FMA in the early period”. I suggest revising it as “in previous DJF, JFM, and FMA”.

**Response:**

Yes, done.

7. Line 278: Figure 3, units needed.

**Response:**

Thanks for your suggestion.

The unit has been added to the legend in Figure 3.

8. Line 310-311: Information of the 27 DEs seems not enough. It is suggested to list 27 DEs and the years in which these DEs occurred in a table, which may be easier for readers to understand better.

**Response:**

Thanks for your comment and suggestion.

The table containing 27 DEs and the years in which these DEs occurred is seen in Table R1 and included in the revised manuscript as suggested (Table 1).

**Table R1.** Based on the CNMC selection criteria, 27 spring DEs and the years in which these DEs occurred in North China during 1980-2020.

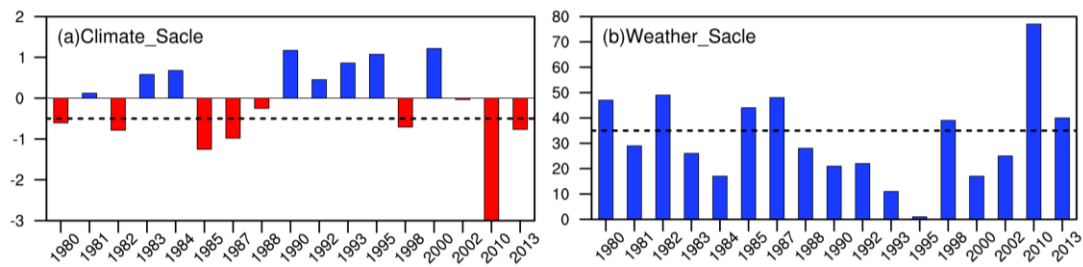
Years	DEs
1980, 1981, 1982, 1983, 1984, 1985	19800419, 19810308, 19810325, 19810502, 19820408, 19820502, 19820508, 19830316, 19830401, 19830428, 19840301, 19840420, 19840428, 19850403
1987, 1988, 1990, 1992, 1993, 1995	19870317, 19880411, 19880417, 19900407, 19920411, 19930424, 19950311
1998, 2000, 2002, 2010, 2013	19980416, 20000327, 20000409, 20020320, 20100320, 20130309

9. Line 316-321: It is not clear how the 9 DEs are selected from the climate scale and the weather scale. It is better to be described in detail by means of figures or tables.

**Response:**

Thanks for your comment and suggestion.

According to your suggestion, we have illustrated the Figure explaining the DEs selected from the comprehensive consideration of climate and weather scales in the revised manuscript (Figure R1) and included in the revised manuscript as suggested (Figure 5).



**Figure R1.** (a) The standardized inter-annual variability of NAOI in previous winter of the years in which these DEs occurred, (b) the number of days when the value of NAOI is less than -0.5 in previous winter of the years in which these DEs occurred.

10. Line 404: Should be (30 °-60 °N, 105-130 °E).

**Response:**

Yes, done.

11. Line 579,603: The citation of references (Gary, 2011) should be revised as (Gary, 2012).

**Response:**

Thanks for your comment and suggestion.

This error has been revised as shown in Line 534, 558 in the revised manuscript.

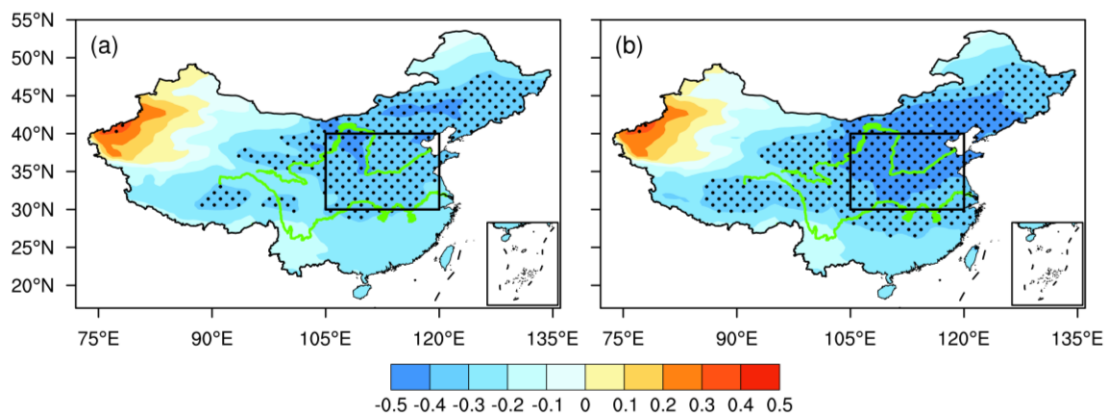
12. Line 728-730: The author also mentioned that both NAO and ENSO play important role in the occurrence and development of DEs in China, and the research on such synergistic effects is relatively little yet. Have you got some preliminary results? Or the authors could conduct research on this issue in the next step of work.

**Response:**

Thanks for your comment and suggestion.

From the analysis of previous work, the ENSO plays an important role in the development process of DEs in China (Li et al., 2021; Yang et al., 2022), and ENSO will also have a certain impact on the development of NAO (Graf and Zanchettin, 2012; Zhang et al., 2015). Through partial correlation (after removing the impact of ENSO), it is found that there is still a good correlation between the spring dust aerosols in North China and previous winter NAOI during 1980-2020 (Figure R2), indicating that the impact of NAO on the aerosols are independent of ENSO.

Anyway, we have not conducted systematic research on the effects of ENSO and NAO on dust aerosols. We will conduct this issue according to your suggestion in our future work.



**Figure R2.** Correlations between the dust aerosols during springtime and NAOI in previous winter (a) during 1980-2020. (b) As in (a), but for the partial correlations (after removal of ENSO). The black box indicates the North China. The black dotted areas are statistically significant at the 95% confidence level.

13. The labels in some figures (Figure 7, Figure 10-13) should be further enlarged, since they are rather small to distinguish.

**Response:**

Thanks for your suggestion.

We have revised these problems in all the figures.

**References:**

Graf, H.-F. and Zanchettin, D.: Central Pacific El Niño, the “subtropical bridge,” and Eurasian climate, *Journal of Geophysical Research: Atmospheres*, 117, <https://doi.org/10.1029/2011JD016493>, 2012.

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Li, J., Garshick, E., Huang, S. D., and Koutrakis, P.: Impacts of El Niño-Southern Oscillation on surface dust levels across the world during 1982-2019, *Sci. Total Environ.*, 769, 7, <https://doi.org/10.1016/j.scitotenv.2020.144566>, 2021.

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