Dear Editors and Reviewers,

Thank you very much for your careful review and helpful comments for improving our manuscript egusphere-2024-2493. We have accordingly made the careful revisions. The revised portions are highlighted in the revised manuscript. Please find our point to point responses to the reviewer's comments as follows:

Responses to the reviewer 3

[This study investigates how the synoptic-scale circulations influence the transport of air pollutants from North China Plain to central and eastern China. They found the quasi-weekly oscillation of the air pollutants in North and East China is mainly attributed to both East Asia winter monsoon disturbance and the periodic activities of Siberian High. I enjoyed reading this manuscript and found its topic is very interesting. The authors gave a clear description of their methods and results. I have only minor comments, as shown below:]

Response: We appreciate very much your constructive comments and encouraging suggestions on our manuscript. We have accordingly made the careful revisions. The revised portions are highlighted in the revised manuscript. Please find our point to point responses to the reviewer's comments as follows:

[1. Butterworth filter: I do not understand this technique. I suggest the authors could add more explanation of this method.]

Response 1: Thank you for your suggestions. We have refined the explanation of atmospheric periodic variations and the Butterworth filter method in Section 2.3 (lines 177-202):

2.3 Butterworth filter

Atmospheric motion encompasses a variety of temporal and spatial scales. The sequences of meteorological variables often contain complex periodic components and exhibit multi-time-scale variations, including daily, weekly, seasonal, and interannual variations. Numerous observations have found QWO with periods of less than 10 days across various meteorological elements in the EAWM system (Compo et al., 1999; Murakami, 1979; Wu and Wang, 2002). Synoptic-scale atmospheric variations are closely related to atmospheric longwave adjustments, with QWO periods of 4-7 days observed in cold air activities of the EAWM (Bai et al., 2022; Wu and Wang, 2002). The synoptic-scale disturbance regulates the generation, transport, and removal of $PM_{2.5}$ in air pollution, which is a key mechanism behind the 4-7 day periodic changes in $PM_{2.5}$ in CEC during the periods of EAWM (Guo et al., 2014; Liu et al., 2018; Quan et al., 2014, 2020). Based on the research objectives, identifying the desired periodic components from the original observational sequences is referred to as sequence filtering. In this study, we employed a Butterworth filter to extract QWO from observational data.

The Butterworth filter is commonly used to separate atmospheric periodic variations across specific frequency bands. Due to its smooth amplitude response, linear phase characteristics, and ease of implementation, Butterworth filter has been widely applied in climate and meteorological studies (Gouirand et al., 2012; Yang et al., 2024a). The Butterworth filter can be configured as a low-pass, high-pass, or band-pass filter, depending on the specific requirements. A band-pass filtering only allows signals within a defined frequency range to pass through with attenuating signals outside the defined frequency range. It is often employed to extract and analyze signals within specific frequency bands, such as particular weather patterns and climate cycles. In this study, to investigate the QWO (8-d) of regional $PM_{2.5}$ transport over the CEC under the influence of EAWM circulations in the synoptic scale, we applied Butterworth band-pass filtering to the daily TFM of $PM_{2.5}$ change and daily SLP anomalies during the winters of 2015-2019 for identifying at the quasi-weekly (6-9 days) synoptic-scale component of regional transport of $PM_{2.5}$ over CEC.

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[2. In equation (6): Is the distance d in the unit of meter/kilometer or degree in longitude and latitude cause the authors mentioned 0.25 by 0.25 grid spacing in Line 159.]

Response 2: The term refers to degrees in longitude and latitude. We have revised it as follows (lines 171-172):

It is necessary to interpolate the station data of zonal and meridional components (F_u, F_v) of $PM_{2.5}$ TFV to grid spacing with **0.25 by 0.25 degree in longitude and latitude** in CEC and then calculate the divergence of $PM_{2.5}$ TF at each grid point according to Formula (6).

[3. Line 204: Delete "found"]

Response 3: Thank you for pointing this out. *"found"* has been removed.

[4. Line 69: It should be "have not yet"]

Response 4: Thank you for pointing this out. It has been corrected in the revised manuscript in line 69.

[5. Line 71: Change it to "one of the most active"]

Response 5: Thank you for your suggestion. It has been corrected in the revised manuscript in line 71.

[6. Lines 77–78: It is not clear. Do you mean the pollutants can be removed by circulations at the regional scale?]

Response 6: We apologize for the unclear expression in the previous version. It has been revised as follows (lines 77-80):

The rapid southward advance of cold air with strong Siberian High can effectively drive the regional transport of air pollutants with less accumulations across CEC, while the weak Siberian High with the slow southward movement of cold air can particularly favorable for the transport of air pollutants from the northern source regions to southern receptor region over CEC.

[7. Line 101: Delete "be beneficial to".]

Response 7: Thank you for pointing this out. The *"be beneficial to"* has been removed.

[8. Line 121–122: What observations 4 times a day are used? ERA5-land is not observational dataset.]

Response 8: Thank you for pointing out the error. The statement has been revised with deleting the "observations" as follows (lines 134-135):

The U- and V-components of the 10-m wind over CEC were **obtained at 00, 06, 12, and 18 UTC daily** during the winter (December-February) of 2015-2019.

[9. Line 132: The units for $PM_{2.5}$ mass concentration TF is not right. Units in the current form is for mass TF.]

Response 9: Thank you for pointing out the error. It should refer to $PM_{2.5}$ mass, not $PM_{2.5}$ mass concentration. The revision is as follows (line 145):

The horizontal $PM_{2.5}$ TF is defined as the $PM_{2.5}$ mass passing through a unit area per unit time (unit: $\mu g\ m^{-2}\ s^{-1}$).

[10. Line 179: should be observations]

Response 10: Thank you for your careful review. It has been corrected with "observations" in the revised manuscript in line 210.

[11. Line 201–204: It needs to be revised.]

Response11: We apologize for the unclear expression. It has been revised as follows (lines 232-234):

EEOF is an extension of the EOF to analyze the autocorrelations of the variable field over time. By selecting a lag time, the original observational matrix is expanded into multiple continuous time matrices, diagnosing the temporal changes in the spatial structure of variable fields.

[12. Figure 1: What do grid cells of white color mean in panel (b)?]

Response 12: The grid cells in white color represent "missing values." Due to the sparse distribution of observational stations in regions with complex terrain, interpolation to grid cells can cause the "distorted" values. To avoid affecting the analysis results, these "distorted" values were replaced with missing values, as described in the figure caption.

Figure 1. Spatial pattern of the (a) EOF1 and (b) EOF2 loadings of the daily changes in $PM_{2.5}$ TFV anomalies (vectors, unitless) and TFM anomalies (color contours, unitless) over CEC during the winters of 2015-2019. The red and blue boxes indicate the NCP and THB, respectively. **The grid cells in white represent "missing values".**

[13. Line 245: Do you mean "temporal structure"?]

Response 13: We apologize for the unclear expression. This refers to "the temporal changes in the moving spatial structure of $PM_{2.5}$ TF", which has been corrected in the revised manuscript in line 281.

[14. For figures showing shadings: please add units for all color bars in the figure.]

Response 14: Thank you for your suggestions. Figures 1, 2, and S1 show spatial pattern of the EOF and EEOF dimensionless loads (unitless). Figures 3, 4, 6, 7, as well as figures S4 and S5, have been updated to include the units of $PM_{2.5}$ (unit: μg m^{-3})， $PM_{2.5}$ TFM (unit: μg m^{-2} s^{-1}), Divergence of $PM_{2.5}$ flux (unit: 10^{-3} μg m^{-3} s^{-1}) , Temperature (unit:℃) and SLP_{QWO} (unit: hPa) on the color bars.