Earth System Dynamics Discussions

Earth Syst. Dynam. Discuss., author comment AC1
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Reply on RC2

Na Ying et al.

Author comment on "Complex network analysis of fine particulate matter ($PM_{2.5}$): transport and clustering" by Na Ying et al., Earth Syst. Dynam. Discuss., https://doi.org/10.5194/esd-2022-9-AC1, 2022

Reply to the Reviewer

We thank the referee for the thoughtful and comprehensive suggestions and their overall positive attitude toward our manuscript. In the following we response on a point-by-point basis. Please note that the reviewer's comments are highlighted in italic font and the red text color represents the revised text.

Reviewer Comments:

Using the complex network theory, the authors studied the particulate matter (PM2.5) transport pattern and routes around China in a more efficient way. They showed evidently that PM2.5 can transport from Beijing-Tianjin-Hebei-Henan-Shandong (BTHHS) region to Yangtze River Delta (YRD) region with one-or two-day time lags, and then they divide 284 cities in China into 9 clusters according to their synchronicity characteristics. This work can give us some advice on inter-city cooperation governance to solve the haze pollution problem, especially in winter when the pollution transport is the most severe. After reading this paper, I have some questions and advice as follows:

Response: We thank the referee for the positive assessment of our paper.

1. In the introduction section, line 50, the authors mentioned that there are considerable discrepancies in the current studies of PM2.5 transmission in different cities/regions during different air pollution periods. I would suggest the authors add one or two examples here to better introduce the "discrepancies".

Response:

We thank the referee for this kind and valuable comment. We have added them in the revised version.

Before

"However, this kind of region division ignores the nonlinear transport characteristics of $PM_{2.5}$ concentrations; furthermore, considerable discrepancies exist in the above studies of $PM_{2.5}$ transmission in different cities/regions during different air pollution periods. Hence, the $PM_{2.5}$ transports in the whole of China over a long-time period have not been fully understood; furthermore, the traditional approaches adopted in the above studies dis not fully consider the nonlinear transport processes between cities."

After:

"However, this kind of region division ignores the nonlinear transport characteristics of $PM_{2.5}$ concentrations; furthermore, considerable discrepancies exist in the above studies of $PM_{2.5}$ transmission in different cities/regions during different air pollution periods. For example, the transport from the BTH region to the YRD is significant during the hazing periods (Huang et al., 2020). High $PM_{2.5}$ in the southwest and south of Beijing is related to the $PM_{2.5}$ transmission in Baoding and Hengshui in Hebei Province, and Dezhou, Liaocheng, Heze, Jining, and Zaozhuang in Shandong Province (Li et al., 2015). Hence, the $PM_{2.5}$ transports in the whole of China over a long-time period have not been fully understood; furthermore, the traditional approaches adopted in the above studies dis not fully consider the nonlinear transport processes between cities."

2. In the introduction section, I would suggest the authors add a few more sentences to show why complex network analyses are important and should be used in the analysis. Compared to the traditional approaches, what are the advantages of complex network analysis?

Response:

We thank the referee for this kind and valuable comment. We have added them in the revised version.

Before

"During the last two decades, complex network theory has been applied to reveal the statistical and dynamic topological features in complex systems (Fountalis et al 2014, Feldhoff et al 2015).

The network-theory based approach has been used to uncover the correlation pattern of $PM_{2.5}$ concentrations (Zhang et al 2018), to analyze the $PM_{2.5}$ spillover routes in BTH cities (Li et al 2019), to discriminate between urban and rural tropospheric ozone (Rafael et al 2019), and to quantify the interaction between upper air conditions and surface $PM_{2.5}$ concentrations (Zhang et al 2019). It is obvious that complex network methods are valuable tools for depicting and quantifying air pollution transmission and cluster among cities."

After

"Methods are required that help to unveil the transport processes at the national scale.

Also, it is important to quantify their spatial and temporary interactions between cities. During the last two decades, complex network theory has been applied to reveal the statistical and dynamic topological features in complex systems (Fountalis et al 2014, Feldhoff et al 2015)."

"The network-theory based approach has been used to uncover the correlation pattern of $PM_{2.5}$ concentrations (Zhang et al 2018), to analyze the $PM_{2.5}$ spillover routes in BTH cities (Li et al 2019), to discriminate between urban and rural tropospheric ozone (Rafael et al 2019), and to quantify the interaction between upper air conditions and surface $PM_{2.5}$ concentrations (Zhang et al 2019). It is obvious that complex network methods are valuable tools for depicting and quantifying air pollution transmission and cluster among cities. In addition, for traditional model simulation, numerous parameters are needed in the simulation process. In contrast, complex network theory is performed based on time series of field observations, so the estimation process is faster and more economic."

3. In line 82, what do you mean by "eliminate the effects of autocorrelations in the records"? Do you mean Eqs. (2) and (3)?

Response:

We thank the referee for this kind and valuable comment. The eliminate the effects of autocorrelations in the records In line 82 is not mean*Eqs. (2) and (3)*. We have modified it in the revised version.

Before

"The anomalies records of $PM_{2.5}$ are adopted, where the anomalies are obtained by subtracting the daily averages and dividing them by the corresponding standard deviations and the function of the denominator is used to eliminate the effects of autocorrelations in the records."

After

"The anomalies records of $PM_{2.5}$ are adopted, where the anomalies are obtained by subtracting the daily averages and dividing them by the corresponding standard deviations to remove the seasonal cycle."

4. In line 128, I guess only zero values indicate that the node is isolated, right?

Response:

We thank the referee for raising this. We have modified according to the comments.

Before

"Nodes with higher values in the network indicate a larger amount of connection with other nodes, whereas lower values indicate that the node is isolated."

After

"Nodes with higher values in the network indicate a larger amount of connection with other nodes, whereas zero values indicate that the node is isolated."

5. In line 159, what is the definition of the "clustering coefficient"?

Response:

We thank the referee for this kind and valuable comment. We have added the definition in the revised version.

Before

"The clustering coefficient, which indicates the degree of connection of the network, is 0.46."

After

"The clustering coefficient measures the probability that the adjacent nodes of a node are connected. If one city has a high clustering coefficient, there are close connections between its neighbors. In this paper, the clustering coefficient is 0.46."

6. In line 191, it should be figure 5.

Response:

We thank the referee for this kind and valuable comment. We have corrected the mistakes in the revised version.

7. In line 200, it should be figure 6.

Response:

We thank the referee for this kind and valuable comment. We have corrected the mistakes in the revised version.

8. The figure caption for Fig. 6 is not correct.

Response:

We thank the referee for this kind and valuable comment. We have corrected the mistakes in the revised version.

Before

"Figure 6. Distribution of in- weighted degree (a) and out- weighted degree (b) in the network of each node for positive cases."

After

"Figure 6. Distribution of in- weighted degree (a) and out- weighted degree (b) in the network of each node for seasons."

9. Figure 7(a) is not very clear, I would suggest the authors improve the resolution of the figure?

Response:

We thank the referee for this kind and valuable comment. We have modified the Figures in the revised version.

10. In line 134, "the weight if node i and j" should be "the weight of node i and j"?.

Response:

We thank the referee for this kind and valuable comment. We have corrected the mistakes in the revised version.

Before:

"where k_i, k_j *is the weight if node i and j,"*

After

"where k_i, k_j *is the weight of node i and j,"*

☐ **End of response to Reviewer**