Journal: ACP
Title: Impacts of Atmospheric Circulations on Aerosol Distributions in Autumn over East China: Observational Evidences
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MS No.: acp-2014-907
MS Type: Research Article

Response to the reviewers

We are grateful to the Editor and the two Reviewers for their precious times in reviewing our manuscript. The comments and suggestions of the Reviewers are very helpful and valuable. The issues raised by the reviewers have been addressed (in blue color) in the revised manuscript. Kindly find a point-by-point reply to the issues as follows (presented in blue color).

by Yunfei Fu
July 23, 2015

Reviewer #1:

1. Fig. 1b presents the SD of AOD, does it the SD mean Shandong province? It is confused.

   Response: Thank you for your nice reminder. The SD presented in Figure 1b means the standard deviation of AOD and has been corrected in the revised manuscript.

2. Annual variations of AOD were shown in Fig.2. More explanations should be given to discuss the reasons.

   Response: Thank you for your important suggestion. In the revised manuscript, two data sets are combined to explore the reasons for annual variations. One is the MODIS fire product that shows the sudden increase in pollution emissions caused by biomass burning in areas. The other is the relative humidity and wind speed issued by NCEP, which may influences AOD via light extinction efficiency of aerosols and modulates the distribution of pollutants. It is found that interannual variation of fire number and relative humidity in the East China are weakly correlated with that of the AOD, However, the interannual variation of the wind speed in lower troposphere was significantly correlated with that of the AOD at 95% confidence level. This implies that the movements of air in vertical and horizontal directions play key roles in the variation of the AOD in the East China in the interannual scale. Therefore, the synoptic patterns were focused. Please find the detailed discussions in the revised manuscript.

3. Fig. 4 and Fig. 5 discussed the two types of air pollution. More discussions should be given how the surface, 850 hPa and 500 hPa circulation match each other to induce the worst air quality or lead to clean air. Temperature contours were also shown, how the temperature influence the AOD distribution?

Response: Thank you very much for your suggestion.

(1) The different circulations corresponding to the two typical cases can cause opposite diffusion conditions in vertical and horizontal direction. According to your suggestion, in the revised manuscript, the vertical velocity and divergence of winds are quantitatively depicted to show the relationship of atmospheric circulation with the AOD distribution in the Figure 5 and Figure 6.

(2) How the temperature influenced the AOD distribution is not easily obtained in this manuscript. It seems that the warm and cold air flows may have such influences. In our work, the temperature field is mainly used to indicate if there are frontal activities in the East China. We found cold front systems in one typical type. In the future, how the temperature is influenced by the AOD distribution will be investigated from view of radiation.

4. It is better to add the emission inventory in the MS in order to show the relationship between AOD and emission distribution.

Response: Many thanks for your nice suggestion. We really want to show the emission distribution in the East China. Unfortunately, the emission data is not available for us in short time. But the previous studies may help us to illustrate the relations between the AOD and the emission distribution. Actually, the AOD data are widely used to enhance the understanding of variations in air quality in local or regional or global scales due to their sensitivity to total abundance of aerosols (Chu et al., 2002; Al-Saadi et al., 2005; Lin et al., 2010). For example, Xin et al (2014) investigated the relationships between daily observed PM2.5 concentration and aerosol optical depth (AOD) in China, they pointed out that there was a high correlation between the two variables, the MODIS AOD are valuable and capable of retrieving the surface PM2.5 concentration as the linear regression function and the correlation coefficient square is R^2=0.57 in autumn (Fig. 1A). Therefore, the AOD are applicable in Chinese regions to characterize aerosol distributions.

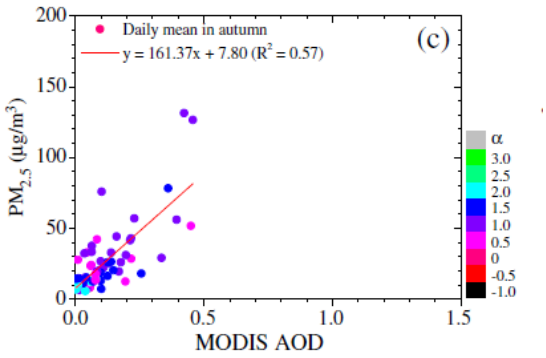

Fig. 1A: The scatterplots and the relationships between the PM2.5 concentration and the MODIS AOD at 550 nm in the autumn. (From: Xin et al, 2014)

References:

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5. Six atmospheric patterns were summarized for polluted episodes. The MS only simply described the phenomena according to the figures. More quantified index should be used to indicate the difference among the six types.

Response: Many thanks for the valuable suggestion. According to your suggestion, we have tried many indexes and eventually find that the values of vertical velocity and divergence of wind field are two optimum indexes to compare the differences in diffusion conditions for each type quantitatively. However, it is indeed difficult to find a quantified index to indicate all differences in atmospheric patterns, such as the diverse position of the weather system, the various direction of wind and so on, therefore, the schematic diagram (Figure 17) are combined in the revised manuscript to clearly show the characteristics of the general circulations, so that the readers can easily identify the differences between the patterns by those indicative marks.

6. Vertical structure should be shown to explain the influence of circulation.

Response: Thank you for your very important suggestion. Based on your request, the vertical cross section of vertical velocity and divergence of wind have added in the revised manuscript (Figure 1, Figure 5-6, Figure 8-16) to address the vertical movement of air flows and convergence of winds on each level. The results show uniform descending flows prevails in the East China, moreover, the degree of the pollutant accumulation in the lower atmosphere is determined by the intensity of downward flows. Therefore, the divergence of wind field at different layer plays a key role in determining the column AOD. In the revised manuscript, the corresponding discussions can be found in Section 3 and 4.