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Atmospheric Chemistry and Physics Discussions

Interactive comment on "East Asian dust storm in May 2017: observations, modelling and its influence on Asia-Pacific region" *by* Xiao-Xiao Zhang et al.

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We sincerely thank anonymous referee #1 for his/her supportive and thoughtful remarks.

General comments

Question 1: In the introduction, the scientific problems and significance should be more come to the point.

Reply: We have revised the Introduction of the manuscript to more clearly state the problem and importance (see Page 3, Line 5-12).

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Question 2: Why data at heights of 2000-3000 m were used to analyzed the trajectories of dust transport?

Reply: The trajectories from dust sources were set at 2000-3000 m based upon observations of Cottle et al. (2013a) and Cottle et al. (2013b). They reported that strong winds can cause emission and transport of dust to altitudes of 2-3 km above the ground. The text was revised to indicate the reason for using 2-3 km data to analyze trajectories (Page 5, Line 30-32).

Question 3: How to exclude airborne dust in the U.S. from its local source?

Reply: We estimated dust emissions over Asia-Pacific region using the WRF-Chem model. Simulated emissions over the western U.S. are shown in Figure 9a and Table 3. The simulations showed that the major sources of dust were Arizona and Nevada in the western U.S. as well as northern Mexico. According to CALIPSO satellite observations and trajectory analyses, Asian dust was chiefly transported across the Pacific Ocean to the U.S. at middle and high latitudes and at high altitudes. We admit that separation of airborne dust over the U.S. from local sources is difficult. However, we believe the likely source was Asian dust due to zonal transport of high altitude dust from Asia as well as seemingly little dust remaining in the atmosphere after accounting for deposition over the southwestern U.S. and northern Mexico. We have added text that briefly describes the influence of local dust sources on airborne dust over the U.S. (see Page 11, Line 1-5).

Question 4: The transport process, such as migrating speed, impact and span on air quality at different localities, should be explained in more detail.

Reply: We've added a more details on transport process and the impact of dust transport on air quality in Section 3.1. (Page 6, Line 13 to Page7, Line8). Figure 2 was also updated.

Question 5: Please revise the method section to make it more concisely.

Reply: We have further revised this section and made it concisely (Section 2, Page 3-5).

Specific comments

Question 1: Page 1, Line 21: It's meaningless to write the number of cities directly.

Reply: The description on the number of environmental cities and meteorological stations has been deleted in the Abstract (Page 1, Line 16).

Question 2: Page 5, Line 23-24: What are those scheme used for?

Reply: Those parametrization schemes are used for the WRF-Chem model to carry out the numerical simulation in this study. We added those schemes description for readers who's interesting to the repeatability of numerical simulation.

Question 3: Page 5, Line 24-28: What is the real accuracy of the simulation?

Reply: The modelling result on dust event on 2-7 May, 2017 with WRF-Chem is reliable. Compared with the spatiotemporal change of PM concentration, AOD and meteorological observation records, the model captured the main characteristics of this dust event. We added the explanation in Page 7, Line 23-26. Moreover the parametrization schemes such as dust emission module Shao et al. (2011b) used in this study was widely applied in East Asia. We plan to prepare another paper focusing on the modelling this dust event by WRF-Chem.

Question 4: Page 6, Line 20-30: What indicator was used to determine the arrival of dust event in a place?

Reply: The indicator that determined the arrival of dust storm event is mainly according to the meteorological records observed at each meteorological station. The WMO made a criteria on the classification of dust weather by code, which described in the Section 2.1.3 (Page 4, Line 24-28).

Question 5: Page 9, Line 9-10: Some references are cited here. Is this result calculated by the authors or quoted by others?

Reply: The result of the iron amount during the dust event was calculated by ourselves. According to the references from Luo et al. (2005) and Mahowald et al. (2017), 3.5% of total aeolian dust is the iron. Thus 5.3 Tg of dust deposited over the North Pacific Ocean included approximately 0.19 Tg iron deposition. We added this explanation in Page 9, Line 21-23.

Question 6: Page 9, Line 1-8: I advise the authors to discuss the contribution of this event to annual dustfall in different cities of China.

Reply: Currently, the environmental monitoring deposition data in major cities of China in 2017 is not available. In addition, the deposition observation during the May 2017 dust event is not systematically carried out. Thus further comparison on the contribution of this dust event to annual dustfall in Chinese cities in 2017 is difficult to discuss due to scarce observation data. Comparison of modeled data during 2-7th May 2017 to long-term annual observation data (e.g. 1981-2004) would not be appropriate because meaningful comparisons must use the same time period.

Question 7: Page 9, Line 1-8: I advise the authors to compare the magnitude of dust deposition with other dust events.

Reply: We've compared the dust deposition magnitude of May 2017 Asian dust event with several other severe Asian dust storm events in revised manuscript of Section 3.4 (Page 9, Line 16-19). New references have been included in this section as:

Shao, Y., Jung, E., and Leslie, L.M.: Numerical prediction of northeast Asian dust storms using an integrated wind erosion modeling system, Journal of Geophysical Research, 107(D24), 4814, doi:10.1029/2001JD001493, 2002.

Uematsu, M, Wang, Z.F., and Uno, I.: Atmospheric input of mineral dust to the western North Pacific region based on direct measurements and a regional chemical transport model, Journal of Geophysical Research, 30(6), 1342, doi:10.1029/2002GL016645, 2003.

Han, Z., Ueda, H., Matsuda, K., Zhang, R., Arao, K., Kanai, Y., and Hasome, H.: Model study on particle size segregation and deposition during Asian dust events in March 2002, Journal of Geophysical Research, 109(D19205), doi:10.1029/2004JD004920, 2004.

Li, J., Han, Z., and Zhang, R.: Model study of atmospheric particulates during dust storm period in March 2010 over East Asia, Atmospheric Environment, 45, 3954-3964, 2011.

Tan, S-C., Li, J., Che, H., Chen, B., and Wang, H.: Transport of East Asian dust storms to the marginal seas of China and the southern North Pacific in spring 2010, Atmospheric Environment, 148, 316-328, doi:10.1016/j.atmosenv.2016.10.054, 2017.

Question 8: Fig.1: I suggest the authors explain more in detail about the dust cloud migration from MODIS image.

Reply: We revised and added explanation in Section 3.1 (Page 6, Line 8-13).

Question 9: Fig.6: Please explain the maximum wind speed exactly, is it the daily maximum wind speed during the dust storm event?

Reply: The CMA provided surface wind speed of each meteorological observation station in every three hours. Therefore, the maximum wind speed in the Figure 6 is referred to the maximum wind speed at temporal resolution of three hours during the dust storm event (Page 4, Line 24-28).

Question 10: Fig.7: Could the authors add dust vertical distribution in the source regions?

Reply: The Figure 7 is the time series change of vertical dust distribution observed by ground-based Lidar. Currently we don't have the access of such ground-based Lidar data or product in East Asian source regions. Here we displayed vertical distribution of dust profile crossing the Gobi Desert sources regions by CALIPSO satellite observation as the following picture (see Figure. Response for Question 10).

Question 11: Fig.9: The exact meaning of loading and deposition needs to make clear.

Reply: In Figure 9, the dust deposition is the total dust deposited onto surface of continent or ocean. The dust loading is vertical dust flux in a computational grid. Figure 9b is the hourly average dust loading. To illustrate clearly, we've changed Figure 9 into daily average with the unit of mg m-2 d-1. (see Page 32, Figure 9)

Please also note the supplement to this comment:
https://www.atmos-chem-phys-discuss.net/acp-2018-205/acp-2018-205-AC1-supplement.pdf

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Interactive comment on Atmos. Chem. Phys. Discuss., https://doi.org/10.5194/acp-2018-205, 2018.

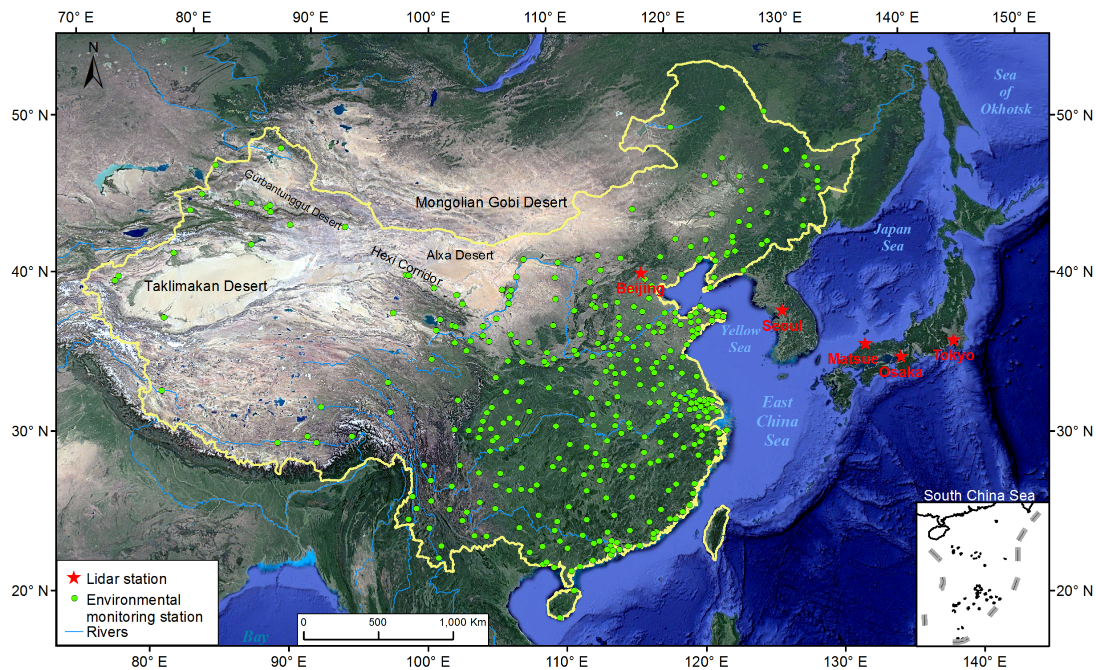

Fig. 1. Figure 2. Location of environmental monitoring stations in China and Lidar monitoring stations in east Asia.

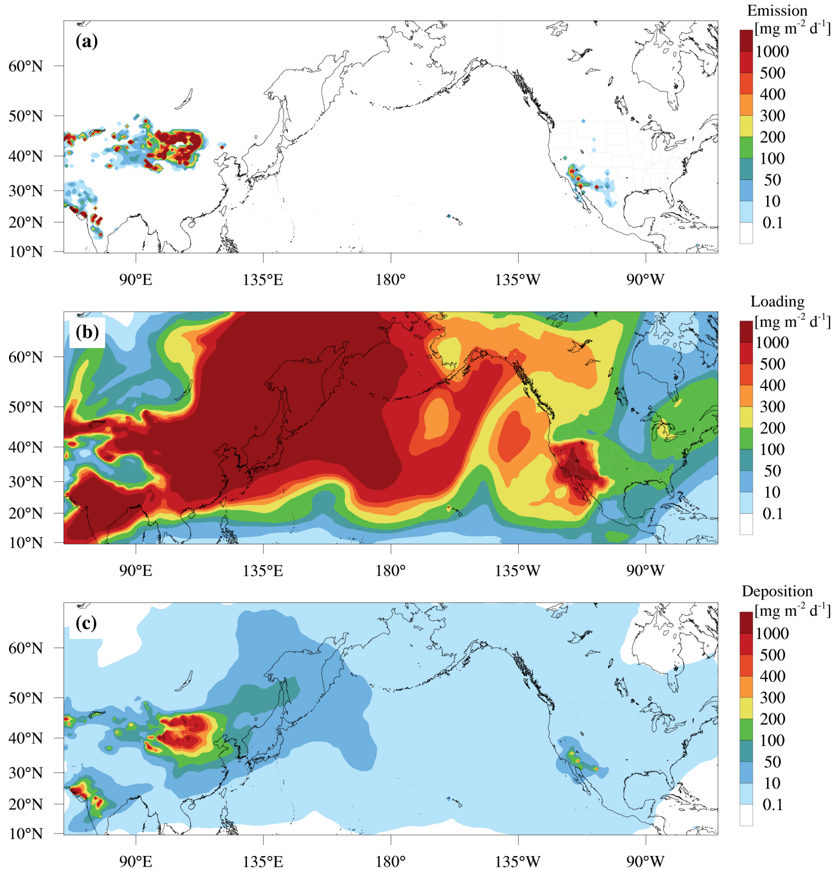

Fig. 2. Figure 9. Estimation of daily dust emission (a), dust loading (b) and dust deposition (c) over Asia-Pacific region during 2-10 May, 2017.

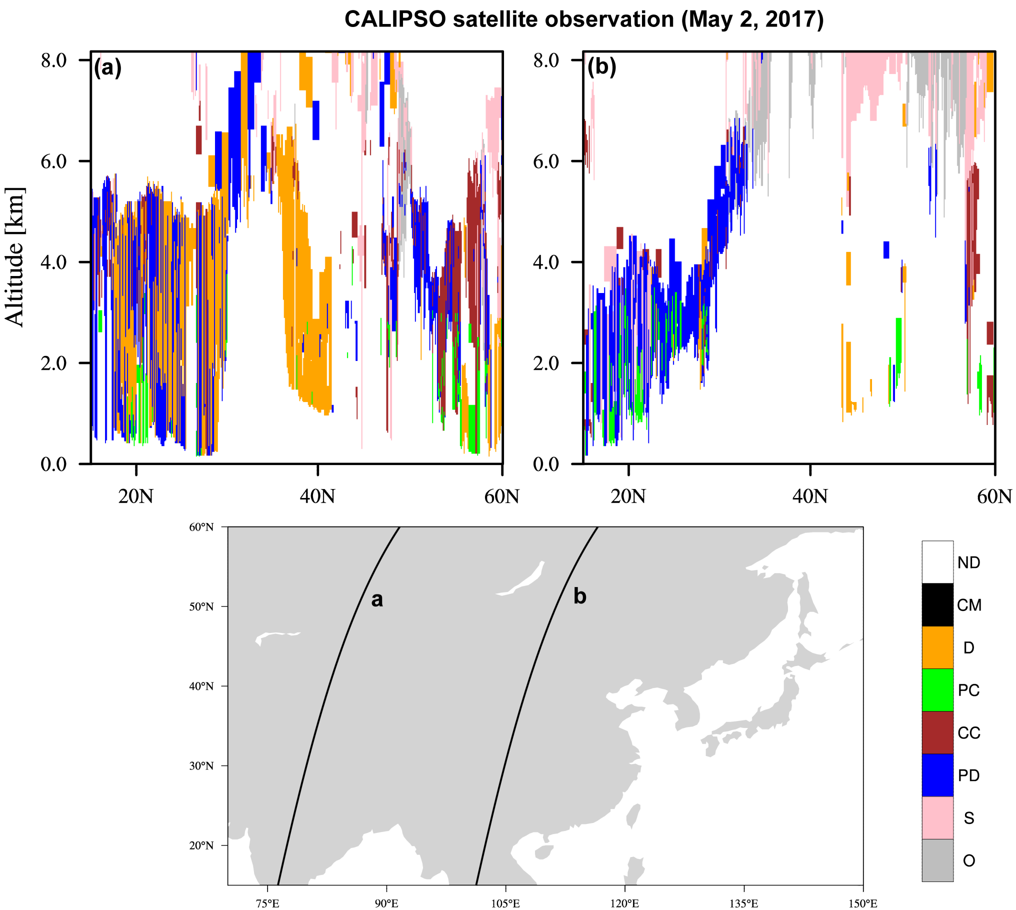

Fig. 3. Response for Question 10. Vertical profiles of atmospheric features derived from CALIPSO satellite VFM data on 2 May, 2017. (ND=Not determined, CM=Clean marine, D=Dust, PC=Polluted continental, CC=Cle

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