

Interactive comment on “Mixing of Asian mineral dust with anthropogenic pollutants and its impact on regional atmospheric environmental and oceanic biogeochemical cycles over East Asia: a model case study of a super-duststorm in March 2010” by J. Li et al.

Anonymous Referee #1

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This study investigates the role of mixing of Asian dust with anthropogenic pollutants using a three-dimensional regional chemical transport model (NAQPMS). An extremely strong dust event occurred during 19–22 March 2010 was chosen for the analysis. Several observations of remotely sensed data and surface measurement data are used for model validation. The model result suggests that major portion of anthropogenic aerosols are mixed with dust. ~60% of the sulfate and 70–95% of the nitrate in the downwind regions was derived from active mixing processes during transport. Fe sol-

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ubility rose from ~0.5% in the Gobi region to ~3–5% in the northwestern Pacific. The surface concentrations of other gaseous pollutants are greatly reduced due to the heterogeneous reactions. The finding in this study is interesting to ACP and the method is reasonable. I would recommend the publication of this paper with major revision.

Major comments:

- 1) Aerosol mixing is highly complex process that depends on the size, shape, chemical compounds, etc. This study relies on a simple reaction rate as presented in Table 1, without considering other effects. It should provide how this simplification affect to mixing in modeling and what are the uncertainty of the reaction rate.
- 2) The number of vertical layers in the simulation setting is 20. I think it is very coarse to cover the column atmosphere. How many levels cover the dust layer? There are two domains of 1 coarse domain and 1 nested domain according to Figure 1. Since the nested domain does not include most dust source regions, the dust in the nested domain is from the lateral boundary condition. How does this impact to the simulation and analysis?
- 3) The simulated aerosol validation relies on the bulk mass or aerosol optical depth and therefore there is no constrain the model results especially to the sulfate, nitrate, and Fe in mixture with dust. It must be difficult to have data that distinguishes mixed and non-mixed portion of aerosols but it is worthy showing how model behaves when mixing is allowed and prohibited. I would suggest to conduct an additional simulation without mixing with dust and to compare the result with the current results. For example, adding the no-mixing simulation result in Figure 6 would better show the impact of the mixing with dust.

Minor comments:

Title: This study is focusing on mixing between dust and anthropogenic pollutants but brief estimation of deposition is presented without thorough examination. I would sug-

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gest to delete "...and its impact on regional atmospheric environmental and oceanic biogeochemical cycles over East Asia." from the title.

Page 2744, Line 6: Write Full name of NAQPMS.

Page 2745, First Paragraph: It is well known that China is heavily polluted however it is not unique. Several places such as Western US, Mediterranean, Northern India, Korea, and Japan are impacted by heavy air pollution and dust in the globe.

Page 2746, Line 18: Please change (China) to (East of China) and delete close in "a close downwind region of China"

Page 2747, Line 19-27: Please specify how great used several times in sentence.

Page 2748, Line 6-7: Dust impact on nitrate by Yuan et al. (2008) is little which is opposite to other studies. Please add a sentence on that.

Page 2749, Line 8: Please specify what is "It", either NAQPMS or WRF.

Page 2750, Line 2-3: Please provide the optical properties in number.

Page 2750, Line 12: "soil dust". Do you mean "mineral dust"?

Page 2750, Line 22-25: How to observe U^*_0 ? Why U^*_0 varies by region?

Page 2751, Line 11: Please specify radius of black carbon, sulfate, and dust. Also please explain how to handle radius of mixed aerosol.

Page 2752, Line 21: (OTTE, 2008). Reference is missing.

Page 2753, Line 14: Please quantitatively specify how successful the model is.

Page 2753, Line 18: Please add a brief description on MODIS. Is it dark ocean product or Deep Blue?

Page 2754, Line 6 and 11: Is it Figure 2 or Figure 5?

Page 2754, Line 20-22: Is API in Taipei the same system of China or an independent
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system? If it is same system why Taipei station has different saturation level?

Page 2755, Line 22: (personal communication). With Whom? It need more specific description.

Page 2756, Line 7-20 & Figure 6: See major comment 3.

Page 2757 and Figure 7: Figure 7 is unclear and hard to follow. Please improve the figure presentation.

Page 2758, Line 5: Please specify the period.

Page 2758, Line 12: What is the range of uncertainty due to the error in the reaction HR12 in Table 1.

Page 2758, Line 22-25: Please clarify. It looks a sudden jump to me. What is the uncertainty of the estimated Fe(II)? Is the fraction by mass or volume?

Page 2759, section 4.2.1: The manuscript not show discussion about NO₂. Please add it.

Page 2759, Line 25: Please add reference.

Page 2758, Line 20-24: The dust event is the largest in the history but the Fe is comparable with observation. Please clarify why it is.

Figures:

Figure 3: What are the mass by dust?

Figure 4: What is the unit?

Figure 5: I see diurnal pattern even during dust period. Does that mean the impact of dust is negligible?

Figure 7: To complicate and unclear. What are the colored lines? Please improve the figure and caption.

Figure 9: How about NO₂?

Interactive comment on Atmos. Chem. Phys. Discuss., 12, 2743, 2012.

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