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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Impact of dust on tropospheric photochemistry over polluted regions: a case study of the Beijing megacity" *by* S. Zhu et al.

Anonymous Referee #1

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This paper investigates the impact of dust on tropospheric chemistry under the conditions of a typical highly polluted region (i.e. Beijing in April) using a box model. The authors conducted a series of experiments to examine the impact of dust through the processes of transport, heterogeneous uptakes, and photolysis alteration. The uncertainties of the impacts owing to the uncertainties of uptake coefficients are explored.

The study improves our understanding on the physical and chemical mechanisms of pollutant evolution, particularly when dust is present. The paper is well organized and the topic is suitable in ACP context. However, the paper needs to be more concise, yet

further in-depth, in its discussion. I recommend accepting it for publication in ACP after the authors make the recommended corrections as following.

General Remarks:

1. A basic analysis which demonstrates the relative importance of various processes (e.g. emission, transport, chemistry, and deposition) to the change of tracer mixing ratio in the studied region is highly recommended. Such analysis helps us know the importance of the target chemistry influence in the entire evolution. For example, the authors explained the influence of the exchange rate coefficient on Ox, NOx, and OH based on their chemistry production and loss in section 3.1 and Figure 5. However, the changes of tracer mixing ratios come not only from chemistry, but also from other processes and sometimes the latter dominates a change (e.g. NOx). I suggest adding a table or figure to depict the Ox, NOx, and OH fields inside the box based on their information of mean mixing ratio (VM), the change of VM during the day (CVM), the fraction of CVM from each of the processes of emission, transport, chemistry, and deposition. Meanwhile, I suggest making the discussion more concise, specifically, by merging Fig5d and Fig6 and removing Fig 5 a-c. Qualitatively, the increase of O3 and the decrease of NOx in the box can be inferred directly from adopted tracer distributions because imported air brings high O3 and low NOx. In addition, the general contributions from the chemistry process shown in Fig 5 a-c are similar to those in Figure 7. OH change is special since it is attributed solely by atmospheric chemistry due to its very short lifetime.

2. The box model in the paper considered the processes of emission, horizontal transport, chemistry, and dry deposition. The results, therefore, reveal the tracer change in atmospheric boundary layer where is important in air quality studies. For climate change studies, we need to know the overall influence over column. It would be nice to see some discussion of the likely overall dust column impact.

Specific Comments:

1. Title: The word “Photochemistry” is not entirely appropriate since the study also included heterogeneous chemistry. 2. Page 4, line 18: Add table 1 after “12 heterogeneous removal reactions”. 3. Page 6, equation 4: What is the relationship between Je in the equation and Be in table 2? 4. Page 8, lines 5-7: Wind from different directions might bring quite a different inflow air mass. Did you check the tracers and dust imported from west and northwest separately? If the difference is significant, then separate treatment might be needed. 5. Page 8, line 21-24: I do not understand why you need to decrease dust surface areas from the faster advection to the slower one. Do you want to force equal deposition importance under various advection cases? The relative importance of deposition does become more important when the advection is weaker under the condition of the same dust surface area. Please clarify the sentence. 6. Page 8, last line to Page 9, line 5: What are the reactions referred here? The impact of dust photolysis alteration on reactions is pretty sensitive to the tracer’s photolytic spectrum. Any quantitative analysis based on the uniform rate (e.g. 50%) for all reactions and all considered conditions might be misled. I do not see useful information from the photolysis examined with this artificial perturbation rate. 7. Page 9, line 6: Could you elaborate why 96 hours is long enough to establish an equilibrium even for CO, whose lifetime is about 50 days in Beijing during spring season? 8. Page 11, lines 4-5: Again, what fraction of the increase of O3 daily average mixing ratio is attributed to chemistry, and what fraction is attributed to transport and other processes? 9. Page 11, lines 7-9: The budget analysis would also help the explanation here. 10. Page 12, line 7: Should be “decreasing slightly from the T16 case to the T08”, not “to the T04”. 11. Page 12, line 15: Please define the relative change. Please also indicate the “changes” as increase or decrease. 12. Page 13, line 15: It would be helpful if the authors explain clearly why T04, not T02, has the largest change. 13. Page 13, line 10: Does this line have the same font size as the other lines? 14. Page 18, last 4 lines: Please clarify the rates stated in this line. To which species do they refer? How do you come up with these numbers? 15. Table 2: What is the initial and upwind dust concentration? Why is it necessary to cite both deposition velocities and deposition

coefficients here? Why is it lower for all NOx and VOC and higher for O3 in upwind airmass? 16. Figure 2: How do you derive these different dust distributions? 17. Figure 8: I like this figure because it depicts the influence due to dust heterogeneous influence directly and clearly.

Interactive comment on Atmos. Chem. Phys. Discuss., 9, 20145, 2009.