**Atmospheric
Chemistry
and Physics
Discussions**

Interactive comment on "The impact of dust on sulfate aerosol, CN and CCN during an East Asian dust storm" *by* P. T. Manktelow et al.

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Review of "The impact of dust on sulfate aerosol, CN and CCN during an East Asian dust storm" by Manktelow et al.

This article explores the interaction of dust and sulfate using a global aerosol microphysics model and aircraft-based observations of dust aerosol during the ACE-ASIA field campaign. The presence of dust shifted sulfate mass somewhat from the fine mode to the coarse mode largely by condensation of H_2SO_4 rather than surface oxidation of SO_2. Changes in CN and CCN concentrations were also assessed. Near dust source regions, Ultrafine CN had a large fractional decrease due to the presence of the dust, whereas CCN showed an increase. Away from the source region, both CN

and CCN showed much more minor changes due to the dust.

The authors limit the amount of SO_2 that may absorb and react on the dust surface, which previous studies had not. This change causes the dust to have a much more minor effect on the overall sulfate-mass budget (excluding microphysical effects) than the previous studies would have predicted. Their results, however, appear to be consistent with the ACE-ASIA observations.

This paper is high quality, presents new information to the field of global aerosol science and is well within the scope of ACP. I recommend this paper to be published in ACP after several minor comments are considered.

Minor comments:

1. Page 14773, line 23 and bottom of page 14780: I am confused when you state a value of the uptake coefficient and then say "(BET surface area)". Is this because the uptake coefficient was found using the BET surface area of the dust? Please explain.

2. Page 14777, line 18: This is probably not an issue over dry, dust-source regions, but using monthly mean cloud cover for simulations where you are comparing to instantaneous observations seems like it could lead to errors through incorrect rainout and aqueous oxidation.

3. Page 14778, lines 20-21: L and L_max should likely be LAI and LAI_max, respectively; otherwise they need to be defined.

4. Page 14780, line 11: Eqn. 5 does not seem to be cited from another source, and so some justification for the choice of Beta or a discussion of its physical significance may be necessary.

5. Page 14781, line 3: There is a missing period between "coefficient" and "Bauer".

6. Figure 1: Flight 5 appears in this figure, but is not discussed in the text.

7. Page 14782, line 22 and map figures: It would be nice to have the flight paths or a box enclosing the area where the flights were located overlayed on the figures containing maps (e.g. Figs. 4 and 6). This will help tie the map figures to the figures showing comparisons of the model to observations.

8. Page 14785, line 14: I believe that "$(dN_i D_p)$" here is intended to be "$(dN_i(D_p))$".

9. Page 14786, lines 8-11: Along with the size distribution uncertainty discussed here, another uncertainty that remains is the history of the dust. The modelled dust concentrations used are within a factor of 2 of observations at the observation site; however, if deposition rates or transport from the source region are incorrect, the dust concentrations may not always have been within a factor of 2 of their correct values, and this could affect the effect of dust on sulfate. Its probably worth mentioning this here along with the uncertainty in size distribution.

10. Table 5, Figure 2 and Page 14787, lines 4-5: Figure 2 makes it look like 100% of modelled fine sulfate concentrations for flight 8 are within a factor of 2 (unless there are points that are off of the plot). Table 5 and the text says its only 63%.

11. Page 14787, lines 7-9 and Figure 2: I'm surprised that the skill scores are so high, particularly for flight 7 where the model shows a decrease in fine sulfate with increases in observed fine sulfate.

12. Page 14788, line 16, and page 14791 line 27: Tang et al. (2004a) and (2004b) are referenced, but only one paper is in the reference section.

13. Page 14792, line 5: 1000 pptv SO2 is equivalent to 4.1 micrograms per cubic meter of sulfate at STP if there was no removal of sulfate during the SO2 oxidation or before the sulfate concentrations are measured.

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14. Page 14795, line 3: For sulfuric acid and ammonium sulfate particles, the minimum activation dry diameter is 65-70 nm at 0.3% supersaturation (50 nm particle would activate at 0.45-0.48% supersaturation.