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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Chinese SO_2 pollution over Europe – Part 2: Simulation of aerosol and cloud condensation nuclei formation" *by* V. Fiedler et al.

Anonymous Referee #2

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Comments on Fieldler et al.

The article by Fieldler et al. presents simulated particle formation during an air parcel's travel from East Asia to the North Atlantic and discusses the implication on cloud condensation nuclei and cloud characteristics. It is not a very exciting paper in that it has no great conclusion. The paper's discussion about more particles make for clouds with more small drops and higher albedo is textbook knowledge. Furthermore, I feel like I am missing the point of the paper. The abstract/conclusions tell me that particles are formed and grow to CCN sizes, which can then affect cloud albedo. However, the 8.5 days from Asia to the North Atlantic were cloud free. Unless this air parcel undergoes

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lifting, it never realizes its CCN potential.

There are some major points that need to be addressed before consideration for publication.

Major Points

1) One thing that I found to be interesting about this paper is that the back trajectories show that the air parcel maintained a fairly constant cold temperature at high altitude, and that the parcel traveled over 8 days from East Asia to North Atlantic without encountering cloud. To have an air parcel cover such long distances over a week's time without encountering significant removal is remarkable. However, there is no supporting information given (in this paper and apparently not in Part 1 either) to substantiate this statement. This topic could be pursued further discussing the potential impacts of various processes (as listed by Referee 1) and the possibility that a laminar layer is encountered (Newell et al., *Nature*, 1999) - although the depth of the layer indicates that it has likely undergone vertical mixing.

2) The paper lacks important citing of previous work. There are papers in the literature of relevance to particle production in the free troposphere. In particular, Lee et al. *Science* (2003), Lee et al. *J. Geophys. Res.* (2004), and Brock et al. *J. Geophys. Res.* (2004). In addition, the INTEX-B mission was being conducted over the Pacific during the time period of interest. It seems likely that the authors could use these data to improve the initial conditions of the model simulations.

3) The realism of the impact of particle formation on clouds is weak. Because the air parcel is at 5-6 km altitude and 240 K, the likelihood of water saturation is very low. Ice particle nucleation is much more likely, especially for cirrus clouds, but ice nucleation most commonly occurs on insoluble aerosols (Seinfeld and Pandis, *Atmospheric Chemistry and Physics* textbook, 1998). Thus, these newly produced sulfate aerosols likely will not contribute to ice cloud formation.

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Specific Points

1) Section 2 regarding measurements. There should be a summary of the findings from the Part 1 paper. Especially useful here are the characteristics of the air parcel trajectory (transit time, altitudes during transit, other state variables, and whether clouds were encountered or not).

2) Page 2767, lines 13-20. It would be good to mention which aerosol modes are represented here.

3) Page 2767-2768, lines 23-7. Initialization of the model needs a better justification.

a) First, how does the air parcel reach 8 km or $\sim$335 hPa over East Asia? If it is via cloud, then some consideration of scavenging of particles and SO_2 must be considered. A good resource for this is Brock et al. (2004).

b) Second, INTEX-B was being conducted during the time period of this study. It seems likely that there are useful measurements, especially for the initialization of the model, from this campaign occurring over the Pacific Ocean.

c) At first, I thought the initial particle concentrations may be too low for an air parcel recently in the Asian boundary layer, but if the air parcel underwent lifting via cloud then these numbers are quite plausible. The representativeness of the initial conditions needs to be discussed.

4) How does an air parcel increase and decrease in humidity but never change temperature?

5) P. 2770, line 3, Particles 30 nm in diameter would need a strong updraft, such as found in cumulus clouds, to reach supersaturations high enough for cloud drop activation. At a 5.5 km altitude, it is pretty unlikely that these 30 nm particles will undergo cloud drop activation any time soon.

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6) P. 2770, line 18-19 which states that the particle growth begins one day later than the no-initial-particles simulation. This is not obvious in Figures 5 and 6. As suggested in the technical details, including grid lines in the figure would help the reader see this point.

7) P. 2772, lines 5-8, What these results tell me is that the availability of both SO_2 and OH is important. The greater increase of particle production when SO_2 is doubled points to SO_2 availability as most important.

8) P. 2772, lines 13-18 are confusing. The point of these results is not clear.

9) Much of the discussion (Section 4. Implications for CCN) written in this paper is well known and textbook information (e.g., p. 2773, lines 15-16; p. 2774, lines 12-17). We are not learning anything new here.

10) P. 2775, lines 4-6. The implications of the study seem moot since clouds were absent during the air parcel's trajectory to the point of sampling and that water saturation will likely not occur for awhile.

Technical Details

1) p. 2768, line 6, Table 1 should be cited in the previous paragraph.

2) Figures 2-8, I think it would aid the reader to have grid lines for each day. It is difficult to see if the T and RH reach a minimum/maximum before or after nucleation occurs.

3) P. 2770, line 22, the word “eventually" is not needed.

4) Figures 9 and 11, and accompanying text (p. 2771). Introducing the right panel first is opposite what is generally done. I suggest switching the right and left panels.

5) P. 2772, line 12, not sure the word “already" is needed.

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6) P. 2774, line 4, “bottom panel". There is no bottom panel to Figure 11.

7) Figure 4, please explain legend.

8) Figure 9, The legend is much too small to read easily. Further, there are no crosses in the legend as there are in the plot.

Interactive comment on Atmos. Chem. Phys. Discuss., 9, 2763, 2009.

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