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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Global 2-D intercomparison of sectional and modal aerosol modules" *by* D. K. Weisenstein et al.

D. K. Weisenstein et al.

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General Comments:

"My strongest criticism of this paper is that it does not sufficiently compare the simulation results to observations from the SAGE II satellite."

We added a new figure (Figure 2) comparing SAGE II aerosol extinctions at 1.02 and 0.525 um under nonvolcanic conditions to the AER150 model, and added a new paragraph (2nd paragraph of Section 4) discussing the comparison and model uncertainties.

We added comparisons to SAGE II surface area density measurements (derived from extinction measurements) after the Pinatubo eruption in Figure 11.

"I also think that the paper could explore the aerosol parameterizations more generally than it does. For instance, the paper could attempt to establish the minimum number of sections required to adequately represent the stratospheric sulfate aerosol."

We added to the paper discussion of a sectional model with 20 bins. This model is very efficient computationally (about 1/2 the runtime of the 3-mode model) but shows significant numerical diffusion in the background case, comparable to UMaer-3mA but more consistent spatially. The AER20 Pinatubo results are surprisingly close to the AER40 results. In addition, we tested a model version with 14 bins (Vrat = 8) which was extremely diffusive and was not included in the paper for brevity.

Specific Comments:

"Please provide some details about the OH, O, O3, and NO3 distributions used in the model. How were they generated, and how do they vary?"

In paragraph 2 of Section 2, after the sentence "Photolysis and reactions with OH, O, O3, and NO3 convert sulfur source gases to sulfuric acid.", we add the sentence "Concentratons of these reactants are taken from a present-day simulation with the AER 2-D chemical-transport model and vary seasonally."

"Please discuss the way the UMaer models move mass from mode to mode. Are there any fundamental microphysical principals involved?"

This process is mentioned in paragraph 3 of Section 2 and in paragraph 2 of Section 3. In Section 3, we had added some additional discussion of the merging process. "In addition, merge radii are required which specify when aerosol mass is shifted to the next larger mode as the mean radius of the mode increases. This process is invoked when 2.5% of all particles in a mode are larger than the specified merge radius. See Herzog et al. [2004] for details of this process." Table 1 gives merge radii used in each version of the modal model. The process is done for reasons of numerical stability and to avoid overlap in the size of the modes, which would invalidate some model assumptions and/or lead to poor simulations.

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Interactive Comment

"Aerosol burdens are not included in Table 1, as stated in paragraph 1 of section 3, but is rather included in Table 2."

We have corrected this error.

"Figure 1: I think that the paper would be improved by including a comparison of the AER150 surface area or optical depth with SAGE II observations."

Added a new figure (Figure 2) comparing SAGE II aerosol extinctions at 1.02 and 0.525 um under nonvolcanic conditions to the AER150 model, and added a new paragraph (2nd paragraph of Section 4) discussing the comparison and model uncertainties.

"To what is the anomaly in Figure 3b at high latitudes in the Southern Hemisphere at 35 km due?"

The anonaly at high southern latitudes at 35 km seen in surface area density difference plots (now Figure 4 and Figure 5) is a change in sign of the percent difference to +70% within one grid point. This region shows strong nucleation and growth of aerosol particles in late spring/ early summer when descending SO2 reacts with OH to produce H2SO4.

"I would like to see a figure like 5a for UMaer"

Figure 6a (formerly 5a) shows the change in aerosol mass density due to sedimentation in model AER40. Plots of this quantity for the UMaer models are very similar and not easily distinguishable by eye. That is why we show differences between the UMaer-3mA and AER40 model, both without sedimentation, in Figure 6b. The other modal models yield very similar results to Figure 6b, as stated: "The UMaer-3mB model does not differ substantially from the Umaer-3mA model without sedimentation. The UMaer-4m model differs from the Umaer-3mA model by 2% or less in aerosol mass density in the lower stratosphere when sedimentation is omitted. The AER20 model without sedimentation does not differ from the AER40 model below 35 km."

"Page 6, end of first full paragraph: Can you indicate when the difficulty the modal parameterizations have reproducing the lower size cutoff would be a significant problem?"

We know of no specific applications for which the particle number densities below .01 um is a large liability.

"Figure 9: I am confused by the results above 30 km and why 4 mode results are worse than 3 mode."

The results above 30 km are showing differences between small values, so are not of great significance globally. They are probably the result of compensating errors in transport, chemistry, and microphysics.

"Figure 10 (as well as later figures): What is the point of showing only equatorial results separated by only 6 km?"

We have modified the Pinatubo figures to show results at the equator and 26 km and at 55N and 20 km. The 55N results represent significantly older air, don't change the conclusions obtained from equatorial results, but do highlight uncertainties in transport and perhaps in the initial dispersion of the SO2 cloud.

"Page 8: I would like to see some additional compariosns with SAGE II observations of extinction, surface area, and optical depth."

We feel that the number of figures in the paper is already high and shouldn't be expanded to more latitudes and altitudes. Though including the 55N comparisons is helpful in this regard. And we have expanded the number of cases examined from 5 to 6.

Interactive comment on Atmos. Chem. Phys. Discuss., 6, 12729, 2006.