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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Intercomparison of modal and sectional aerosol microphysics representations within the same 3-D global chemical transport model" *by* G. W. Mann et al.

Anonymous Referee #1

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General comments:

This study presents the comparison of a modal aerosol module and a sectional aerosol module in the same 3-D global offline transport model. Model with either of the two schemes is reported to be able to capture the main feature of the observed tropospheric aerosol size distribution. However, in theory and in previous box model studies, the modal method is proved to be not as accurate as the sectional method under certain conditions. Therefore the authors tried to adjust the mode width and the intermode separation size of the modal scheme in order to achieve better agreements with the sectional model and observations. Results of the revised modal model are shown

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to agree better with sectional model than the original setting. Apart from the model inter-comparison, the authors also compare the model simulations with various types aerosol measurements.

The manuscript is well written and the findings would be interesting and important to the aerosol modeling community. I recommend to publish this manuscript if the authors can address my specific comments below.

Specific comments:

Page 627, Line 27: Did Bauer et al. (2008) use modal method?

Page 628, Line 16: "This study, for the first time in a 3-D global model, compares modal and sectional aerosol schemes, sharing the same process representations."

Interestingly, a similar study very recently reported by Bergman et al. (2011) compared the modal module M7 and sectional module SALSA in the ECHAM5-HAM model. Compared to their study, this work not only compares the two methods, but also tried to improve the modal scheme. I would recommend the authors to cite this GMD discussion paper and emphasize this point.

Page 629, Line 16: I recommend the authors to add a schematic diagram showing the mode and/or bin boundaries. This could help the reader to understand how the bins in the sectional method overlap with the modes in the modal methods.

Page 630, Line 1-5: Either remove this part and merge it into Sec. 2.1 or remove similar contents in Sec. 2.1 (Line 20-23).

Page 633, Line 9-12: Why the size of acc. mode particles is larger in the revised model than in the original model between 30S and 50N?

Page 633, Line 20-21: Dentener et al. (2006) suggested both the median radius and its standard deviation (1.8) of the emission particles. Did you adapt the median radius for your model standard deviation (sigma=1.59) when you calculate the particle number

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emission rates?

Page 634, Line 10: "with the σ = 1.4 run agreeing much better with the observed tail of the accumulation- mode". I stared at Fig. 3 for several minutes, but I still haven't seen there is better agreement with the observation if sigma = 1.4, at least not in the range of 200nm-400nm radius. Furthermore, I would doubt the tiny difference we see here is significant, as the model sampling error may override the model-obs difference. I see only the monthly mean data are used in this study and the simulation year is different from that of the observation.

Page 636, Line 4: As far as I know, CN usually stands for particles with dry radius larger than 5nm (Dp>10nm). Particles with Dp>3nm are often called as ultrafine CN (UCN, see Clarke et al. 2002 paper).

Page 636, Line 22 to Page 637 1st paragraph: I would recommend the authors to investigate in more detail why the simulated lifetime is different in modal and sectional models. For example, why does BC lifetime decrease while POM lifetime increases? Though AeroCom studies indicate large spread of simulated lifetimes, such results were obtained from various models with very different treatments of aerosol source and removal processes. As you have almost identical treatments of these processes for modal and sectional method in your model framework, the change of lifetime we see in table 2 is not negligible.

Table 2: Are the modal results for the original modal setting or the revised one? Why not showing both?

Page 637, Line 12-14: Is the in-/below- cloud scavenging coefficient size-dependent for both modal and sectional schemes? What do you mean "better treatment"?

Page 638, Sec. 7.1, Fig 4 and Fig 5: How about the difference between simulations with the original and revised modal scheme? Is it significant? Same questions for Figs 7,8,9,10.

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Page 647, Line 26-30: Don't you consider the aerosol water uptake by sea salt and organic aerosols?

Page 648, Line 17-18: Just out of curiosity: Which aerosol nucleation scheme do you use?

Page 648, Line 7,13,19-23, etc: For the b and R values of modal and sectional simulations, they are calculated based on only a few points and very likely they are not statistically significant. So unless their difference is really remarkable, I don't think one is able to declare it is "slightly better" or "better correlated".

How do you calculate optical properties of aerosols? Are there any special treatments for modal and sectional model respectively?

Technical comments:

1. Too many lines in Fig. 2 and 3. It's not easy to follow the text and find the right position where the authors would like to point. Maybe some arrows could help. 2. Most of the figure fonts are too small.

Additional recommended references:

Bergman, T., Kerminen, V.-M., Korhonen, H., Lehtinen, K. J., Makkonen, R., Arola, A., Mielonen, T., Romakkaniemi, S., Kulmala, M., and Kokkola, H.: Evaluation of the sectional aerosol microphysics module SALSA implementation in ECHAM5-HAM aerosol-climate model, Geosci. Model Dev. Discuss., 4, 3623-3690, doi:10.5194/gmdd-4-3623-2011, 2011.

Weisenstein, D. K., Penner, J. E., Herzog, M., and Liu, X.: Global 2-D intercomparison of sectional and modal aerosol modules, Atmos. Chem. Phys., 7, 2339-2355, doi:10.5194/acp-7-2339-2007, 2007.

Zhang, K., Wan, H., Wang, B., Zhang, M., Feichter, J., and Liu, X.: Tropospheric aerosol size distributions simulated by three online global aerosol models using the M7

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microphysics module, Atmos. Chem. Phys., 10, 6409-6434, doi:10.5194/acp-10-6409-2010, 2010.

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