



Interactive comment on “Toward a minimal representation of aerosol direct and indirect effects: model description and evaluation” by X. Liu et al.

Anonymous Referee #2

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General comments

In this study the modal aerosol modules (MAM) are incorporated into a general circulation model, Community Atmosphere Model version 5 (CAM5). The CAM5 with MAM can calculate global aerosol distributions simulating aerosol size distributions considering the mixing state (internal or external), and then this work is also effective for simulating cloud droplet nucleation explicitly. On the whole, this study and manuscript is good, therefore I suggest that this manuscript will be able to be published if the authors fully address specific comments indicted below. However, the authors should consider that it is separated into two papers because it is too long although I can understand it

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is a description paper and this journal for model developments.

Specific comments

Title: It is too general, so that this title should be changed more specifically, from which readers can understand what do the authors do in this study.

P3847, L9-14: “Major approximations in MAM3 include assuming immediate mixing of primary organic matter (POM) and black carbon (BC) with other aerosol components, merging of the MAM7 fine dust and fine sea salt modes into the accumulation mode, merging of the MAM7 coarse dust and coarse sea salt modes into the single coarse mode, and neglecting the explicit treatment of ammonia and ammonium cycles.” It is difficult to understand such an unkind sentences. I think that you do not need it in the Abstract. Instead of it, you should state a primary aim of this manuscript.

P3847, L18-20: “because of the assumed hygroscopic nature of POM, so that much of the freshly emitted POM and BC is wet-removed before mixing internally with soluble aerosol species”. It cannot be understood why this is a reason for a small differences in POM and BC between MAM3 and MAM7. You have to rewrite if you think it is important.

P3488, L16: Absorbing aerosols necessarily do not reduce the cloud cover. If they concentrate just above the surface or in the boundary layer, they can increase cloud cover due to getting instability of the atmosphere through the semi-direct effect (e.g., Koch et al. 2010, Takemura et al. 2011).

P3494, L1: IPCC AR5 is firstly appeared. Write full name.

P3494, L8-9, L12-13: “sulfur from forest fire and grass fire is emitted at higher elevations (0–6 km)”, “POM and BC from forest fire and grass fire are emitted at 0–6 km”. How are the sulfur, POM, and BC emitted? Constant mass mixing ratio to the vertical profile? And what is a reference of this height?

P3498, L19: What is the accommodation coefficient?

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P3499, L4: What is $M_{SO_4,cond}$?

P3500, L17: Explain the UW parameterization.

P3501, L8: Write a reference for assuming a cloud regeneration time scale of one hour. And describe a sensitivity of the time scale if possible.

P3502, L10-11: “The activation fractions currently are 0.0 for the primary carbon mode, 0.4 for the fine and coarse dust modes, and 0.8 for other modes”. Do you have any references for these values? I guess they are one of the tuning factor.

P3502, L21-22: Simply describe the method of calculation of the scavenging coefficient for interstitial aerosols (which parameters are depended on, and, if possible, with a equation).

P3504, L20-21: “The treatments of droplet and crystal nucleation have been modified.” What has been modified from?

P3507, L28-29: Explain the lambda and gamma parameters with the shape parameter.

P3517, L4: “smaller SO₂ sources”. From Table 6, SO₂ source in this study is not small compared with the AeroCom study.

P3533, L20-27: The authors should't write about ammonia/ammonium in the conclusion section because there are not any discussions on them before the conclusion.

References

Koch, D., and Del Genio, A. D.: Black carbon semi-direct effects on cloud cover: review and synthesis, *Atmos. Chem. Phys.*, 10, 7685–7696, 2010.

Takemura, T., and Uchida, T.: Global climate modeling of regional changes in cloud, precipitation, and radiation budget due to the aerosol semi-direct effect of black carbon, *SOLA*, 7, 181–184, 2011.

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Technical corrections

P3490, L1; P3491, L4: Change “between” to “among”.

Interactive comment on *Geosci. Model Dev. Discuss.*, 4, 3485, 2011.

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