**Atmospheric
Chemistry
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Discussions**

Interactive comment on "Aerosol indirect effects in a multi-scale aerosol-climate model PNNL-MMF" *by* M. Wang et al.

Anonymous Referee #3

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In this study the aerosol and cloud distributions, aerosol direct effect, and aerosol indirect effect are simulated with the Multi-scale Modeling Framework (MMF) that embeds a cloud-resolving model (CRM) which is in each grid of a general circulation model (GCM), CAM5. It is certain that traditional general circulation model with horizontal resolution over hundred kilometers is insufficient for presenting the aerosol indirect effect. On the other hand, long-term global simulations with horizontal resolution about several kilometer is not realistic because of the present computer resources. Then the model in this study which considers only the subgrid cloud-aerosol interaction based on the GCM is useful and shows one of the directions of the concerned modeling studies for the moment. Therefore I suggest that this manuscript will be able to be published if the authors address major and minor revisions indicted below.

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\<Major revisions\>

1. This manuscript as a whole is wordy, especially in section 4.2.2. The same detailed explanations both in figure captions and main text is not needed. Enumeration of numbers in main text same as tables is also not needed. The wordiness results in difficulty in understanding advantages of the PNNL-MMF model. Clarify more predominance of the PNNL-MMF model in evaluating the cloud-aerosol interaction all over the manuscript, especially in abstract.

2. page 3406, lines 10-11: "Results from the 34 months are used in this study" Therefore the analysis in this study may incline about the seasonal cycle because it includes 3 years for 10 months and 2 years for the other 2 months. If the model need 2 months for spin-up, the MMF model has to be integrated for 38 months.

3. page 3409, lines 13-14: Why is the shortwave cloud forcing almost same between MMF and CAM5 although the low cloud fraction and the droplet effective radius at cloud top in MMF is smaller and larger than those in CAM5, respectively, as shown in Table 1? Can you show the annual mean cloud droplet effective radius, for example, by the latitude-vertical plot with zonal mean?

4. page 3409, lines 14-16: Why is the longwave cloud forcing in MMF larger than in CAM5 although the high cloud fraction in MMF is smaller than in CAM5? How is a difference in the ice crystal effective radius between them?

5. page 3410, lines 25-27: A difference in the cloud fraction between MMF and ISCCP is very large ($\sim$10%), so that more detail discussion is needed. What is the other reasons?

6. page 3413, line 1: The sulfate burden in MMF is about twice as large as in CAM5. This is a critical problem. Compare them with observations and describe which is better.

\<Minor revisions\>

7. page 3408, lines 23-24: What is the differences in the microphysical schemes?

8. page 3409, lines 1-3: Does black carbon act as cloud condensation nuclei or ice nuclei? And is this treatment same as this study (CAM5-CRM-MMF)?

9. page 3411, line 5: Change "-0.5" to "-50.5".

10. page 3411, lines 10-11: How is shape of snow particle, which is an important information for the calculation of radiative transfer.

11. final paragraph of section 3.1.2: Discuss reasons for a difference in the cloud-top droplet number concentrations among MMF, CAM5, and MODIS.

12. page 3414, line 2: Change "show" to "shows".

13. page 3414, lines 6-8: Describe the reasons. Is it because differences in vertical diffusion and advection of aerosol between MMF and CAM5?

14. 1st paragraph of section 4.1: Change "Angstrom" to "Ångström" (3 parts).

15. page 3415, line 20: Change "most" to "some". According to Fig. 2 in Quaas et al. (2009), some models show the similar slope to the satellite retrieval.

16. page 3416, line 2: Change "AOT" to "AI".

17. page 3427, line 2: Change "clear-sly" to "clear-sky"

18. page 3428, line 26: It is not a "common" feature as described above.

19. caption of Table 1: Add "at cloud top" after "droplet effective radius".

20. caption of Fig. 11: Change "weighted average" to "weighted averages" and "is show" to "are shown".

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