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Geoscientific Model Development Discussions

Interactive comment on "Description and evaluation of a new 4-mode version of Modal Aerosol Module (MAM4) within version 5.3 of the Community Atmosphere Model" *by* X. Liu et al.

Anonymous Referee #1

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The authors present a 4-mode modal aerosol model (MAM4) by introducing a primary carbon mode to the existing 3-mode version of MAM (MAM3) in the Community Atmosphere Model version 5 (CAM5). They further design two sets of sensitivity experiments, one to change the aging properties of primary carbon and another to change model resolution, to investigate the potential improvement of atmospheric black carbon simulation. The paper is well written. I recommend publishing the paper on ACP after the authors make some minor modifications.

General Remarks: My only concern is the performance of MAM4 relative to MAM3. The authors evaluate BC results simulated from MAM3 and two sets of sensitivity experiments of MAM4 using various aircraft measurements. With the exception of high

latitudes of the Northern Hemisphere, the performance of MAM4 BC simulation over global broad coverage is deteriorated, overestimating BC compared to measurements. Over the North Pole region, MAM4 BC is still underestimated and the authors suggest further improvements on in-cloud scavenging and vertical transport in convective cloud and on emissions. These actions, while they can potentially improve BC over North Pole, are very likely to further downgrade BC simulation outside North Pole regions.

Specific comments: 1. Page 8342 lines 22-23: Overestimating BC over Pacific region is a common problem for many global aerosol models. Changing emission based on various available emission inventories cannot solve the problem. 2. Page 8343 line 22: Add Bian et al., 2013 alone with Wang et al., 2013. 3. Page 8343 line 23: Add Jiao et al., 2014 after "dry and wet deposition". 4. Page 8344 line 1: Add "and II" and "Phase I". 5. Page 8344 line 1: Add "Samset et al. 2014" after "Schwarz et al., 2010". 6. Page 8344 line 11: Add "nitrate" after "sulfate". 7. Page 8344 lines 15-16: Does "its" refer to BC's? If yes, why is "BC's" absorption of sunlight enhanced significantly since soluble species, typically sulfate and nitrate, have less absorption than BC's? 8. Page 8345 lines 19-24: If these are the reasons for the underestimation of BC at high latitude of Northern Hemisphere, then how do the authors explain the overestimation of BC over other regions? 9. Page 8346 lines 10-12: How does aerosol affect convective cloud? 10. Page 8348 lines 8-11: Do the authors use different hygroscopicity for fossil fuel POM and biomass burning or use the same value for both? 11. Page 8349 lines 13-15, Page 8350 lines 3-4, and Figures 6-14: How large is the inter-annual variation of BC over the comparison regions? The current approach of the comparison implies that the inter-annual change of BC is very small. 12. Page 8354 line 19: Add Bian et al., 2013 after Ma et al., 2013. 13. Figure 6: Why is MAM3 result not shown on the figure? 14. Figures 7-12: How are the model results sampled spatially and temporally when they are compared with observations?

Technique corrections: 1. Page 8344 lines 4-5: Change "compared" to "comparable" and delete "the models tend to be in better agreement".