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Interactive comment on "Assessing the CAM5 physics suite in the WRF-Chem model: implementation, evaluation, and resolution sensitivity" *by* P.-L. Ma et al.

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Response to comments from Reviewer #1

This is an excellent paper summarizing a major accomplishment, which is to port climate model physics into a mesoscale model and make this available to a broader community. The paper documents this process well and will serve as a valuable reference for those wishing to test CAM5 physics over regions and at different resolutions, especially the chemistry aspects. The paper clearly discusses the technical challenges of the work. Overall I recommend this work for publication and include some minor suggestions that may help its clarity.

We thank the reviewer for the positive comments. We address his/her comments point-by-point below.

Minor Points 1. p6165, line 26. Please mention whether this cloud fraction also includes components from the shallow convection and deep convection or not. The sentence implies just microphysics.

We have revised the text to “When the CAM5 microphysics scheme is selected, the total cloud fraction (the combination of stratiform, and shallow and deep convective cloud fraction) is computed and used in the radiative transfer calculation”.

2. Figure 4. The thing that stands out most in Figure 4 is the high IWC reaching 1 g/m3 and its bias, but nothing is said of this.

We have added the text: “Model simulations occasionally exhibit large in-cloud IWC values when the ice cloud fraction is small and/or snow takes place.”

3. Figure 5, p6174. For BC and OM, this seems to only reach three orders of magnitude because of occasional dips, but generally magnitudes are OK. From this figure alone, I would conclude spurious low events rather than a bias for BC and OM, at least (the bias is more obvious in Figure 6). I recommend modifying the discussion of bias for this Figure.

We have modified the text to “. . . aerosol mass concentrations of black carbon, organic matter, ammonia, and sulfate are low in all model simulations about one order of magnitude (Figure 5). Model simulations also exhibit occasional drops of aerosol concentrations when the aircraft measurements are near the surface, showing 2-3 orders of magnitude lower aerosol concentrations than observations.”

4. p6175, line 11. Typo "models consistently"?

Corrected.

5. Figure 7, p6175, line 19. The argument about source deficiencies is more supported

by the fact that the peak value was about correct. If transport deficiencies dominate, the peak would also be affected, I think. We agree with the reviewer that the aerosol emissions might have been under-estimated (Stohl et al., 2013; Wang et al., 2011b) and this is likely a key factor controlling the aerosol concentrations in the Arctic. However, we have not excluded the model deficiencies transporting aerosols into the Arctic, either. Our previous studies show that CAM5 has weaker eddy transport (Ma et al., 2013b) and stronger wet-scavenging near the source region (Wang et al., 2013) that contribute the under-prediction of black carbon transport into the Arctic. We have included this sentence in the text.

6. Figure 8. Is this the whole domain? A domain map would be useful. If this is the domain, I think Barrow may be close to the north boundary, but the location of Barrow is not given in the paper.

This is the domain without the buffering zone along lateral boundary. Barrow is close to the northern boundary but it is not within the buffer zone. Note that our domain covers almost the entire North Pacific Ocean, which is much larger than most regional atmospheric chemistry domains. Barrow is far enough from the northern boundary so that it is not affected by boundary adjustment issues. The northern boundary also does not have a lot of inflow for aerosols, with most of the chemistry related information approaching Barrow from the south. We have added the latitude and longitude of Barrow in Section 4 when Barrow is first mentioned, and added a blue star in Figure 3 to denote the location of Barrow.

7. p6176, line 2. It was not quite clear, but I assume this range is for the corresponding 16x16 points in the 10 km domain. I think also of interest would be how the 160 km average of the 10 km run compares to the 160 km point value. When time series or values are shown among the different resolutions I am assuming these are all nearest point values rather than averaged to the same reference area, but this could be stated, if it hasn't been.

GMDD
6, C2652–C2656, 2014

We have revised the text to "...the simulated surface BC over Barrow (nearest model point from Barrow) increases by over one order of magnitude..."; "The instantaneous maximum BC concentration within the corresponding 160 km grid cell over Barrow increases by about a factor of 30..."; and "The BC concentrations over Barrow in the high-resolution simulations averaged over the corresponding 160 km grid cell increases monotonically with increasing resolution, reaching 50.96 ng kg-1 in the 10 km grid-spacing simulation."

8. Figure 9, p 6177. I would also note about this Figure that there is always a significant jump from 20 km to 10 km as though this resolves something new.

We have revised the text accordingly: "The 10 km model simulation appears to show a much larger increase of aerosol burdens over other simulations."

9. Figure 10. I assume this is a domain-wide average, but that is not stated.

Susceptibility is expressed as the slope of a measure of fractional increase of cloud LWP to fractional increase of AOT, calculated from hourly model output of AOT and LWP for the whole simulation period at every grid point over the entire domain." We have revised the text accordingly.

10. p 6178, line 18. Which land-surface model is used in these simulations?

We used the Noah Land Surface Model. We have revised the text with the proper citation.

11. Figure 14, p6180, line 21. Too "little" light precipitation? Perhaps a confusing way to put it. Too much precipitation where observed precipitation was light would be more precise.

We have revised the text accordingly.

12. Figures 15 and 17. I think mean profiles over the period would summarize the figures well.

GMDD
6, C2652–C2656, 2014

We intend to demonstrate the similarity and differences of the time evolution of liquid and ice water profiles from model simulations and observations. In Figure 15 and 17, we have provided the mean in-cloud liquid and ice water content averaged over the whole simulation period, and the frequency of occurrence of liquid and ice clouds in the simulation period. We hope the reviewer will let us use these two figures as they are.

13. Figure 16, p6181, line 2. The long tail at the high end stands out for CAM5 and could be mentioned. A similar thing is implied by the IWC in Figure 18. Interestingly insensitive to resolution implying a well resolved microphysics effect.

We have revised the text accordingly: "... but WRF_CAM5 simulations exhibit some high in-cloud LWP events when the liquid cloud fraction is small and/or raindrops are present", and "The distributions of the frequency of occurrence for both ice and liquid clouds are found insensitive to model resolution."

Interactive comment on Geosci. Model Dev. Discuss., 6, 6157, 2013.