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Geoscientific
Model Development
Discussions

Interactive comment on "Sensitivity of remote aerosol distributions to representation of cloud-aerosol interactions in a global climate model" *by* H. Wang et al.

Anonymous Referee #1

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This paper uses observations of BC in combination with a sophisticated climate model (PNNL-MMF) capable of resolving sub-grid cloud processes to diagnose the sensitivity of remote BC concentrations in the tropical high troposphere, and polar regions to changes in bulk cloud-processing parameters in the global atmospheric model CAM. They find that inclusion of a new unified treatment of vertical aerosol transport and convection (increasing the scavenging rate of BC in the tropical troposphere) improves the models agreement with high altitude observations of BC. While, at the poles, BC concentrations increased 10-fold in winter due to a combination of reductions in the frequency of liquid-phase cloud scavenging in the mid-to-high latitudes and an increase in the BC ageing lifetime. Inclusion of these 'improved' parameters significantly im-

proved the agreement between the PNNL-MMF climate model and CAM. However, winter-spring concentrations in the Arctic are still significantly underestimated in both models.

This study is extremely broad and in some places quite difficult to understand although the conclusions are consistent with previous work in the field. Below are some suggestions to improve the clarity of the paper.

1. Line 17 page 333, over-predict should be over-predicts

2. Line 11 page 337, BC and POM is emitted into the accumulation mode in MAM3 but a primary carbon mode in MAM7. How large is this primary mode and is the biomass and anthropogenic component separated? Are BC/POM particles transferred directly to the accumulation mode after ageing or to the soluble Aitken? In general the paragraph beginning at line 5 needs more detail. For reference it would be useful to have a typical size-range included for each mode i.e. Aitken (xnm-ynm). If primary BC is emitted into an Aitken primary mode how does the emission size impact the studies result (i.e. does the increase in BC stem from ageing or from a reduction in the average size of carbon particles?)?

3. Line 24 page 339, What do the authors mean by surface wet-deposition flux? Is this the mass deposited to the surface per day or the BC mass in the model surface layer deposited per day? Does this flux include a mixture of impaction/in-cloud scavenging? Or in-cloud (nucleation scavenged) only. When discussing scavenging processes please indicate the type each time.

4. Page 339-340, I am assuming that the wet deposition flux is for the total column as Fw,ta has the same subscript as Bta (although it is unclear why this subscript is present). Unless the subscript is explained I would suggest rewriting the formula as: Rw = Fw/B. In general this description is too vague, all terms need to be clarified.

5. Figure 1 (Figure 2): Fractions should be shown on a linear scale. A plot of LWC

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would also be useful here.

6. Equations 1 - 3 pages 339-340, The methodology described here is extremely opaque and requires clarification. Is the first term of this equation (Fw,ta/Bca) calculated as the autoconversion rate of the cloud-water or as the modeled deposition flux over the calculated burden? It is my understanding that the aerosol burden in models is calculated from model output after the deposition flux has been subtracted. If this is the case than the first-order wet removal will be biased high. Please explain where these terms come from.

7. Line 4 page 343, please explain the meaning of wet-removal adjustment factors.

8. Table 1, This table is not useful it would be better as a grid with the model simulations on the left and the new parameters at the top with symbols (i.e. tick marks) showing which model improvements are in which simulation.

Interactive comment on Geosci. Model Dev. Discuss., 6, 331, 2013.