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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Aerosol size-dependent below-cloud scavenging by rain and snow in the ECHAM5-HAM" *by* B. Croft et al.

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Response to referee #2

The authors wish to thank this referee for the constructive comments and suggestions.

General comments:

Q. "The collection efficiency is assumed to be zero for aerosol particles that are 10 nm or less in radius"...I think the parameterizations and calculations should be corrected with respect to this assumption. ...I cannot see how this assumption would be justified.

We agree with the referee that the assumption of zero collection of particles with radius smaller than 10 nm is best left to a sensitivity study alone. We have now corrected all

figures, tables and text in regard to this point. We re-ran all model simulations with this correction. We have replaced the zero-collection assumption with the assumption that the collection of particles smaller than 10 nm in radius is by Brownian motion. This was done for all simulations except 2 sensitivity simulations. We now include 2 sensitivity studies related to particles smaller than 10 nm in radius, which are now described in Section 2.1.2. BCS2-ULOW assumes zero collection of particles in this size range, and BCS2-UHIGH assumes that collection is like that of an irreversibly soluble gas (we chose water vapor). The assumption of collection of particles 10 nm and smaller by Brownian motion is supported by the work of numerous authors, which are noted in Section 2.1.2. We agree that zero collection of these ultra-fine particles should be isolated to a sensitivity simulation, and found the comment of this referee to be very constructive towards improving the methodology and presentation of this work.

The global and annual mean mass and number deposition budgets are not significantly changed following this revision. However, in regard to ultra-fine particles we have added a new Fig. 12 in response to the question from referee 1 about whether the nucleation of new particles was increased in the lower troposphere following the more vigorous below-cloud scavenging since the amount of available condensation surfaces for sulfuric acid would be reduced. Fig. 12 shows the change in zonal and annual mean nucleation mode number concentrations between the control simulation and the various size-dependent scavenging simulations. The enhanced scavenging for the size-dependent simulations is associated with increased nucleation mode number concentrations in the lower troposphere. This is expected since the available condensation surfaces from the accumulation and coarse modes are reduced following the more vigorous scavenging. Thus, new particle nucleation increases, and this effect dominates over the enhanced nucleation mode scavenging for the size-dependent scavenging simulations, relative to the CTL simulation, particularly over the southern oceans. Additionally, we find that enhanced ultra-fine particle scavenging in the sensitivity simulation BCS2-UHIGH does reduce the nucleation mode number concentrations over the southern oceans. This discussion is added to the last paragraph of Section 3.3.

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Specific comments:

Q. Scavenging coefficients are typically in SI-units i.e. s-1.

We have now corrected the units on the figures to show the scavenging coefficients in units of s-1.

Interactive comment on Atmos. Chem. Phys. Discuss., 9, 7873, 2009.

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