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Influence of different prescribed scavenging ratios on global aerosol and cloud properties in ECHAM5-HAM

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Aerosol particles can change the climate system by altering the Earth's radiation budget (direct effect) and by influencing the cloud properties (indirect effect). However, the uncertainty of the radiative forcing of the direct and indirect effect is still very large, which makes it desirable to increase the understanding of the different interactions between aerosol particles and hydrometeors. A key process of aerosol-cloud interactions is the removal of aerosol particles from the atmosphere either by the activation to cloud droplets (nucleation scavenging) or by collision of aerosol particles with cloud droplets (impaction scavenging) with subsequent removal as precipitation.
The standard version of the general circulation model ECHAM5-HAM (Lohmann and Hoose, 2009) uses prescribed aerosol scavenging ratios (percentage of removed particles per aerosol mode) for in-cloud scavenging. The benefit of prescribed scavenging parameters lies in the low computational costs, which are markedly increased when more sophisticated approaches like physically detailed size-dependent aerosol scavenging fractions (e.g. Croft et al., 2010) or prognostic aerosol cloud processing schemes (Hoose et al., 2008a,b) are used.
Using different prescribed aerosol scavenging ratios, we investigate their effects on the global aerosol and cloud properties. The results show that the cloud droplet number burden is decreased when the scavenging of aerosol particles is reduced as compared to the standard scavenging parameters of ECHAM. The reduced cloud droplet number concentration can be explained by the reduced formation of aerosol particles due to the higher aerosol concentration initially. The presence of more aerosol particles in the beginning leads to more condensation of sulfuric acid and organic vapors onto existing particles. Hence the nucleation of new aerosol particles is suppressed and coagulation of existing aerosol particles to form larger aerosol particles is more important. Therefore, the overall cloud droplet number concentration is reduced but the aerosol mass mixing ratio is increased when the scavenging ratios are reduced.

References:
B. Croft, U. Lohmann, R. V. Martin, P. Stier, S. Wurzler, J. Feichter, C. Hoose, U. Heikkilä, A. van Donkelaar, and S. Ferrachat: Influences of in-cloud aerosol scavenging parameterizations on aerosol concentrations and wet deposition in ECHAM5-HAM, Atmos. Chem. Phys., 10, 1511-1543, 2010.

Hoose, C., U. Lohmann, R. Bennartz, B. Croft and G. Lesins: Global simulations of aerosol processing in clouds, Atmos. Chem. Phys. 8, 6939-6963, 2008a.

Hoose, C., U. Lohmann, P. Stier, B. Verheggen, and E. Weingartner: Aerosol processing in mixed-phase clouds in ECHAM5-HAM: Model description and comparison to observations, J. Geophys. Res., 113, D07210, doi:10.1029/2007JD009251,2008b.

Lohmann, U., and C. Hoose: Sensitivity studies of different aerosol indirect effects in mixed-phase clouds, Atmos. Chem. Phys., 9, 8917-8934, 2009.