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In-cloud scavenging scheme for sectional aerosol modules – implementation in the framework of the Sectional Aerosol module for Large Scale Applications version 2.0 (SALSA2.0) global aerosol module

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Black carbon (BC) affects the radiation budget of the Earth by absorbing solar radiation, darkening snow and ice covers, and influencing cloud formation and life cycle. Modelling BC in remote regions, such as the Arctic, has large inter-model variability which causes variation in the modelled aerosol effect over the Arctic. This variability can be due to differences in the transport of aerosol species which is affected by how wet deposition is modelled.

In this study we developed an aerosol size-resolved in-cloud wet deposition scheme for liquid and ice clouds for models which use a size-segregated aerosol description. This scheme was tested in the ECHAM-HAMMOZ global aerosol-climate model. The scheme was compared to the original wet deposition scheme which uses fixed scavenging coefficients for different sized particles. The comparison included vertical profiles and mass and number wet deposition fluxes, and it showed that the current scheme produced spuriously long BC lifetimes when compared to the estimates made in other studies. Thus, to find a better setup for simulating aerosol lifetimes and vertical profiles we conducted simulations where we altered the aerosol emission distribution and hygroscopicity.

We compared the modelled BC vertical profiles to the ATom aircraft campaign measurements. In addition, we compared the aerosol lifetimes against those from AEROCOM model means. We found that, without further tuning, the current scheme overestimates the BC concentrations and lifetimes more than the fixed scavenging scheme when compared to the measurements. Sensitivity studies showed that the model skill of reproducing the measured vertical BC mass concentrations improved when BC emissions were directed to larger size classes, they were mixed with soluble compounds during emission, or BC-containing particles were transferred to soluble size classes after aging. These changes also produced atmospheric BC lifetimes which were closer to AEROCOM model means. The best comparison with the measured vertical profiles and estimated BC lifetimes was when BC was mixed with soluble aerosol compounds during emission.