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The parameterization of black carbon aging in the OsloCTM2 and the importance for atmospheric burden and deposition in the Arctic

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A critical parameter for the atmospheric lifetime of black carbon aerosols (BC), and hence for the range over which the particles can be transported, is the aging time, i.e. the time before the aerosols become hydrophilic and can be removed by wet deposition. The aging time is often included in atmospheric models by assuming a constant transfer rate from insoluble to soluble mode. In reality the aging involves interaction with soluble species, such as sulphate, and regional and seasonal differences in aging time are expected. This study compares two different parameterizations of BC aging in the Oslo chemistry transport model (CTM2). The effect on transport and distribution in general and on regional contributions to Arctic BC is explored. In the standard version aging is represented by a constant transfer from hydrophobic to hydrophilic mode. The microphysical module (M7) has been implemented in the OsloCTM2 to represent size distribution and particle interaction and allow for the formation of mixed particles and a varying aging time. In M7 aging is a result of the coating by sulphate.

Using the M7, the atmospheric concentrations of BC in high latitudes are increased, mainly during winter. In higher northern latitudes (i.e. Russia and Europe) the aging time shows a seasonal variation, with slower aging during winter, presumably due to the lack of available solar radiation for production of sulphate. For emissions in China the aging is faster than in higher latitudes and shows little seasonal variation. Emissions in Europe are most important for the atmospheric BC burden north of 65°N, especially at low altitudes. With M7, the contribution to Arctic BC burden from emissions in Europe and Russia is increased during winter, reflecting the slower aging. These results indicate that the treatment of aging might contribute to improving the discrepancy between models and observations seen in the seasonal cycle in BC concentrations at Arctic stations. Contributions from emissions in China are reduced using M7. The amount of BC deposited in snow and ice north of 65°N is also reduced. Mechanisms for this result will be discussed.

M7 capture regional and seasonal variations in BC aging which affect regional contribution to burden in the Arctic relative to the standard aging parameterization. Uncertainty is related among other to the treatment of coating. Recent studies indicate that species such as soluble organic carbon and nitrate also contribute to the coating of BC particles. If included in the M7 this might affect the results.