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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Parameterization of black carbon aging in the OsloCTM2 and implications for regional transport to the Arctic" *by* M. T. Lund and T. Berntsen

Anonymous Referee #2

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Review of "Parameterization of black carbon aging in the OsloCTM2 and implications for regional transport to the Arctic"

This manuscript compares the transport and deposition of black carbon aerosols (BC) based on two aging parameterizations in the OsloCTM2: a bulk aerosol method which assumes a fixed aging time 1.15 days to convert hydrophobic BC to the hydrophilic mode, and a microphysical method based on M7. Besides aging, dry deposition (and maybe wet removal process) is treated differently. The authors find that the simulation with detailed microphysics allows a slower aging rate in high-latitude winter, resulting in a significantly increase of BC loading in the Arctic winter. In addition, the authors

compare regional contributions to the Arctic BC concentrations as well as BC in snow and ice, which may have significant policy implications for hemispheric-scale regulation of long-range transport of BC to the Arctic.

This paper is clearly written and structured, and I recommend it being published in Atmospheric Chemistry and Physics after the following issues have been addressed:

(1) As described by the authors, aging is an important process determining the rate of soluble materials coating on BC particles. However, the simulated concentration and deposition of BC also depend on how the removal processes (i.e., wet + dry) are parameterized. In section 2, there are some descriptions on BC aging, dry deposition and wet deposition of the bulk method. For the microphysical method, however, only the aging process is described. Details on the parameterizations of dry and wet deposition of BC and other aerosols (e.g. sulfate) in the microphysical method, as well as brief comments on their difference to the bulk scheme are needed.

(2) On Page 32505 "Aging then occurs due to condensation of sulfuric acid produced in the gas-phase reaction OH+SO2−H2SO4 or coagulation with sulfate particles . . ." I'd like to know which process (condensation or coagulation) is more important for BC aging (usually both BC and sulfate concentrations are enhanced over the Arctic during the haze period).

(3) Is OH simulated online or offline?

(4) The authors should state how aqueous oxidation of SO2 is treated in the bulk and M7 schemes. Some previous studies found sulfate aerosols are mainly oxidized in the liquid phase. It would be nice to have a discussion on the effects of aqueous-phase chemistry on BC aging and then wet deposition.

(5) The aging rate of BC in M7 depends on both SO2 and OH concentrations, which are variable by locations. It would be nice to add a figure which shows the distribution of BC aging time based on the M7 parameterization.

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(6) In the bulk simulation, dry deposition velocity is set to 0.025cm/sec, which seems to be too small according to both measurements and previous modeling studies. As a result, drydep will contribute little to BC deposition and wetdep will be the dominant term. This could indirectly overstate the role of aging. The authors may want to provide the reference of these values. In addition, in the microphysical method, drydep is based on Grini 2007. I wonder how this would be different to the bulk method.

(7) As shown in Figure 4, the observed BC concentrations at Alert, Barrow and Zeppelin are highest during February to April (i.e., the haze period), which seems different to the seasonality of oxidation of SO2, a process determined by the availability of oxidants which are lowest in DJF and highest in JJA in the northern hemisphere. This may partly explain why the simulated BC with improved aging is usually highest in winter. The authors may want to have a discussion on this and differentiate the role of aging and treatment of other processes on the Arctic BC concentrations.

(8) A number of previous studies have reported the global budget of deposition flux (i.e., drydep and wetdep). This study has quantified the atmospheric burden and lifetime of BC aerosols in Section 3.1.1. It would be also useful to quantify the global budget of dry and wet deposition, and compare them to the previous work.

(9) There are always some difficulties to evaluate model results with aircraft measurements, which need to match the exact conditions of the sampling period, including emissions (particularly the biomass burning emissions) and meteorology. The simulation period of this study is 2006 and the measurements were made (as a few snapshots) in 2009. The authors should be careful about those differences.

(10) It would be good to evaluate the model with some surface measurements in the Southern Hemisphere.

(11) In Fig. 6a, are these high spots over the high-latitude regions the observed values?

Interactive comment on Atmos. Chem. Phys. Discuss., 11, 32499, 2011.

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