Atmos. Chem. Phys. Discuss., 11, C13397–C13400, 2011
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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 #1

Received and published: 20 December 2011

The paper reports on the effect of using two parameterizations of black carbon aging in the OsloCTM2 global climate model, with a focus on how calculated atmospheric and surface snow and ice concentrations of BC are affected by the two parameterizations. Comparisons are made between modeled and measured atmospheric and snow BC concentrations using the two parameterizations. The test are done with a bulk parameterization (BULK) whereby BC is transformed from hydrophobic to hydrophilic at a set e-folding rate and with a more sophisticated parameterization (M7) that accounts for particle size distribution and the presence of other constituents (which itself is influenced by e.g. the amount of sunlight available for photochemical reactions). Thus, while BC aging rate doesn't vary with location or season in BULK, with M7 BC aging

– and therefore lifetime and wet deposition rates – varies with emissions location, emissions source and season.

Global climate models have been shown to do a poor job of reproducing Arctic atmospheric BC concentrations, and some analyses suggest this is largely due to errors in modeled wet deposition rates. The focus on how changing parameterized BC aging (and therefore hygroscopicity and wet removal rates) affects BC distributions is therefore scientifically important.

The paper is well-written, clear and should be published with some minor edits/additions.

More substantive changes:

1. A curiosity of the results presented is that the use of the more sophisticated parameterization (M7) improves the representation of near-surface atmospheric concentrations of BC in the Arctic but it worsens a high bias in modeled concentrations aloft. The finding that modeled values of surface concentrations are too low but concentrations aloft are too high is not new to this paper, but I am wondering if the model studies with BULK and M7 tell us anything about what processes are leading to this result; e.g. does this indicate anything about the relative roles in transport versus deposition in these biases? The paper could do better than to just present the numerical results of the comparison.
2. It is noted that the conversion from hydrophobic to hydrophilic in M7 is via condensation of sulfate onto the B C, and it's pointed out a couple of times that in reality measurements have found that organics (usually co-emitted with the BC) may also mix with BC and convert it to hydrophilic. On pg. 32509, lines 5-9 the slow conversion from hydrophobic to hydrophilic in the Arctic winter is noted to be due to the lack of sunlight and therefore slow production of sulfate. I would like to see some

ACPD

11, C13397–C13400, 2011

discussion here of how accounting for internal mixing with organics might change this, and therefore how it might change the calculated wintertime atmospheric and surface snow concentrations of BC. The implications of accounting for organics could also be expanded upon on page 32513, lines 15-19.
3. Section 3.1.2 discussion + Conclusions, pg 32517, line 21 to end of paragraph + Figure 5: The contributions of fossil fuel (FF) and biofuel (BF) emissions from different regions is presented and discussed. It has been observed (e.g. during POLARCAT) that biomass burning may account for a large fraction of Arctic BC, and a lot of the biomass burning emissions may be anthropogenic. I think it is important therefore that in addition to showing the FF and BF contributions to the Arctic from different regions they also to show the regional BB emissions. BB emissions are of course very specific to a given year, but it can be specified whether the year(s) shown are particularly low, high or typical burn years within a given region.

Smaller points:
4. Section 2.2.2, page 32504, line 22: “RF” should be spelled out.
5. Section 3.1.1, page 32508, lines 5-9 and Figure 2c-f: Are the model data averaged over the same gridboxes as the location of the aircraft measurements, or are the model averages over all data in given latitude bands? Please give more detail here on how the model averages were calculated for the comparison.
6. Section 3.1.2, page 32512 line 26 to page 32513 line 2: "The contributions from Europe and Russia increase strongly below 5km in January (in M7) compared to BULK. Annual average percentage contributions change only by a few percentage points, to 18% for Europe AND 13% FOR RUSSIA. There is no change in the contribution from China. The contribution FROM RUSSIA INCREASES TO 13% WITH M7.”
a. It’s not clear if you are still talking about column burdens (versus e.g. only below 5km), so it would be good to be explicit.
b. If I’m reading this correctly, you are repeating the statement that Russia increases to 13% with M7; i.e. the two bits of text in all caps above.

ACPD
11, C13397–C13400, 2011

7. pg. 3253, line 23: “averaged...over the top three modeled snow layers”. Please specify the depth of the top three snow layers (cm?).
8. Section 4 Conclusions, pg 32516, line 25: “. . .and hence does not lead to significant improvements.” This wording is a bit misleading/odd: Using M7 doesn’t lead to significant or insignificant improvements; it leads to worse agreement between the modeled and measured values. Please reword.

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