Geosci. Model Dev. Discuss., 5, C499–C502, 2012
www.geosci-model-dev-discuss.net/5/C499/2012/

Geoscientific Model Development Discussions

Interactive comment on "Development of a parameterization of black carbon aging for use in general circulation models" *by* N. Oshima and M. Koike

Anonymous Referee #2

Received and published: 2 August 2012

This paper presents a parameterization of the black carbon aging time scale τ_{BC} for the use in global climate models. The authors employ a CCN-based aging criterion where BC-containing particles that would activate at $s = 0.1\%$ are considered as "aged". Using this criterion the aging time scale τ_{BC} is then defined as the time required for the hydrophobic BC mass concentration to decay to 1/e of its initial value. The authors propose that τ_{BC} can be expressed as a function of the mass condensation rate onto the hydrophobic BC particles, V_{BC}, and a factor that depends on parameters of the initial lognormal size distribution. With their box model MADRID-BC, which resolves BC mixing state, they compute V_{BC} and τ_{BC} for a number of initial conditions, varying the concentration of precursor gases, temperature, relative humidity, and BC

mass concentrations. They also outline instructions for applying the parameterization in global climate models. The current formulation includes only condensation of inorganic substances as aging mechanism. Condensation of SOA, coagulation with other particles, in-cloud processing and photochemical aging processes are not included in the parameterization.

General comment:
I agree with the general comments made by Referee 1, but would like to add that while many global models indeed treat mixing state and the aging process explicitly, several global models still exist that use the time scale conversion framework. For those models a parameterization as presented in this paper would be useful, and I think that this paper can be a valuable contribution. Having this said, I do share the concern by Referee 1 regarding the limitations of the parameterization. Given that MADRID-BC does not include coagulation, I assume that it is not possibly at this point to use equation (9) as underlying aging model. However, as already requested by Referee 1, the authors should at least include an error estimate to address this limitation.

Specific comments:
p. 1265, l. 3: Description of freshly emitted BC: From single particle analysis (e.g. Toner et al., 2006) it has become evident that even freshly emitted particles usually contain coatings of OC (from lubricating oils), and hence it is misleading to say that they are "bare".

Methodology: For the calculation of the critical supersaturation for each 2D grid cell, what diameter is assumed? The mean diameter of the bin?

p. 1264, l. 24: Change sentence to: BC has been recognized as one of the most important aerosol type

p. 1266, l. 29: treat

p.1267, l. 23: add “primary” organic matter for clarification.

p. 1269, l. 13: supersaturation threshold of 0.1%: The environmental supersaturation in clouds varies widely depending on the underlying aerosol population and the cooling rate, and as such there is no “typical value”. Given that there is a strong dependence of the aging time scale on the supersaturation threshold, what is the rationale for choosing this value?

p. 1269, l. 27: change to “were conducted for one hour”

p. 1269, l. 29: The term “increase rates” is awkward. I suggest changing it to “growth rates”.

p. 1272, l. 13: “tend to have a hydrophilic nature (i.e. CCN activity)”: This is a strange sentence. I believe the authors mean that for larger particles the Kelvin effect is smaller, and hence they activate at lower environmental supersaturations.

p. 1272, l. 20: The argumentation regarding the impact of σ is unclear. Please rephrase.

p. 1274, l. 6: treat

p. 1277, l. 4: Heterogeneous hydrolysis impact: How is the heterogeneous hydrolysis treated in the model (i.e. what value for the uptake coefficient is used)?

Appendix A: The dependence of the parameterization on supersaturation threshold is interesting and I would consider this section integral to this paper. I suggest

adding this section to the main body of the manuscript instead of having an appendix.

p. 1280, equation A1: Please supply additional steps how to arrive at this equation.

References

Toner, S.M, D.A. Sodeman, K.A. Prather, Environ. Sci. Technol., 40, 3912-3921, 2006.

Interactive comment on Geosci. Model Dev. Discuss., 5, 1263, 2012.