Atmos. Chem. Phys. Discuss., 10, C199–C202, 2010
www.atmos-chem-phys-discuss.net/10/C199/2010/

Atmospheric Chemistry and Physics Discussions

Interactive comment on "Impact of brown and clear carbon on light absorption enhancement, single scatter albedo and absorption wavelength dependence of black carbon" *by* D. A. Lack and C. D. Cappa

Anonymous Referee #2

Received and published: 22 February 2010

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Review of Manuscript:
Impact of Brown and Clear Carbon on Light Absorption Enhancement, Single Scatter Albedo and Absorption Wavelength Dependence of Black Carbon
by D. Lack and C.D. Cappa

General Comments:

The authors highlight the results of Mie scattering calculations on a core-shell type particle containing a black carbon core and mildly absorbing outer layer. They examine the absorption enhancement of a mildly absorbing shell relative to one that is purely scattering with consideration for wavelength dependence and uncertainties in the imaginary refractive index of the coating material. A separate set of calculations are run to separate the effect of the "lensing" and absorption on the overall absorption enhancement of the absorbing shell. There are two main conclusion from this manuscript. The first is that the Angström exponents near unity do not necessarily imply the observation of pure black carbon, as different geometries of mixed black-carbon-brown-carbon particles can also yield such values. However, this uncertainty can be reduced with the size distribution of the black carbon core is provided. The second is that mildly absorbing coatings can possibly the absorbance enhancement predicted by black carbon particles coated by purely scattering species.

This work presents a systematic investigation of a subset of possible light absorption scenarios by black-carbon containing particles and its implications are important for the atmospheric science community. This reviewer recommends the publication of this manuscript after the following comments are addressed.

Specific comments:

1. The authors appear apologetic for using Mie calculations for large, spherical core-shell particles. It is certainly possible (and has been shown) that in some or many cases, the aggregated spherules collapse and approach an approximately spherical shape (as a limiting case) upon atmospheric processing and aging, and measurements that suggest that a significant amount of mass of black carbon in the atmosphere is above 70nm (and is not just a modeling assumption). The

manuscript would be strengthened by referencing this literature. Also, the results of Liu, Mishchenko, Arnott (2008) should be discussed to communicate potential differences in radiative properties among collapsed and uncollapsed black carbon particles, albeit in the uncoated case, to provide context for the calculations in this manuscript.

2. The authors suggest that concurrent measurements of size distribution of BC and coatings thicknesses are necessary to interpret the Angström exponent (to determine the presence of an absorbtive coating). This is a valid point, but given the uncertainties in definition, measurement, and actual morphology of BC and BC-containing particles (e.g., particles with non-spherical morphologies may require additional parameters), there should be some acknowledgement and discussion of the difficulty in executing this directive.

3. The Angström exponent analysis appears to be over-interpreted, and is presented in a way that may be over-interpreted by readers. While the authors have made a case that AAE of 1.6 is a threshold for unambiguous determination of brown carbon in their modeled system, the actual threshold may be different when interpreting measurements from field campaigns as these mixed particles may appear in different morphologies. The phrasing in section 4.5.3 (and abstract) should be re-evaluated in the context of this uncertainty.

Technical comments:

1. p. 9 line 17 - “doesn’t” -> “does not”

2. p. 19 line 10. The project is GoMACCS and the reference is missing from the reference list.

3. Fig 1. Should there not also be a scattering component in the brown carbon hemisphere?

4. Fig. 8 - Perhaps I am misreading this figure but should not the AAE along the x=y line be undefined? Also for such figures, it may be more clear to show figure with [data] aspect ratio of 1.

5. Fig. 9 - It is surprising that the AAE is not monotonically decreasing with core size for the coating/core volume ratio of 63 (third panel). Is this correct? Also, the legend is a bit confusing initially, as it is split among two panels - better to have it together off to the side?