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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

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This is a comprehensive study on the possible effects of "brown" carbon coating on absorbing aerosols' optical properties. Specifically the paper focuses on how the absorption in the shorter wavelengths reduces the enhancement of absorption due to the lensing effect which is common for non absorbing coatings. Not surprisingly it is shown that the absorption of light by the brown carbon coating becomes more and more important with increasing specific absorbance, with the incident wavelength and with the thickness of the coating. The paper also investigates the effects of internal versus ex-

ternal mixing on the single scattering albedo, showing that the wavelength dependence of the SSA cannot be simply used to deduce the presence of brown carbon coatings, as was previously thought. While the literature is well cited, I am pointing out a few of our recent studies that have addressed a few points that are related to this study, such as measurements of coated particles, values for refractive indices of brown carbon from biomass burning, pollution, diesel soot and SOA. I hope the authors will find these papers useful.

The paper uses simple core/shell Mie codes to study this fundamental issue that has significance for the absorption of solar radiation by aerosols. It is well written, easy to follow and discusses the issue very well. The paper addresses very well the readership of this journal and I recommend its publication after minor revision.

Specific points to address:

1. P4L12: aged atmospheric BC may also be coated/mixed with secondary material, not only POM.

2. P4L18: Adler et al (PNAS early edition)(Adler et al., 2009) measured recently the complex refractive indices of organic matter intrinsic to diesel soot. Dinar et al (Dinar et al., 2008) measured the complex refractive index of primary and secondary water soluble HULIS. These measurements provide additional input that can be directly used in the calculations and should be added.

3. P5L16: Adler et al estimated that the MAC of aggregate soot at 355 nm would be 13.3 m2g-1 in line of the estimation here.

4. The effects of coatings on the extinction of light has been recently studied experimentally by Lang et al as well as by (Abo Riziq et al., 2008), and results with this study can be compared.(Lang-Yona et al., 2010).

5. P7L1: add after CBrown "and layer thickness".

6. P7L22: In light of the increased absorption by brown carbon at short wavelength I

suggest that the calculations will be conducted down to 30 0nm.

7. P8L3: the values of kBrown given in Dinar et al(Dinar et al., 2008) at 390 nm are higher for primary HULIS (about 0.1) and lower for secondary HULIS (0.02). These numbers can be used in the calculation for more realistic scenarios and also for demonstrating the effects of increasing absorption on the enhancement.

8. P9L9: the discussion is mostly for thick coatings. However, thinner coatings are probably more prevalent in the atmosphere. What happens with thin coatings? What is the threshold for an effect? How does it relate to the wavelength (thin and thick would relate to the wavelength).

9. P9L22 and throughout the paper: most of the discussion is limited to calculations for a fixed wavelength (400 nm). While the general conclusions are valid, I think that in all the discussion a caveat about this fact should be added. As stated above, the behavior will be different for different wavelength because of the varying absorption and also because the ratio of the layer thickness to the incident wavelength will change. Finally, estimation for the entire solar spectrum should be done in all cases (was done in several cases) followed by discussion of the effects of coatings on the entire solar spectrum. Flores et al (Flores et al., 2009) for instance found that integrating over the entire solar spectrum, brown carbon can be treated as purely reflective material (in terms of Q extinction). Is this also correct for coatings by brown carbon? Probably not according to this paper. This is an interesting point to discuss.

10. P9L22: This phenomenon is a function of wavelength. Hence one has to discuss and study this “hyperspectrally” and the discussion should emphasize the wavelength dependence.

11. P11L3: state the wavelength of the calculation in the text.

12. P11L19: again, depends on the incident wavelength.

13. P15L4: As shown by Adler et al(Adler et al., 2009) the calculation by equivalent

volume spheroid, or aggregates gives different results depending on the size of the spherule and the overall size of the agglomerate. Adler et al suggest that the coatings should be treated in the calculation, in line with the conclusions of this paper.

14. P21L18: add “and the shell thickness” before the end of the sentence.

15. P22L5: again, the statement is probably not completely true as it will be different for short and long wavelengths.

References

Abo Riziq, A., Trainic, M., Erlick, C., Segre, E., and Rudich, Y.: Extinction efficiencies of coated absorbing aerosols measured by cavity ring down aerosol spectrometry, Atmos. Chem. Phys., in press, 2008.

Adler, G., Abo Riziq, A., Erlick, C., and Rudich, Y.: The effect of intrinsic organic carbon on the optical properties of fresh diesel soot, Proc. Natl. Acad. Sci. USA, in press, 2009.

Dinar, E., Riziq, A. A., Spindler, C., Erlick, C., Kiss, G., and Rudich, Y.: The complex refractive index of atmospheric and model humic-like substances (HULIS) retrieved by a cavity ring down aerosol spectrometer (CRD-AS), Faraday Discussions, 137, 279-295, 2008.

Flores, J. M., Trainic, M., Borrmann, S., and Rudich, Y.: Effective broadband refractive index retrieval by a white light optical particle counter, Phys. Chem. Chem. Phys., 11, 7943-7950, 2009.

Lang-Yona, N., Abo-Riziq, A., Erlick, C., Segre, E., Trainic, M., and Rudich, Y.: Interaction of internally mixed aerosols with light, Phys. Chem. Chem. Phys., 12, 21-31, 2010.

Interactive comment on Atmos. Chem. Phys. Discuss., 10, 785, 2010.