Atmos. Chem. Phys. Discuss.,
https://doi.org/10.5194/acp-2017-836-RC1, 2017

Atmospheric Chemistry and Physics Discussions

Interactive comment on "The Absorption Ångström Exponent of black carbon: from numerical aspects" *by* Chao Liu et al.

Anonymous Referee #1

Received and published: 2 November 2017

This paper systematically tested the sensitivity of the AAE of BC in three representative morphology, and point out which factors should be considered when deriving AAE from possible available measurements. Though the calculation itself is not new, but the concept and focus is scientifically important. This paper is well organized and generally well written, but in this version it reads a bit too technical, so I would recommend final publication after incorporating a bit more work, to allow this work within the scope of ACP.

Major points:

1) the most lack of this study is the authors have not calculated the AAE of BC in bulk but only for single BC particle. If I understand correctly, the authors have only given the BC lognormal size distribution, coating distribution as a guidance of size range

selection for sensitivity test, however the single BC particle calculation has not been applied in the particle distribution to work out how these calculation will influence the whole. The information in bulk may be more valuable for the ambient measurement as most of the instruments measure in bulk.

2) The particle size as called GMD in this study is a bit confusing. For the coated size, I presume this is the size as entire BC particle, i.e. the coated particle, but if we compare everything all in GMD, would the coated BC has a less content of BC core? I'm not sure how comparable are they if in a same figure. Also, given the BC has complex morphology, what is GMD, is it supposed to be volume-equivalent diameter? This is important to be clarified.

3) How the coating has been associated with BC core is not clearly presented, are they partly coated or embedded? How did you treat the coating interaction with BC? One recent study (Liu et al., 2017, DOI: 10.1038/ngeo2901) could be referenced in page 6 line 10 or page 10 line 28 etc. to support your discussion.

4) The empirical equation (equation 6) is almost all about refractive index uncertainty, and they are separately discussed for three different morphology cases. Though the refractive index has large variation from different literatures, but mostly we are using a fixed refractive index or fixed spectral dependence of refractive index, otherwise there will be no real value for anything. However the authors have not really given how the BC morphology has actually influenced AAE, such as Df value, the amount of coatings associated. These are most interested to communities who care about how the BC ageing will influence its mixing state/morphology and how the AAE will be modified by these factors.

Others: In page 6, the representation of coating thickness according to Schnaiter et al. (2005), could you point out which source of BC are they, and are they fresh BC, how long have they been aged?

Page 6 line 30 to page 7 line 10, there are many parameter assumptions which have

not been clearly explained: the100 monomers are used, so are we actually only resting one BC core size? Have we tested the sensitivity to different monomer sizes (only 30nm is used here)? Liu et al., 2015 (DOI: 10.1002/2014GL062443) point out the AAE could be sensitive to the monomer size, also give the reference you choose 30nm.

For compact BC, the Df is used as 2.8 which is nearly sphere, any reference for this value? As above, it would be useful to test the sensitivity to Df.

Page 7 line 8-16: the whole discussion here is rather confusing, you should point out what size previous instruments actually measured, the coated particle size or only BC core size, currently they are mixed up. You should point out SMPS measured mobility diameter is very sensitive to the particle shape (which is different from the volume equivalent diameter you present here), but references you referred Reddington et al., 2013; Wang et al., 2015 used the BC core size, measured by the single particle soot photometer.

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