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

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The manuscript "The absorption Angstroem exponent of black carbon from numerical aspects" by Liu, Chung and Yin (ACPD 2017, doi:10.5194/acp-2017-836) is on a very interesting topic. The authors present numerical simulations of BC properties for 3 test cases of morphology using computer-modelled soot aggregates.

The value of these results is clear; the effects of variations in BC microphysical properties on the AAE are clearly seen. However, the limitations of the results could be discussed in much more depth. I have several comments related to this:

1. The words "diameter" and "size" are used in multiple ways throughout the study. Especially when discussing the results of Schnaiter et al., with respect to coating

thicknesses of BC, the word diameter is poorly defined as it would refer only to the apparent mobility of the particles (increased by coatings but decreased by restructuring).

2. The use of a change in mobility diameter (Schaiter et al.) to infer size-dependent coating thicknesses is invalid, as noted above. As a reviewer noted, Liu et al. (Nat. Geosci 2017) should be referenced here. In any case, I am not sure of the value of this size-dependent coating thickness. Since all of the results were plotted against diameter, there is no possibility that the reader misunderstands that coating thickness depends on particle size and history. A constant volume fraction of coatings would allow a fair evaluation of the size dependence to be made. Currently the x axis of the figures (labelled GMD) reflects changes in both size and coating thickness, and is therefore difficult to interpret.

3. The number of primary particles in an aggregate was mentioned as hundreds or even thousands, but what is the most likely number?

4. (page 6) The authors might cite the previous studies which have modelled coatings on complex BC morphologies, eg Liu et al. 2016 (doi:10.1016/j.jqsrt.2015.08.005) and references therein. As the authors noted, however, no previous study discussed the AAE.

5. To what degree might the results change with different choices of monomer diameter and monomer number?

6. On page 11, lines 10-14 do not follow from the previous discussion. The authors are saying that the BC RI may change between sources, so that the AAE may not be fixed. But it has been assumed that the imaginary and real RIs are free to vary independently, which is not a justified assumption (Bond et al. 2006; Moteki et al. JAS 2010, doi:10.1016/j.jaerosci.2010.02.013). This assumption would have

led to overestimated variability in AAE. Also, this assumption was necessary to define A and B as independent in equations 4 and 5.

Also I have a couple of minor comments which were not noted by the reviewers:

- Palas soot (page 3) should be referred to as spark-generated carbon nanoparticles.
- At page 4 line 20, Moosmüller et al. (2011, doi:10.5194/acp-11-1217-2011) should be cited.
- In Section 2.2, please rewrite the discussion. It currently sounds like you are saying that an SMPS measures the diameter of volume equivalent spheres.
- On page 10, I don't understand why a linear regression (I assume of log-transformed data?) should give the best representation of the AAE if the relationship is not exponential. A linear regression of log-transformed data is not reliable even when the data follow a power-law relationship (Clauset et al., 2009, doi:10.1137/070710111)

Finally, the authors have proposed that their numerical results are a suitable absolute reference for BC properties. This is clearly not the case, as a closure between experiment and theory is still lacking (Bond et al., 2006; Radney et al., 2014). Radney et al. (2014, doi:10.1021/es4041804) is particularly relevant to this study because they have used the same T-matrix approach in combination with direct measurements of uncoated BC, yet were unable to satisfactorily model particle extinction. This shows that T-matrix models of BC aggregates should not be used to make strong conclusions on BC properties. Rather than interpret these numerical results as a comprehensive guide and absolute reference, the authors could interpret these results as a clear demonstration of the importance of various parameters on the optical properties of BC. As noted

above, I found these results to be quite interesting, because they demonstrate quantitative the theoretical impacts of changes in various properties on BC in a way that has not been done before.

References

All references were either made in the submitted manuscript or were cited using doi's. These doi's provide direct links to the articles via http://dx.doi.org

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