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Interactive comment on "Modeled source apportionment of black carbon particles coated with a light-scattering shell" *by* Aki Virkkula

Anonymous Referee #1

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The author simulated the absorption Ångström exponents of black carbon aerosol ensembles with varied particle morphologies and mixing states using the core-shell Mie model. The shapes of size distribution were presented for indicating the particle sizes of the entire BC-containing aerosol ensembles. The mixing states of coated BC particles are modeled using two morphologies: 1) particles with a BC core coated with a constant non-BC shell thickness; and 2) particles with the constant volume fractions of BC core and non-BC shell. Biomass-burning fractions were also calculated for pure and coated BC particles mixing with non-absorbing ammonium sulfate. This paper showed that the narrow size distributions result in higher absorption Ångström exponents and biomass-burning fractions than the wide size distributions. Moreover, the sensitivity of absorption Ångström exponents and biomass-burning fractions to varia-

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Discussion paper

tions in shell volume fractions is the highest for accumulation mode particles. These results are useful for this field, however, some technological issues are not clear in current manuscript and the advantages of these presented models compared to the current models should be highlighted. While you revise the paper, please take the following into consideration.

1. The method: absorption Ångström exponents of BC aerosol ensembles are calculated using two morphological models. The diversities of BC optical calculations between these two models are suggested to be investigated in this study. For a single BC aerosol ensemble, it can be described by these two models with the same volume-equivalent BC core size, non-BC shell size or the other parameters (as a single core-shell model). The same number-weighted Dp-to-Dcore ratio may also be a good option. The current comparison in Figure 2 showed the trend rather than the diversity. Moreover, the better model can also be supported by the observations.

2. In Section 3.2, the first and second maximum of BC absorption Ångström exponents is presented when a size-independent shell grows on a BC core. This point is useful, however, it seems like that the volume-equivalent BC core size and non-BC shell size of the cases are different. This presented variation was corresponding to the BC-containing particles with larger BC core size and smaller BC volume fraction. The situations may also be reproduced by those single particles with the same volume-equivalent BC core sizes and non-BC shell sizes.

3. Figure 7, the absorption properties of the single particles generally showed the similar non-monotonous variations with growing particle sizes. The assumption of the same BC volume fractions for all particles may also be simplified by the single core-shell model with the volume-equivalent BC core sizes and non-BC shell sizes.

4. The absorption Ångström exponent is an important indicator for the particle sizes and mixing states of black carbon aerosols. The simulations of the absorption Ångström exponent between 470nm and 950nm can be validated by the measure-

ments of AE33. Moreover, the other wavelength couples can also be simulated and compared to the observations. For example, the absorption Ångström exponent between 440nm and 870nm at all AERONET sites (Schuster et al., 2016).

5. Please check the acronym. For example, Line 19 of Page 3, Dc and Dcore may be the same. Define all the acronym in a list if possible, because they are confusing.

6. Please check the writing errors in current manuscript. For example, Line 19 of Page 6, 'thicnesses' may be 'thicknesses'.

Reference Schuster G L, Dubovik O, Arola A, et al. Remote sensing of soot carbon-Part 2: understanding the absorption Ångström exponent. Atmos Chem Phys 2016; 16(3): 1587-1602.

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