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Interactive comment on "Effects of black carbon morphology on the brown carbon absorption estimation: from numerical aspects" *by* Jie Luo et al.

Anonymous Referee #2

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This paper presents results from numerical experiments aimed at exploring the bias in quantifying BrC absorption based on methods that do not account for complex BC morphology. The experiments involve constructing BC/BrC particles with complex morphologies and employing 3 AAE attribution methods to retrieve BrC absorption. As expected, the numerical experiments show deviation between "true" and retrieved BrC absorption.

Major comments:

1) The fact that AAE attribution methods or assuming spherical particles (i.e. Mie calculations) lead to bias in attributing measured absorption to BC and BrC is well

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known. However, there is a reason why these approximations are employed, which is that it is not possible (or at least not feasible) to account for the complex mixing state and morphology of atmospheric aerosols. It is not clear that utilizing a detailed optical model (e.g. DDA) that does not accurately represent the mixing state and morphology would do enough of a better job than simplified (e.g. Mie) calculations to justify its use in interpreting ambient observations and/or in large-scale models.

Put in other words, utilizing detailed optical models requires single-particle level knowledge of mixing state and morphology, which is not currently feasible. The examples given in the paragraph starting at Line 272 are not enough to provide such information. If one uses these types of measurements, they'll end up with a situation where they have to assume some sort of "average" population morphology based on a parameterization similar to Equation (3) – it is not clear that such an exercise would substantially improve the representation of reality compared to the AAE attribution or Mie calculations.

The results in this paper (e.g. in Figure 3) are specific to the parameters employed in the numerical experiments and cannot be generalized in any quantitative sense to help interpret real measurements. Therefore, the paper in its current form does not tell us more than what we already know, which is that simplified methods can lead to uncertainty in BrC / BC absorption. For this paper to make an impact, it needs to make a convincing case that employing their complex morphologies in atmospheric retrievals provides improvements compared to the simplified methods. Or it needs to provide useful information that can be utilized to quantify the uncertainty associated with the simplified methods.

2) Along the same lines, there is no justification as to the choice of "true" mixing states / morphologies and how representative they are of atmospheric aerosols. To play devil's advocate, for some of the "true" mixing states / morphologies, there is very good agreement between the true and simplified cases – what if those are the most representative of atmospheric aerosols? In this case, sticking to the current simplified approaches is

good enough.

3) The choice of optical models in the study is not well justified. Why is MSTM used for externally mixed particles and DDA for internally mixed particles? For the reader to be convinced of the validity of the outputs of these models, they need to be validated against each other and against Mie calculations. The authors need to show that for spherical homogeneous particles and spherical core-shell particles, MSTM, DDA, and Mie calculations yield the same absorption cross-sections.

4) For this paper to be publishable, it requires substantial language editing. There are many instances of misuse of articles, inappropriate word choice, and incoherent sentence structure.

Specific comments:

1) Figure 1: This figure is confusing. As referenced in the text, it is supposed to be an overview of the method, but I don't think it accomplishes this goal.

2) Line 21: estimation of BrC what?

3) Line 75: well mixed is not appropriate here as it usually refers to the case where the components do not form separate phases. Since lensing is mentioned, here the authors refer to core-shell morphology, which has 2 separate phases and is not well mixed.

4) Line 165-167: MSTM and Mie calculations should produce the exact same results for spherical particles. This should actually be done to validate MSTM – if it deviates from Mie for spherical, the results for non-spherical cannot be trusted.

5) Line 174: Here you mention that WDA is calculated based on Mie theory, but earlier (Line 166) you state that MSTM was used in the calculations.

6) Line 183: this is not uncertainty (though uncertainty exists) but real variability in optical properties due to variability is BrC chemical composition. Using "suffer" is not

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appropriate here since it is actual variability.

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