

Review Comments for “Effects of brown coatings on the absorption enhancement of black carbon: a numerical investigation” by Luo et al.

The topic of black carbon (BC) absorption enhancement has been investigated by numerous previous modeling/lab/field studies. The present manuscript systematically quantified the effects of brown carbon coating and associated morphological properties on BC absorption enhancement and proposed a “sunglasses effect”, which provides some new understanding in this topic. This study is suitable for ACP and its structure is clear. Before it can be considered for publication, I have a few comments and suggestions to help improve the manuscript.

1. Abstract: The authors mentioned “thickly-coated” and “thinly-coated” here. How thick is “thickly-coated”? Please quantitatively define it here and in the main text as well.
2. Abstract (Lines 11-12): “the uncertainties ... have differences of less than 2.6% and 6% ...”. The expression “uncertainties have differences ...” is weird. Please rephrase this sentence.
3. Page 1, Line 20: “second contribution” should be “second contributor”. The reference for this sentence should also include Bond et al., 2013 (JGR).
4. Introduction: The authors mentioned that BC absorption enhancement varies significantly in different field measurements, which could be due to complex morphology and mixing state during BC aging processes. But one missing part is the evidence for the complex BC morphology and mixing state observed in field measurements (e.g., *Y. Wang et al.* 2017, doi:10.1021/acs.estlett.7b00418; *S. China et al.* 2013, doi:10.1038/ncomms3122). I suggest including several sentences in the introduction to point out this aspect.
5. Page 4, Lines 8-10: Using D_f values to define “thickly-coated” and “thinly-coated” BC is not straightforward. Why not use the coating thickness or mass directly? There may be some situations where D_f is smaller than 2.6, but the coating is still more than that of BC with a relatively higher D_f .
6. Page 5, Lines 6-10: Recently, another important and efficient particle light-scattering method, the geometric-optics surface-wave (GOS) method (*Liou et al.* 2011, doi.org/10.1016/j.jqsrt.2011.03.007; *C. He et al.* 2016, doi.org/10.1016/j.jqsrt.2016.08.004), has also been developed and applied to resolve complex BC coating structures and showed consistent results with MSTM, which could be included here.
7. Page 6, Lines 13-14: The authors assumed BrC coatings are uniformly distributed over the BC surface, but they also argued that the blocking effect of coating is important, which could be affected by how coating materials are distributed over BC particle surface. Thus, assuming the uniform distribution of BrC coating may lead to nontrivial biases in calculations. Could the authors comment or add some discussions on this?
8. Page 7, Lines 11-12: “Generally, E_{abs} increases ... with increasing k_{BrC} .” Is this true for all wavelengths? Please clarify here.

9. Page 7, Lines 16-17: "... compared with BC with non-absorbing coatings, Eabs for thinly-coated BC with absorbing coatings seems to be less wavelength-dependent, ...". This is interesting but a little counter-intuitive. Could the authors provide some explanations?

10. Section 3: The authors highlighted two important but opposite effects: conventional lensing effect and sunglasses effect. It is interesting to see how these two effects vary with k_{BrC} , D_f , and wavelength. Since the authors already calculated the absorption due to these two effects, it is straightforward to calculate the contributions of these two effects to the total absorption enhancement. This would be very informative and worth discussing. Also, according to the authors' arguments, there should be one critical point (or critical k_{BrC} value) for the two effects to be the same. It would be very interesting to see what this point/value is.

11. Page 8, Line 19: "shorter wavelength". Please give a more quantitative wavelength range.

12. Page 8, Line 15 (and elsewhere): "relative errors". I suggest using "relative uncertainty" instead of "error".

13. Page 12, Line 1: "combined of Eabs ...". Should it be "combining Eabs ..."?

14. Section 4: Could the authors add some discussions on how to apply their results in this study to climate models? Current climate models do not simulate any morphological information of aerosols and generally assume a core-shell structure or external mixing for aerosols.