

## ***Interactive comment on “Effects of brown coatings on the absorption enhancement of black carbon: a numerical investigation” by Jie Luo et al.***

### **Anonymous Referee #2**

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Black carbon (BC) particles mixing with brown carbon (BrC) coatings are simulated by two morphologies, including: thinly and thickly coated states. Light absorption properties of BC-containing particles are calculated using the superposition T-matrix method. The sensitivity of the imaginary part of BrC refractive index on the light absorption is investigated for the realizations with the aerosol ensembles. The authors showed some interesting results, but the effects they presented are not clear and the simulations are not validated by the measurements. While you revise the paper, please take the following into consideration.

1. In this study, the absorption enhancement, lensing effect, blocking effect, sunglasses

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effect, and strengthening effect are discussed, but they are confused. In the previous studies, e.g. Liu (2017), “lensing effect is that the addition of non-black-carbon materials to black-carbon particles may enhance the particles’ light absorption by 50 to 60% by refracting and reflecting light”. The clear definitions of these effects are important, because brown coating also absorbs solar radiation itself. In Equation (3), the effect of brown coating on absorption enhancement is not considered, and may generate an unreasonable Eabs value, such as 5.4 (Line 5 in abstract). It would more appropriate to compare the absorption of BC coated by BrC with an external mixture of BrC and BC, rather than bare BC alone. In Equation (4), how to calculate far-field results of Cabs\_brc (total\_size) and Cabs\_brc (bare\_size) in the BC-BrC mixtures, and do you considered the complex morphologies of BrC in ‘total size’ cases? In bare BC, the BrC coating may be not exist. The ‘lensing effect’ is widely used in the climate studies, thus, Equation (5) may be potentially misleading. It is necessary to clearly explain these effects.

Referece: Liu, Dantong, et al. "Black-carbon absorption enhancement in the atmosphere determined by particle mixing state." Nature Geoscience 10.3 (2017): 184.

2. Line25-27, Page 2. “Nevertheless, in the atmosphere, there is a type of organic carbon that absorbs the radiation in the range of the ultraviolet and visible spectra, which is known well as brown carbon (BrC); BC can also be mixed with BrC.” Please give the references about the morphologies and mixing states of BC-BrC mixtures to support this simulation.

3. In Section 3.2 Bulk radiative properties, it is suggested to estimate the absorption enhancements of BC aerosols by the mass absorption cross section (MAC) rather than the cross section (Cabs), because of the normalization of BC mass. Moreover, the simulations of MAC can be validated by the previous measurements.

4. In the abstract, please define the ‘Cabs’, ‘KBrC’ before use them.

5. In Figure 6, 7 and 11, the range of color bar is suggested to be unified.

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