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***Interactive comment on “Impact of brown and clear carbon on light absorption enhancement, single scatter albedo and absorption wavelength dependence of black carbon” by D. A. Lack and C. D. Cappa***

**Anonymous Referee #3**

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The manuscript represents an important contribution to our general understanding of the role of brown carbon in the atmosphere. This aspect – to the best of my knowledge – has never been exploited so comprehensively. The main findings convey both good and bad news for the atmospheric modelling community. The good news is that the selection of the internal/external mixture for atmospheric BC is perhaps less critical than previously thought. The bad news is that the overly simplified approach that identifies brown carbon from ambient AAE measurements (by assigning AAE values greater than unity to brown carbon) is basically wrong, and there is no single and simple

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method for that. Furthermore, then manuscript introduces a more realistic schematic representation for physical forms of BC: the core-with-slightly-absorbing-shell model. Since brown carbon is likely emitted with BC in biomass burning, and it consists of low volatility species, it is likely that BC will acquire an absorbing shell relatively fast in biomass burning plumes. Cloud processes may later reduce the absorptivity of the shell by depositing inorganic compounds. Thus a slightly absorbing shell is a more reasonable assumption for ambient BC particles than purely scattering shell can be. It is also important to stress that the concept introduced by the authors is tested against a wide range of parameters.

The authors devote much of their efforts into separating the lensing effects and the absorption of the shell. This introduces substantial uncertainty and even bias to their calculations. An important question arises in connection with the basic assumption supporting this separation (Page 791, line 27-28): is it really so that the absorption by brown carbon shell is exactly the same on a purely scattering core as on black carbon? Basic optics implies that the two should be different: absorption must be higher in shells surrounding a scattering core, since scattered radiation can again be captured by the shell, which is not the case for a shell above highly absorbing black core. If the basic assumption is not true, it will essentially invalidate the entire concept of 'remaining absorption' (e.g. page 792, line 9) to which a substantial part is devoted in the manuscript.

The manuscript focuses on what may happen with absorption when a transparent shell is replaced with a slightly absorbing one. From modellers' perspective, it is the overall absorption that matters, i.e. there is little interest in how much absorption is lost relative to a hypothetical case. A more interesting issue would be to see what happens in the model case (slightly absorbing shell on BC core) relative to the case in which brown carbon and BC is treated separately (as an external mixture). Nevertheless, this manuscript is one of the first attempts to introduce the concept of brown carbon to the modelling community.

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Minor comments: Figure 1 I would have also indicated 'scattered light' on the right half-panel of the figure (brown carbon case)

Page 798 line 5 typing error

Page 801 line 7 typing error

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Interactive comment on Atmos. Chem. Phys. Discuss., 10, 785, 2010.

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