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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Exploring the observational constraints on the simulation of brown carbon" *by* Xuan Wang et al.

Anonymous Referee #2

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General comments

The paper of "Exploring the observational constraints on the simulation of brown Carbon" investigates the optical properties and DRE of BrC using GEOS-Chem model coupled with RRTMG model. They applied a photochemical scheme in the model to address the aging effect of BrC absorption and tested it against BrC absorption measurements from two aircraft campaigns. This study aims to "explore how assumptions for BrC sources, processing, and properties impacts the comparisons with these observational constraints and estimate the resulting global direct radiative effect of BrC under these conditions". While the authors addresses the topics listed in the paper, it is not immediately clear how significant the results actually are.

First, they need more constraints from observations near sources in addition to the

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aircraft campaigns used in the study to test the photochemically whitening process for BrC absorption. Detailed comparison between Modified_Age and Modified_Simple should be provided to show the necessity and advantage of this aging scheme.

Second, the authors argued "DRE of BrC has been overestimated previously due to the lack of observational constraints from direct measurements and omission of the effects of photochemical whitening". However, they ignored some studies, which do not include this aging effect but show low DRE of BrC. For example, Hammer et at. (2016) estimated DRE of 0.03 W m2 for BrC constrained by OMI UVAI values, which is even lower than the result in this work (doi:10.5194/acp-16-2507-2016). Comparison with such studies may help to understand the factors contributing to the uncertainties in BrC absorption and to verify this aging scheme.

Finally, the MAC and the subsequently whitening process are strongly affected by the fraction of BrC associated with biomass burning. The authors assumed that the optical properties for biomass burning SOA are the same as those for biomass burning POA. But such assumption contradicts with their earlier statement that SOA is not absorber, at least not a significant absorber. Thus they may overestimate the fraction of BrC and underestimate the MAC for biomass buring OA.

In summary, this paper is well written and is easy to follow along. Its topic fits ACP and it is worthy of publication in ACP subject to addressing these and specific comments below.

Specific Comments

p. 1, line 23-24, the AAE is not constrained from absorption measurement

p. 2, line 10-11, as stated above, there are also studies with low DRE of BrC

p.4, line 28-30, the factor converting extract absorption to aerosol absorption is a function of aerosol size distribution. Is the factor of 2 consistent with the model assumption of OA size distribution in this study?

p.7, line 15, what is the density of OA used in the model? Will the assumption of the GMD of OA strongly affect its MAC?

p.8, line 16, from biomass burning and biofuel

p.9, line 24-25, high CH3CN and high CH3CN-OA may be due to the transport of plumes mixed with biomass burning and other sources. More evidence (e.g. enhancement ratio CH3CN/CO) is needed to support the conclusion of little contribution from sources other than biomass burning.

p. 10, line 2-3, the difference between 145% and 36% is $\sim$ 110%, not 80%

p.10, line 7-8, although lower than 0.03, the BC/OA of 0.027 should be still within the uncertainty range of biomass burning emission ratios

p. 10, line 29-30, only biomass burning OA is increased in FixBB. This won't affect the estimation of BrC absorption, but overestimates its contribution to total AAOD (the analysis in Sec. 5) as BC mass is still underestimated.

p. 14, line 17-18, the peak in the middle troposphere from SEAC4RS is not reproduced

p. 15, line 25, any explanation for high BrC absorption contribution in NA and Russia? The discrepancy between model and the observation is large as seen from the figure.

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