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Comment on acp-2021-49

Anonymous Referee #2

Referee comment on "Rapid transformation of ambient absorbing aerosols from West African biomass burning" by Huihui Wu et al., Atmos. Chem. Phys. Discuss., https://doi.org/10.5194/acp-2021-49-RC2, 2021

This manuscript by Wu et al. presents aircraft measurements of ageing smoke plumes of agricultural and savannah flaming fires in the Senegal region. The measurements characterized the evolution of size distributions, chemical composition, and light-absorption properties of the aerosol emissions for plume ages up to 12 hours. The major findings include (1) observed significant chemical transformation of the organic aerosol (OA) but without increase in OA loading, which is attributed to a combination of primary OA oxidation, secondary OA formation, and primary OA evaporation due to dilution; and (2) increase in brown carbon absorption with atmospheric age. The paper is well-written and is a valuable contribution to the atmospheric chemistry literature. I have just one major comment on the optical calculations, detailed below.

Major comment:

The use of different models to calculate MAC values and derive BrC contribution to absorption does not seem to add useful insight to the analysis and conclusions regarding the evolution of BrC absorption in the plumes. With absence of detailed information on particle morphology and actual MAC_BC, there is a lot of uncertainty that goes into these MAC calculations. (1) The calculations are based on the assumption that MAC_BC = 7.5 m2/g at 550 nm applies to the measurements in this study. This alone can lead to substantial uncertainty. Any over/underestimation in BC mass concentration measurements and/or over/underestimation in light-absorption measurements would lead to misattribution of absorption enhancement to lensing and/or BrC absorption. (2) It is not clear that the experimental conditions on which the empirical models (Liu, Wu, Chak) were based apply to the aerosol in this study.

The message on the evolution of BrC absorption with plume age, which I believe is an interesting one, can be delivered more cleanly by just relying on MAC_measured_BC and AAE. Instead of Figure 6 (which is a bit hard to follow), I would add another panel to Figure 5 that shows box plots of MAC_measured_BC at different ages.

As for BrC contribution, I believe that the simple AAE attribution method (with absence of detailed information to allow more involved modeling) is the best that could be done. In fact, the AAE method seems to yield more reasonable results (in terms of wavelength-dependence of fractional BrC absorption) than the modeling methods which show very weak wavelength-dependence of fractional BrC absorption.

Specific comments:

Line 169: the statement about inverting the SMPS data is not clear.

Line 224: It is not clear why modeled MAC instead of B_Abs was used to calculate AAE.

Line 233: replace "some" with a number (more quantitative).

Line 234: what is the assumption that the plumes are less than 0.5 hours old based on?

Line 321: add "aerosol" after "secondary organic".