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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Laboratory studies of fresh and aged biomass burning aerosols emitted from east African biomass fuels – Part 1 – Optical properties" *by* Damon M. Smith et al.

Anonymous Referee #2

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This manuscript presents measurements of single scattering albedo (SSA) of size-selected aerosols emitted from controlled combustion of African biomass fuels under three conditions: fresh emissions, dark aged aerosols and photo-chemically aged aerosols. Three types of wood fuels were combusted in a tube furnace at two different temperatures (500 C and 800 C) and an indoor smog chamber was used to age aerosols in clean and polluted (VOC rich) environments. The authors claim that the significance of their work lies in providing optical and chemical characterization of a previous unstudied group of fuels that contribute significantly to aerosol emissions in Africa. However, there are no novel findings reported in this study and claims of significance are greatly overstated. While the particular fuels in this study might not have been

characterized, there is a robust body of literature regarding the effect of combustion conditions on optical properties of emitted aerosols in controlled (example: Chen and Bond, 2010, ACP; Saleh et al., 2018, ES&T) as well as representative household use (Roden et al., 2006, ES&T; Chen et al., 2012, ES&T) settings. This study was limited by a lack of chemical characterization and SSA measurements limited to mid-visible wavelengths, and therefore could only reiterate the well-known effect of combustion temperature on absorption efficiency. The aging experiments show that both dark and photochemical aging reduce the absorption efficiency of size-selected aerosols (photochemical more so than dark) but no chemical properties were measured to illuminate the mechanism of absorption loss. Further, the aging results are only presented for 500 C aerosols because (Line 471): "Therefore, due to the very low number concentration and highly absorbing nature of the particles, the scattering coefficient at 800 C was below the detection limit of our nephelometer during the aging experiments." The authors propose that future studies will include these missing measurements (performed by increasing the amount of fuel burnt) but I am puzzled why these changes were not made for this study. There are similar problems with aging experiments in a polluted environment (Line 505: "This is because we took our measurements after 12 hours of aging, which seems long enough to characterize the impact of the added VOC due to aging in UV. This fact suggests that a more carefully controlled study is needed to accurately simulate the impact of urban pollution on aerosol single scattering albedo") that indicate that the authors did not rigorously handle their motivating hypotheses, leaving glaring holes in their manuscript.

Aside from concerns about significance and study design, there are significant issues in how the manuscript is presented. Instances of grammatical errors and confusing sentence construction are far too many to enumerate but more importantly, several arguments/claims are not supported by findings in this study or citations from literature. The authors establish that the fuels studied here are household fuels and acknowledge the potential differences between typical household use and controlled burning. They do not present any discussion of how findings from controlled combustion can be ex-

tended to a more realistic condition: this undermines the purported importance of their findings. Further, they designate their 800 C burn condition as flaming (a reasonable assumption) and 500 C burn as smoldering (which is much higher than smoldering temperatures in literature). These assumptions are not substantiated with any further evidence. The SSA values reported for smoldering appear too low for pure smoldering combustion (eg. - those in Sumlin et al., 2018, JQSRT) and I am not convinced that the authors ensured that they are not from mixed combustion conditions. Line 415 (comparing SSA values here with previous studies) states: "This could explain why our SSA calculations for BrC was lower than expected". All measurements in this study are for total aerosols, BrC is mentioned without any justification. Many hypotheses are presented for the aging observations however the study was not conducted in a way that allows any plausible claims about "night-time formation or aromatic nitrogen containing compounds", for example. SOA formation is presented as a hypothesis for SSA reduction (Line 492) during photochemical aging but fragmentation of absorbing aerosols is not considered. Finally, the choice of figure type for representing the results in figures 4, 6 and 7 is baffling to me: why are SSA values plotted over this very narrow range of wavelengths? Clearly, no wavelength dependence can be seen between 500 and 570 nm. I fail to see the purpose of multiple figures that contain a series of zigzagging flat lines.

Overall, a lot of more thought is needed in designing experiments and choosing the type of measurements needed to answer important questions about the chemical and optical properties of African biomass fuels. A lot more care in presenting those findings and placing them in context of recent studies is also required.

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