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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Parameterization of Single Scattering Albedo (SSA) and Absorption Angstrom Exponent (AAE) with EC/OC for Aerosol Emissions from Biomass Burning" *by* Rudra P. Pokhrel et al.

Anonymous Referee #1

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The paper by Pokhrel et al. summarizes measurements of optical properties, namely SSA at 405 nm, 532, and 660 nm and the angstrom exponent of absorption, of biomass burning aerosol formed in the lab. They provide parameterization of these properties as a function of EC/OC or EC/(OC+EC) and demonstrate how such parameterizations are more robust compared to the parameterizations against modified combustion efficiency (MCE) for a variety of biomass fuels and burn conditions. The concept that brown carbon concentration emitted in fires can be related to BC/OA has already been put forth, and so it's not surprising to have correlations between SSA and EC/OC since these parameters are all related. The uniqueness of the paper is in determining the

SSA/AAE for the different samples and to determine the new parameterizations that are more robust when EC and OC are readily available. I support publishing the manuscript after the following comments are addressed.

Holistic comments:

Which parameter is more easily and accurately available for fires on regional and global scales? MCE or the amount of BC and BB OC (or OA)? Since OA/CO ratios for fires are quite variable and hard to predict in models, which SSA parameterization would then lead to the least uncertainty in the radiative effects of wildfire aerosols? See also my specific comment below.

MCE, EC/OC, and EC/(OC+EC) all have uncertainties/errors associated with them, so the fits are more appropriate if they're ODR with uncertainties as weights of the fit and not least-square linear regression lines as is done throughout the paper. (This is the main reason for my rating of the paper as 'major' revisions since all the figures, tables, and numbers in the text are to be updated accordingly).

Other specific comments: P4, L8: The authors discuss possible evaporation of semi-volatile components after sample dilution, but another factor is temperature differences in the relatively long sampling line. What was the temperature of the sampling lines kept at? If it wasn't controlled, how does this temperature difference impact redistribution of semi-volatile components of aerosols?

P4, L28: How is the response of activated carbon monolith to gaseous organic species? Could this sample treatment introduce negative artifacts in organic aerosols?

P5, L27: What does 'excess' extinction and absorption mean? I'm not sure how SSA/AAE for stack burns in calculated- I thought it should be just based on average values of abs and ext, but not sure what summing up the 'excess' amounts mean.

P6, Section 3.1: I agree that the data suggest EC/OC ratios are more variable for a given fuel than MCE and therefore relationships of optical properties with EC/OC

are more robust. Can the authors elaborate on what specifically changes in the 'burn condition' that leads to such variability in aerosol characteristic? Is the different in the water content of the fuel or the starting temperature of the fire, etc. etc?

P9, Section 3.4: Can you perform a simple calculation to estimate instantaneous TOA forcing difference of BB aerosol depending on the choice of SSA (new vs. old parameterization) so readers get an idea about the magnitude of the change in forcing? This calculation should be done considering the uncertainties in MCE, EC/OC (or EC/(OA+EC)) and SSA.

P9, L19: I'm confused by the statement "While climate models may not directly parameterize optical properties based on EC/OC, the parameterization provides a good sanity check of model schemes to predict optical properties." If models have EC/OC data to do this sanity check, do the authors not recommend the modelers to use this parameterization instead of other estimates? If yes, I think the sentence needs to be rephrased. If not, elaborate why this shouldn't be the recommended approach.

P10, line 16-18: I do understand that the average SSA of peat burning aerosol is lower, but given the uncertainty for the SSA values, the difference at 532 nm vs. 405 nm is not really significant. The relatively high AAE is more convincing for the presence of BrC in peat burning. What is the uncertainty in AAE for this sample? Add that value as well.

P10, L 30: I question the assumption of PM2.5 in a fire being composed of only BC and OM. In most fires, there could also be aerosol nitrate and chloride. How does the ratio of EC/(EC+OC), and therefore, estimate of SSA change if say 5-15% of PM2.5 is assumed to be inorganics? Also, looking at Table 3 in Yokelson et al., ACP 2009, there were direct PM1-OM measurements. Why not use that measure of OM when calculating OC?

Additionally, BC and EC are not necessarily presenting the same type of species. Can you reference papers that perform both measurements on a series of burned fuels and

comment on the 'goodness' of this assumption and how it will impact the predicted SSA?

Minor comments:

Page 2, L7: primary OA=POA

Page 3, L16: 'effectiveness of our . . .'

P7, L 3-4: "At high MCE, AAE is $\sim$1 because BC absorption proportional to frequency" incomplete sentence. Also, by frequency, do you mean 'wavelength'?

P7, L4-5: should clarify that low MCE burns give high SSA at long wavelengths, since in the following sentences it's mentioned that the OA in low MCE burns is highly absorbing as BrC.

P9, L 13: consider ". . ..how significant of an impact. . ."

P9, L18: during . . .? Incomplete sentence

P 10. Indonesian Peak section should be 3.6

P10, L6: What's the explanation for the parameterization not capturing the measured SSA in plumes with lower SSA? Also, tart the sentence with "However" instead of "But", or combine the two sentences

P10, line 21-22: Rephrase the sentence, sounds like summary bullets and not a complete sentence.

P11, line 27: When giving the range of SSA, separate it for 405 nm vs. 660 nm.

P12, Line 5-6: Indicate again the errors bars for SSA of peat aerosol at 405 nm and longer wavelengths as well as the error bar for AAE.

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