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Reply on RC2

Biao Luo et al.

Author comment on "Parameterizations of size distribution and refractive index of biomass burning organic aerosol with black carbon content" by Biao Luo et al., Atmos. Chem. Phys. Discuss., https://doi.org/10.5194/acp-2022-192-AC2, 2022

Responses to anonymous referee #2 General comments:

Comment: Abstract is too detailed and technical. I strongly recommend to re-organize the abstract, summarizing the most fundamental findings and leaving details for main text and conclusions.

Response: Many thanks, we agree with the reviewer, and the abstract is revised as the following:

"Biomass burning organic aerosol (BBOA) impacts significantly on climate directly through scattering and absorbing solar radiation and indirectly through acting as cloud condensation nuclei. However, fundamental parameters in the simulation of BBOA radiative effects and cloud activities such as size distribution and refractive index remain poorly parameterized in models. In this study, biomass burning events with high combustion efficiency characterized by high black carbon (BC) to BBOA ratio (0.22 on average) were frequently observed during autumn in the Pearl River Delta region, China. An improved absorption Ångström exponent (AAE) ratio method considering both variations and spectral dependence of black carbon AAE was proposed to differentiate brown carbon (BrC) absorptions from total aerosol absorptions. BBOA size distributions, mass scattering and absorption efficiency were retrieved based on the changes in aerosol number size distribution, scattering coefficients and derived BrC absorptions that occurred with BBOA spikes. Geometric mean diameter of BBOA volume size distribution D_{gv} depended largely on combustion conditions, ranging from 245 to 505 nm, and a linear relationship between D_{gv} and ΔBC/ΔBBOA was achieved. Retrieved real part of BBOA refractive index ranges from 1.47 to 1.64, with evidences showing that its variations might depend largely on combustion efficiency, which is rarely investigated in existing literatures however requires further comprehensive investigations. Retrieved imaginary parts of BBOA refractive index ($m_{i,BBOA}$) correlated highly with ΔBC/ΔBBOA (R>0.88) but differ much with previous parameterization schemes. The reason behind the inconsistency might be that single formula parameterizations of $m_{i,BBOA}$ over the whole BC/BBOA range were used in previous studies which might deviate substantially for specific BC/BBOA ranges. Thus, a new scheme that parameterize wavelength-dependent $m_{i,BBOA}$ was presented, which filled the gap for field-based BBOA absorptivity paramterizations of BC/BBOA>0.1. These findings have significant implications for simulating BBOA climate effects and suggest that linking both BBOA refractive index and BBOA volume size dsitrbutions to BC content might be a feasible and a good choice for climate models."

Comment: The application of PMF to AMS data should be better described: neither in the main text nor in the supplementary it is described in any way other than by presenting its resulting chosen solution (profiles and time-series of the factors). Not even in the manuscript already published (referred to in P7, L185-186) there is a detailed description of the procedure used to determine the PMF solution presented (no info on choosing the best number of factors, on diagnostics of the statistical model, on the interpretation of the factors, etc.). Considering that all the other elaborations made in the present manuscript are based on the determination of the BBOA factor, I believe that a broader discussion of the PMF approach and of the robustness of the solution is necessary.

Response: We agree with the reviewer that these information should be included in the supplement for reader's convenience considering that all the other elaborations made in the present manuscript are based on the determination of the BBOA factor. In the revised manuscript, the section "determination of PMF factors from SP-AMS measurements" was added as Sect S1.1. In this section, information on choosing the best number of factors, on diagnostics of the statistical model, on the interpretation of the factors were added, as well as profiles and time-series of those factors.

Technical comments:

Comment: P6, L154-155: unclear and perhaps grammatically incorrect sentence, please rephrase.

Response: This sentence is revised as:

"However, aerosol absorption values measured by AE33 bear uncertainties associated with loading and multiple scattering effects."

Comment: P6, L158: "babs" in the equation should be subscript.

Response: corrected.

Comment: Consistency between main text and supplementary should be better checked and the Supplementary should be reorganized accordingly. In particular:

-the order of the supplementary sections should follow the main text order: for instance, SP-AMS PMF results (in Sect. S2) should go before the modelling methods (Sect. S1).

-Some Supplementary Figures are not well presented: for instance, in the legend of Fig.

S1b is not possible to differentiate the dashed lines and so to understand what the

different lines in the graph are representing.

-In the text of Supplementary (at L116) there is a figure referenced as Fig.Sx.

More inconsistencies can be present and should be checked.

Response: Many thanks for the suggestion, we have reorganized the supplement and put PMF analysis of SP-AMS measurements in Sect. S1.1 of the manuscript, and made the method part follow the main text order. The legend of the original Fig.S1b is modified and easy to differentiate, the Fig.Sx is also corrected and we have scrutinized the manuscript and the supplement to avoid inconsistencies.