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Comment on acp-2022-618

Anonymous Referee #1

Referee comment on "Impacts of biomass burning and photochemical processing on the light absorption of brown carbon in the southeastern Tibetan Plateau" by Jie Tian et al., Atmos. Chem. Phys. Discuss., https://doi.org/10.5194/acp-2022-618-RC1, 2022

This paper reports on measurements of spectrally resolved particle light absorption combined with aerosol chemical composition measured at the southeastern edge of the Tibetan Plateau. The particle light absorption data are used to infer BrC and BC levels. Based on the chemical signatures the aerosol was divided into two groups and the BrC optical properties were determined for each group. Overall radiative effects of the BrC relative to BC on a per particle mass basis showed that BrC has an important role. Back trajectory analysis was used to identify source regions of the BrC. The paper is well suited for publication in this journal. The authors consider uncertainty in their approach to determine BrC, which is a nice feature of this paper. A number of suggestions for further analysis and clarifications are noted below.

General Comments:

Some of the methods description may be too detailed, such as the HERM algorithm description. A plainer language description would be better. Eg, line 128 and on describing Eq(3). First, this is a classic inversion problem encountered for many instruments in aerosol science (and many other fields). My understanding is that X is the measured ACSM mass spectra of the organic species, (why call it the receptor site?), G is the source contributions, which is what is you are trying to determine, and F is the mass spectra of the specific sources. Normally one knows F and performs the inversion to solve for G. In this case F is unknown, so a modified approach is used. This can then be described.

A major possible issue is the characterization of the two sources identified by the source apportionment discussed above. Despite the complicated inversion, it seems the separation of source comes down to two things, the po-OOA source characterized by m/z 44 (which seems similar to MO-OOA in other studies using this instrument, see discussion below), and m/z 60 the fragments of levoglucosan and other carbohydrates known to be

emitted primarily from biomass combustion (and cooking, but which is not discussed here). The issue is one way to interpret these source apportionment results is that both are from biomass burning, BBOA is the possibly fresher or less photochemically processed BBOA and po-OOA are more aged and chemically processed BBOA. To me, this clarifies the data interpretation and is supported by the idea that both have the same source region and that they are correlated (line 262, r=0.63). However, arguing against this is that the MACs are higher for po-OOA which one would not be expect if this was more aged and possibly more photochemically bleached relative to the fresher or less processed (less bleached) BBOA.

Specific Comments:

When discussing Eq(1), might want to say something about how well a power law fits data.

Where does the term for one of the identified sources(po-OOA) come from. Has it been used before or is it being introduced here? Essentially, it seems to be driven by mass spectral peak at m/z 44, which is carboxylic acid fragment and which in past studies of ACSM/AMS is largely indicative of more aged oxygenated organic aerosol from various sources. Why not discuss this (ie, how that peak is determined in other studies and why a different name is used here).

In the back trajectory analysis, one could test the sensitivity to the assumed starting height of 500 m by varying this parameter over some range and see if the predicted trajectories change much?

In the calculation of SFE, one might also do a sensitivity test on the assumed variables, possibly most importantly the albedo (also what type of ground cover does a surface albedo of 0.9 represent)?

Line 217, 18-41 fold is relative to what?

What are the bracketed variables in Table 1?

The AAE frequency distribution is stated to be normally distributed (line 225), but it looks possibly bimodal. What is the justification for stating it is normally distributed?

Line 259 and on discussing po-OOA correlation with O3 and RH. The logic here is not clear. Both O3 and RH vary substantially both spatially and even diurnally. Given this, how can O3 and RH at the measurement site be used to infer what the particles were exposed to over the time when transported from source region to where measured? It is the history of what the particles were exposed to that determines the properties at the measurements, the conditions at the measurement site may have only a small or minor impact.

Line 261 to 264, seems that another explanation is that most of the po-OOA is processed BBOA, as discussed above.

The last statement of the Discussion (line 319) and in the conclusions is not clear. That is, how does knowledge of the secondary BrC help tackling climate change? Be more specific, this is too general a statement to be meaningful.