Atmospheric Chemistry and Physics Discussions

Atmos. Chem. Phys. Discuss., referee comment RC1
https://doi.org/10.5194/acp-2022-167-RC1, 2022


# Comment on acp-2022-167

Anonymous Referee #2

---

Referee comment on "Intensive aerosol properties of Boreal and regional biomass burning aerosol at Mt. Bachelor Observatory: Larger and BC-dominant particles transported from Siberian wildfires" by Nathaniel W. May et al., Atmos. Chem. Phys. Discuss., https://doi.org/10.5194/acp-2022-167-RC1, 2022

---

This manuscript by May et al. presents field measurements of BB aerosols transported to the MBO site, including long-range transported smoke from Alaskan and Siberian boreal forest wildfires and emissions from regional wildfires.

The measurements characterized the physical and optical properties of BB aerosols for plume age from 10 h to 14+ days. The major findings include (1) This work supports the widespread influence of different wildfire emissions on aerosol properties in the western US; (2) The short and long-range transported plume aerosols present different physical and optical properties, which are related to sources and various chemical and physical processes during transport. The paper is well-written and is a valuable contribution to the BB studies. I have some comments detailed below.

Major comment:

1. Section 3.4, Page 12: the discussion of $\Delta PM_1/\Delta CO$

1) Please check the unit of $\Delta PM_1/\Delta CO$. It should be (μg $m^{-3}$ $ppbv^{-1}$)?

2) Line 285-287: Suggest adding more information, i.e. "The concurrent measurement of decreasing $\Delta OA/\Delta CO$ with increased transport time in Farley et al. (2022) is still because that net OA loss through evaporation and deposition was great than the secondary processing. And OA is the majority component of $PM_1$. Thus, the trend of $\Delta PM_1/\Delta CO$ follows the $\Delta OA/\Delta CO$, which can support the observation of $PM_1$ loss in this study".

2. Section 3.4, Page 13: the discussion of MAE and BC dominance

Line 318: I prefer not to use “BC enhancement” in this para, it is “the normalized enhancement ratios of BC (ΔrBC/ΔCO) in Siberian events were identified higher than other cases” (Farley et al., 2022). In Farley et al. (2022), the highest ΔrBC/ΔCO ratios were measured during both Siberia and Oregon events, suggesting that these events had more influence from flaming fires. It is still not explained why the Siberian events exhibited a higher average MAE (0.60 $m^2\ g^{-1}$) than the SW OR events (0.30 $m^2\ g^{-1}$). Suggest checking BC fraction in $PM_1$.

The mean MAE in the 8/12 Siberian event (0.48 $m^2\ g^{-1}$) is actually close to most other events, the mean MAE in the 8/17 Siberian event (0.72 $m^2\ g^{-1}$) is much higher, which leads to the higher average MAE of Siberia events. What caused this difference between the 8/12 and 8/17 Siberia events?

The discussions indicate that Siberia events in this study had more influence from flaming fires, thus having a high ΔBC/ΔCO and MAE. I agree with this, more flaming fires do generate plumes with enhanced BC emissions (ΔBC/ΔCO). However, in this study, the ΔBC/ΔCO ratios are not only related to the source fire conditions but also the transport processes, i.e., Siberia events are suggested to experience wet deposition. It’s needed to mention that although the Siberia events experienced strong wet deposition, the ΔBC/ΔCO ratios are still higher than other events. A study ( https://doi.org/10.1029/2020GL088858) observed enhanced fraction of BC after vertical transport from the surface to the top of the boundary layer due to the lower removal efficiency of BC than the non-BC materials and the evaporation of other non-BC materials, which may be also related the transport processes.

3. Line 343: A recent laboratory study also found the imaginary part of BrC could be half decayed in a few hours, in line with the loss of its absorptivity after transport (https://doi.org/10.1021/acs.est.0c07569).

The laboratory work by Cappa et al., 2020 (hhttps://doi.org/10.5194/acp-20-8511-2020) and field observation from Wu et al., 2021 (https://doi.org/10.5194/acp-21-9417-2021) suggest that the evolution of AAE and BrC absorptivity with photochemical aging is dependent on the fire burn conditions and initial emission particle properties. There is an initial enhancement stage of AAE and BrC absorptivity followed by the decrease with longer aging times for more flaming fires, while more smouldering fires are suggested to experience a net decrease upon aging. The short-range transported (10-15 h) SW OR events with the highest AAE may experience the initial enhancement stage or decrease during this short-range transport period depending on the fire condition. Suggest adding more clarification here.

Line 393-395: “Notably, a portion of the 8/17 Siberian event exhibited a combination of elevated AAE and low SAE that is typically indicative of dust aerosols with enhanced absorption at short wavelengths." Siberia events did exhibit lower SAE than other events due to larger size mode particles. However, the AAE values in Siberia events were not elevated compared to other events. What does the "elevated AAE" mean? The AAE values in Siberia events were close to another long-range transport event (Alaska event). I don't think the AAE can be evidence of the dust aerosols mixing with plumes.

4. Page 22: For the aerosol size distribution in Siberia events, I agree that the observed <100 nm modes may be indicative of the influence of entrained background air and/or new particle formation. However, in Siberia events, the suggested wet deposition during transport would remove larger-size BB aerosols and would also result in a smaller size mode under 100 nm. Examples from Taylor et al., 2014 (https://doi.org/10.5194/acp-14-13755-2014) can support this. This is also related to the conclusion on Page 24.

Specific comments:

Line 143: need a full name for "PSAP".

Line 171: Please check the correction of OPC $PM_1$ measurements in the supplementary, not found.

Line 198: How do you get the BB event criteria of $\sigma_{scat}$ > 20 $Mm^{-1}$ and CO > 110 ppbv?

Line 214: In Figure1, need to add annotation (the blue, green and red lines in $\sigma_{abs}$ and $\sigma_{scat}$ plots represent blue, green and red channels respectively).

Line 220-221: Two BB events (7/5-7/7), rather than the (7/5-7/6) in the manuscript. The ΔWV of Alaska events is -1.52 in Table 1, not consistent with -1.53 here. Some values in Table 1 are not consistent with the manuscript, please check them.

Line 239: Which prior observations? If indicating previous work, please add the reference.

Page 11, Table 1: It would be good to add notes explaining why some of the data are missing in Table 1 (not measured or not good quality data?).

Line 313: "in the / during Siberia BB event" repeat word? Please re-phase

Line 314: the result *"of"* increased aqueous-phase cloud processing during transport

Line 330: ARCTAS-A aircraft measurements in Alaska *"reported"* a much larger BC/CO ratio.

Line 337: What is “PNW” BB event? BB event from where?

Line 369/370: Please explain what is “$D_{pm}$”?