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Atmospheric Chemistry and Physics Discussions

# *Interactive comment on* "In-situ measurements of trace gases, PM, and aerosol optical properties during the 2017 NW US wildfire smoke event" *by* Vanessa Selimovic et al.

**Anonymous Referee #3**

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Interactive comment on "In-situ measurements of trace gases, PM, and aerosol optical properties during the 2017 NW US wildfire smoke event" by Vanessa Selimovic et al.

This manuscript presents a major wildfire aged smoke measurement of some aerosol properties and trace gases in Missoula (US) during August-September 2017. During this period the measurement location was affected by several smoke plumes from wild fires, more importantly a smoldering and nighttime fire chemistry case is presented. Model back trajectories and satellite retrievals allowed for some of the fire locations to be identified and investigated. In summary, this data set presented here contains approx. 500 h of ground-based plume measurements and can provide valuable infor-



mation on statistics for modeling and emission factors based on flaming vs. smoldering combustion on a regional scale. The prescribed burning comparisons are an interesting start to a much-needed solution. I think this paper is acceptable but could benefit from a deeper look into the implications for modeling use via smoldering and nighttime chemistry.

Major comments

Page 3 line 15: The author indicates that this can be used to inform model mechanisms; however, outside of presenting numbers for ratios (which can and is helpful) without context of in what way to use these ratios. Meaning, all numbers are not created equal, in what modeling scenario should these new numbers or measurements be applicable? Are these numbers for nighttime generated smoke? Can one use these numbers when a fire is detected at night or during the day and expected to be smoldering? E.g. page 6 line 5: "time series of mixing ratios" is helpful to point out in detail. E.g. BC/CO as a function of distance would be helpful.

Page 4 line 3-5; brief discussion of the uncertainties; there needs to be more in this paper about those uncertainties associated with each calculation and its use in a modeling platform or intended use.

Page 6, line 18-21 MCE is not a good indicator of flaming vs smoldering compared to BC and CH4 ratios to CO, needs a citation, unless you are planning on providing evidence in this paper of this using the data collected?

Page 7, line 18-27 it seems that the authors had an opportunity with this data set to take a look into the various composition of fuels and impacts on transported chemistry. The small caveat to this is that hysplit will not likely give you 100% certainty on the origin, but with the fires that were identified, I would have liked to see an attempt to separate out measured emissions vs fuel types. This could potentially be a nice case study for Lolo Peak fire and Rice Ridge fire. As this fuels composition could be one explanation of the presented results differences between the other studies.

Page 8, line 17 “time since emission” I would have like a deeper dig into this as the results all hinge upon the accuracy of this. The authors claim the smoke came from late afternoon to nighttime but do not show this anywhere outside of the supplemental materials. And since hysplit does not include full chemistry it seems odd to use it to look at full chemistry transported, but as you indicated the ratios compared to the relatively conserved CO should be okay.

Page 8, line 35 the separation of smoldering vs flaming vs residual smoldering is difficult, particularly in modeling and source attribution. If there was a ratio or tracer method that was found to actually indicate one of the other this was not clear to me reading this. It appears the distinction was made based off time of day (and one case presented grew at night), knowledge of fires state, and measured chemistry. Which is nice but going forward most cases wont have all that information.

Page 9, line 17. It appears that this study used only three heights to initialize hysplit, but did not indicate why those heights where chosen (if it was based purely on the elevation of the terrain then that makes sense). However, it does not include the effects of plume rise? As smoldering smoke tends to pool near the surface but can reach higher elevations, and vice versa for flaming smoke.

Consider the references

Wilkins JL, Pouliot G, Foley K, Appel W, Pierce T (2018) The impact of US wildland fires on ozone and particulate matter: a comparison of measurements and CMAQ model predictions from 2008 to 2012. International Journal of Wildland Fire, https://doi.org/10.1071/WF18053.

Zhou L, Baker KR, Napelenok SL, Pouliot G, Elleman R, O’Neill SM, Urbanski SP, Wong DC (2018) Modeling crop residue burning experiments to evaluate smoke emissions and plume transport. Science of the Total Environment 627, 523-533, https://doi.org/10.1016/j.scitotenv.2018.01.237.



Page 9, line 33 aging and/or higher average temperatures at lower elevation may encourage some OA evaporation and reduce downwind PM impacts. This line is very interesting and should be expanded upon, as it’s a critical finding from this study. What here is indicated as higher average temperatures? Is this flaming stage or just hot temperatures in the atmosphere as the plume ages? (page 10, line 12-15 also are confusing for the same reason “and thus strongly cooling”). Furthermore, can a statement be made in this section about smoldering plumes traveling in hotter temperatures or temperature of plume on evaporation of PM? This point would be good to attempt to relate to prescribed burns, as the emissions tend to be more toxic (or higher for PM) from the incomplete combustion and lower temperatures of burns and therefore longer smoldering time periods.

Also, for the section 3.2 (page 10, line 3-5) are the authors discussing BC on average or BC for smoldering cases. It seems from the way its written that this ratio is for smoldering and the one presented in Liu et al. is for flaming? Could there be a statement made such as BC/PM < x is expected to be from smoldering while BC/PM > x is expected to be flaming?

Page 13, line 20 It states that a possibly explanation is that more BC is being generated during the day, however it transported to the site over night inorder to arrive by 5am. Or is this statement meant to mean, the transported plume that remained over Missoula cooked during the daytime hours and generated more BC during the daytime while at Missoula?

Minor comments

There is a need for a careful defining of terms. Some terms are used before they are defined, and others are never defined. And I believe all terms should be defined that are used in the abstract. E.g. BrC is used on page 1 line 23 and defined later on line 28; “US” is used on page 1 line 37 and is not defined. The authors need to decide whether or not to abbreviate which terms and remain consistent, e.g. Biomass burning

appears as BB sometimes and other times not, also Air quality is sometimes AQ.

A through grammar check is needed. There are some run on sentences and some missed placed commas and periods. E.g. page 2 line 3-10 very long run-ons.

Page 10, line 35 does this ratio come with a trend or can expect numbers be inferred?

Page 11, line 36 what is meant by “870 nm is unity to a good approximation “ the transitions at the end of paragraphs in my opinion are not needed (e.g. Page 13, line 12) “ which we examine next”

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