

Answer to the review of Hugh C. Pumphrey (reviewer 1).

Thank you for the comments that have helped us improve the manuscript. You will find our answers in blue text below.

Review of “Five satellite sensor study of the rapid decline of wildfire smoke in the stratosphere” by Martinsson et al.

January 5, 2022

1 General Comments

This paper studies the aerosols injected into the stratosphere by the pyroCb event of August 2017 (named the “Pacific Northwest Event” (PNE) by several authors). I note that I am very familiar with this event, being the lead author on a recent paper on the subject. However, I can not claim great expertise in the measurement of aerosols.

The authors have done something which appears novel to me, in that they have combined both passive limb and active (Lidar) nadir data to show that:

- The two observation techniques do not agree when the aerosol is very thick because the limb path becomes opaque, and much of the aerosol in it is not observed.
- The aerosol decays very rapidly during the first week or two, staying relatively constant after that. The authors hypothesise that the aerosol contains two components: black carbon, which is long-lasting, and organic particles, which are removed by photolysis on a short timescale.

The paper is generally well-written and is not too hard to follow. I note a few corrections to the English in the “Technical corrections” section below, but the errors I correct do not cause the writing to be hard to understand.

The figures could do with a considerable amount of improvement. I note some specific issues below, but I also note that the size of text used on the figures needs consideration throughout. I cannot always be sure what needs to be done as it is not always clear whether the figures are intended to be printed at single-column or at two-column width. The authors should aim to use text on their figures which will be of a similar size to the caption text. It is a bit self-serving for me to suggest that the authors should reference my own paper on the 2017 event (<https://doi.org/10.5194/acp-21-16645-2021>), which also makes use of the MLS H₂O data. However, a big lesson which I learned in the review process of that paper is that although August 2017 is over four years ago now, papers on the event continue to appear in the literature, and the authors will probably need to add a number of references, both while replying to the referees and while working with the production staff on the final copy. Papers they may feel the need to add include

- Lestrelin et al., (2021) (<https://doi.org/10.5194/acp-21-7113-2021>)
- Fromm et al., (2021) (<https://doi.org/10.1029/2021JD034928>)

The authors note that the event observed here is one of two very large events in the last few years, the other being the Australian New Year event of December 2019. The “Black Saturday” event of February 2009 was also quite large and also occurs within the operational period of CALIOP and MLS.

I am not going to suggest that the authors should extend their analysis to either, or both, of these events. But they might spell out why they have not done so, and whether they intend to do so in the future.

Thank you for the suggested references. We include them. We work on a manuscript on the 2019 – 2020 Australian fire which we aim to publish.

2 Specific Comments

- Lines 12–13: To describe the source of the aerosols in this event as being in “Western North America” is a bit vague. A variety of studies (including my own, noted above) have pinned down the source region with more accuracy than this. (Also, “Western” here is not part of a name, so it should not have a capital letter.)

We changed the spelling. The fires were around the border between Canada and USA, but mainly in Canada according to Fromm et al. (2021, JGR Atmospheres). We changed to a more detailed geographical description in the Introduction section but retain the shorter description in the abstract.

- Line 313: On mentioning the A-train it is probably a good idea to include a reference explaining what the A-train is. One possible reference is Tristan S. L’Ecuyer and Jonathan H. Jiang “Touring the atmosphere aboard the A-Train”, *Physics Today* 63(7), 36 (2010), doi:10.1063/1.3463626

Thank you, we include the reference.

- Line 970, Figure 1: The labelling on the colour scales in this figure is FAR too small, even if the figure is printed at two-column width.

We agree, we have changed size. To save space we use the number format “aE-b” in one of the color scales. That way we will show as much as possible of the graph, and we explain the format in the figure caption.

- Line 1015, Figure 6: The tiny numbers on the CALIPSO orbit tracks are too small to read and not useful to the reader. They should be removed.

We agree in principle. However, this figure was generated from NASA Worldview where these numbers are not optional. We therefore want to keep the numbers, although we agree with the reviewer that the figure would look nicer without the numbers.

- Line 1029, Figure 8: This is quite a useful summary figure, but the authors should consider an alternative colour scale. This, as far as I can tell, is the notorious “jet” colour scale. See <https://doi.org/10.1038/s41467-020-19160-7> for a recent discussion of colour scales. If the authors are dead set on a scale with similar colours to jet they might try Google’s “turbo” scale: see <https://ai.googleblog.com/2019/08/turbo-improved-rainbow-colormap-for.html>. It is not clear to me that the labels used for the volcanoes and the two fire events will be readable in the final figure; the authors should consider making these labels larger, and perhaps using a heavier font.

We have not thought a lot about color scales before, but of course we became interested and tested a turbo scale. Particularly the distinct effects of turquoise and yellow in the jet scale we used produced steps that are not present in the turbo color scale. Therefore, we changed to a turbo scale in the revised version. Thank you for making us aware of this problem.

- line 1045, Figure 10: It is confusing that parts a and b are plotted with higher altitude at the bottom. The caption should explain that the legend items in a and b are dates in the form yymmdd. It might be worth reducing clutter by removing all of the year digits as they are 17 in every case.

We actually tried to reverse the scale, but the plotting software used somehow collapsed because the scale is logarithmic. Therefore, we ended up with the scale in this direction. Concerning the dates: we believe that the risk of misunderstanding the labels is less when including the year. We would therefore want to keep the labels as they are.

3 Technical Corrections

Thank you, we have made use of all your comments below.

- L56: “example on” should be “example of”.
- L164: “The first weeks” should be “During the first weeks”.
- L228, eq 5: It is better to avoid whole words (such as “base” and “top” as used here) in equations. If they are to be used, they should not be in italics.
- L262: “laps” should be “orbits”. I would also suggest that “14 – 15 orbits” is misleading, suggesting that the satellite’s speed is variable. In reality, it completes exactly the same number of orbits per day, every day, but this number is not an integer, lying somewhere between 14 and 15. (This last point also applies to line 116.)
- L289: “likely” should be “probably”. (“Likely” is an adjective synonymous with “probable”, not an adverb synonymous with “probably”).
- L315: “Livesley” should be “Livesey”.
- Line 408 “. . . variability the first . . . ” should be “. . . variability during the first . . . ”
- “Easterly” should be “an easterly”. (Note that compass directions only have a capital letter when they are part of a name, such as North Dakota or East Timor. “East” later in the same sentence should also not have a capital E.) It might actually be better to use “eastward” rather than “easterly” due to the way that meteorologists use “easterly” to mean “coming from the east”.
- line 993, Figure 3, line 1039, Figure 9, line 1045, Figure 10 and possibly elsewhere: As ACP is a journal in English, decimal points in axis labelling should be points, NOT commas.
- Line 1000, Figure 4. The notation 1E-3 should be avoided in the axis labels if possible. Either 0.001 or 10⁻³ would be an improvement.
- lines 658–667: ACP prefers that data sets are referenced with a DOI and an item in the references list. For example, the MLS water vapour data has doi:10.5067/Aura/MLS/DATA2508 and approved reference text “Lambert, A., Read, W. and Livesey, N. (2020), MLS/Aura Level 2 Water Vapor (H2O) Mixing Ratio V005, Greenbelt, MD, USA, Goddard Earth Sciences Data and Information Services Center (GES DISC), Accessed: [Data Access Date]”.
- lines 679 – 957: The references should be consistent about how the DOI is presented. For preference it should always appear as doi:10.1029/2010GL042815 and never as <https://doi.org/10.1029/2010GL042815> ; the authors currently have a mix of these two styles.