

Dear Editor!

Here are the answers to the comments of Mike Fromm. Our answers in bold. Changed text in the revised manuscript is also indicated in bold.

Mike Fromm (reviewer #1):

O2O have diligently addressed the reviewers' concerns and questions. The work may be considered acceptable for publication after O2O address questions arising from the new material.

General:

P4, L21. "...pyroCB convection evolved over the fire areas in southeastern Australia and downwind over the Pacific..." This clearly indicates that pyroCbs occurred over the ocean. This is physically unrealistic and unsupported. Any mention of oceanic pyroCbs should be removed.

We removed this statement (Section 3.1., page 4).

P4, L25. "Based on an extended trajectory analyses..." What is meant by |"extended"? I noticed that O2O used the HYSPLIT ensemble method for the trajectories. Is that what is meant rather than extended? Please clarify and correct the grammar.

Now we provide detailed information about the forward trajectory analysis (start location, heights, times, which days...) and the same for the backward trajectories (Section 3.1, pages 4 and 5).

But we want to keep this part as short as possible, so we leave out to show any further trajectory figure. Fig.2 is sufficient to demonstrate that the smoke came from Australia. In follow up papers, we may present much more of the HYSPLIT analysis results (in figures).

P4, L19. Regarding O2O's description of tropospheric smoke on 10 Jan, it's still unclear to me where the smoke is distinct from clouds in this raw backscatter depiction. Clouds are at all the altitudes in the range mentioned in the text. The reader must take it on faith that there is some smoke there. If O2O want to press this point they need to show additional lidar data such as depolarization ratio.

We changed again the text in the respective Figure 1 caption. We explain the colors better: white are clouds, red and yellow show virga, and all blue to green shows smoke plus some long lasting coherent aerosol structures in yellow below and above the tropopause.

That must be sufficient! This is easy to understand and easy to see. It is simply not the central point of the paper..., it is an interesting aspect, therefore we want to mention it..... but it is of secondary importance for this paper.

So, a clear 'NO'! ... regarding further figures.

P5, L2: "...forward trajectories..." No details on these trajectories are given. The citation only points to the general HYSPLIT page. No information on the source location, date, altitude is given. Please elaborate on the details of this analysis.

As mentioned above, now we provide detailed information about the forward and backward trajectory analysis (start location, heights, times, which days...) (see Section 3.1, pages 4 and 5).

P5, L3. "...permanent diabatic heating..." What is meant by "permanent"? Please clarify.

We removed the word 'permanent'

P5, L5. "...the respective trajectories show many circular movements..." Where is this shown? This whole discussion of forward trajectories and diabatic heating is incomplete and flawed. As O20 acknowledge, HYSPLIT calculations do not and cannot account for such diabatic effects. The reader has no basis on which to follow the argument for the claimed upward movement of the smoke plume.

It is not shown . . .and we state it now clearly with statements like (not shown)... on page 4.

We provide more details to the performed backward and forward trajectories and discuss the results in combination OMI products (500 nm AOT maps). All this is easy to understand! Why is this discussion incomplete and flawed? We do not agree with Mike Fromm.

P5, L6. The "OMI, 2020" citation doesn't directly provide the reader with any targeted details of the features to which O20 allude. If this is relevant to the analysis, it is suggested that some specific maps be provided.

The paper is on lidar ratios and depolarization ratios and not on OMI results! So, we will not show OMI AOT maps. We may do that in follow up papers...

Regarding the OMI (2020) reference: We provide now the full way how to download the OMI data and how we processed them. See the five lines (!) in the references to OMI, 2020 (on page 16).

P5, L7. "...30 January 2020 according to the backward trajectories." It is not evident how the back trajectories show what O20 claim. The only ones shown and discussed are launched on 10Jan. Please elaborate.

We changed the text (Section 3.1, on pages 4 and 5) to make it more clear. We also say trajectories for 30 January are 'not shown'.

We are a bit confused why we should show so many trajectory plots, the OMI maps, may be even CALIPSO smoke curtain plots from Australia to South America... If we would follow all the suggestions of Mike Fromm we would end up with a completely new story.. We want to avoid that. This is simple not the topic of the paper.

And we are also confused because we believe the discussion on the long range transport with all the backward and forward trajectories, the OMI observations, etc., is very clear... None of our co-authors had a problem with this, even reviewer #2 was obviously happy...

P5, L11-12. "An almost monotonic ascent was recorded

with a constant rate of 1 km per day from 25 January (layer top at 22 km) to 30 January..." Is this based on PA data? If so, it would be good to show the data. If not, please explain the basis.

Sorry, the statement was not clear enough, we improved it and say.... 'This unusual case will be further discussed in Sect. 3.2 based on the final figure of this article.'

In Section 3.2, we explain Figure 5 in more detail now. The ascent rate can be easily seen in this Fig.5...., the layer top (shown in the figure) moved upward by one km, day by day, from 25 to 30 January.

P5, L16. "...forward trajectory analysis..." Here again O20 refer to trajectories that are not characterized or shown. These seem to be equal in importance to the back trajectories they show. It would be important to understand the details of the forward trajectory source location, time, altitude, and length.

As already said several times above, we improved this!

P6, L4, first sentence. Is the point here to suggest to the reader that other back trajectories were attempted from other smoke layers that did not make a connection to the Australia origin? This would make sense if indeed there was significant diabatic lofting of some of the smoke that ended up over PA. That would be reasonable and worth mentioning, especially considering the attention O20 devote to the discussion of the CALIPSO data.

We removed the respective sentence. It is not needed, but obviously confusing

P6, L11-14: "It should be noted that all trajectories arriving between about 11.5 and 15 km at Punta Arenas showed similar large-scale descending features (descend rate, advection speed and direction) so that continuous upward motion of the smoke by solar heating and large-scale downward motion of the air masses occurred without a significant change of air flow direction." I don't understand this logic. The PA observations at the end of the back trajectories suggest that they arrived under quasi-isentropic flow conditions.

The same here, we removed the statement. Is not needed, but obviously produces confusion.

P6, L15. "The respective backward trajectory analysis here..." The only trajectory analysis shown applies to an endpoint at 12.5 km. Nothing can be inferred about the separate, higher layer from these trajectories. Are there other trajectories that are not shown?

Yes many, and we now clearly state at many places '(not shown)'. But again, we give more details to the forward and backward trajectories, as mentioned above. All this is sufficient now, to our opinion.

P6, L29-30: "In contrast to the record breaking events discussed here, the smoke-related 532 nm AOT was 0.002 in March 2010..." This implies nothing about the source AOT. PA might have just sampled a weak, fringe of a larger plume. One could probably find some portions of the 2020 plume over PA that have very weak AOT (e.g. at the onset or evacuation of a layer blowing over PA.) While it is true that the 2010 pyroCb event was small in comparison to the 2020 event, making such a comparison of aged AOT so far downstream of two very different origins has little significance.

We agree and removed this statement. But we concluded (at the end of Section 3.1, page 6):

The good agreement between the model results and the observations indicate that self-lifting effects were obviously rather weak.

We added a recently published ACPD paper from my PhD student and coauthor here...: Floutsi et al. (2020) summarized recent aerosol observations in the free troposphere over Punta Arenas (November 2018 to December 2019) and also found a smoke plume (at 11 km height), advected from southern Australia within 9-10 days in March 2019.

P8, L29. O20 mention the difference of smoke emissions from flaming vs. smoldering fires. But here we are talking about UTLS smoke that most likely came from very intense flaming connected with pyroconvection. Unless there is a point that I missed, I'd suggest removing this unnecessary statement.

We removed the sentence.

P10, L11. Citation needed for this final sentence. Perhaps Peterson et al., (2018), who detailed the 12 August 2017 pyroCb event.

We included now: (Peterson et al., 2018; Hu et al., 2019; Torres et al., 2020a)

Technical:

P4, L30. Change "and remained" to "remained."

Done

P4, L30. "These smoke layer" should be "layers."

Done

P5, L2. "The respective air mass..." Respective of what?

We removed ...respective...

P5, L7. "had an horizontal" should be "had a horizontal."

Text is changed...

P5, L11. "unique opportunity" What is unique and to what opportunity do O20 refer?

Unique is removed...

P6, L9. "This descend" should be "This descent."

Done

P9, L13. "descend rate" should be "descent rate."

Done