

Answer to the comments of referee 1.

Some minor comments:

L6: change to Still persist after six months

L30: Is the "and 5S" needed here. I don't really understand it please clarify

The authors could add in "(Figure1a)"

Done as suggested

L44: This sentence is really confusing.

"Figure 3b and d-e show a fast descent is visible in the two latitude bands (Fig. 3a-d) which would imply unrealistically large aerosol sizes (Fig. 3e)."

Why are the authors referring to b and d-e at the beginning of the sentence? only b and d show vertical motion. Why are then referring to Figure 3a-d.

This sentence was really confusing with the figure references, probably a consequence of a wrong cut and paste. It has been fixed.

The section extinction of the plume could be improved if the authors were to mark the clouds, for example, C1 and C2 in the figure.

Then for example in line 82, the authors could say "Comparing Figs. 5a and b, makes apparent that the conversion to sulphates is almost complete in the western strip associated to C1 in Fig. 4e while it is incomplete in the eastern strip associated with C2." And if the authors add these labels to these subplots everything will be much easier.

L102: If the authors use the C1 and C2 labels, this will be much clearer

We have applied this suggestion which indeed simplify the wording and makes easier to follow the discussion.

L124: the remaining plume -> remaining sulphate plume

No, at this stage, the plume contains (at least) SO₂, sulphate and water.

L132 Do the authors mean 2 and 3

Yes, corrected.

L139 Do the authors mean 1.4 as discussed through the rest of the paper

Yes, corrected.

L145. There is no reason to assume this, nor is needed for the rest of the article.

We think it is a reasonable assumption. This comment is independent of the rest of the article but we also think it is a useful element of the discussion. Our findings support a fast conversion sulphate that suggests prior estimates of SO₂ injection that ignore this fact are too low.

L176 only SO₂ or you meant to say and volcanic-specific trace gases (SO₂) Can you not do that with RTTOV 11?

Please clarify

RTTOV 11 does resolve the SO₂/sulphate bands and cannot be used in this retrieval.

L195 please add: as well as other trace gases, temperature and cloud ice.

L196 .. grid of 1.45 (add space) resolution

Done.

L202: This only affects 1d retrievals. From Gorkavyi et al 2021 "One way to account for such effects is to use a two-dimensional (2D) radiative transfer model (RTM) that is able to account for such effects along with multiple observations in a tomographic retrieval (e.g., Livesey et al., 2006; Zawada et al., 2018; Loughman et al., 2018)." The first citation is the manuscript that describes the MLS retrieval, that is, the MLS products should not be affected by the arch effect. Please move this discussion of the arch effect to the OMPS section.

Thanks for this. The sentence has been moved to the OMPS section. It seems, however, that during the early phase, the bottom boundary of the MLS water vapour anomaly is in better agreement with OMPS than CALIOP.

L212 This statement needs a citation

A citation has been added.

L270 The link is not working

[This temporary institutional link has been replaced by a link to the zenodo depository with a doi.](#)

We do wish to apply the changes suggested by referee 2. His lengthy report repeats comments that he made previously and that we already answered. He is basically wishing us to alter our analysis and conclusions to mention that ultra-thin ash could have been hidden within sulfate aerosol droplet. This is a possibility upon which one can speculate but there is nothing in the available data that detect such compounds in the two main components of the plume released initially at 31 and 28 km that are the focus of our study. The referee wrongly claims that he sees a strong depolarization in our figure 4f where it is shown that it does not exceed 1%. There is nobody having some experience with lidar data who would not say that this is very small depolarization. And this magnitude is preserved for the dispersed plume over several months until it is not possible to assess the depolarization. In comparison, the thin cloud seen on 15 January by CALIOP at 35 km, mentioned by referee 2 and that we mentioned ourselves on the SSIRC VOLC exchange forum, was depolarizing 50%. This is large depolarization, not 1%. This thin cloud was seen also on 16 January by CALIOP and on 20 January over La Reunion and then was lost. We did not mention this event because we consider it as an epiphenomenon related to the two main clouds which generated a persistent plume and because it is mentioned in Khaykin et al., 2022, which shares a number of common authors. The referee further speculates that if CALIOP was not turned off during one week between 19 and 26 January because of solar activity we would have seen ash aerosols. This is a very imaginative analysis of unrecorded data. However, Baron et al. (2022) report lidar measurements at La Reunion during that week and Taha et al. (2022) report TROPOMI UV measurements which both do not see ash. Therefore we tend to stick to our interpretation that the ash was removed by the ice condensation and fall that followed the huge initial injection of water, leaving a saturated stratosphere up to 35 km (see Sellitto et al. and Khaykin et al, 2022). The remaining ash, if any, cannot be optically detected in the main plume and therefore can be safely ignored. We have added a sentence in the conclusion mentioning that the absence of detection does not rule out the possibility of hidden presence but we cannot go further. The referee 2 makes a few other suggestions for rewording that we consider as purely obstructive as this stage.