

Manuscript ID: acp-2022-56

Title: Retrieving Instantaneous Extinction of Aerosol Undetected by CALIPSO Layer Detection Algorithm

Comments to the author:

Dear Authors

Please implement the minor corrections/revisions as recommended by Anonymous Referee #4 in the most recent Open Report #2. Once these are completed, the paper will be accepted for publication. Thank you.

Specific comments

1. Line 73. The level 2 products do not explicitly report chemical parameters. Recommend removing “chemical”

RE: Removed.

2. Table 1 and lines 140-143. The molecular number density, ozone number density, and tropopause height are provided by the MERRA-2 model. Adding this information into the manuscript will help avoid giving the impression that CALIOP retrieves these values.

RE: The related sentence has been added at the caption of Table 1, as follows ‘[The tropopause height, molecular number density and ozone number density are provided by the Global Modeling and Assimilation Office.](#)’

3. Line 107. I do not think the Knepp et al. 2021 is an appropriate reference because it is still in discussion. Please consult the ACP editorial staff for their standards about this. I believe the Knepp 2021 paper references another paper when describing the extinction to correction. If so, consider referencing that other paper instead since it has fully completed the peer review process. Similarly, the Knepp 2021 reference is used in this manuscript to describe the Raikoke event (line 281). There are other papers that have been published describing the eruption observations that may be used instead if you do not want to reference a paper in

discussion. If the ACP editors are ok with referencing a paper in discussion, then I withdraw my comment.

RE: The Knepp et al. 2021 have been replaced to the published papers, as follows:

- 1) Wang, H. J. R., et al. Validation of SAGE III/ISS solar occultation ozone products with correlative satellite and ground based measurements. *Journal of Geophysical Research: Atmospheres*, 125, e2020JD032430. <https://doi.org/10.1029/2020JD032430>, 2020.
- 2) de Leeuw, J., et al. The 2019 Raikoke volcanic eruption – Part 1: Dispersion model simulations and satellite retrievals of volcanic sulfur dioxide, *Atmos. Chem. Phys.*, 21, 10851–10879, <https://doi.org/10.5194/acp-21-10851-2021>, 2021.
4. Lines 229-232 “...is the 20 km aerosol extinction of CALIPSO”, “is the uncertainty for one-degree aerosol extinction of CALIPSO”, “...or the CALIPSO retrieval”. It is not clear with the expressions if they refer to the extinction and uncertainties reported in the official CALIPSO products or if they refer to the values calculated in this study. Can this be made specific?

RE: Sorry for the confusion. The related content has been revised as follows:

‘The CALIPSO extinction in Figure 5a comes from the averaged extinction profiles over the one-degree matched range with SAGE (Figure 1a). They are equal to the average of the five 20-km extinction profiles over the matched range. Therefore, considering the systematic error of the lidar ratio in Eq. 7, we calculate the uncertainty of averaged extinction within one-degree range according to the following equation:

$$(\Delta\alpha_{1^\circ})^2 = \sum_{i=1}^n \left(\frac{1}{n} \times \left(\frac{\Delta\beta_p}{\beta_p} \right) \times \alpha_{20\text{ km}} \right)^2 + \left(\sum_{i=1}^n \left(\frac{1}{n} \times \left(\frac{\Delta S_p}{S_p} \right) \times \alpha_{20\text{ km}} \right) \right)^2, \quad (8)$$

5. Line 284. Raikoke misspelled.

RE: Revised

6. Lines 294-296. “The results show that the aerosol subtype in this region is sulfate,

which supports that the aerosol enhancement is more likely to be from the eruption of the Raikoke Volcano.” Actually, there is some literature that suggests Siberian wildfire smoke may be contributing to stratospheric aerosol in the region where figure 8d passes through (Ansmann et al., 2021). It is worth considering adding an acknowledgment of the possibility in this sentence.

RE: We have added an acknowledgment about the possible effect of Siberian wildfire on the enhanced stratospheric aerosols, as follows:

‘Additionally, the previous study indicates the Siberian wildfire smoke possibly contribute to the enhanced stratospheric aerosols in 2019 by the combining CALIPSO observation and backward trajectories model (Ansmann et al., 2021).’

Ansmann, A., K. Ohneiser, A. Chudnovsky, H. Baars and R. Engelmann, 2021: “CALIPSO Aerosol-Typing Scheme Misclassified Stratospheric Fire Smoke: Case Study From the 2019 Siberian Wildfire Season”, *Front. Environ. Sci.*, 9:769852, <https://doi.org/10.3389/fenvs.2021.769852>.

References

Ansmann, A., Ohneiser, K., Chudnovsky, A., Baars, H., and Engelmann, R.: CALIPSO Aerosol-Typing Scheme Misclassified Stratospheric Fire Smoke: Case Study From the 2019 Siberian Wildfire Season, *Frontiers in Environmental Science*, 9. doi:10.3389/fenvs.2021.769852, 2021.