

Atmos. Chem. Phys. Discuss., referee comment RC1
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Comment on acp-2022-56

Anonymous Referee #1

Referee comment on "Retrieving instantaneous extinction of aerosol undetected by the CALIPSO layer detection algorithm" by Feiyue Mao et al., Atmos. Chem. Phys. Discuss., <https://doi.org/10.5194/acp-2022-56-RC1>, 2022

General comment

In this manuscript, the authors use the instantaneous observations of CALIOP to retrieve faint aerosols missed by CALIOP's official aerosol layer and profile products. Comparison analyses with SAGE III aerosol product demonstrate good agreement from the middle troposphere to the stratosphere. Also, in the 2019 Siberian fire event, retrieved instantaneous aerosol provided more information on faint aerosol propagation trajectory with higher spatial and temporal resolution than CALIPSO Level 3 monthly-averaged aerosols product.

This study is very interesting because most of the previous studies focused on aerosol and cloud layer retrieval, but the authors propose a novel method to retrieve the generally-ignored faint background aerosol based on CALIOP instantaneous observations. The manuscript is well-written and straightforward. The results are satisfactory and effectively described. This method is expected to provide new data for the investigation of aerosol-cloud interaction, which may offer new insights into the aerosol climate effect that otherwise cannot be seen by studies based on integrated or surface aerosol information (i.e., AOD). Therefore, I suggest this manuscript be published after minor revisions.

Major comments

- The introduction needs to become more refined and better linked to the scientific literature. It should be clearer where the gaps are in the literature and what the contribution of this study is in this respect.
- The authors use a lidar ratio of 28.75 sr in the troposphere, referring to Kim et al. The lidar ratio is one of the key parameters for aerosol extinction retrieval and varies with aerosol type. Therefore, I suggested the authors more deeply discuss and analyze the

lidar ratio, including the difference between land and ocean.

- The CALIPSO retrieval of instantaneous faint aerosols is very challenging. Is there a useful way to improve the retrieval in the future, such as using a wavelet to denoise the CALIPSO level 1 data before retrieval? Although I do not recommend using denoising algorithms in the study of this paper because we prefer to do original research using the most formal methods first, I suggest discussing it for guiding future work.

Specific comments

- Line 23: "capture" should be "captures".
- Line 38: it is not always true to argue that the aerosol particules in the PBL "can usually be detected by CALIPSO", which is inconsistent with previous findings. Therefore, this statement can be rephrased as "can only be detected by CALIPSO in the upper PBL in the absence of cloud (doi: 10.16/j.atmosres.2016.05.010)"
- Line 43: The citation may be corrected.
- Line 49: Clouds interact directly with surrounding aerosols, and in particular sub-cloud aerosols have a more significant effect on cloud production. However, these aerosols are not exactly the same as what the authors refer to as faint aerosol. A more rigorous and accurate expression is recommended.
- Line 50: This study is not motivated by the aerosol proxy used for aerosol-cloud interaction. I think the ignorance of faint aerosol surrounding high-altitude cloud layers is the culprit to complex the quantification of aerosol climate effect. Therefore, "an improper aerosol proxy (such as AOD)" can be changed to "the ignorance of faint aerosols surrounding high-altitude cloud layers" or something like this.
- Line 68: "in" should be "since".
- Line 73: It is recommended use the full name of the product (e.g. VFM) where it first appears in the manuscript.
- Line 97: "vertical" should be "vertically".
- Line 105: How is the SNR calculated here based on this formula?
- Line 126: The matching of CALIPSO and SAGE considers spatial distances. What about temporal distances?
- Line 144: The "red dash boxed area" is not marked in the figure 3a.
- Line 163: Suggest reword "shows well the consistency" to "shows high consistency".
- Line 226: The range described here (60-10°N) does not correspond to the range of the red rectangular box in the diagram (40-10°N), and it is suggested to keep it consistent.
- Line 240: "and compared them" can be changed to "which are compared"
- English should be further improved by a native English speaker.