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

Comments to the author:

Dear Authors,

In general, you have successfully implemented the recommended corrections/revisions from the referees. However, you have also made changes to the text in addition to what was suggested by the referees. I have some suggested changes to these additional modifications and a few additional comments as follows:

1. Lines 32-35. Suggest rewording "However, aerosols still represent a major uncertainty in global climate change and energy balance with a low scientific understanding (Lee et al., 2016; Watson-Parris et al., 2020), which is partly attributed to not enough observations for three-dimensional (3D) aerosol distribution characteristics." to something along the lines of: "However, aerosols still represent a major uncertainty in global climate change and energy balance with a low scientific understanding (Lee et al., 2016; Watson-Parris et al., 2020), which is partly attributed to insufficient observations to accurately characterize the three-dimensional (3D) aerosol distribution."

   RE: Thank you for your suggestion. Revised.

2. Lines 43-47. The revised wording of these two sentences is confusing to me. The original sentences read: "However, these faint aerosols are usually extremely optically thin to be detected by the CALIPSO layer detection algorithm with a minimum 0.05 threshold of column aerosol optical depth (AOD). A previous study indicated the retrieved AODs of aerosols undetected by the CALIPSO layer detection algorithm can reach 0.03–0.05, which accounts for approximately 20% of the total AOD and are very important for climatology (Toth et al., 2018; Smirnov et al., 2011; Levy et al., 2013)."

   The new sentences read: "However, these faint aerosols are usually extremely

optically thin to be detected by the CALIPSO layer detection algorithm. Previous studies indicated the aerosols undetected and retrived by the CALIPSO generally have the aerosol optical depth (AOD) of 0.03–0.05, which accounts for approximately 20% of the total AOD and are very important for climatology (Toth et al., 2018; Smirnov et al., 2011; Levy et al., 2013)."

First of all, retrieved is misspelled in L. 45. But the inclusion of the word "retrieved" now implies that the aerosols are undetected but retrieved by the CALIPSO (algorithm). I'm not sure what that actually means. Is that what you intend to say? Otherwise, you should add the word "not" before retrieved: "undetected and not retrieved by the CALIPSO algorithm…" I think the original wording is clear and see no reason to reword these sentences.

RE: Sorry for the confusion. We change the related sentences back to the original version, as follows: 'However, these faint aerosols are usually extremely optically thin to be detected by the CALIPSO layer detection algorithm. A previous study indicated the retrieved AODs of aerosols undetected by the CALIPSO layer detection algorithm can reach 0.03–0.05 (Toth et al., 2018), which accounts for approximately 20% of the total AOD and are very important for climatology (Toth et al., 2018; Smirnov et al., 2011; Levy et al., 2013).'

3. Line 110. "Due to this bias is negligible at 450 and 755 nm." What is negligible? The low bias? If yes, then the sentence should read something like: "This low bias is negligible in the 450 and 755 nm aerosol channels."

   RE: You are right. Revised as your suggestion.

4. Equation 8. This is an estimate of the uncertainty in extinction due to the two sources on the right hand side of the equation. It is odd that the first term on the right is the sum of the squares of errors (this is typical error propagation) but the second term is the square of the sum of the errors. Is this a typo?

   RE: Sorry for the confusion. The first term on the right indicates the random error of averaged extinction at one-degree range. It is equal to the sum of the squares of

errors based on the five related extinction values at 20-km horizontal resolution. However, the second term indicates the systematic error from lidar ratio (S_p) uncertainty, and is equal to the square of averaged systematic errors of 20-km extinction values. Based on the error propagation principle, the systematic error should not decrease with the average scale.

We slightly revised Equation 8 to make it clearer, and add the related description about the uncertainty with the conderation of systematic components.

$$(\Delta\alpha_{1^\circ})^2=\sum_{i=1}^{n}\left(\frac{1}{n}\times\frac{\Delta\beta_{p,i}}{\beta_{p,i}}\times\alpha_{20\,km,i}\right)^2+\left[\sum_{i=1}^{n}\left(\frac{1}{n}\times\frac{\Delta S_{p,i}}{S_{p,i}}\times\alpha_{20\,km,i}\right)\right]^2, \quad (8)$$

where n represents the number of CALIPSO 20 km profiles (i =1, 2, …, n) in the matching range, $\alpha_{20\,km}$ is the 20 km aerosol extinction of CALIPSO, and $\Delta\alpha_{1^\circ}$ is the uncertainty for one-degree aerosol extinction of CALIPSO. The first term on the right indicates the random error, and is equal to the sum of the squares of errors based on the five related 20-km extinction values. The second term indicates the systematic error from the lidar ratio, and should not decrease with the average scale based on the error propagation principle.