Response to Anonymous Referee #3 Comments

The manuscript "The CALIPSO version 4.5 stratospheric aerosol subtyping algorithm" present the changes in the stratospheric aerosol subtyping algorithm, as well as the performance assessment of the updated algorithm for several events. The use of integrated attenuated backscatter color ratio was eliminated, the values of depolarization threshold and low-r' threshold were revised, and ash lidar ratio was updated. The subtypes are also revised, "sulfate" and "unclassified" are used instead of "sulfate/other". Results are promising, and the stratospheric aerosol subtyping is improved. The dataset is interesting, and the manuscript is well written. The manuscript is worthwhile to be published, after addressing all the points raised by reviewers.

In the current version (v4.5), only products from 532 nm are used for the typing (for ash, smoke, sulfate and unclassified), and 1064 nm is not used as it does not seem to provide additional improvement in aerosol typing. Results show removing the color ratio would improve the accuracy of typing. The current aerosol typing is similar by using a single wavelength polarization elastic lidar. Maybe authors can comment on the advantage of using multiple wavelengths, which could be useful for future satellite missions.

Thank you for your excellent suggestions and corrections that you noted. For the request above, indeed, using multiple wavelengths could be useful for stratospheric aerosol subtyping with future missions. The concluding paragraph touches on this: "More sophisticated instrumentation will improve discrimination capability in the troposphere, such as high spectral resolution lidar with depolarization sensitivity at 355 nm, 532 nm, and 1064 nm (e.g., as in Burton et al., 2015) or combined lidar plus passive instrument retrievals." The requested changes for minor comments below have all been implemented.

Please see below some minor comments:

"particulate depolarization ratio" is used in the figures, but the parameter used in the study is the "estimated particulate depolarization ratio", maybe change them to "estimated particulate depolarization ratio" for the clarity (fig3, 6, 7, 8, 13, 18)

The text in the figures is modified to estimated particulate depolarization ratio as suggested.

P7 l181, add "at 532 nm" for the molecular depol

Added. Good call!

P13 l307-308, High depolarization ratio suggests the aspherical shape. Can you clarify which observations suggest the smaller size of smoke particles at higher altitudes, color ratio?

The sentence was clarified as follows, "These observations, primarily representing pyroCb events, suggest that smoke injected to extremely high altitudes contains particles that are aspherical and smaller (based on enhanced depolarization and lower color ratios, respectively) compared to smoke injected to lower altitudes."

P17 l407, why using 20 as the threshold of |CAD score|?

A |CAD score| of less than 20 indicates that the cloud-aerosol discrimination has no confidence in the determination of if the layer is a cloud or an aerosol. It is a standard quality assurance practice to exclude layers having these CAD scores to avoid introducing cloud contamination. In order to make our intention clearer, the sentence is modified as, "In order to remove no-confidence retrievals and any possible cloud contamination, only layers with retrieved lidar ratio uncertainty < 100 % and |CAD score| > 20 contribute to the histogram."

P19 l456, "." is missing before "There is a small".

Added

P19 fig11, the low-r' layers were defined using different thresholds for v4.2 and v4.5, it would good to add such information in the caption.

The caption has been revised to "Low-γ' layers, based on the γ' threshold for the relevant version, are indicated by hatched bars."

P20 l471, in the Fig.S1,3,4, which parameter of unique layers was used, layer mid/top or top-to-base?

The layer top and layer base were used to determine the altitudes that each unique layer spanned. To make this clearer, the captions for Figs. S1, S3, and S4 are changed to: "Horizontal axis indicates number of aerosol samples within each 100 m range bin based on the top and base altitude of each unique layer."

P21 fig12, clarify the version in the caption. (a) change 30 N to 30 S

The caption was changed to "For ash-dominated events in V4.5…" and the latitude limits are corrected (thanks for catching that).

P24 fig15, (d) y-label is missing

The y-label has been added.

P27 l617, change PBL to planetary boundary layer (only used once)

Changed to planetary boundary layer.

Note from the authors on additional changes to the manuscript
- The release date for the V4.5 level 2 data products has changed from 2022 to early 2023. This is now reflected in Sect. 2 and in the Data Availability section.

- We changed the notation for attenuated scattering ratio, discussed in Sect. 2, from R_{mas} to R'. The previous notation was used for consistency with that of Omar et al., 2009. However, we find the R' notation is clearer because the prime indicates it is an attenuated quantity, the consequences of which are now discussed in the section. Further, R' is a common notation for attenuated scattering ratio within the lidar community and is used throughout CALIOP algorithm theoretical basis documents.