

Atmos. Chem. Phys. Discuss., referee comment RC2
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Comment on acp-2021-467

Anonymous Referee #2

Referee comment on "Three-dimensional climatology, trends, and meteorological drivers of global and regional tropospheric type-dependent aerosols: insights from 13 years (2007–2019) of CALIOP observations" by Ke Gui et al., Atmos. Chem. Phys. Discuss., <https://doi.org/10.5194/acp-2021-467-RC2>, 2021

Review of "Three-dimensional climatology, trends and meteorological drivers of global and regional tropospheric type-dependent aerosols: Insights from 13 years (2007–2019) of CALIOP observations" by Gui et al. (Paper #ACP-2021-467).

General Comments:

This study investigated the three-dimensional (3D) climatological distribution of tropospheric type-dependent aerosols using the CALIOP globally gridded aerosol extinction data during 2007–2019. This study focused on filling the limited spatial and temporal coverage of ground-based Lidar, and have significantly improved the comprehensive understanding of the vertical distribution of aerosols and their climatic effects. Moreover, the regional tropospheric type-dependent aerosols and their association with meteorological factors for more than 10 years was provided, which is helpful for pollutant transport, modeling air quality research. Overall, the manuscript is well written, has a complete structure, and has many impressive visualizations presented. However, I think, this paper need some revision before final acceptance. Below are some of my detail comments to the submitted manuscript that I hope the authors can use to improve their study.

Major comment:

- In this study, trends in CALIOP L3 monthly AODs are compared against several other datasets. Although CALIOP is independent in relation to the other four datasets, these datasets are not independent of each other. Two datasets (MERRA-2 and CAMS) are not independent as they incorporate information from both MISR and MODIS retrievals. In addition, there are temporal sampling differences between observations, such as

differences in satellite crossing times. Therefore, it is important for the authors to add more details to this when describing the data and to discuss, as much as possible, the possible influence of these factors on the results. Finally, I'm also interested in whether CALIOP has good synergy with the other datasets over the 12 ROIs.

- There is no doubt that the AOD (especially the AOD within the boundary layer) has a significant diurnal variability. Although CALIOP is the only satellite-based lidar currently operating for more than 10 years, its relatively long cycle time and incomplete global coverage make it difficult to assess the impact of diurnal variations of aerosols on the results of this study. Therefore, it is suggested here that the authors look forward to future work, especially using other observational instruments that enable all-weather observations (e.g., CATS: Measuring Clouds and Aerosols from the International Space Station) to explore the diurnal variability of aerosol vertical distribution and partitioning at different altitudes.
- The conclusion section is too lengthy and the authors should refine the results of this study and highlight the notable contributions.

Specific Comments:

- Line 120, How large is the uncertainty in the vertical extinction profile of CALIPO during daytime and nighttime? Please cite some relevant assessment literature.
- Line 123, 99.99 km^{-1} ? Please check it.
- Line 126, I did not find the eighth QC from this technical literature, please confirm.
- Line 154, Reduce to some extent? Expressions are too absolute.
- Line 156, Remove the extra "-".
- Line 234-235, This wording is slightly unclear. Consider rewording as either "we required that at least 60% of the data in each annual time series be valid before the trend calculations could be performed" or "we needed to obtain at least 60% of the valid data in each annual time series before performing the trend calculations" depending on your meaning.
- Line 255, the author can briefly explain their climate effects, such as absorption?
- Line 255-259, This part of the description should be moved to the method data introduction section.
- Line 329-330 and Line 340-342, Add reference.
- Line 349, the word "studies" could be changed as "study".

11. Line 357, the word "shows" could be changed as "show".

- Line 360, "reaches a maximum value" or "reaches its maximum".
- Line 384, the words "aerosol" could be changed as "aerosols".
- Line 401, "1 %" could be changed as "1.0 %", and the decimal number is unified in the text.
- Line 409, the word "values" can be deleted.

16. Line 472, the word "(i.e., CC and CC)", What are these two CC refer to.

