Review of the manuscript by Chouza et al. “Long-term (1999-2019) variability of stratospheric aerosol over Mauna Loa, Hawaii, as seen by two co-located lidars and satellite measurements”

The paper by Fernando Chouza and coauthors presents two-decades of lidar observations of stratospheric aerosol over Mauna Loa by two well established lidars, both making part of the NDACC network. The Mauna Loa observatory is the only lidar site in the Northern tropics providing continuous stratospheric aerosol observations for over 2 decades, whereas the MLO NOAA aerosol lidar record dates back to mid 1970s. This study is a valuable effort towards a better constraint on the aerosol variability in the tropical stratosphere, a home of the aerosol reservoir. The presented lidar observations reveal perturbations of stratospheric extinction following the moderate volcanic eruptions during the post-Pinatubo era. The study takes advantage of the outstanding capacities and high-altitude location of the MLSOL 355 nm lidar, allowing a decent Raman stratospheric signal, which enables estimation of the lidar ratio. In addition, the synergy of MLSOL and 532 nm NOAA lidar, allows deriving the Angstrom exponent for Vis/UV range, which could eventually serve for aerosol retrievals from Aeolus and EarthCare space lidar missions (both 355 nm) and their homogenization with CALIOP@532nm observation record.

The lidar-based extinction profiles are compared against a recently introduced CALIPSO lidar L3 stratospheric aerosol product, the GloSSAC merged satellite dataset as well as with SAGEIII-ISS observations since 2017. The statistical figures suggest fair to good agreement between the data sets, although with time- and altitude-variable discrepancies, which are briefly discussed.

While the experimental setup and methodological aspects of aerosol retrieval are properly described, the scientific significance is somewhat compromised by an inaccurate attribution of the observed variability of extinction as well as by an unclear representability of the provided case-based estimates of aerosol optical properties. The remarks below are intended to help the article gain the scientific significance and minimize the ambiguous interpretations.

General remarks

1. The attribution of enhanced stratospheric extinctions to the recent volcanic and PyroCb events (Sect. 4.3) is based on very general considerations and may thus be inaccurate. No observational or model-based evidence is provided regarding the detection of smoke from the BC-2017 wildfires at MLO. The authors attribute the SAOD enhancement in late 2019 entirely to Raikoke eruption, whilst totally ignoring the tropical Ulawun eruption that occurred shortly after Raikoke and led to SAOD perturbation of similar magnitude. Please see specific remarks on this matter.
2. I believe it would be very useful to include time-latitude section of SAOD from e.g. CALIOP L3 dataset, which would facilitate the correct attribution of SA variability observed locally by the MLO lidars.
3. Do you perform any sort of cloud screening for lidar data processing? I assume that although rarely, the cirrus clouds may occur as high as 17 km above MLO.

4. The color maps used to present time-altitude variation of extinction makes it somewhat difficult to read the upper panel in Fig. 1 and very difficult to compare the panels in Fig. 8. Would it be possible to use another color map for these panels, e.g. rainbow type?

5. The intercomparison between monthly-averaged SAOD derived from MLSOL and NOAA lidars reveals important discrepancies, strongly varying with time and reaching 100% during quiescent periods. This bias cannot be explained by the different sampling frequency. I believe, the possible reasons for the observed discrepancies between the two well-established and powerful lidars should be carefully discussed. This is particularly important in the context of synergistic use of the lidars for derivation of the color ratio. Could the color ratio for the 532/1064 nm pair be available from the NOAA lidar?

Specific remarks

p.4, l.1. Please specify which wavelength does the provided laser power correspond to.

Fig.1. I wonder if the upper panel could be provided in scattering ratio instead of extinction coefficient, which is reported in Fig. 8 anyway. It would also be useful to slightly expand the time axis in both panels in to order to avoid an impression that SAOD curve is truncated by the axis limits.

p.10, l.20-23. The authors claim that BC-2017 smoke plume could have been observed above MLO already on 1st September, which would require a fast equatorward transport of the plume. Could you be more specific how the attribution of the observed backscatter features is supported by CALIOP and backward trajectories? How do you distinguish between the smoke and cirrus cloud?

p.11, l.1. Do you mean here “slight variations of stratospheric AOD”? What was the maximum altitude of the smoke plumes detected above MLO? For an accurate characterization of the smoke observation by MLO lidars, I would suggest the authors to check the following articles describing the global spatiotemporal evolution of the BC smoke: Khaykin et al., GRL, 2018; Bourassa et al., JGR, 2019; Kloss et al., ACP, 2019.

Fig. 3. It would be very useful to show other examples of aerosol profiles bearing volcanic signals to support the discussion on the altitude variation of the various plumes.

p.11, l.6-7. The top altitude of the plume does not seem to exceed 26 km.

p.11, l.10-11. The enhancements below 21 km could also be attributed to the Ulawun plume. I really don’t think the Siberian wildfires had any contribution to the tropical stratosphere.

Figure 4 is an excellent demonstration of the equatorward progression of the Raikoke plume, which would hardly be possible using trajectory analysis. Could you provide more detail on how the tracking was done using CALIOP L1 data? The latter should probably be introduced in the datasets section as it is exploited for analysis.

p.12., l.9. Please provide an appropriate reference on the Aeolus mission

p.13, l.12-14 and Fig.5 left. I am not sure to understand the point of deriving the color ratio from CALIOP L3 and MLSOL if the former argued to yield systematically higher values compared to MLSOL and SAGEIII. I don’t think these results are worth mentioning at all.

p.14, l.5-8. Please specify the wavelength for which the lidar ratios are provided

Figure 6. I suppose that the backscatter profiles from the two lidars are provided at their native wavelengths. This is controversial with the statement in p.13, l.18. Please clarify.

p.15, l.1-3. “This difference is partly due…” This sentence is difficult to understand and furthermore I am not sure that this small wavelength difference would matter. Please clarify.

p.16., l.7. There is no mention regarding the Angstrom exponent of -1.6 in Sect. 5.

p.16, l.22. The word “slight” is hardly applicable to the differences reported in Fig.9d, which, at the first glance, vary between -50..50%. Please provide quantitative estimates of the differences and ideally a discussion on their possible sources.

p.18,l.3. I don’t think that the differences between long-term averages of MLSOL and NOAA extinction profiles could at all be attributed to the different sampling.

p.20, l.6-7. This sentence should belong to the data availability statement. Normally, all the data assets should be publicly available at the time of writing. While waiting for archival at NDACC, the reprocessed MLSOL data could already be made publicly available through a file-sharing service.

p.20, l.12. “…based on alternative methodologies.” The ascent rates derived from MLSOL measurements are compared to only one study by Minschwaner et al. (2016). What about comparison with ascent rates derived directly from aerosol by Vernier et al., ACP, 2011?

p.21, l.14, l.19. Comparison of the obtained results with published studies should be discussed in the main body of the article, it does not belong to conclusions.

p.22, l.21-22. Please provide the proper links to all data sets used in the study.

Technical correction

p.7, l.25. Replace “periods” by “sessions”

p.8, l.2. Suggested correction: “Several studies focusing on midlatitude refer to the time period between…”

p.8, l.9. « Ulawun »

p.10, l.17 « On 12 August… »

p.12, l.8 « latter »

p.12, l.9 “derived using Raman lidar…”

p.13, l.30. “stratospheric”. Replace “during” by “after”.

p.14, l.1 replace “high receiver aperture” by “large receiver”

p.14, l.4-5. “A well defined plume…was found at…”

p.14, l.10. “Intercomparison of…”