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Discussions

Interactive comment on "Variability and evolution of mid-latitude stratospheric aerosol budget from 22 years of ground-based lidar and satellite observations" *by* Sergey M. Khaykin et al.

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The OHP lidar data presented in the ACPD version of the article are restricted to the altitude range between 15 and 31 km. The lower boundary (15 km) is justified in the article in consideration of the signal saturation issues (recalling that the lidars are optimized for the stratosphere) and the presence of cirrus clouds above OHP up to 14 km. In Sect.3 (Intercomparison of OHP lidars and satellite sounders) it was pointed out that the aerosol extinction profiles obtained by the lidars are high-biased with respect to the satellite profiles below 17 km and the bias increases with decreasing altitude (Fig. 2). The same inference could be made on the basis of Fig. 6 and 7, where the lidar data are qualitatively compared with those of CALIOP. Several questions were raised

by the referees, which regarded the OHP lidar data quality in the lowermost stratosphere (LMS) and the reasons for the overestimation of aerosol backscatter/extinction below 17 km by OHP lidar (as could be inferred from the comparison with CALIOP). Referee #1 noted some inconsistency in the mention of altitude range limitation for the lidar aerosol retrieval and questioned the proposed explanation of the LMS discrepancies. Referee #3 expressed concerns on the consistency between OHP and CALIOP data presented in Fig. 6. In addition, a short comment posted by M. Fromm raised a question regarding the absence of signatures of the Sarychev plume above 20 km in an ensemble of vertical profiles reported in Fig. 4. The received remarks led us to revisit the OHP lidar data and investigate the issues with the data at lower altitudes. It was found that a large fraction of the aerosol profiles were affected by overcorrection for the signal saturation, which resulted in a positive bias below about 17 km, increasing towards the tropopause level. Figure AC1.1 shows how the overcorrection for the signal saturation affects the retrieval of a single scattering ratio profile. The red dashed ("overcorrected") profile, while being identical to the correctly retrieved profile above 20 km, exhibits a significant positive bias in the LMS. The incorrect retrieval had a minor effect on the integrated aerosol optical depth above 17 km (sAOD1730), a fair effect on the sAOD1519 series and a major effect on the data below 15 km. Thus, all the lidar data had to be fully reprocessed using the correct parameters applied to signal treatment, which yielded reasonable data down to the tropopause. The revised LiO3S AOD series differ from the initial ones on average by +1.9% (sAOD1730), −16.9% (sAOD1519) and −34.6% for the AOD between the tropopause and 15 km. It should be clarified here that while the study makes use of two different OHP lidars (LiO3S and LTA) only the data of LiO3S could be recovered down to the tropopause. The LTA system, being optimized for the middle atmosphere, could not be used to obtain useful information on the aerosol in the LMS. In addition to the improved signal treatment for both lidars, the resulting data have been subjected to a manual profile-by-profile screening and filtering of cirrus clouds occurring around the tropopause. A particular attention was given to the periods of volcanic plumes sampling, namely the detection of Okmok, Sarychev and Nabro plumes. This effort showed that a semi-automated screening procedure applied to the initial version of the data has left behind some of the useful measurements, e.g. a strong aerosol peak at 21.5 km originating from the Sarychev eruption or an early detection of Nabro plume (15 days after the eruption as opposed to 45 days reported initially). All the analysis involving OHP lidar observations as well as the respective figures and tables have been updated using the reprocessed data set. The lower boundary of all the plots that show aerosol vertical distribution have been extended below 15 km. While the scientific interpretation of the results remains intact, the reprocessed OHP data appear more consistent with those of CALIOP in the LMS and the updated figures provide a better insight into the annual cycle of aerosol in the lowermost stratosphere and its long-term change. The reprocessed data induced a number of changes to the figures, tables and text. Most of them are mentioned in the replies to reviewers. We provide below the list of the most important changes that were made beside the revision suggested directly by the referees.

Changes to figures. Fig. 1. The lidar monthly-mean series appears somewhat less noisy Fig. 2a.b. Lower altitude limit extended down to 12 km, LiO3s extinction profiles no longer exhibits a positive bias compared to satellites. LTA extinction profile is removed from the figure. Fig. 3. Mean OHP lidars sAOD1730 appears less noisy Fig. 4a,b. Lower altitude limit extended down to 12 km, dates of first detection corrected, color scale revised, new (previously discarded) profiles included. Fig. 5. Lower altitude limit extended down to 13 km, average SR profile for the "reference" period (solid black) no longer shows positive bending in the LMS Fig. 7a,b Lower altitude limit extended down to 13.5 km, color scale adjusted to better demonstrate the annual pattern. Fig. 7c. Lower altitude limit extended down to 13.5 km Fig. 8a. In addition to some minor alteration of the month-altitude pattern of the AOD change related to the new reprocessing, the updated plot is fixed in terms of the vertical scaling, which was found to be wrong for the initial version of the plot.

Principal changes to the text Section 3 (Intercomparison of OHP lidars and satellites

sounders). Paragraphs 1-2. All the figures obtained on the basis of OHP lidar data have been updated Last paragraph. The discussion around Fig. 2 showing intercomparison of extinction profiles has been fully revised. Section 4 (Volcanic plumes and quiescent periods) Discussion around Fig. 4 showing the detection of Sarychev and Nabro plumes (Sect. 4.2.1) has been entirely revised. The period posterior to Merapi eruption is excluded from the list of volcanically-perturbed periods for OHP. The mention of it in Sect. 4.4 (last paragraph in former Sect. 4.1) has been removed. Section 5.1 (Annual cycle) Paragraphs 3-5 discussing Fig. 7a and 7b have been revised following the changes in Fig. 7.

Changes to tables. Table 2 (former Table 1). The intercomparison figures involving OHP data have been updated: the new values of relative difference and correlation coefficients indicate slightly improved agreement. Table 3 (former Table 2). The period posterior to Merapi eruption is excluded from the list of volcanically-perturbed periods for OHP.

Please also note the supplement to this comment:
http://www.atmos-chem-phys-discuss.net/acp-2016-846/acp-2016-846-AC1-supplement.pdf

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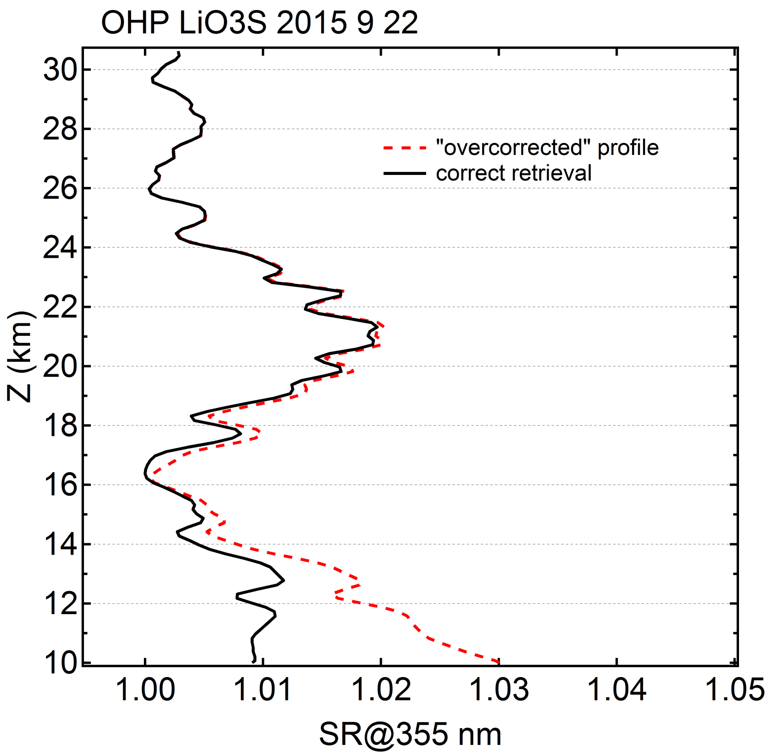

Fig. 1. Figure AC1.1 Vertical profiles of scattering ratio @ 355 nm from OHP LiO3S lidar showing the effect of overcorrection for signal saturation on the aerosol retrieval in the lower stratosphere.