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Atmospheric Measurement Techniques Discussions

Interactive comment on "Comparison of NLC particle sizes derived from SCIAMACHY/Envisat observations with ground-based LIDAR measurements at ALOMAR (69° N)" *by* C. von Savigny et al.

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Reply to comments by reviewer 2

First of all we thank both reviewers for their (overall) positive and constructive comments. We followed the comments and suggestions in almost all cases, and believe that the manuscript has improved considerably. Our detailed responses are listed below. Our responses are italicized.

General Comments:

This manuscript presents a comparison between NLC particle sizes derived from SCIAMACHY limbâĂŘscanning measurements and ground based lidar measurements obtained from the ALOMAR facility. This is a difficult comparison to make, primarily because the two data sets are obtained using very different measurement techniques, and have very different spatial and temporal sampling characteristics. Nevertheless the authors have done a thorough job of trying to account for these differences to compare the particle size retrievals in a meaningful way. When these differences are accounted for good agreement is found between the two data sets. The paper is generally well written and clear in its presentation of the measurements and the analysis. The conclusions are straightforward and I have no significant objections to the analysis used. I recommend that the paper be published, but offer some comments below for the authors to consider.

Specific Comments Questions:

Section 3

1) The single most important factor in obtaining a consistent agreement between the SCIAMACHY and ALOMAR data sets seems to be using the right width in the assumed size distribution for the SCIAMACHY retrievals. To this reviewer the argument presented to justify the rather large distribution width (24 nm) based on the sampling volume of the SCIAMACHY measurements at first did not make sense. But with more thought the reasoning seems sound. For completeness I think it would be good to show the sensitivity of the SCIAMACHY particle sizes to this parameter. For example, if you had just used the mean ALOMAR width parameter of 17 nm how much would the particle sizes change?

We agree with the reviewer, that the retrieved sizes based on a width of 17 nm should be mentioned in the paper. This is now mentioned and discussed in section 5 (discussion).

2) The size distribution width assumed in the SCIAMACHY analysis should be stated

in the abstract for completeness.

Done

3) It would be useful to have more information on the instrument degradation mentioned at the very end of this section. Although a reference is provided to Robert et al. [2009] the current paper should be clear whether this degradation contributes to errors in the SCIAMACHY particle sizes or not.

We added a short paragraph explaining the basic principle of the degradation correction we used. The random error of the derived degradation correction exponents is very small, because of the large signal-to-noise ratios associated with the solar occultation observations used for the throughput monitoring.

Section 4

4) Regarding the subset selection for the coincidences, the SCIAMACHY footprint at ALOMAR latitudes is at most 25 degrees wide in longitude. It seems to me that allowing a 16–degree offset between the ALOMAR location and the center of the footprint would sometimes put ALOMAR outside the satellite footprint. I am assuming that the orientation of the SCIAMACHY footprint is fairly reproducible from orbit to orbit – am I missing something?

The reviewer is of course right that Alomar will sometimes be outside the satellite footprint. As with almost all other validation of comparison studies the choice of co-location criteria is arbitrary to a certain extent. We used different test criteria, but decided to go with the $\pm$16 deg longitude range in order to have a sufficient number of collocations. And we decided to use a larger longitude range, because we expect the latitudinal gradient in particle size to be larger than the longitudinal gradient.

5) The paper does not state what altitude is used is used from the SCIAMACHY profile for doing the Angstrom coefficient fit. Presumably the altitude of the peak in the scattering profile is used, but this should be stated. Because of the coarse vertical sampling

of SCIAMACHY this altitude will generally not coincide with the peak altitude seen by the lidar? How does it compare in general? Since the sampling is 3.3 km, the peak SCIAMACHY altitude could easily be either below the lower lidar altitude or above the upper one. In these cases does the weighted mean defined in Eq (4) still make sense?

We agree with the reviewer, that it should be mentioned what tangent height is used here. It is indeed the tangent height with the largest NLC radiance, which is 82.2 km on average. This is now mentioned in section 3.

Section 5

6) Can you state explicitly how the lidar data are averaged for the yearlyâĂŘaveraged comparisons shown in figure 4 and table 1? It's not clear to me what constitutes a lidar "observation", since the instrument operates continuously. Are these daily averages?

The LIDAR is in principle operated continuously, but depending on tropospheric cloudiness and the presence of NLCs there are gaps in the LIDAR particle size time series. Furthermore, only 1 in 5 (1 in 10 before 2005) observations is a multi-colour observation allowing particle size retrievals. The yearly-averaged LIDAR observations are averages over all LIDAR measurements within a given year. The LIDAR particle sizes are first averaged for the 3 altitude ranges (above, at and below the brightness peak) individually, followed by the determination of the altitude weighted size based on these averaged values for the 3 altitude ranges. Note, that the number of LIDAR observations contributing to the yearly averages is also listed in the 4th column of Table 1.

7) Also, can you comment on why there are so few SCIAMACHY same-day coincidences with ALOMAR? I would think that if the lidar is operating continuously during the PMC season you would essentially get a temporal coincidence every time the SCIAMACHY footprint met the geolocation criteria. What am I missing?

Although the LIDAR is operated continuously, size retrievals are not available for every day. Before 2005 only one in ten measurements was a multi-colour measurement

allowing particle size retrievals. In 2005 the fraction increased to one in five measurements. Additionally, about 60% of the LIDAR observations are affected by tropospheric clouds.

Furthermore, size retrievals above ALOMAR from SCIAMACHY are not available for every day. There are limb measurements fulfilling the co-location criteria every day, but there may be no cloud in the field of view, or it may be not strong enough for a particle size retrieval to be performed. The limited number of same – day coincidences is therefore simply due to gaps in both the SCIAMACHY and LIDAR time series.

We added a short paragraph to section 5 discussing the reasons for the relatively small number of coincidences.

8) I am assuming that all the results shown here assumed spherical particles and a Gaussian distribution of width 24 nm for the SCIAMACHY retrieval. However, this is not stated explicitly in the discussion of figures 3-6 and I think it should be.

All the SCIAMACHY results (The cases presented in Table 2 are the only exceptions) shown in Figs. 3 — 6 are based on cylindrical particles, a Gaussian size distribution of width 24 nm. This was already explicitly mentioned in section 3 (paragraph below equation 1), as well as in the caption of Fig. 3. In order to make this clearer, we added an additional statement at the beginning of chapter 4.

9) When discussing the sensitivity of the retrieved particle size to the assumptions made about the underlying size distribution, I think it would be instructive to quote how the SCIAMACY result would change if you just used the mean distribution width derived by the lidar (17 nm) rather than the smeared out distribution width of 24 nm. Presumably this would give much smaller particle sizes from SCIAMACHY.

Using a width of 17 nm leads to larger SCIAMACHY particle sizes – not smaller, as suggested by the referee – compared to a width of 24 nm. We now discuss this in the manuscript in section 5 (Discussion). The mean particle size increases by about 18

nm to 74 nm, when decreasing the width from 24 nm to 17 nm.

Interactive comment on Atmos. Meas. Tech. Discuss., 2, 1161, 2009.