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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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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. Note, that our responses are italicized.

Reply to comments by reviewer 1

General Comments: This paper attacks the difficult job of comparing PMC particle

sizes derived from satellite and ground based measurements. The authors are successful and have shown innovation in their approach. The differences in the observational aspects of the two instruments (SCIAMACHY and LIDAR) provide a challenge to the comparisons. The two issues that are most important are the differences in the vertical and horizontal resolutions of the instruments. In my view, the vertical resolution issue is handled properly. The horizontal resolution issue is more critical in some ways and needs more explanation in the text. I will explore this more in my detailed comments. Finally, assuming the validity of the assumptions used, the results show good agreement between the measurements. I also see a potential issue in the results where there appears to be a bifurcation that is not discussed in the text.

1) Specific comments: Abstract: A statement of the adopted width of the distribution should be given.

Done

2) Introduction: I think the results from other papers should be at least quoted here. The two I think should be mentioned in addition to those summarized are:

Rusch, D.W., S.M. Bailey, G.E. Thomas, and A.W. Merkel, Seasonal Variation of PMC Particle Size from SNOE UV Measurements for the Northern 2000 and Southern 2000/2001 Seasons, Journal of Atmospheric and Solar-Terrestrial Physics, 70, 2008.

Bailey, M. Scott, Gary E. Thomas, David W. Rusch, Aimee W. Merkel, Chris Jeppesen, Justin N. Carstens, Cora E. Randall, William E. McClintock, and James M. Russell, III, Phase Functions of Polar Mesospheric Cloud Ice as Observed by the CIPS Instrument on the AIM Satellite, J. Atmos. Solar-Terr. Phys., doi:10.1016/j.jastp.2008.09.039.

Both papers were included in the introduction

3) Section 3, eqn 1: Please define the variables in the equation.

Done

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4) Section 3, discussion of adopted distribution width: The adoption of the 24 nm width, which is significantly larger than that derived by the LIDAR measurements, needs more discussion and support. My concern is that the derivation is not as simple as described, especially since you state in Section 5 that the scattering cross section, and thus the scattered radiance, scales with the 5th power of the particle radius. This seems to indicate that the derivation of σ_{scia} is very non-linear with particle size. Please clarify.

*We appreciate the reviewers comment and try to better justify the approach used. We first discuss the determination of the effective width of 24 nm used for the SCIAMACHY NLC particle size retrievals. The potential issue related to the 5th power scaling is discussed after that. The main reason for adjusting the width used for the SCIAMACHY particle size retrievals is the large difference in sampled air volumes (or horizontal areas). The horizontal area sampled by the LIDAR for an individual observation is about 20 m by 30 km, whereas the area covered with a single SCIAMACHY limb observation corresponds to 400 km by 1000 km. The LIDAR observations resulted in a mean width of the assumed normal particle size distribution of 17 nm. Furthermore, the standard deviation of the mean sizes for all individual LIDAR particle size retrievals is also 17 nm. Therefore, we can imagine the air volume sampled by SCIAMACHY to be composed of the much smaller air volumes sampled by the LIDAR for which the width of the size distribution is 17 nm, and the standard deviation of the mean sizes for each LIDAR volume is also 17 nm. The effective width seen by SCIAMACHY is then (17**2 + 17**2)**0.5 = 24 nm. In order to back up this approach, we performed Monte-Carlo simulations, where we superimposed normally distributed random variables with 17 nm width and with mean sizes which are also normally distributed with 17 nm width. Using this approach the effective width used for our comparisons can be confirmed with arbitrary accuracy, if the ensemble size is chosen large enough.*

A short paragraph describing these aspects was added to section 3.

Regarding the 5th power scaling issue we don't see an issue here. The larger particles will of course contribute more to the overall limb signal (as they do for the LIDAR signal),

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but if the assumed particle size distribution is correct – this is an assumption one has to make of course – then the correct mean particle size can be retrieved, although a certain fraction of the particle population will contribute close to nothing to the observed limb radiance.

A similar argument holds for the LIDAR retrievals that provide both the mean radius and the distribution width. The LIDAR observations are not equally sensitive to all particle sizes occurring in the particle size distribution, but assuming that the assumed distribution is correct, the true size distribution parameters can be retrieved (within experimental error bars).

5) Section 4.1: You state "This implies that the retrieval ... for the descending part of the orbit." Would you please quantify this statement? Is the difference significant?

As Fig. 1 illustrates the Angstrom exponent for the ascending part observations will only change by 0.5 when increasing the particle radius from 20 to 70 nm. For the descending part observations this radius change will lead to a difference in Angstrom exponent of 1.5. This explanation was added to the text. We realized that the "much" in "is much less sensitive" is probably not justified, and removed it.

6) Section 5, 1st par: Here you state the 5th power dependence of the cross section. Please refer to my comment wrt distribution width determination.

See our response to point 4) above.

7) Section 5: The discussion of Figure 6 does not provide us with an explanation of the obvious bifurcation of the results along the SCIAMACHY axis. The vertical spread in the results is also very large. Would you comment on these issues, especially the bifurcation? Thank you.

We agree with the referee that the bifurcation should be mentioned in the discussion. We currently have no complete explanation for the occurrence of this bifurcation, but it can likely be attributed to the small size of the sample, because if the NLC particle size

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retrievals for all ALOMAR overpasses are considered, then the "gap" for sizes between 50 and 60 nm disappears. Regarding the vertical spread, we attribute this to the large intrinsic variability in NLC particle sizes and NLCs in general in combination with the relatively small spatial scales sampled by the LIDAR.

We added a paragraph discussing these aspects to the part of section 5 dealing with the results shown in Fig. 6.

8) Typing and other issues: Abstract: I would replace the 1st sentence with the following: SCIAMACHY, the Scanning Imaging Absorption spectrometer for Atmospheric CHartographY, provided measurements of limb-scattered solar radiation in the 220 to 2380 nm wavelength beginning in the summer of 2002.

Thanks, after thinking about since sentence and asking native speakers, we decided to change the sentence to "SCIAMACHY has provided ... since summer of 2002.". We believe present perfect should be used, because SCIAMACHY is still operational. We hope this is correct?

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