

Interactive comment on “Observations and analysis of polar stratospheric clouds detected by POAM III and SAGE III during the SOLVE II/VINTERSOL campaign in the 2002/2003 Northern Hemisphere winter” by J. Alfred et al.

Anonymous Referee #1

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General Comments:

The paper by Alfred et al. presents the first integrated POAM and SAGE III analysis of Polar Stratospheric Cloud (PSC) occurrence by using a unified method of PSC detection. The method is presented in detail and has been applied very carefully to the two datasets. Despite the sensitivity for PSC detection of both instruments looks slightly different the unified method results in consistent statistics, as well in comparison to other analyses and satellite observations in the literature over the same winter. The temperature dependence of the PSC observation frequency in respect to the Ni-

tric Acid Trihydrate saturation point have been used to infer irreversible denitrification over the entire winter, with levels up to 80% by early January between 400 and 550 K potential temperature.

The paper is clearly structured and the presented results are well described. However, parts of the section on denitrification can be improved and additional references should be addressed. Some figure captions are not completely clear to me. As well some more detailed questions to different topics should be addressed. Details and suggestion are described below.

Main Comments:

It is very positive that the authors discuss in detail the PSC temperature relationship and their uncertainties. However parts of the discussion are confusing and overloaded by details.

Inferring the denitrification by the change PSC occurrence is a very nice tool. However, this method has limits. It would be very valuable to compare the presented analysis to the work of Davies et al. (2006), where the authors have compared model results including denitrification and microphysical formation and sedimentation of particle with HNO₃ observations of the MIPAS instrument on ENVISAT for exact the same winter. To use the method as a tool for other satellite measurements to analyse long Arctic denitrification record - like suggested in the summary - it would be necessary to validate the method in more detail, e.g. in comparison to more global-like HNO₃ measurements by satellites (MLS or MIPAS) and models. The latter might help to close the gap to regions of the polar vortex not observed by the satellites but definitively important regions to get the total budget of denitrification correctly. Because such an extensive analysis is out of scope of the paper, the authors should address the limits of the denitrification analysis method more carefully (e.g. in the last section of summary).

Specific comments:

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The paper is missing a more general introduction on the PSC types and e.g. why T_{NAT} is an important threshold temperature.

P11396: A maybe more detailed description of the winter 2002/3 than in the Manney et al. 2005 paper is given in Naujokat and Grunow (2003).

P11397: It is not clear to me how the authors defined a background profile (BG). Any enhanced extinction profile due to a PSC will enhance the BG values. Is there any cloud clearing beforehand the BG computation? For example, in the SH winter it might be very difficult to find inner vortex non-cloudy profiles at all, because part of the winter the whole vortex will be filled with PSCs.

P11398: because the Randall et al reference is so far not published and the results are very important for applied method it would be helpful to present a few more details about the reasons of the POAM/SAGE bias.

P11399: Could any disagreement in the profile comparison caused by systematic altitude offsets/errors. Is there a noticeable tangent height error for the instruments. If yes, then please specify.

P11400: Fig. 5 description, can not a different viewing direction for both instruments to the coincidence region cause differences in the extinction profile shapes and absolute values?

Fig. 7.: The SAGE statistics show a kind of bimodal distribution with a local maximum at $T_{\text{NAT}} = 0$ K, not obvious in the POAM data. Any idea why this peak has formed, is it a specific region of the vortex and why it is not in the POAM data?

P11402: That Poole et al. observed a similar behaviour is not surprising, due to the fact that they used SAGE III data as well, but Spang et al. analysed MIPAS data. To my mind the different instruments should be noted, to highlight the differences in the measurement technique and/or analysis method.

P11403: The PSC type differentiation method is not well described. To my knowledge

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the method is mainly sensitive to the size of the particles, or not? If so, then this should be mentioned. Finally, can the authors draw some conclusions from the PSC type occurrence over the winter? Is the method sensitive to NAT rocks? This would give direct indication for denitrification. Is the method able to differentiate clouds of small NAT particles from STS clouds? If not, the drawn of conclusions from the analysis are limited.

P11405-07: The discussion on the Type 1a to 1b ratio is confusing and the type differentiation might have limits, which causes error in the analyses. I would suggest to condense the discussion and to focus on the main results.

Technical corrections:

The abstract should include the wording for NAT

Introduction last sentence: ‘ temperatures are used TO infer’

P11408: You describe the short cut HAGAR but not SIOUX, this is inconsistent.

P11407: What’s HiZmin? Please clarify.

Fig.8: In my print-out I cannot find blue vertical lines for saturation in respect to ice.

References:

S. Davies, G. W. Mann, K. S. Carslaw, M. P. Chipperfield, J. J. Remedios, G. Allen, A. M. Waterfall, R. Spang, and G. C. Toon, Testing our understanding of Arctic denitrification using MIPAS-E satellite measurements in winter 2002/2003, *Atmos. Chem. Phys.*, 6, 3149-3161, 2006

Naujokat, B. and Grunow, K.: The stratospheric arctic winter 2002/03: Balloon flight planning by trajectory calculations. *Proceedings of the 16th ESA Symposium on European Rocket and Balloon Programmes and Related Research*, St. Gallen 2003 (ESA SP-530), 421-425, 2003.

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