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Interactive comment on "Testing our understanding of Arctic denitrification using MIPAS-E satellite measurements in winter 2002/3" *by* S. Davies et al.

Anonymous Referee #2

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Review of the manuscript submitted to ACPD "Testing our understanding of Arctic denitrification using MIPAS-E satellite measurements in winter 2002/3", by S. Davies, G. Mann, K. Carslaw, M. Chipperfield, J. Remedios, A. Waterfall, G. Allen, R. Spang, and G. C. Toon

General comments

The paper presents the ability of the DLAPSE/SLIMCAT model to reproduce the evolution of denitrification inside the polar Arctic vortex during the early phase of the winter 2002/3. During that winter, very cold temperature occured which gave favorable con-

ditions for PSC formation and possible denitrification. The results of the model have been compared to single observation from balloon-borne MarkIV interferometer and to the MIPAS-E observations which were for the first winter available after the ENVISAT launch on March 1, 2002. The study is mainly restricted to the first period of the winter, that is December 2002 until early January 2003.

The objective of the study is to test if the timing and the spatial distribution of the observed denitrification is correctely reproduced by the four main model simulations, in which various denitrification schemes using different microphysical or equilibrium parameters are used.

For the comparison with MIPAS, denitrification in the model is deduced from HNO3-passive NOy while denitrification in MIPAS data is estimated by the difference HNO3 - NOy* where NOy* is determined from a correlation with N2O measured also by MIPAS.

For the comparison with MarkIV which measures most of the NOy species, denitrification in the model is deduced from NOy-passive NOy while denitrification in MarkIV data is estimated by the difference NOy -NOy* .

The author conclude that DLAPSE model is broadly able to capture both the timing and the spatial distribution of the observed denitrification. The onset of denitrification can be explained by the formation, growth and sedimentation of NAT particules indicating that the NAT formation mechanism is correctely understood now.

The paper is well written and well organised. After an enhancement of the paper concerning some specific comments and few clarifications, it can be recommended for publication in ACP.

Specific comments:

MIPAS-E:

The author are using version 4.53-5 of MIPAS-E data. I thought that the official MIPAS-E data were version 4.61 and 4.62. Are the results similar with the “official” versions?

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A CI-threshold of 2.0 has been used. How does this value influence the results? If using a threshold of 1.8 like it is implemented in MIPAS operational processing, does the comparison change?

Comparison with MarkIV:

Figure 3 shows very nice comparison between denitrification from MarkIV and the four outputs from the model. I suspect that the legend is wrong and I had big difficulties to follow the demontration in the text reading the figure. For me E1 should correspond to orange colour and E2 to red. (which are the colour used for E1 and E2 in fig 4) . Considering that E1 is orange, I agree that equilibrium model E1 better matches the observed denitrification from MarkIV and that both E1 and E2 overestimate denitrification between 550 and 650K. But I do not agree that E2 better reproduces the observed re-nitrification. For me the better agreement in re-nitrification with the observed black plot is the orange one and not the red one.

I think that a good coherence between text, plot and legend is needed.

Spatial distribution of denitrification:

In this section and in figure 5 the author compare the modelled spatial distribution at 505K in run M2 and E2 with Mipas-E. But as shown in figure4 the agreement at 505 K is better with E1 than with E2. Why use the equilibium model E2 which shows already a large difference?

The bimodal mode seen with M2 model is not obvious in MIPAS (may be it is due to the scale used?). Has the same comparison been done with E1? Does E1 simulate a bimodal mode? In fact, what does this bimodal mode represent?

Conclusion:

One of the conclusion is that the best fit to observations was achieved using M2 microphysical denitrification sheme with high nucleation rate. Another conclusion is that the equilibrium denitrification sheme tend to denitrify 10 days too early. I think that it is

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specially true for E2 model with small velocity and small equivalent radius conditions, but it is not so clear for E1. Can you comment?

Technical corrections:

Page3: line 77 “decrease in HNO3 did not occur over the Arctic” and not “ over the over the Arctic”

Page3: line 79 “coverage is restricted to 80 degrees” and not “is restricted is limited to “

Page 5: line 126 I propose to remove “ in a retrieval “ from the text as it is also indicated just above that the “PSC particules may impact on the retrieval of both species”.

Page 16: line 471: “considerable differences in the spatial distribution are apparent” and not “ the spatial distribution of distribution”

Fig 1: caption of 1c not clear: why not write renitrification in front of postive values and denitrification in front of negative values

Fig 3: E1 should correspond to orange colour and E2 to red. The colour for each run should be the same for figure 3 and 4.

Interactive comment on Atmos. Chem. Phys. Discuss., 5, 10997, 2005.