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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.

S. Davies et al.

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We thank the referees for the useful comments made and have updated the manuscript accordingly. Our replies follow:

1. NO_y Partitioning

   The referee points to the relationship of HNO_3 to NO_y. We should have been clearer in section 2.4 and have amended the paper accordingly. The period in question is important in this discussion. In the Arctic mid-winter period of 2002-03 from early December to early January, we have examined the model

fields for both descent and partitioning and find that HNO_3 is by far the dominant component of NO_y at both 465 and 505 K.

We have included an additional figure which shows a frequency distribution of the difference between modelled NO_y and HNO_3 at all valid MIPAS observation locations for the December and early January period. The mean offset between NO_y and HNO_3 in the model is $<$1 ppbv and the maximum difference is 1.5 ppbv. The result described here is for model run M2 but the result is not dependent on the model run used. Therefore we have confidence that HNO_3 is an excellent proxy for NO_y in the model for the mid-winter period and limited altitude range studied.

Independent observations of HNO_3 and NO_y partitioning are sparse. In-vortex observations from the MarkIV balloon during the mid-winter period of this study (December 16, 2002) also show that HNO_3 is an excellent proxy for NO_y. Below $\sim$570 K, the offset between observed HNO_3 and NO_y is $<$1 ppbv.

The Tsidu paper referred to by the referee studies a few days around the period of the Antarctic winter of 2002 which are quite different in character (namely the study of an early spring period in an Antarctic winter with strong descent in a period of considerable vortex warming prior to a major vortex split). The technique is not intended to cover such extreme dynamical conditions. In the study, we only apply the technique until January 10, 2003 which was before the first major deformation of the polar vortex when it split on January 14. We therefore believe that the Popp et al. relationship is a good guide to NO_y between 400 to 550 K in the cold and highly processed early- to mid-winter Arctic vortex.

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2. PSCs

We agree with the referee that some sequestration of HNO_3 into thin PSCs (CI>2) cannot be excluded but we can estimate the maximum impact of such processes from the model and we find that the mean amount of condensed HNO_3 between T_{NAT} and T_{NAT}-2 K is ∼1 ppbv. The majority of condensed HNO_3 is in the form of NAT rather than locally-sequestered STS in the model.

We have included an additional figure showing the frequency distribution of modelled NAT-phase HNO_3 at all valid MIPAS observation locations for the December and early January period. Using the more strongly denitrified model run, M2, we find that the model very rarely (∼10 occasions) predicts HNO_3 condensed as NAT at MIPAS observation points to be between 1 and 2 ppbv. The more weakly denitrified model run, M1, would show slightly less condensed HNO_3. We have also calculated the mass of HNO_3 locally sequestered into STS at MIPAS locations in the model (following Carslaw et al., 1995) and using analysed ECMWF temperatures. We find the mass of HNO_3 locally sequestered into STS at MIPAS locations to be <0.2 ppbv in all cases where T>T_{NAT}-2 K and CI> 2.

Furthermore, we have examined the dependence of HNO_3 anomalies relative to a tracer correlation from early November (N_2O/CH_4) versus cloud index and find that for CI>2 there is no evidence from the data for uptake greater than ∼1 ppbv which is consistent with the model. A manuscript describing in detail this procedure is in preparation and should be submitted shortly. These upper limits to the uptake should be compared to the strength of the denitrification signal which is of the order of 8 ppbv or more in late December. We have amended the paper in sections 2.1 and 3.2 accordingly.

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3. Minor comments

The amendments to the bibliography have be carried out in accordance with the useful suggestions of the referee.

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