

Interactive comment on “3-D microphysical model studies of Arctic denitrification: comparison with observations” by S. Davies et al.

S. Davies et al.

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We thank Referee 1 for their positive comments and will update the manuscript accordingly. Our responses to their comments as follows:

1) It is true that the model results presented in earlier work (Mann et al, 2002, 2002) contained no chemistry. The aim of this work was to evaluate the new kinetic denitrification scheme in an idealised environment. All the model results presented in this work utilise the full SLIMCAT stratospheric chemistry scheme coupled to the microphysical denitrification model.

2) It is true that the timing of model output is 12UT and temporal interpolation to the observations are not performed. We will perform the required interpolations and amend

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any figures as necessary.

3) The absence of denitrification in Fig. 7 is due to the location of sampling of the vortex by the ER-2. The duration of encounters with re-nitrified air was short in comparison to the time spent in denitrified (or non-denitrified) air. Therefore, the probabilities of such encounters are below the threshold of the diagram. Fig.3 and Fig. 5 provide an indication of the brevity of these encounters.

4) This point is also addressed by Referee 2. Fig.8 indicates the difficulty of initialising a global 3-D CTM from a single in-vortex Mark IV balloon profile. We feel confident that the initial model NO_y inside the vortex is sufficiently accurate in the region of interest (350-600 K) to allow reasonable conclusions to be made about the performance of the model. The initial NO_y in mid-latitudes appears relatively poor by comparison. However, studies by Greenblatt et al (2002) for this winter indicate that the vortex was well isolated from mid-latitudes throughout the period of the comparison (January - March).

5) Only model NO_y was adjusted from Mark IV observations. This will be clarified in the text.

6) The factor of 4 was found from a sensitivity study. The sensitivity study was carried out using a transport-only version of the model due to the computational constraints involved in full-chemical and microphysical simulations. This increased nucleation rate has been used in the Voigt et al. (2004) study of NAT particle formation during the 2002/03 Arctic winter. We are in the process of comparing the sensitivity of the model denitrification to nucleation rates described here with observations of denitrification from 2002/03 winter. It seems that the higher nucleation rate produces better agreement with both MIPAS and SIOUX observations of denitrification in this winter.

7) The warm bias in the 31-level ECMWF operational analyses during the 1994/95 winter were reported by Knudsen (1996). The Waibel et al. (1999) modelling study of denitrification during this winter also applied a correction to their model to account for this bias. The reported bias for 1996/97 is much lower at 0.25 K below 40 hPa

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(Knudsen, 2003). The improvement is attributed to corrections applied to the sonde assimilations in the 96/97 winter (Lait, 2002).

The technical correction to the caption in Fig 13 will be amended.

Any typographical errors will also be corrected.

Other errors which I would like to correct before publication in ACP:

a) p348, line 18, "although the lack of observations north of 67N make it difficult ..." should be more precisely "although the lack of observations north of 67N in the beginning of February make it difficult ..."

b) Fig. 13a should be 11 February rather than 25 February and the error identified above will also be corrected.

Davies, S et al., Modeling the effect of denitrification on Arctic ozone depletion during winter 1999/2000, *J. Geophys. Res.*, 107, 8322, doi:10.1029/2001JD000445, 2002

Greenblatt, J.B. et al., Tracer-based determination of vortex descent in the 199-2000 Arctic winter, *J. Geophys. Res.*, 107, 8279, doi:10.1029/2001JD000937, 2002

Knudsen, B.M., Accuracy of Arctic stratospheric temperature analyses and the implications for the prediction of polar stratospheric clouds, *Geophys. Res. Lett.*, 23, 3747–3750, 1996

Knudsen, B.M., On the accuracy of analysed low temperatures in the stratosphere, *Atmos. Chem. Phys.*, 3, 1759–1768, 2003

Lait, L.R., Systematic differences between radiosonde instruments, *Geophys. Res. Lett.*, 29(10), 10.1029/2001GL014337, 2002

Mann, G.W. et al., Polar vortex concentricity as a controlling factor in Arctic denitrification, *J. Geophys. Res.*, 107, 4663, doi:10.1029/2002JD002102, 2002

Mann, G.W. et al., Factors controlling Arctic denitrification in cold winters of the 1990s,

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Atmos. Chem. Phys., 3, 403–416, 2003

Voigt, C. et al., Nitric acid trihydrate (NAT) formation at low NAT supersaturations, Atmos. Chem. Phys., 4, 8579–8607, 2004

Waibel, A.E. et al., Arctic ozone loss due to denitrification, Science, 283, 1756–1758, 1999.

Interactive comment on Atmos. Chem. Phys. Discuss., 5, 347, 2005.

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5, S227–S230, 2005

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