

Interactive comment on “Factors controlling Arctic denitrification in cold winters of the 1990s” by G. W. Mann et al.

Anonymous Referee #1

Received and published: 7 February 2003

Review report on MS-NR: 2002-86 Title: Factors controlling Arctic denitrification in cold winters of the 1990s Authors: G. W. Mann, S. Davies, K. S. Carslaw, and M. P. Chipperfield

General comment:

This paper describes the complex vortex-dynamical conditions that are necessary for severe Arctic denitrification to develop. Since denitrification has a controlling effect on Arctic chemical ozone depletion, it is important to study the conditions where this could occur. In particular, it is important for larger-scale models (e.g. chemical-climate models) to be able to represent denitrification for better estimates of chemical ozone depletion in a future climate which would require more accurate parameterizations of denitrification. Although this study does not provide directly applicable parameteriza-

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tions the paper, in a very comprehensive way, points out the necessary conditions for denitrification to develop. It is beyond the scope of the present paper to make the necessary comparison with observed denitrification, but the presented results offer good opportunities to pursue this. The developed concept of closed-flow, which is shown to have close links to denitrification, would also be an interesting parameter to use in analyses of chemical ozone depletion in addition to other parameters, e.g. PSC-areas. The paper is clearly written and of interest to the broad stratospheric research community. I can recommend it to be published after some minor comments have been considered.

Specific (line-by-line) comments:

p. 2558, l. 26: I would remove "NAT", and write on p. 2559, l. 2 after the parenthesis "presumably composed of NAT". It is being said so often that the large particles are composed of NAT that people begin to take this for a fact.

p. 2559, l. 23: which winters is the word "these" referring to?

p. 2560, line 26: I think it would be relevant to mention, that if the PSCs were characterized by mixtures of liquid STS particles and higher number concentrations of smaller solid type PSCs, the denitrification would be much smaller. I guess it is only because you have such low number concentrations of NAT particles in competition with the liquids for the available HNO₃ that the NAT particles grow so large in size.

p. 2561, l. 21: I guess denitrification means removal to total HNO₃ (gas+condensed). Also I assume that the passive runs include particle formation (but no sedimentation). This is not completely clear and has a bearing on the next point:

p. 2563, l. 2: I guess the fields of NAT-supersaturation (panels b in Figure 1-4+6) are calculated using the actual partial pressures of HNO₃ (and not the initial values). But then how can fields of NAT-supersaturation develop where you have strong denitrification (e.g. Fig. 1 around day 25)? I am confused here, because you mention on p.

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2570, l. 6-9 that denitrification causes areas to develop with very low mixing ratios of HNO_3 , preventing the NAT particles to form (which is true, of course). This seems to contradict co-located fields of NAT-supersaturation.

I think the confusion arises because it seems that you do not discriminate in the discussion between the cold pool and NAT-supersaturated regions. They are of course co-located early in the winter, but when denitrification develops the NAT-supersaturated regions diminish inside the cold pool. You begin the discussion on page 2567, l. 23 with a comparison of the vortex location and the NAT-supersaturated region, but then defines the fraction of the cold pool that is in closed flow (p. 2569, line 13) from the temperature fields and continue the discussion based on this parameter. The discussion is much clearer to me if you by the NAT-supersaturated regions mean where temperatures occur below T_{NAT} ; T_{NAT} being based on the initial HNO_3 mixing ratios, i.e. simply low temperature regions.

p. 2570, line 16: Regarding the vertical structure of the closed flow, I think it would be interesting to plot the c-flow parameter into figures 1-4+6. I assume that the depth of the c-flow parameter would have an influence on denitrification in the sense that a larger vertical depth of high c-flow would allow particles to sediment over longer vertical distances without evaporation. Could the depth of c-flow reduce the scatter in Fig. 8?

p. 2560, l. 16-18, and p. 2572, l. 13-21: The authors might discuss in somewhat more detail what meteorological conditions cause the vortex and the cold pool to be concentric, e.g. could there be there a connection to the NAO or some other large-scale parameters.

Technical corrections:

Fig. 8: Figure 8 in a printed version is not very clear. Perhaps using filled and somewhat larger symbols could improve this.

Interactive comment on Atmos. Chem. Phys. Discuss., 2, 2557, 2002.