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Atmospheric Chemistry and Physics Discussions

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

Anonymous Referee #2

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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 comments:

The manuscript presents 3D Lagrangian simulations of denitrification with a particle model for four cold arctic winters of the 1990s. It focuses on the meteorological factors determining the denitrification. They are recognized as the extent, depth and concentricity of the cold pool and vortex. A definition for a "closed area flow" as a principal meteorological influence is proposed. I regard this paper as a worthy contribution for ACP and recommend publication after consideration of the comments

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below.

Specific comments:

1) p. 2558, l. 14: Here you mention that the closed flow area applies for air trajectories. This should be repeated when you introduce the definition of the closed flow area in the plain text (Section 4.2) instead of using the misleading particle trajectories (p. 2568, l. 19 & 25).

2) p. 2561, l. 1-3: it would be good to write "" because in your case study the flow was unbalanced (i. e. not realistic).

3) p. 2562, l. 18: "as was observed in Jan to Mar 2000 (Northway et al., 2002)". If you mean Northway et al. 2002a, their Figure 6 and plate 2 are in contradiction with your citation (their data showed significant temporal and spatial variability).

4) p. 2567 l. 13-14: I recommend to repeat at this place the uncertain role of the nucleation of the particles.

5) p. 2569, l. 16: do you consider the mean of the full simulation height range or do you fix an isentropic level? Please clarify.

6) Figure 8: I guess you could easily get rid of the first (and possibly most important) factor causing the large scatter in the plot by showing a mean relative denitrification rate instead. That is dividing the mean denitrification rate by a similar mean of the available gas phase HNO3. Further, the normalized denitrification [$\% \, m^{-1} s^{-1}$], by comparison with your original Figure, becomes a mean to qualitatively assess the effect of this thermodynamical equilibrium factor.

7) Figure 8: as a suggestion, I recommend to add a sensitivity studies of the time shift would have been welcome as elsewhere you underline the crucial role of the time

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available for particle growth. You show the correlation only for a 3 days shift, but in the text you mention 8 days as an optimum for denitrification.

Technical corrections:

▷p. 2559, l. 14: "to answer directly this question" would be more precise than "to answer this question".

▷p. 2559, l. 23: Which winters are meant?

▷p. 2562, l. 16: the quotation of Fueglistaler et al. is not listed in the references.

▷p. 2563, l. 25: the descent can be seen in all winters.

▷p. 2564, l. 4: "to carried out" should read "to be carried out".

▷p. 2564, l. 10: "mid winter" could read "early winter".

▷p. 2565, l. 26: "Fig 3b" should read "Fig 3c".

▷p. 2567, l. 5: "winter 1996/97" should read "winters 1995/96 and 1996/97". The end of the paragraph should then be adapted.

▷Figure 6: negative denitrification means (re)nitrification?

▷p. 2568 l. 2: I gauge the "significant" reduction in mean radius as exaggerated.

▷Following technical corrections rely on the *web of science*.

p. 2574, l. 20: "18800" should read "1880".
p. 2575, l. 11: "aerosols" should read "aerosol".

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p. 2575, l. 12: "winters" should read "Winters".
p. 2576, l. 15: "during winter" should read "during the winter".
p. 2577, l. 9: "differences" should read "variations".

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