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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Stratospheric water vapour as tracer for vortex filamentation in the Arctic winter 2002/2003" *by* M. Müller et al.

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We thank reviewer #1 for his critical comments which helped us to improve the manuscript. We would first like to comment on his main concern (the placement of our work in the context of other work in this field) before addressing the specific comments.

"General Comments"

We are aware that our findings are in row with previous works both on filamentation at the polar vortex edge and on the suitability of water vapour as a tracer. Yet, by presenting the effect of vortex edge dynamics on the distribution of stratospheric water vapour, we present new results that are important for the research community involved in UTLS and polar stratospheric studies. We agree that the former presentation of the paper did not sufficiently highlight the main results, that are e.g.

- We present the first published high-resolution stratospheric water vapour profiles measured far north of 70°N. Comparable Arctic measurements have been performed rarely, and the results presented show the usefulness of such studies.

- Dehydration has been found in several Arctic water vapour profiles (e.g. Vömel et al., 1997; Schiller et al., 2002). During the early Arctic winter 2002/2003, temperatures allowed the existence of ice PSCs and thus the possibility of dehydration. Yet, with our combination of measurements and transport model, we are able to demonstrate that the observed feature on 11 February 2003 is purely dynamical. The existence of discrete structures in water vapour profiles due to air masses with different origin has been noted before at low latitudes (Kley et al., 1980) and polar regions (Ovarlez and Ovarlez, 1995), whereas our measurements are clearly related to the dynamics at the polar vortex edge. By introducing the MIMOSA model into the analysis we are able to visualize these structures in a larger context.

- A distinct highlight of our presentation is the comparison with the MIMOSA model. The agreement in space and time between measurement and model is better than would be expected from sensitivity studies. Compared to prior publications (e.g. Waugh et al., 1994; Flentje et al., 2000) the analysed filament feature is found on a much smaller spatial scale. The results confirm the accuracy of the MIMOSA model at high latitudes, which was earlier shown to be successful in mid-latitudes (Heese et al., 2001).

We have accordingly changed the structure of the paper and produced new figures to place emphasis on these results.

"Specific Comments"

1. We revised the English language of the paper.

2. The units of the figures have been changed in the following way: We keep the water vapour profiles in units of mixing ratio, as on the one hand it is the parameter retrieved

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from the measurements and on the other hand it is the most common unit to describe the vertical H2O distribution in the stratosphere (SPARC, 2000). As we do not compare the tracer concentrations of H2O and O3, but instead use the ozone profiles to back up the dynamical activity in the vortex edge region, we feel free to use a different unit here. Both O3 sonde and lidar profiles are now presented in units of partial pressure, as this is the parameter directly retrieved from the ozone sonde measurement. The units for the O3 lidar have been changed accordingly.

3. We state that 5 ppmv are commonly used in calculations for PSC formation, referring to e.g. Carslaw et al. (1998) who perform these calculations at an altitude of 550 K according to a PSC observed around 22 km altitude. In fact, the range where one might expect to find PSCs in Ny-Ålesund extents up to 27 km. For example our water vapour profile on 17 January 2003 shows values of 5.5 ppmv at 19.7 km, 6 ppmv at 20.7 km, and 6.5 ppmv at 22.6 km. As mentioned in the paper, an increase of 1 ppmv in water vapour leads to an increase of about 0.8 K in TNAT (Hanson and Mauersberger, 1988), and even 1 K in TICE (Marti and Mauersberger, 1993). We therefore think that our note on the difference between the observed and the commonly assumed water vapour concentration is justified. The point is even more important as publications on the effect of the PSC area use constant - and thus altitude-independent - values even lower than 5 ppmv for their calculations (Pawson et al., 1995: 3 and 5 ppmv; Schulz et al., 2000, 2001: 4.6 ppmv).

4. From our water vapour profiles we could not identify descent within the lower part of the vortex.

5. The reference has been added.

6. We modified the sentence bearing in mind that the MIMOSA model has not been introduced before.

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