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Stratospheric water vapour as tracer for Vortex filamentation in the Arctic winter 2002/2003

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Abstract. Balloon-borne frost point hygrometers measured three high-resolution profiles of stratospheric water vapour above Ny-Ålesund, Spitsbergen during winter 2002/2003. The profiles obtained on 12 December 2002 and on 17 January 2003 provide an insight into the vertical distribution of water vapour in the core of the polar vortex. The water vapour sounding on 11 February 2003 was obtained within the vortex edge region of the lower stratosphere. Here, a significant reduction of water vapour mixing ratio was observed between 16 and 19 km. The stratospheric temperatures indicate that this dehydration was not caused by the presence of polar stratospheric clouds or earlier PSC particle sedimentation.

Ozone observations on this day indicate a large scale movement of the polar vortex and show laminae in the same altitude range as the water vapour profile. The link between the observed water vapour reduction and filaments in the vortex edge region is indicated in the results of the semi-lagrangian advection model MIMOSA, which show that adjacent filaments of polar and mid latitude air can be identified above the Spitsbergen region. A vertical cross-section produced by the MIMOSA model reveals that the water vapour sonde flew through polar air in the lowest part of the stratosphere below 425 K, then passed through filaments of mid latitude air with lower water vapour concentrations, before it finally entered the polar vortex above 450 K. These results indicate that on 11 February 2003 the frost point hygrometer measured different water vapour concentrations as the sonde detected air with different origins. Instead of being linked to dehydration due to PSC particle sedimentation, the local reduction in the stratospheric water vapour profile was in this case caused by dynamical processes in the polar stratosphere.

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