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Enhanced upper stratospheric HNO_3 during Antarctic winter 2003 and Arctic winter 2003/2004

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Vertical profiles of stratospheric HNO_3 were retrieved from limb emission spectra recorded by the Michelson Interferometer for Passive Atmospheric Sounding (MIPAS) aboard the Envisat research satellite during the Antarctic winter 2003. A high second maximum of HNO_3 was found around 34 km altitude with abundances up to 14 ppbv HNO_3 during July. Similar high abundances had not been reported in the literature for previous winters, but for the subsequent Arctic winter 2003/2004, after severe perturbations due to solar proton events. The second HNO_3 maximum in the Antarctic stratosphere started to develop in early June 2003, reached peak values during July 2003, and decreased to about 7 ppbv by the end of August while being continuously transported downwards before finally forming a single HNO_3 layer over all latitudes in the lower stratosphere together with the out-of-vortex primary HNO_3 maximum. The HNO_3 decrease in August 2003 was correlated with photochemical build-up of other NO_y species as $ClONO_2$ and NO_x. From the time scales observed, it can be ruled out that the 2003 long-term HNO_3 enhancements were caused by local gas-phase reactions immediately after the solar proton event on 29 May 2003. Instead, HNO_3 was produced by ion cluster chemistry reactions and/or heterogeneous reactions on sulfate aerosols via N_2O_5 from high amounts of NO_x being continuously transported downwards from the lower thermosphere during May to August. By comparing the evolution of the second upper stratospheric HNO_3 maxima in the Antarctic winter 2003 and the Arctic winter 2003/2004, we conclude that it is likely that similar production processes took place during both winters.