Forschungszentrum Karlsruhe
in der Helmholtz-Gemeinschaft

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Continuous Ground-Based Millimeter-Wave Observations of Ozone and HNO_3 in Winter/Spring 2000/2001 at Kiruna

Overview

During Arctic winter 2000/2001, the ground-based millimeter-wave radiometer MIRA2 of the Forschungszentrum Karlsruhe has been operated in the Swedish Institute of Space Physics at Kiruna (67.8°N, 20.4°E, 425 m ASL), Sweden. This instrument covers the frequency range 268-280 GHz and is capable to measure ozone, HNO_3, ClO, and N_2O. Nearly continuous time series of ozone and HNO_3 vmr-profiles in the altitude range 17-55 km were retrieved from the measurements. A vertical resolution of at best 7 km for ozone and of at best 12 km for HNO_3 has been achieved.

Figure 1 shows the potential vorticity and the temperature at 550 K-level over Kiruna for all days when measurements with MIRA2 were performed (ECMWF data). Although this Arctic winter was relatively warm in the lower stratosphere with a quite unstable vortex, temperatures over Kiruna dropped below PSC formation temperatures in January. For some days in January and February Kiruna was well inside the polar vortex.

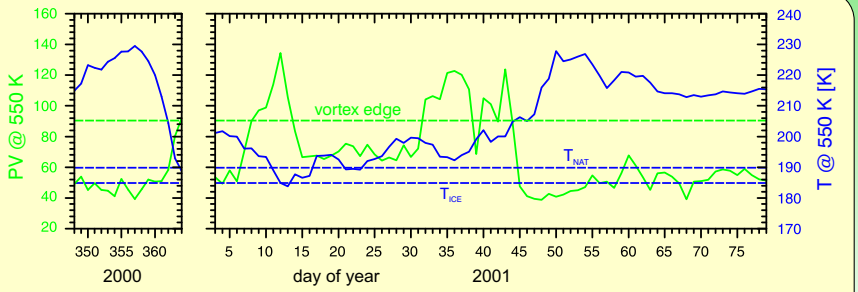

Figure 1: Potential vorticity and temperature at 550 K-level over Kiruna from December 13, 2000, to March 20, 2001 (ECMWF data).

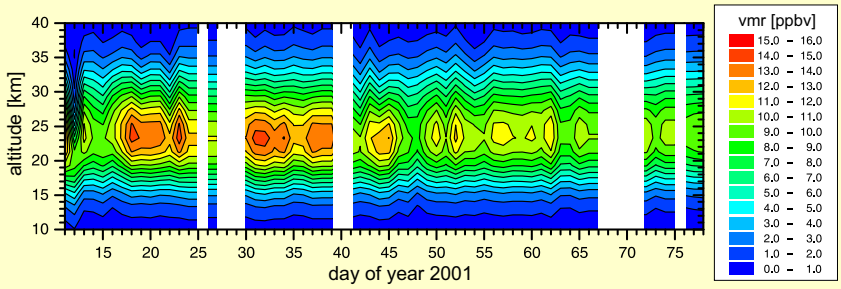

Figure 2: HNO_3 over Kiruna from January 11 to March 19, 2001. On January 12 the mixing ratios were reduced drastically due to the uptake of HNO_3 into PSCs.

HNO_3

Figure 2 shows the results for HNO_3 between January 11 and March 19, 2001. On January 12, when Kiruna was well inside the vortex and temperature at 550 K-level dropped below ice frost point (see figure 1), maximum HNO_3 mixing ratios decrease drastically due to the uptake of HNO_3 into PSCs. After day 16 temperatures increased over NAT formation temperatures and the HNO_3 mixing ratios recover.

Between day 32 and 43 Kiruna was again well inside the vortex for most of the time, but temperatures were too high for PSCs. The maximum mixing ratios of HNO_3 show high values up to over 15 ppbv for most days which indicates that there was no significant vortex wide denitrification. After day 45 Kiruna was outside the vortex for the rest of the time resulting in lower mixing ratios due to photolyzation and the observation of mid-latitude air.

Ozone

The measurements of ozone between December 13, 2000, and March 20, 2001 are shown in figure 3. It is obvious, that on days, when Kiruna was well inside the polar vortex, the retrieved profiles show reduced volume mixing ratios in the lower stratosphere. Since the vortex was quite unstable in winter 2000/2001, it is not clear whether this is a result of dynamic processes or chemical depletion.

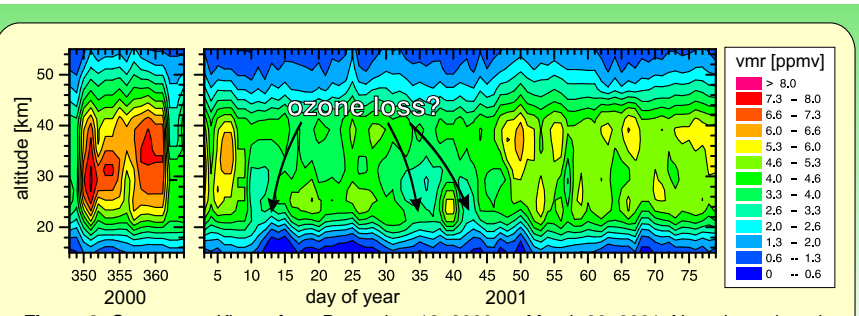

Figure 3: Ozone over Kiruna from December 13, 2000, to March 20, 2001. Note the reduced mixing ratios in the lower stratosphere on days when Kiruna was well inside the polar vortex.

Acknowledgement: We would like to thank the European Centre for Medium-Range Weather Forecasts for the PV and temperature data

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