Millimeter-wave measurements of stratospheric O₃ and N₂O from the high-altitude station of Testa Grigia (Italy; 45.9°N, 7.7°E, 3500 m a.s.l.)

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During the winter 2003-2004, we started a project aimed at studying the mid-latitude stratosphere at Plateau Rosa (or Testa Grigia, 45.9°N, 7.7°E, elev. 3490 m above mean sea level), a high mountain site near Cervinia, on the Italian Alps, at the border between Italy and Switzerland. The high elevation makes Testa Grigia an excellent site for carrying out hydrox tests at mid-latitudes with instruments that require a low water vapor column content.

Measurements of rotational lines at frequencies between 230 and 280 GHz were carried out with a heterodyne spectrometer (Ground-Based Millimeter-wave Spectrometer, or GBMS) [de Zafra, 1995]. The GBMS measures rotational lines in emission of O₃ (276.923 GHz, HNO₃ (269.211 GHz), CO (236.538 GHz), HDO (255.650 GHz), NO (276.328 GHz), and HCN (265.856 GHz) with a spectral pass band of 600 MHz and a maximum resolution of 65 kHz resulting in the retrieval of vertical profiles of species concentrations between -15 and -75 km altitude. Observations took place during 4 winter periods, from February 2004 to March 2005, for a total of 116 days of measurements [Muscari et al., 2007; Santer et al., 2007; Fiorucci et al., 2008].

Typical vertical profiles with their uncertainties

During most times of GBMS observation a large part of O₃ columnar content is concentrated in the column below 10 km, with tropospheric weather systems and advection of tropical tropospheric air into the lower stratosphere over Testa Grigia having a large impact on the observed variations. Nearly concurrent measurements of N₂O are used for determining the origin of the observed air masses.

Typical spectra

Generally, GBMS O₃ profiles from Testa Grigia are in good agreement with concurrent balloon-borne O₃ measurements carried out from the NDACC station of Pay湄 (46.8°N, 6.9°E) [Lehner et al., the Federal Centers for Meteorology and Earth Science, Mercyville].

A case study: March, 2005

The Arctic Winter 2004-2005 was characterized by a particularly cold lower stratosphere and a remarkable Ozone depletion [e.g., Manney et al., 2006].

Column densities between 15 and 2.1 km

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O₃-N₂O Correlation

15-day backtrajectories arriving at Testa Grigia for specific dates (circled and indicated in the figure) are shown ([Courtesy of the Goddard Space Flight Center, NASA].

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O₃ mixing ratio (ppmv)

N₂O mixing ratio (ppbv)

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