Geophysical Research Abstracts
Vol. 14, EGU2012-5552, 2012
EGU General Assembly 2012

High time resolution observations of the polar stratosphere and mesosphere using a ground-based 230-250 GHz microwave radiometer

D.A. Newnham (1), P.J. Espy (2), M.A. Clilverd (1), D.J. Maxfield (1), P. Hartogh (3), K. Holmén (4), S. Blindheim (5), and R.B. Horne (1)

(1) British Antarctic Survey, Cambridge, United Kingdom (david.newnham@bas.ac.uk), (2) Department of Physics, Norwegian University of Science and Technology, Trondheim, Norway (patrick.espy@ntnu.no), (3) Max Planck Institute for Solar System Research, Katlenburg-Lindau, Germany (hartogh@mps.mpg.de), (4) Norwegian Polar Institute, Tromsø, Norway (kim.holmen@npolar.no), (5) ALOMAR, Andøya, Norway (sandra@rocketrange.no)

Microwave radiometry is used to measure thermal emission by the Doppler- and pressure-broadened molecular rotational lines of atmospheric gases, from which vertical abundance profiles can be determined. Since solar radiation is not required for the measurement, the technique has the advantage that continuous observations are possible including throughout the polar winter.

We describe the development of a passive microwave radiometer [Espy, P. J., P. Hartogh, and K. Holmen (2006), Proc. SPIE, 6362, 63620P, doi:10.1117/12.688953] for ground-based remote sensing of the polar middle atmosphere. The instrument measures nitric oxide (NO), ozone (O_3), and carbon monoxide (CO) vertical profiles over the altitude range 35-90 km with time resolution as high as 15 minutes, allowing the diurnal variability of trace chemical species to be investigated. Heterodyne detection of atmospheric emission at 230 GHz and 250 GHz (wavelength $\sim$1.25 mm) with a receiver noise temperature of 300 K is achieved using a superconductor-insulator-superconductor (SIS) mixer cooled to 4 K. The down-converted signals at 1.35 GHz and 2.10 GHz are analysed using both a moderate-resolution (28 kHz, 220 MHz bandwidth) and a high-resolution (14 kHz, 40 MHz bandwidth) chirp-transform spectrometer (CTS). The instrument was operated semi-autonomously at Troll station (72˚01'S 02˚32'E, 1270 m above sea level), Antarctica during 2008-10 and at the Arctic LIDAR Observatory for Middle Atmosphere Research (ALOMAR, 69˚16'N, 16˚00'E, 380 m above sea level), northern Norway during 2011-12.

NO volume mixing ratio (VMR) profiles have been inverted from calibrated brightness temperature spectra of the NO line centred at 250.796 GHz, observed above Troll station, using the Microwave Observation Line Estimation and Retrieval (MOLIERE) version 5 code. A priori pressure, temperature, ozone, water vapour, and NO profiles above 30 km were calculated using the Sodankylä Ion and Neutral Chemistry (SIC, version 6.8) model under geomagnetically quiet conditions. For altitudes up to 30 km MIPAS/Envisat (Michelson Interferometer for Passive Atmospheric Sounding) data were combined with 10-year (1999–2008) averages of ozonesonde data from Neumayer station (70˚39'S, 08˚15'W). Reference data for radiative transfer calculations are from HITRAN 2008. The retrieval is constrained with measured CTS channel response curves. Data inversion was performed from the ground to 120 km with NO and water vapour profiles adjusted in the forward model calculations to provide the best fit to the observed brightness temperatures. The area of the normalized averaging kernels is $\geq$0.5 for atmospheric layers between 35–83 km, indicating good information retrieval over this altitude range, although the measurements contribute to the retrieved NO VMR profiles up to at least 90 km. The vertical resolution is estimated from the width of the averaging kernels to be 8 km.