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Data Set Description:
PI: Dr. Giovanni Muscari
Instrument: Stony Brook Ground-Based Millimeter-wave Spectrometer (GBMS)
Site(s): Thule Air Base (Pituffik), Greenland
Measurement Quantities: Ozone profile

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Instrument Description:

The Instrument is a mm-wave heterodyne spectrometer (GBMS) observing rotational lines emitted by stratospheric trace gases at frequencies between 230 and 280 GHz (tunable).It employs a high sensitivity cryogenically cooled SIS (Superconductor-Insulator-Superconductor) tunnel junction mixer, followed by two Acousto-Optical Spectrometers (AOSs). One with a spectral window of 600 MHz and a resolution of 1.2 MHz and a second with a passband of 50 MHz and a resolution of ~65 kHz (used only for measurements of O3 and CO). The GBMS observed the O3 line at 276.923 GHz until March 2010 and switched to observing the line at 264.925 GHz starting in January 2011, due to better sensitivity in the latter frequency range. An integration time of ~1 hour is typically needed for observing the O3 line with a satisfactory S/N ratio. Taking advantage of the pressure broadening of the spectral line, the GBMS bandwidth and resolution allow the retrieval of O3 mixing ratio vertical profiles between ~15 and ~80 km.

Algorithm Description:

Mixing ratio vertical profile are retrieved using an Optimal Estimation method. The a priori profile variance ranges from 1 ppmv to 3 ppmv and a correlation between gas concentrations at different altitudes is considered (correlation length = 5 km).The covariance matrix of the measurement vector is diagonal with all the diagonal elements equal. The value of the diagonal elements is used as an adjustable parameter for optimizing the retrieval sensitivity (Fiorucci et al., 2012).

Expected Precision/Accuracy of Instrument:

Estimated uncertainty for each profile at each retrieved altitude level is reported in the data file. These errors are estimated by adding in quadrature the uncertainties due to forward parameters, instrumental calibration and spectral noise. Errors on GBMS O3 profiles are mainly due to instrument calibration and data scaling procedures (~8%) (Parrish et al., 1988;Cheng et al., 1996), and to parameters used in the forward model calculation (7%). These two contributions add up (in quadrature) to an overall ~11%. Measurements noise (random) is computed following Connor (1995) and gives a small contribution (<0.05 ppm at all altitudes) to the overall uncertainty. The smoothing error is not included in this estimate since it can be removed in comparison with higher resolution data sets convolving the higher resolution profiles with the GBMS Averaging Kernels. According to the GBMS Averaging Kernel the O3

retrieved profiles have a vertical resolution (FWHM of the Averaging kernels) that varies from ~9 to 12 km.

Instrument History:

he GBMS was designed and built at the Physics and Astronomy Department of the State University of New York at Stony Brook in the early 90's (de Zafra, 1995; Parrish et al., 1988), and has been regularly operated at a variety of sites, at polar and mid-latitudes, since then. Although the instrument has undergone several minor upgrading since it started operating, the only significant change is the replacement of filterbanks with an Acousto-Optical Spectrometer after the South Pole field campaign in 1995. Until 2008 the GBMS O3 data were analyzed using a Chahine-Twomey technique (Twomey, 1977; Cheng et al., 1996). In 2009 the retrieval algorithm has been upgraded to the Optimal Estimation (Rodgers, 1976).

Field campaigns:

Amundsen-Scott Base, South Pole:	April 1993 - January 1994
	March 1995 - November 1995
	May 1999 - July 1999
Thule Air Base (Pituffik, 76.5°N, 68.8°W), Greenland:	Jan-Mar 2002
	Jan-Mar 2003
Testa Grigia, Italian Alps (45.9°N, 7.7°E, 3500 m a.s.l.):	regular winter campaigns from November 2004 to March 2007
Thule Air Base (Pituffik, 76.5°N, 68.8°W), Greenland:	Jan-Mar 2009
	Jan-Mar 2010
	Jan-Mar 2011
	Jan-Mar 2012