SOUNDING THE UPPER TROPOSPHERE-LOWER STRATOSPHERE USING A TOMOGRAPHIC APPROACH

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RATIONALE

The Upper Troposphere-Lower Stratosphere (UTLS) is crucial for the atmosphere in terms of radiative forcing and climate. However, the highly interconnection of dynamics, chemistry, radiation and microphysics makes it possibly the most complex and highly variable layer of the atmosphere, preventing until today to determining in detail its behavior and influence on the troposphere.

Satellite missions, with their global and multi-year coverage, give unprecedented possibilities in studying the physical and chemical quantities of the atmosphere, as their distribution, variability and long term trends. Among these missions, the Michelson Interferometer for Passive Atmospheric Sounding (MIPAS), onboard ENVISAT limb sounds the upper troposphere and stratosphere since March 2002.

Measurements from MIPAS, both in its original configuration (July 2002-March 2004) and in its new configuration (since January 2005) have been analyzed with the 2-D tomographic Geo-fit Multi-Target Retrieval (GMTR) system.

The scan pattern of the new configuration, having a finer measurements vertical grid, especially in the UTLS region, gives the possibility to obtain a better vertical resolution in respect to the old configuration. Furthermore, dedicated UTLS mode observations have been set to achieve also an improved resolution in the horizontal domain, making it highly suitable for UTLS studies, from troposphere-stratosphere intrusion events to long term chemistry trends. In this paper we present an insight into these measurements.

THE GMTR ANALYSIS SYSTEM

The GMTR [1] is an open source code specifically designed for MIPAS measurements, delivered to ESA to be included in the BEAT tools repository [2]. The GMTR inversion system is based on the Geo-fit approach [3] upgraded with the Multi-Target Retrieval (MTR) functionality [4]. The Geo-fit approach performs a 2-D retrieval of the whole orbit adopting a 2-D discretization of the atmosphere which enables to model horizontal atmospheric inhomogeneities. The MTR method fits simultaneously target species that can interfere, thus eliminating the systematic error components due to the propagation of the uncertainties on p, T and on the amount of molecules that generate interfering spectral features. The capabilities of the GMTR are particularly important in regions such as the polar vortex or the day-night terminator where strong horizontal gradients are poorly reproduced by common 1-D retrievals [5].

MIPAS LEVEL-1B DISTRIBUTION

Figure 1 gives the MIPAS Level-1 distribution per month from the beginning of the mission to the end of 2008. The most frequent observation modes (FR=full resolution, OR-NOM=optimized resolution-nominal, UTLS-1=one of the two observation mode dedicated for the UTLS region, MA=middle atmosphere, UA=upper atmosphere) are also shown.

During the period that extends from April 2004 to January 2005 MIPAS was not operating (only some test orbits have been acquired in August and September).

MIPAS restarted operations on the 9^{th} of January 2005 with a resolution reduced by 41% and a duty cycle shorter than 40%. Since then, due to the improving performances of the instrument, the duty cycle was progressively increased up to 100% starting from the 1^{st} of December 2007.

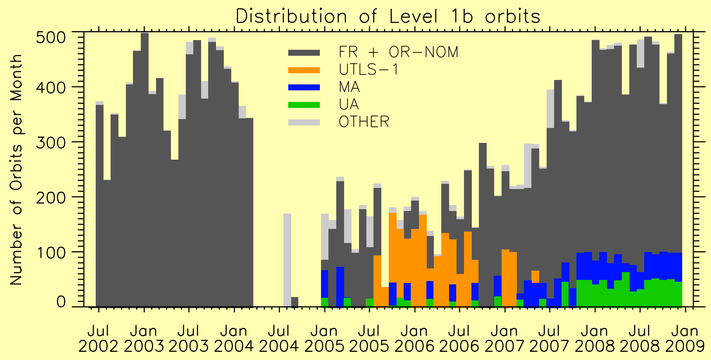

Figure 1: MIPAS Level 1b distribution/month

The scan pattern of the FR, OR-NOM, MA and UTLS-1 observation modes is shown in fig. 2.

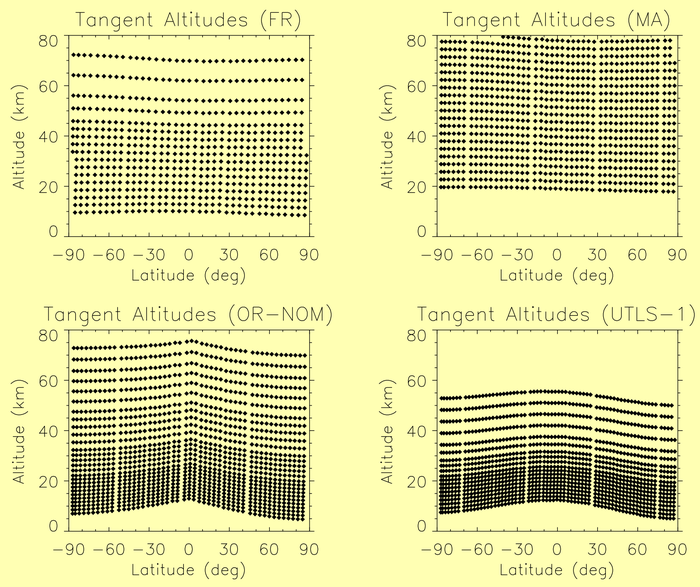

Figure 2: MIPAS Level 1b tangent altitudes

The UTLS-1 observation mode is, as expected, with its finer measurement grid in the UTLS both in the vertical and in the horizontal domain, the most suitable to study this region.

This statement is evidenced in fig. 3 that reports the OR-NOM and UTLS-1 information load ($nW/cm^2 \cdot sr \cdot cm^{-1}$) [6]. It can be noticed that the UTLS-1 has, in that region, for CH_4, a higher and more uniform information load distribution.

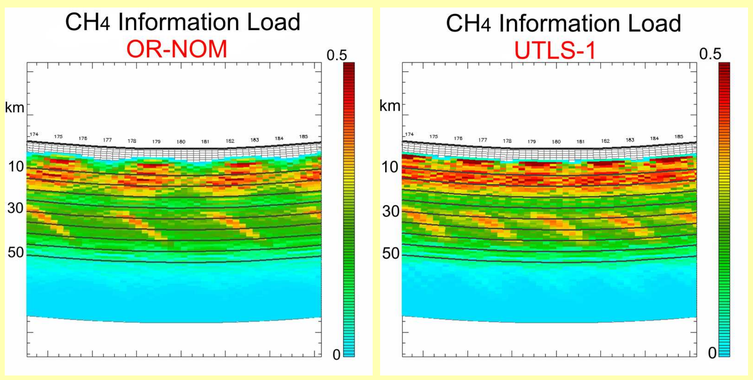

Figure 3: CH_4 Information Load for OR nominal (left) and UTLS-1 (right) observation modes around south pole

THE MIPAS2D IN THE UTLS

The MIPAS2D database [7] contains 2-D fields of pressure, temperature and Volume Mixing Ratio (VMR) of six key atmospheric constituents (H_2O, O_3, HNO_3, CH_4, N_2O and NO_2) from MIPAS full resolution, optimized resolution and UTLS-1 measurements.

The derived fields are provided on a retrieval grid defined as follows: in the vertical domain the grid is defined by the nominal tangent altitudes of the full resolution measurements while in the horizontal domain profiles are retrieved every 5 degree latitude (thus equispaced) along the entire orbit track (this latter option is possible only with a 2D retrieval system).

Fig. 4 maps show five-days averaged values of temperature, and VMRs of ozone, nitric acid, water vapor, methane and nitrous oxide in the Antarctic Region.

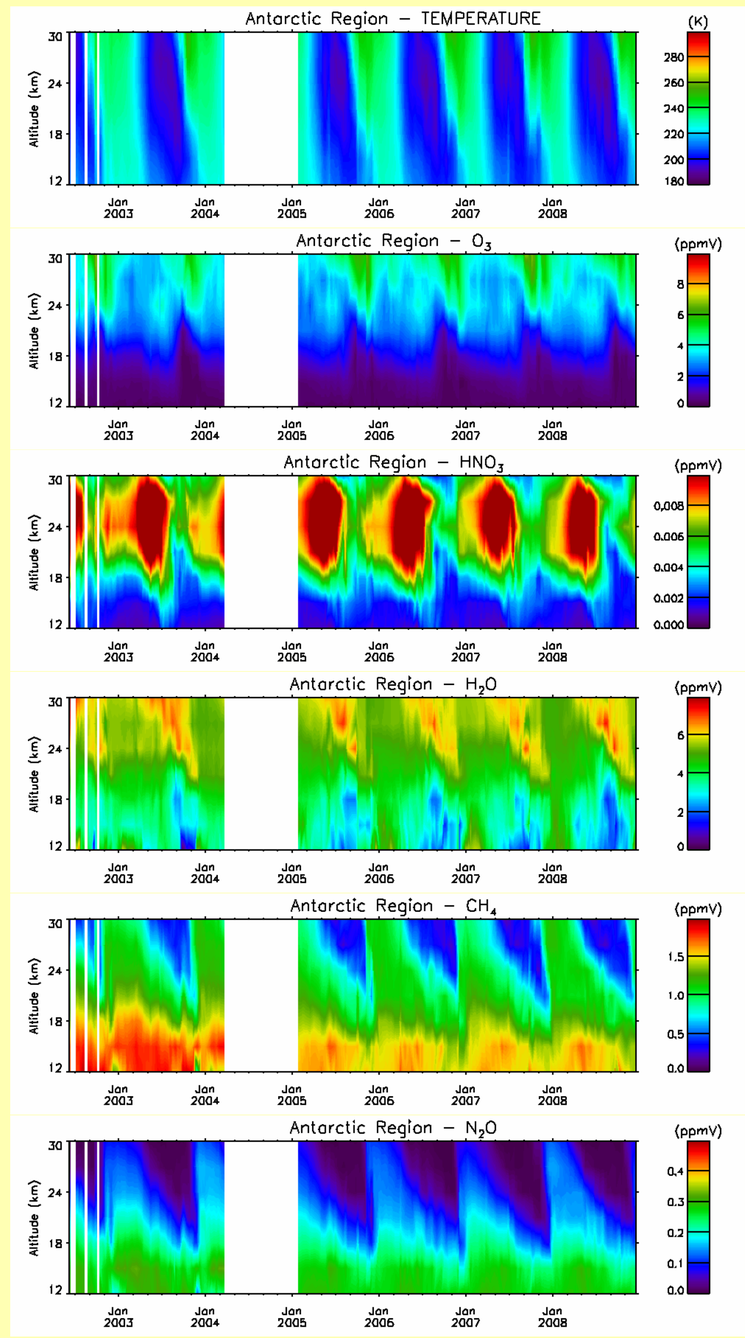

Figure 4: Time series of temperature, ozone, nitric acid, water vapor, methane and nitrous oxide in Antarctic region

References

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[7] B.M. Dinelli et al. The MIPAS2D database of MIPAS/ENVISAT measurements retrieved with a Multi-Target 2-dimensional tomographic approach. *Submitted to Atmos. Meas. Tech.*

The MIPAS2D database can be accessed via scp. For credentials, please send an e-mail to: mipas2d@safire.fci.unibo.it.

Web: http://www.mbf.fci.unibo.it, http://www.isac.cnr.it/∼rss/mipas2d.htm