IASI measurement of the HNO_3 distribution

C. Wespes[1], P.-F. Coheur[1], D. Hurtmans[1], C. Clerbaux[1,2], S. Turquety[2]

[1] Service de Chimie Quantique et de Photophysique, Université Libre de Bruxelles, Brussels, Belgium

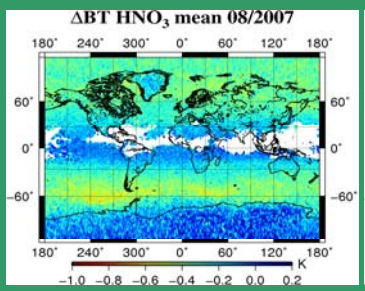
[2] Service d'Aéronomie, CNRS/IPSL, Paris, France

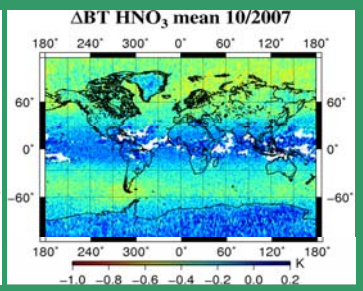
Reactive nitrogen compounds play an essential role in processes that control the ozone abundance in the low atmosphere. Information on HNO_3, which constitutes the principal reservoir sink for the reactive nitrogen oxides in the lower atmosphere, can be accessed using satellite measurements in the infrared spectral region. It is anticipated that global distribution of HNO_3 should improve our understanding of chemical processes in the troposphere and the lower stratosphere.

IASI MEASUREMENTS

For a first assessment of the HNO_3, global distributions based on brightness temperature differences measurements in *Q* branch at 896 cm^{-1} of 2v9 absorption band and absorption free channels are calculated in a operational mode.

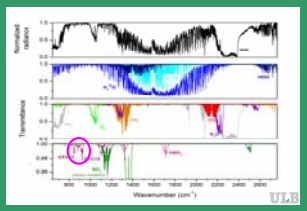
► Brightness temperature differences between the channel 1005 and channels 1001 and 1017 located on both sides of HNO_3 *Q* branch. As water vapor contributes to the absorption in the channel 1005, a other filter based on brightness temperature differences measured in a water vapor line has been added.



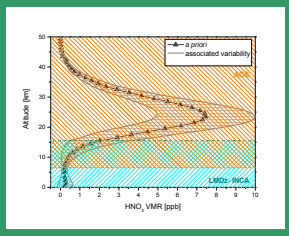


For the treatment of the IASI data, we have used the Atmosphit software, developed at the Université Libre de Bruxelles. It is based on the Optimal Estimation Method (OEM), which constrains the retrievals with a measurement covariance matrix and an *a priori* information.

► Spectral domain selected for the retrievals of HNO_3 from IASI is between 860 and 900 cm^{-1}. Only water vapor absorbs in this spectral domain and is fitted, along with the HNO_3 total column and surface temperature.



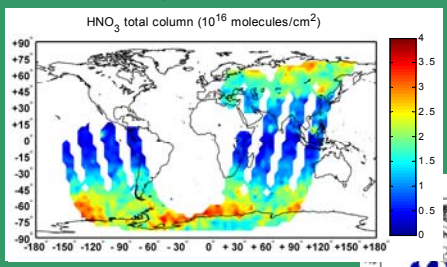
► The mean *a priori* state and the *a priori* covariance matrix are generated from the HNO_3 ACE profiles measured during two years of operation (version offline) coupled to the lower troposphere with profiles from LMDz-Inca model.

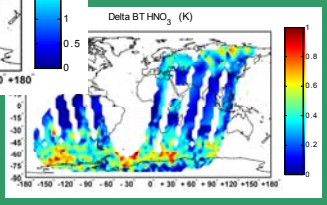


The IASI sounder provide a way for accessing HNO_3 total columns in the atmosphere.

A cloud filter based on the surface temperature comparison between the ECMWF model and temperature restituted from spectra, has been applied, as well as a filter rejecting the inhomogeneous scenes.

► Retrievals of HNO_3 for 4 IASI orbits on May 25 2007.





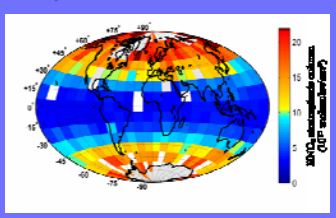
► Good agreement between the delta BT HNO_3 and the retrieval results of HNO_3 principally in polar region where the water vapor abundances are lower.

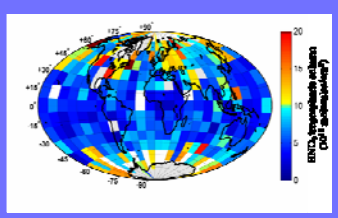
High values of HNO_3 are observed around the Antarctic continent, with a decrease at the southern highest latitudes, probably indicating denitrification due to sedimentation of PSC particles at this time period.

COMPARISONS WITH IMG MEASUREMENTS

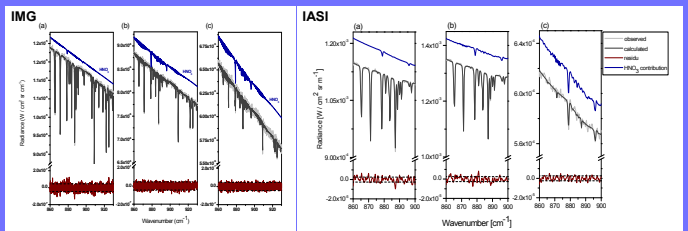
A precusor of the nadir TIR sounders, the IMG instrument (Interferometric Monitor for Greenhouse gases) was launched on 17 August 1996 onboard the ADEOS platform into a polar sun synchronous orbit at about 800 km altitude and provided a global Earth coverage every four days with a set of high-resolution (0.1 cm^{-1}) FTIR nadir spectra. This analyses provided the first reported global distribution of HNO_3 [1]. The good measurement vertical sensitivity allowed to decorrelate the tropospheric and stratospheric layers. The results of HNO_3 retrievals from the IMG spectra, recorded during 10 successive days in April 1997 are shown in comparison with the IASI measurments.

► Global distributions of HNO_3 tropospheric and stratospheric columns measured by IMG

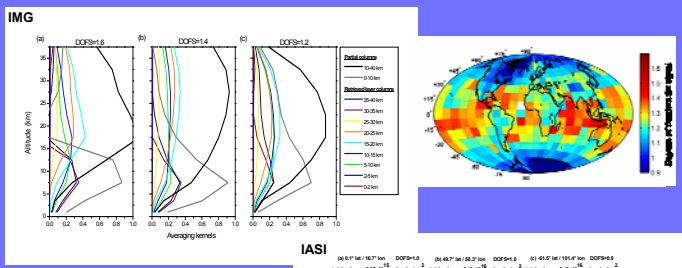


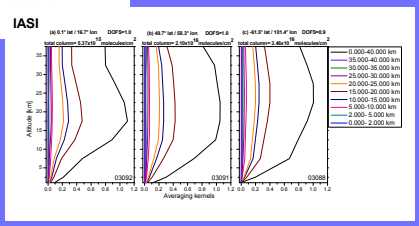


► Three typical spectra measured by IMG on the left and by IASI on the right, recorded in tropical, middle and polar latitude respectively



► Three typical examples of HNO_3 averaging kernels for IMG and IASI spectra recorded in tropical, middle and polar latitude respectively.





Compared to IMG measurements which offered DOFS up to 1.8 in the intertropical region, the vertical sensitivity of IASI HNO_3 measurements are characterized by a DOFS of 1 due to the lower spectral resolution of IASI instrument (0.1 vs 0.5 cm-1 for IMG), despite its best signal-to-noise ratio. The calculated degrees of freedom for signal (DOFS) indicates no decorrelation between the atmospheric layers, justifying the retrieval of total columns for HNO_3.

Work in progress

► Huge quantities of IASI data arriving daily => the retrieval time based on a line-by-line scheme is too long for operational processing of HNO_3

►► look up table of cross sections at predefined pressure and temperature sets in the forward model

► Validation of HNO_3 retrievals

►HNO_3 tropospheric columns from total columns using HNO_3 stratospheric data from other sounders (MLS,…) and/or a global chemistry transport model

[1] *Wespes, C. et al., (2007), First global distributions of nitric acid in the troposphere and the stratosphere derived from infrared satellite measurements, J. Geophys. Res., 112, D13311, doi:10.1029/2006JD008202.*