

# Tropospheric water vapour isotopologues ( $H_2^{16}O$ , $H_2^{18}O$ , $H_2^{17}O$ and HDO) retrieved from IASI/METOP data.



H. Herbin<sup>1</sup>, D. Hurtmans<sup>1</sup>, P.-F. Coheur<sup>1</sup> and C. Clerbaux<sup>1,2</sup>



<sup>1</sup>) Spectroscopie de l'Atmosphère, Service de Chimie Quantique et de Photophysique, Université Libre de Bruxelles, Brussels, Belgium  
<sup>2</sup>) Service d'Aéronomie, CNRS/IPSL, Paris, France

## Introduction

Water vapour is involved in many key atmospheric processes, in particular in the troposphere, where it is an essential component of the global climate system. The measurement of the isotopologic composition is a powerful tool to study transport and chemistry of atmospheric water vapour and the knowledge of the vertical and horizontal distribution of the different water isotopologues gives insight onto the hydrologic processes. However, the quick changes of water concentration in space and time represent a major difficulty, and very few measured profiles of the heavier isotopologues of water vapour have been reported [1].

In a previous work, we have presented, for the first time, simultaneous profile retrievals of the main water isotopologues (i.e.  $H_2^{16}O$ ,  $H_2^{18}O$  and HDO) and their ratios on a quasi-global scale [2]. These results were obtained by exploiting infrared spectra recorded by the Interferometric Monitor for Greenhouse gases (IMG) instrument.

Here, we present the first results obtained for  $H_2^{16}O$ ,  $H_2^{18}O$ ,  $H_2^{17}O$  and HDO by exploiting the Infrared Atmospheric Sounding Interferometer (IASI) data.

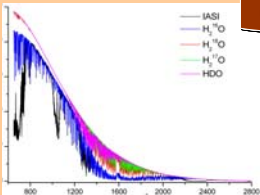
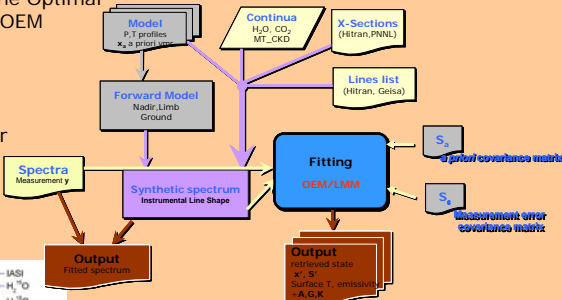
## 2. The Retrieval Method

Atmosphit software developed at ULB

-Based on a line-by-line radiative transfer model

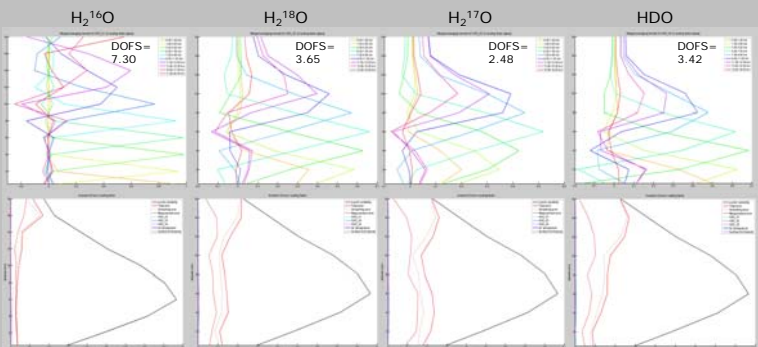
-Inversion: Use of the Optimal Estimation Method OEM

-A-priori profile and covariance matrix: ECMWF or based on Level 2 IASI data for P, T and Humidity



-Each Isotopologue has many strong absorption lines.  
 -Large spectral windows were chosen to perform a simultaneous adjustment of all isotopologues.

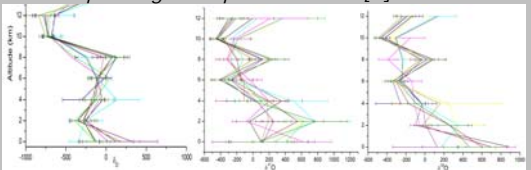
## 3. Some Results



• Example of results obtained for a typical scene corresponding to tropical latitudes [3]

Depletion of heavier water isotopologues is measured using the conventional notation:

$$\delta = \left( \frac{R}{R_{SMOW}} - 1 \right) \times 1000$$



• Examples of water vapor isotopic composition

## References

[1] Zahn, A., Franz, P., Bechtel, C., Groß, J.-U., and Röckmann, T.: Modelling the budget of middle atmospheric water vapour isotopologues., Atmos. Chem. Phys. **6**, 2073– 2090, 2006.  
 [2] Herbin, H., Hurtmans, D., Wespes, C., Barret, B., Turquety, S., Hadji-Lazarou, J., Clerbaux, C., and Coheur, P.-F.: Global distributions of water vapour isotopologues retrieved from IMG/ADEOS data., Atmos. Chem. Phys. **7**, 3957– 3968, 2007.  
 [3] S. Fally, H. Herbin, P.-F. Coheur, C. Clerbaux, M. Carleer, D. Hurtmans, C. Senten, M. De Mazière, C. Hermans, B. Dils, M. Kruglanski, A. Merlaud, F. Scolas, C. Vigouroux, J.-L. Baray, J. Leveau, J.M. Metzger Ground-based and IASI satellite FTIR measurements of water vapour isotopologues above Ile de la Réunion, Reunion Island International Symposium, Saint-Gilles les Bains, 5-9 November, 2007.

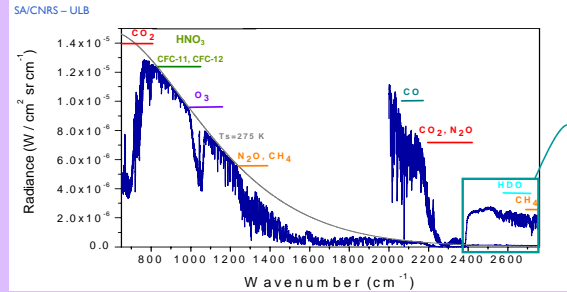
## 1. The IASI Data

Infrared Atmospheric Sounding Interferometer: Launched on October 19, 2006

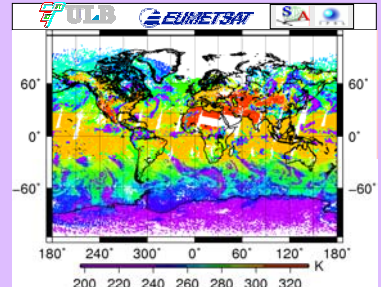
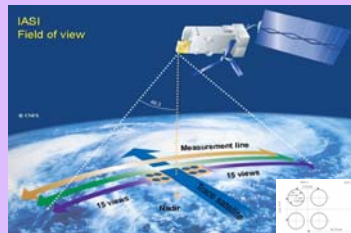
-Nadir viewing Fourier transform interferometer: Spectral resolution: 0.5  $cm^{-1}$ ,

Spectral coverage: 645-2760  $cm^{-1}$

-Level 1c data since May 24, 2007, Level 2 (P, T, Humidity) since October, 2007.



Thermal + reflected radiation (daytime)



-Global coverage 2 times/day: 30 x 4 = 120 spectra along the swath (2400 km), i.e 10<sup>6</sup> Spectra/day.

• IASI/METOP 24h coverage

### ► Priorities:

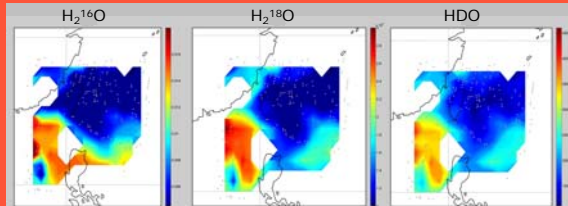
- Numerical Weather Predictions: T & Humidity profiles each km in the troposphere, with respectively 1 K and 10 % accuracy.
- Tropospheric chemistry and climate: Integrated concentrations or vertical profiles for a series of target trace gases

## 4. Work in progress

- Quasi-real time treatment of Water vapor isotopologues.
- Study of isotopologic ratios on local and global scales.
- Concentration variations during major climatic events.

### ► The case of the Super Typhoon Krosa:

October 1—October 8, 2007: Krosa (a Category 4-equivalent typhoon) between east of the Philippines, Taiwan, and east of China. At least 17 people were reported injured and 730,000 people were evacuated.



• Preliminary results of local distribution on October 1, 2007: Volume Mixing Ratios at 4 km of altitude. Data are averaged on a 1°x1° longitude-latitude grid.

## Conclusions & Outlook

- ✓ First results of isotopic ratios from IASI spectra
- ✓ Successful retrievals of vertical profiles between 0 & 18 km for  $H_2^{16}O$  and 0 & 16 km for  $H_2^{18}O$ ,  $H_2^{17}O$  and HDO with unprecedented levels of independent information
- ✓ Possibility of global and local studies for isotopologic variations
- ✓ Probe typhoon and other climatic events