Measurements and modeling of IASI Tropospheric Ozone

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Introduction

The Infrared Atmospheric Sounding Interferometer (IASI) provides near real-time measurements of ozone with an excellent geographic coverage, opening new perspective for chemical forecasting with an unprecedented amount of data. In particular, significant improvements for ozone peaks forecasting are expected, through data assimilation of IASI ozone measurements into a three-dimensional chemistry-transport model.

We present preliminary analysis undertaken for the data assimilation of IASI observations into the CHIMERE continental atmospheric model [Vautard[1] et al., 2001; Schmidt[2] et al., 2001]. As IASI measurements will be assimilated, we first need to validate them. Retrievals of ozone total and partial columns have been performed and initial comparisons of ozone total column is showed. The detailed characterization of the ozone retrievals is presented, in particular the evaluation of the sensitivity of the measurement with respect to the different atmospheric layers. The first available IASI data will be discussed in the framework of data assimilation for chemical forecasts.

[1] Vautard, R., Beekmann, M., Roux, J., & Gombert, D. (2001), 'Validation of a deterministic forecasting system for the ozone concentrations over the Paris area', Atmospheric Environment, 35 2449-2461.
[2] Schmidt, H., Derognat, C., Vautard, R. & Beekmann, M. (2001). 'A comparison of simulated and observed ozone mixing ratios for the summer of 1998 in western Europe', Atmospheric Environment.

IASI trace gases retrieval

2 complementary tools

Operational mode : SA-NN

[Turquety[1] et al., 2004]

Neural network based techniques

- **1 total column** (O3, CO, CH4)
- **3 partial columns** (O3)

0–6 km, 0–12 km & 0–16 km

[1] Turquety, S., Hadji-Lazaro, J., Clerbaux, C., Hauglustaine, D. A., Clough, S. A., Cassé, V., Schlüssel, P. & Mégie G. (2004). Operational trace gas retrieval algorithm for the Infrared Atmospheric Sounding Interferometer, J. Geophys. Res.; 109, D23101, doi:10.1029/2004JD004821.

Research mode : Atmosphit

[Coheur[1] et al., 2005]

Optimal estimation theory

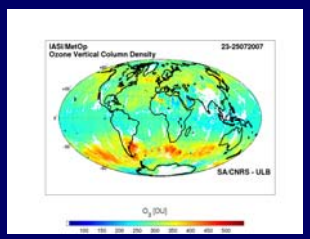
[Rodgers[2], 2000]

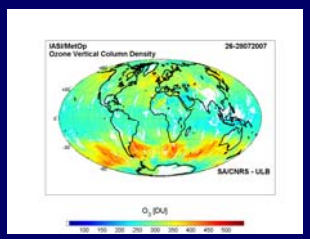
- **Vertical profiles**
- **Averaging kernels**
- **Errors**

[1] Coheur, P.-F., Barret, B., Turquety, S., Hurtmans, D., Hadji-Lazaro, J. & Clerbaux, C. (2005). Retrieval and characterization of ozone vertical profiles from a thermal infrared nadir sounder, J. Geophys. Res., 110, D24303, doi:10.1029/2005JD005845.
[2] Rodgers, C. D. (2000). Inverse Methods for Atmospheric Sounding : Theory and Practice, Atm. Oceanic Planet. Phys., vol2, 238 pp., World Sci., River Edge, N. J.

IASI OZONE Total column – global scale

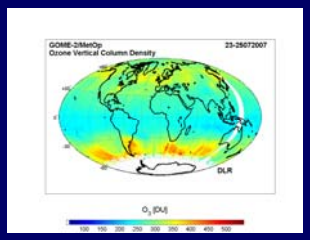
3 Days

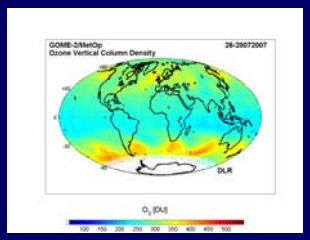


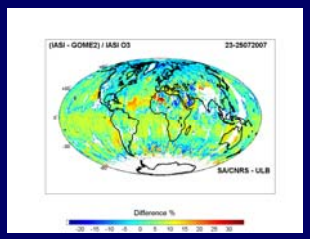


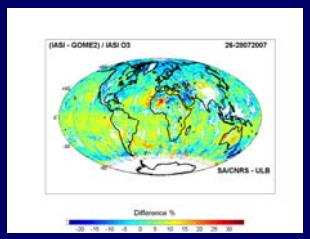
Initial comparisons with GOME-2

GOME-2 L2 data : Courtesy from DLR









First comparisons with GOME-2 DLR retrievals show good agreement

Problems:

1. Sensitive to sand particules emission (see over Sahara)
2. L2 METOP temperature needed (ECMWF Temperature is used as METOP Temperature L2 is not yet available)

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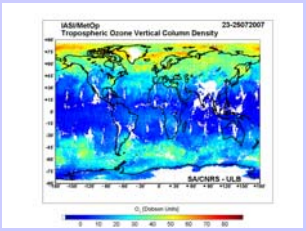
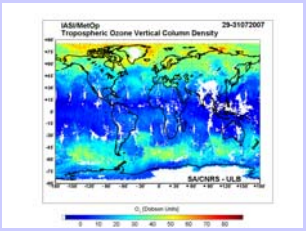
Supervisors : Cathy Clerbaux and Matthias Beekmann

IASI OZONE Tropospheric column – global scale

3 Days

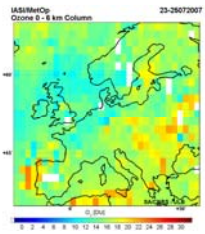


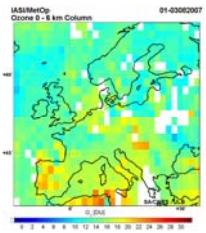


These distributions are preliminary results that will be further validated with ozone sondes and other satellites measurements

IASI OZONE 0–6 km column : local scale

3 Days



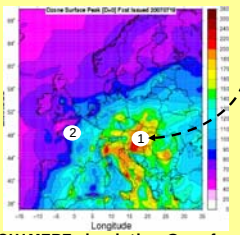


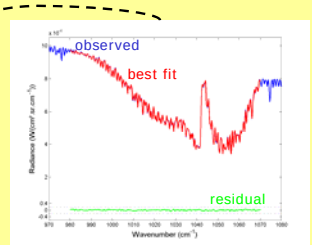
The results show interesting 0–6 km column retrievals : this study is in progress (comparisons with model are being performed)

IASI spectra and profile retrievals

In order to exploit the IASI data into the assimilation scheme, we need to analyse the retrievals, in particular the averaging kernels.

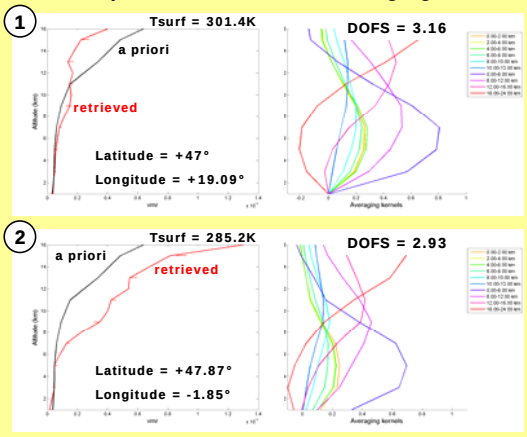
The behaviour of the averaging kernels is analysed in order to identify if a single averaging kernel for a season or by latitude band can be used into the assimilation scheme.





CHIMERE simulation @ surface on Jul 19, 2007

Vertical profiles retrieved & Averaging kernels



First analyses with Atmosphit show :

- Maximum of sensitivity in the middle troposphere
- Averaging kernels quite similar for a given season & at the same latitude
- Different sensitivity near the surface

Further work

❖ **Complete evaluation of IASI performances for ozone Total, Tropospheric and 0–6 km column**

- ➢ Comparisons IASI – SONDES
- ➢ Comparisons IASI – GOME-2, TES, ...

❖ **Characterization of ozone profiles**

- ➢ Analysis of averaging kernels at different latitudes and for different seasons
- ➢ Analysis of error budgets