CENTRE NATIONAL D'ÉTUDES SPATIALES

ATMOSPHERIC CHEMISTRY USING IASI/METOP : OVERVIEW OF INITIAL RESULTS

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OUTLINE

- Introduction
- IASI for atmospheric chemistry
- First results by SA-ULB
- Other products
- Future work for day-2
- Conclusion

INTRODUCTION

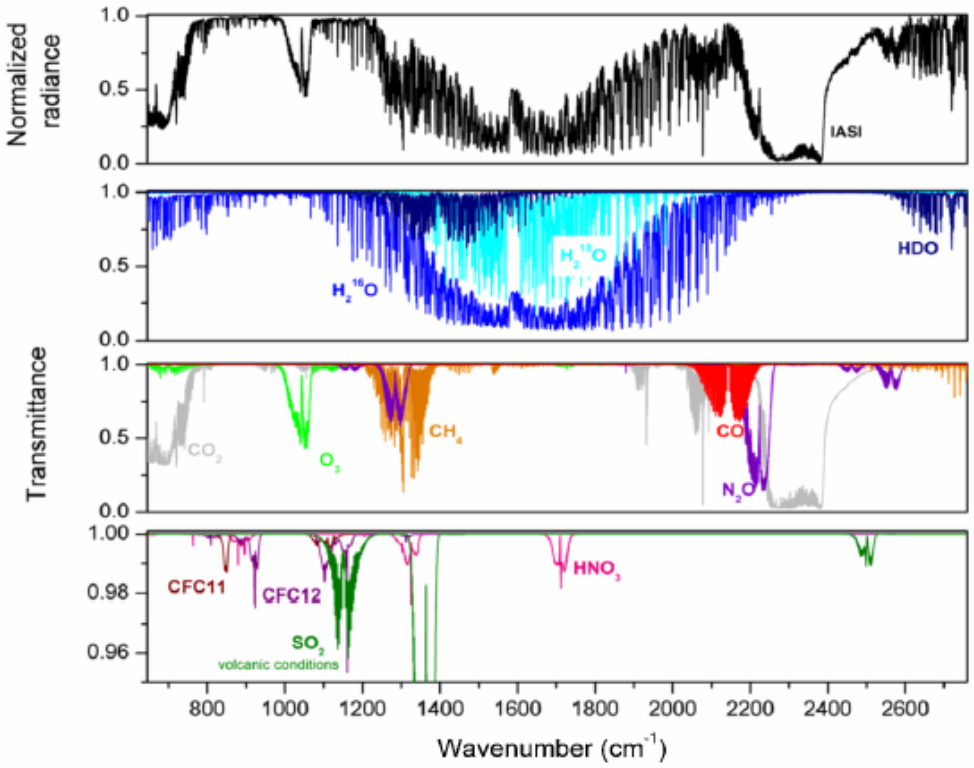
- **Strong support of CNES to atmospheric chemistry for**
  - **Atmospheric composition and Climate**
  - **Ozone depletion monitoring**
  - **Development of applications and services**
    - Air Quality
    - Hazards (fires, Volcanoes, etc.)

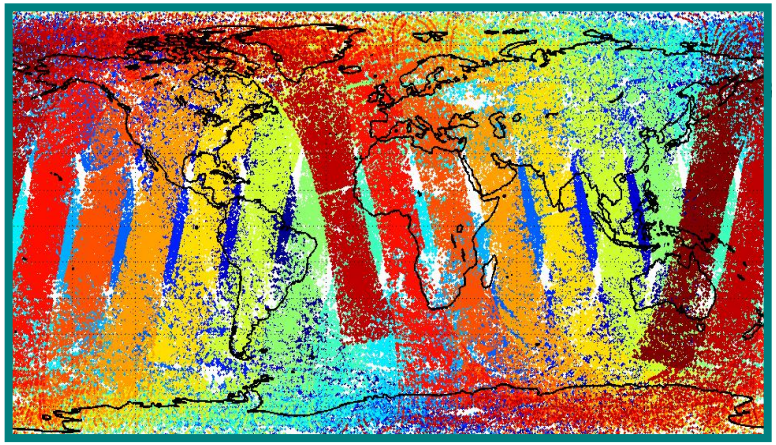
- **Through different actions**
  - **At ISSWG level**
  - **At national level :**
    - Subsidizing the laboratories
    - Setting up R&D projects
    - Internal activities

- **The actors in France :**
  - **Laboratories : SA, LPMAA, LMD, CNRM, LA, LISA**
  - **NOVELTIS**
  - **CNES**
  - **Ether national data centre for atmospheric chemistry**

IASI : A very good tool for atmospheric chemistry

- Spectral range covering absorption bands of GG
- Adequate spectral resolution for columns (to demonstrate capabilities in the IR domain)
- Adequate spatial sampling
- Long time mission with continuity of data
- Very good absolute calibration





Monitoring of atmospheric composition with IASI at SA/ULB

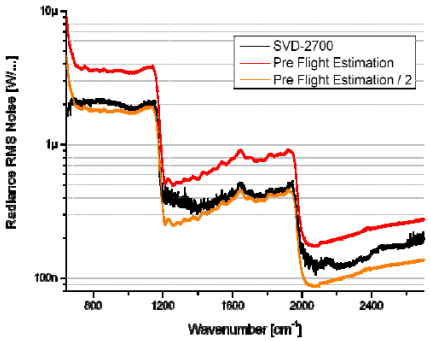
The SA/ULB activities are organized along three main axes

- Climate variables (T, H2O, CH4, N2O, CO2, CFCs)
- Ozone hole chemistry (O3, HNO3)
- Operational services (O3 pollution peaks, fires: CO + other molecules, volcanoes: SO2, CO2, H2O)

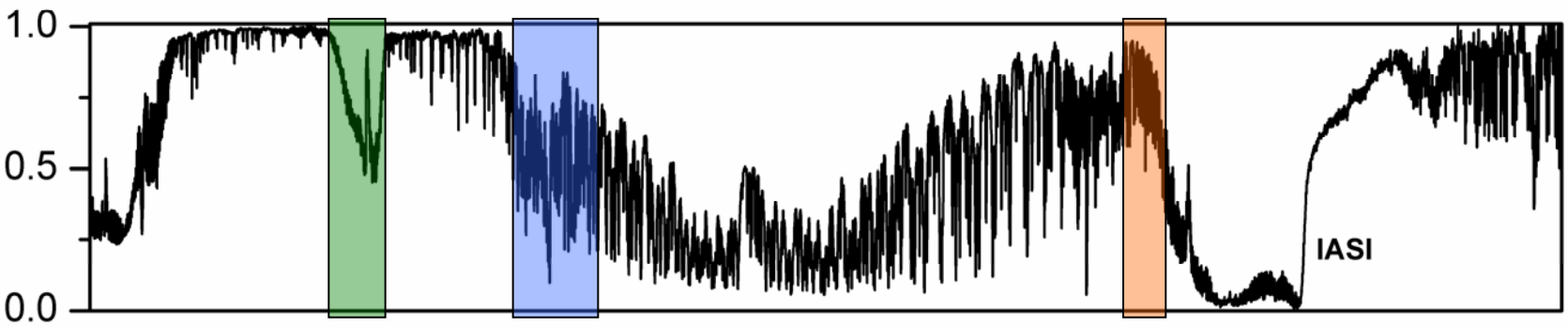
SA-ULB developed two main methods of retrieval :

- NN for operational .
- 1d Var retrieval for research . (Zoom on areas) (a priori from Mozart)

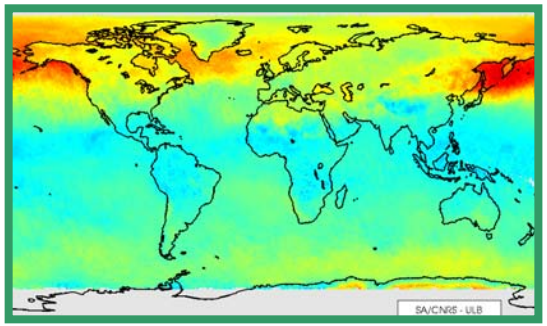
Validation of Eumetsat L2 products not on purpose

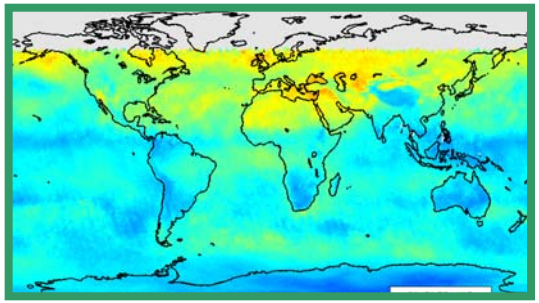


Operational trace gas retrieval from IASI (NN-SA)

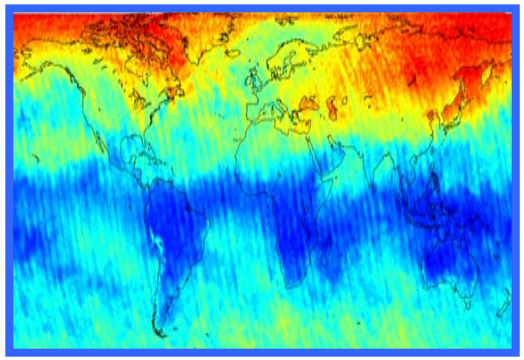


O_3





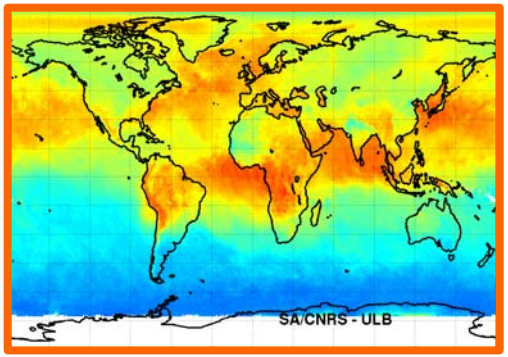
CH_4



A. Razavi

(EGU, 2008)

CO



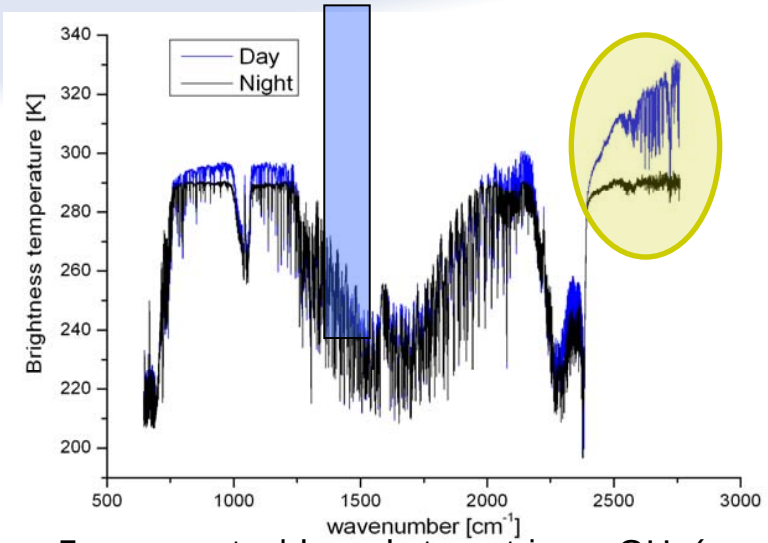
M. Pommier

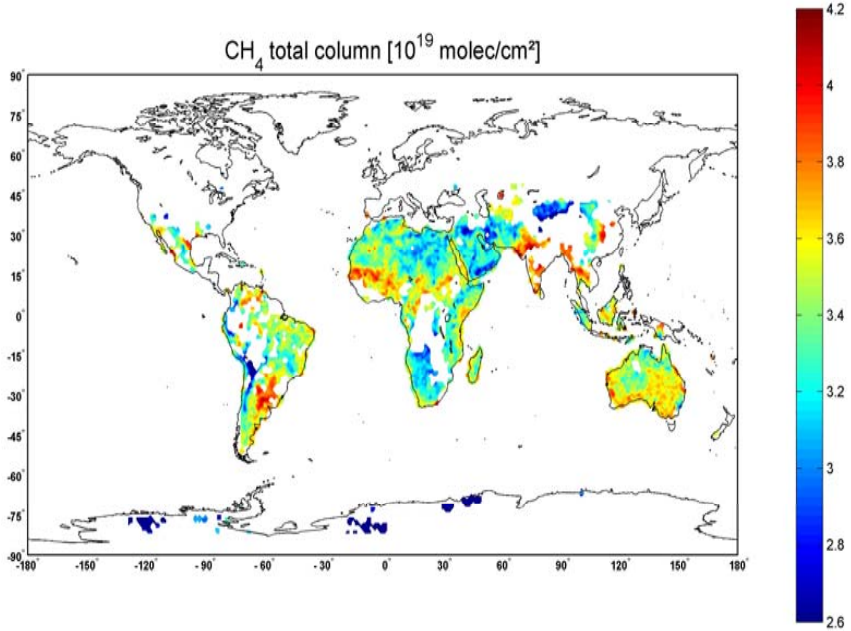
(EGU, 2008)

+ Research products :

CO prof , O_3 prof , H_2O, HNO_3, SO_2, other

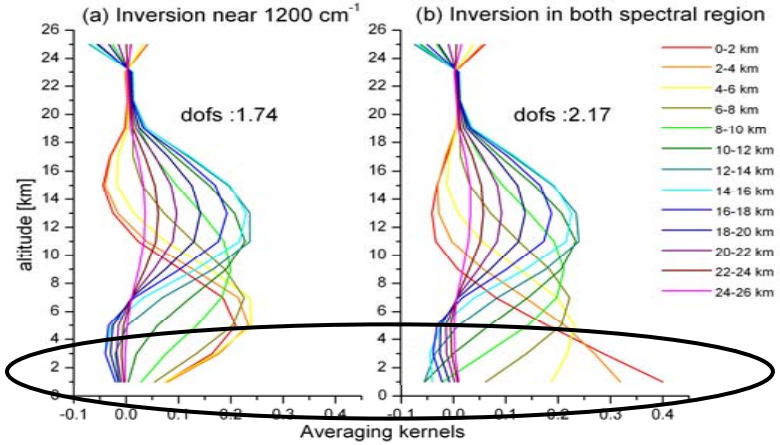
Climate variables: CH_4 total columns





Two spectral bands to retrieve CH_4 (ν_3, ν_4)

Above 2500 cm-1 >> reflected solar radiation



Improvement of the sensitivity in the boundary layer

4 days average,

combined bands

daytime

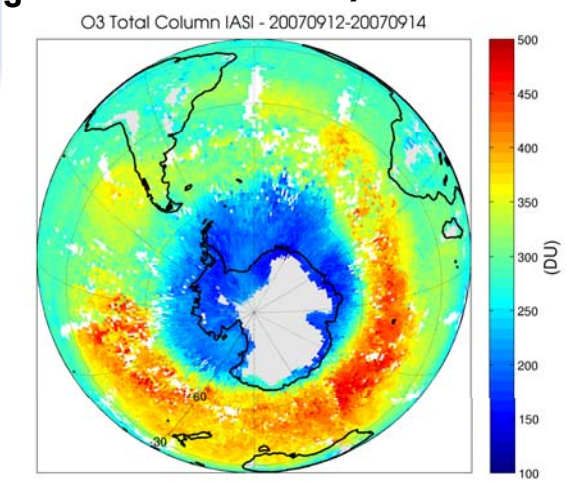
A. Razavi

(EGU, 2008)

Ozone chemistry

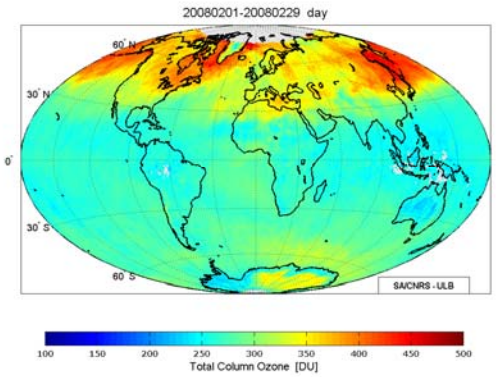
Validation

O_3 total columns, South Pole

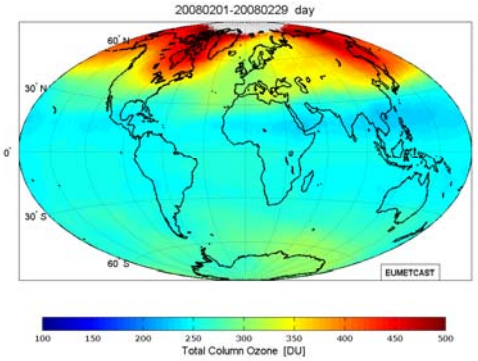


O_3 total columns, Global scale

IASI



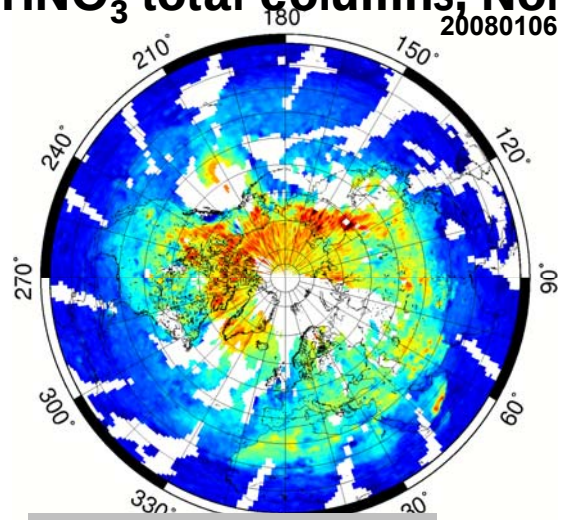
GOME-2



Courtesy A. Boynard

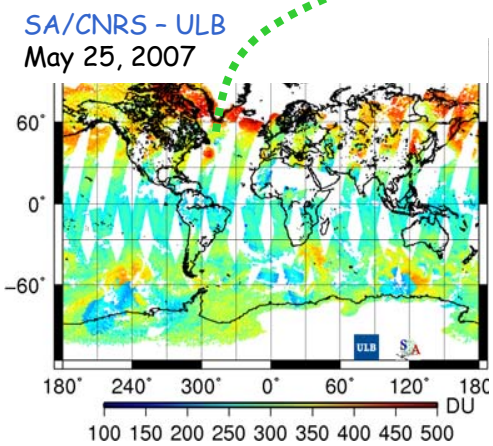
HNO_3 total columns, North Pole

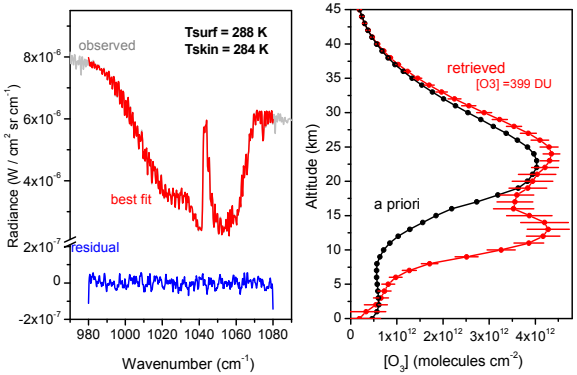
20080106 – 20080110



Courtesy C. Wespes

Stratospheric intrusion

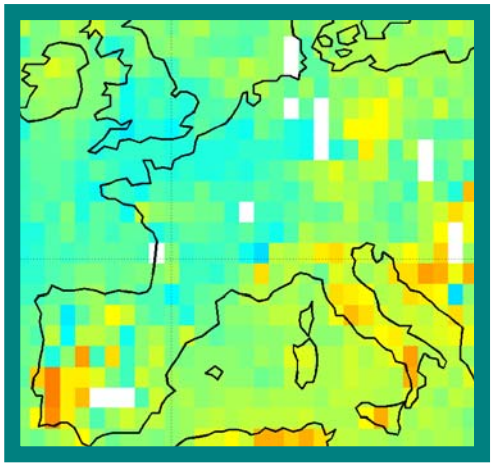




Courtesy P. Coheur

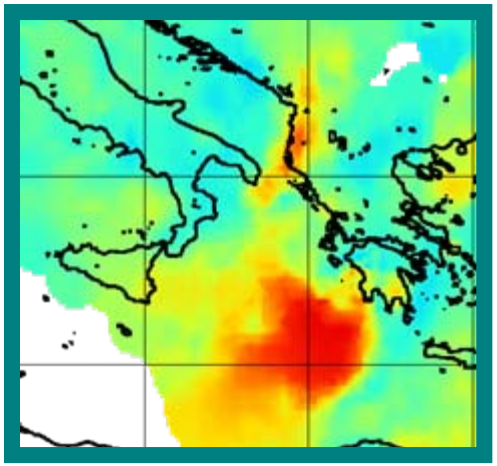
IASI/METOP – Operational applications (GMES)

Pollution forecast



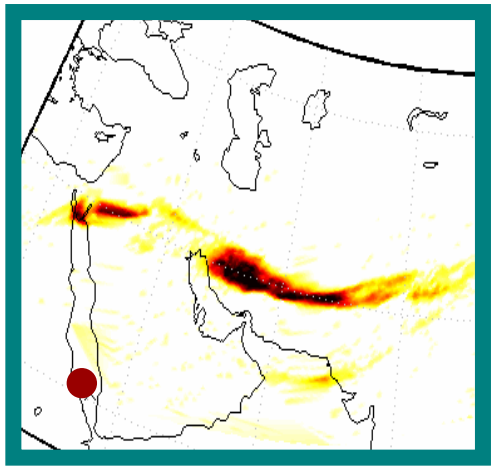
Ozone peaks

Fire detection



Long-range pollution

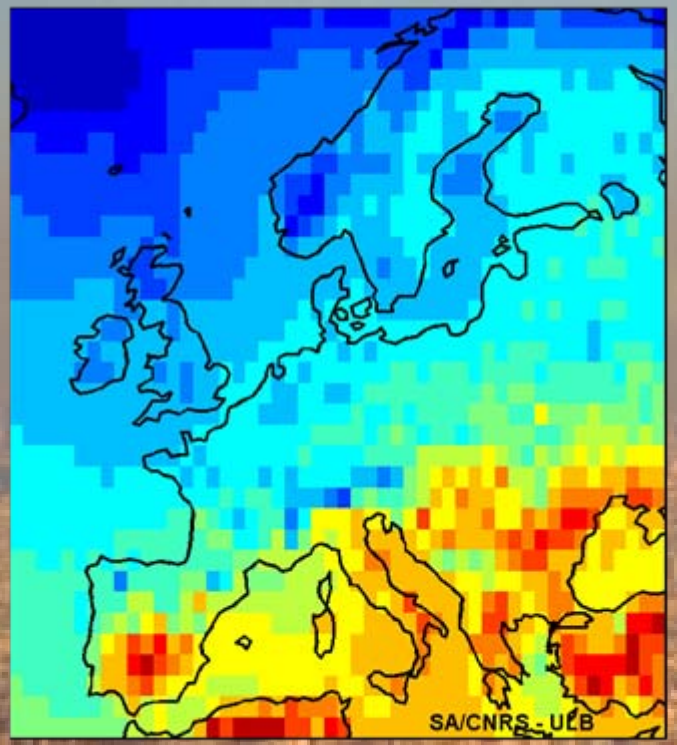
Volcanic plumes



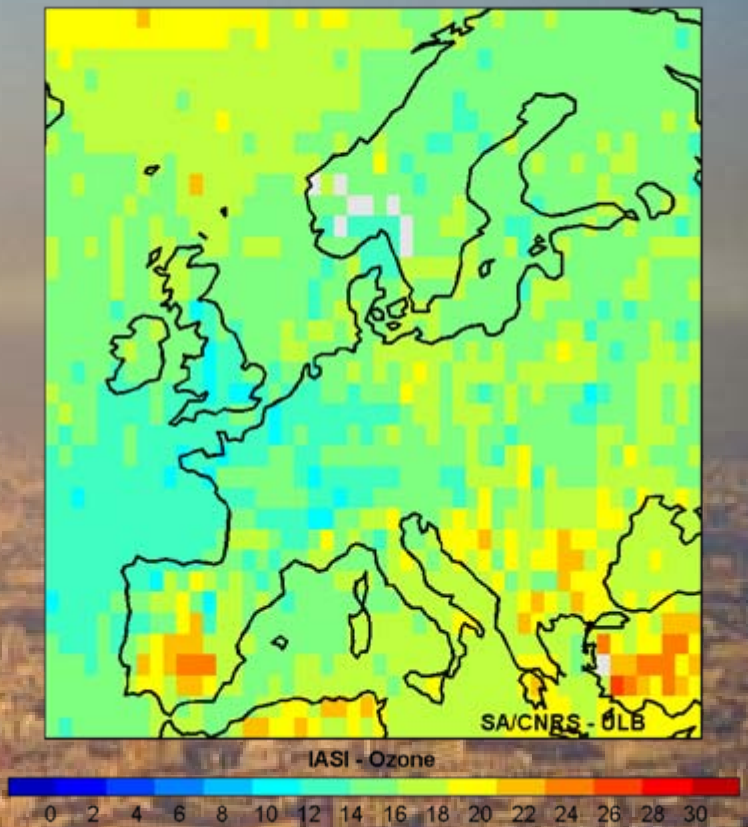
Aviation threat

Ozone (O_3) - pollution peaks,

South of Europe, 22-26 July 2007



Temp, ECMWF data



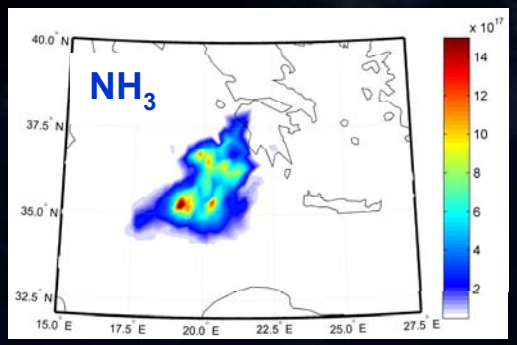
IASI data: Ozone 0-6 km

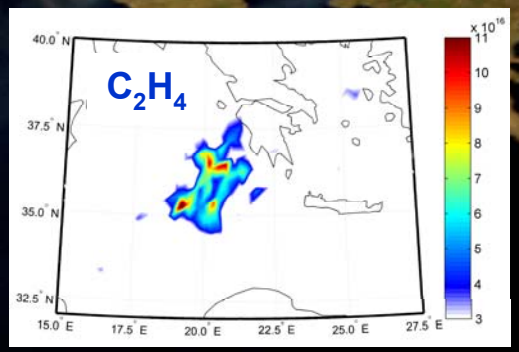
Courtesy A. Boynard

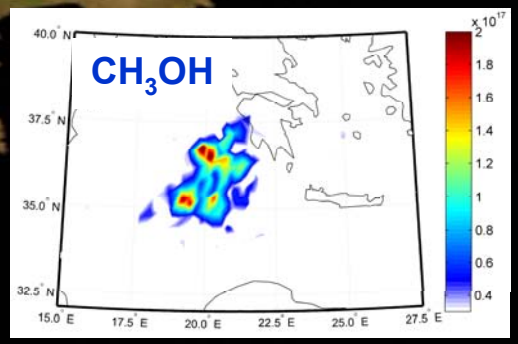
Carbon monoxide (CO) – Fires

Greece, 25-28 August 2007

Courtesy D. Hurtmans, S. Turquety





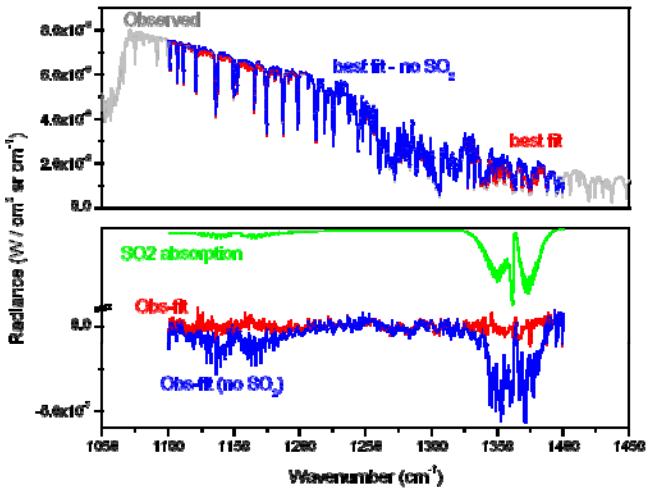


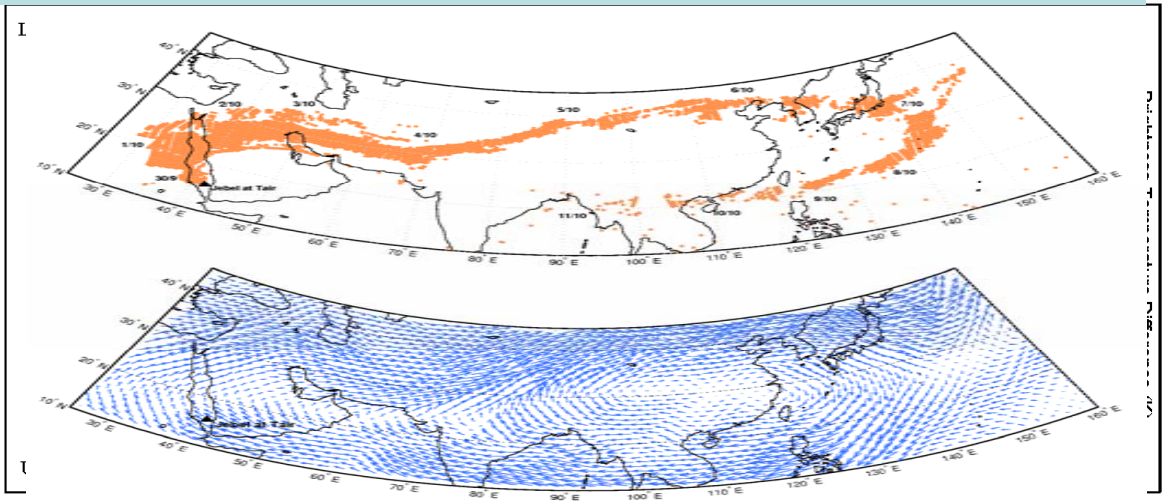
Courtesy P. Coheur

Volcanic SO2

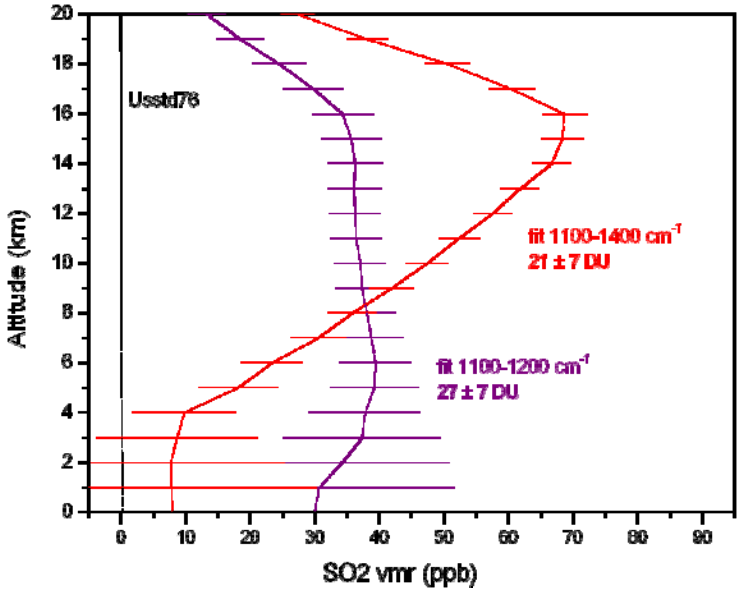
Sulfur dioxyde (SO_2) – volcano plumes

Jebel at-Tair (Red sea), 1 October 2007





Note: Different profile information if entire 1100-1400 cm-1 interval or only 1100-1200 cm-1 is used. May be linked to problem with H2O at 1300 cm-1 (see weird SO2 band shape in the residual).
Similar columns in both cases



Credits : L. Clarisse, P.F Coheur

Results at Noveltis

- CO_2 (See poster by L.Chaumat et al)
- Heterogenous scenes (see poster by T. Phulpin et al)
- Assimilation of CO (C. Clerbaux with the support of Noveltis)

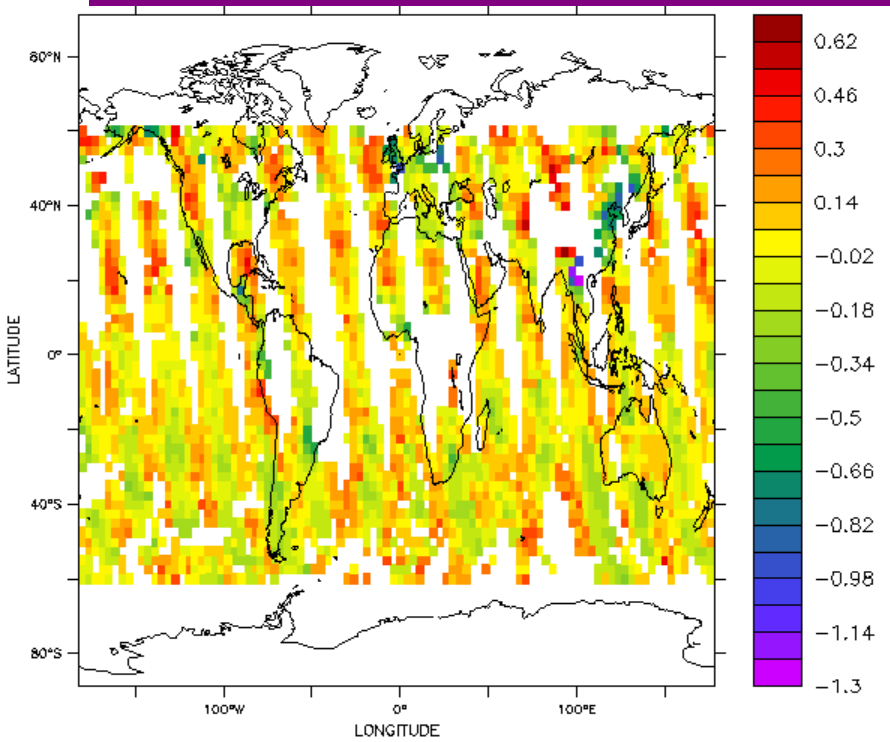
Assimilation of IASI CO column data in the LMDz-INCA chemistry-transport model (1)

- IASI level 2 CO column data provided by Service d'Aeronomie (SA). The columns are obtained with the neural network approach.
- The assimilation module is based on the Kalman filter and was developed by JF Lamarque and B. Khatattov (NCAR, USA)
- The module was adapted to work with IASI CO columns by NOVELTIS in the framework of a study funded by the CNES' TOSCA program (PI of the project: Cathy Clerbaux, SA)
- The figures shown are taken from the operational, near real-time assimilations put in place by NOVELTIS
  - starting date of the assimilation : 28/03/2008
  - starting model error: 50%
  - observation error: 1.E17 molec/cm2 over sea, 2.E17 molec/cm2 over land
  - model error growth: 0.005*CO for each assimilation window of 30 minutes

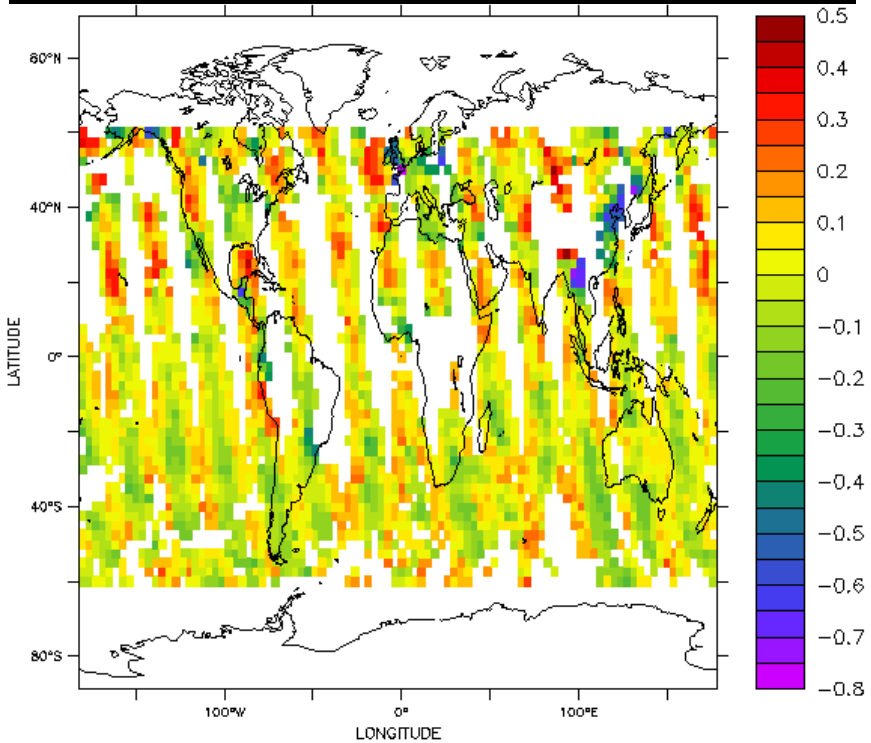
Assimilation of IASI CO column data in the LMDz-INCA chemistry-transport model

- 09/03/2008, assimilation of night observations only

observations-forecast

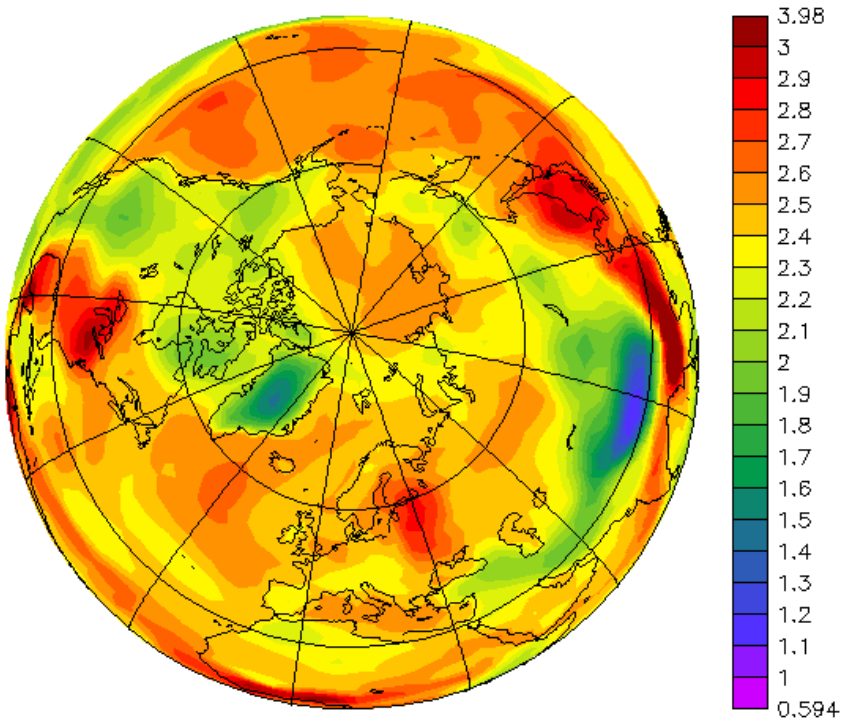


change in model CO column due to assimilation

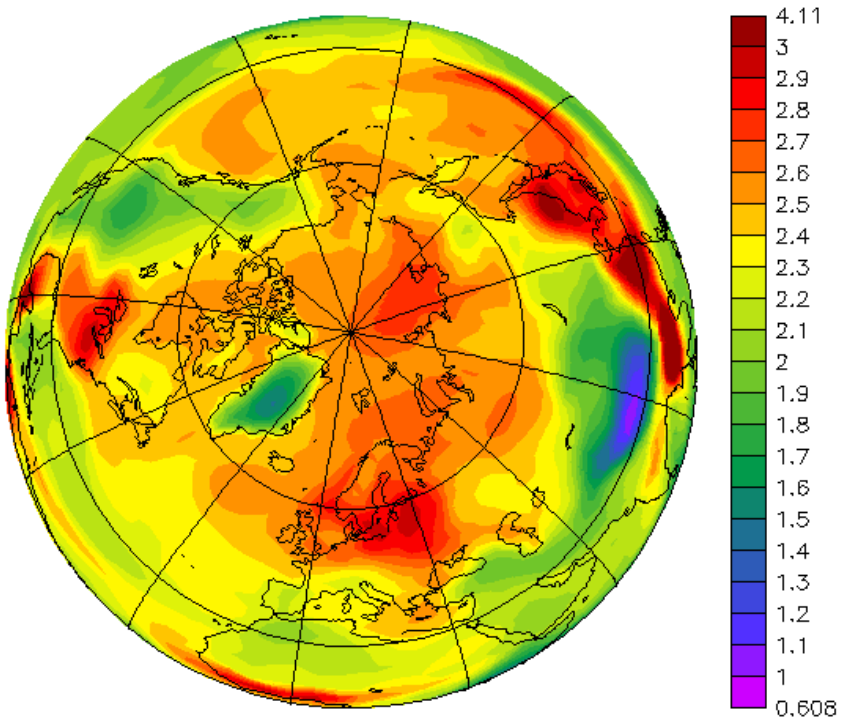


CO column, 07/04/2008

With assimilation



No assimilation

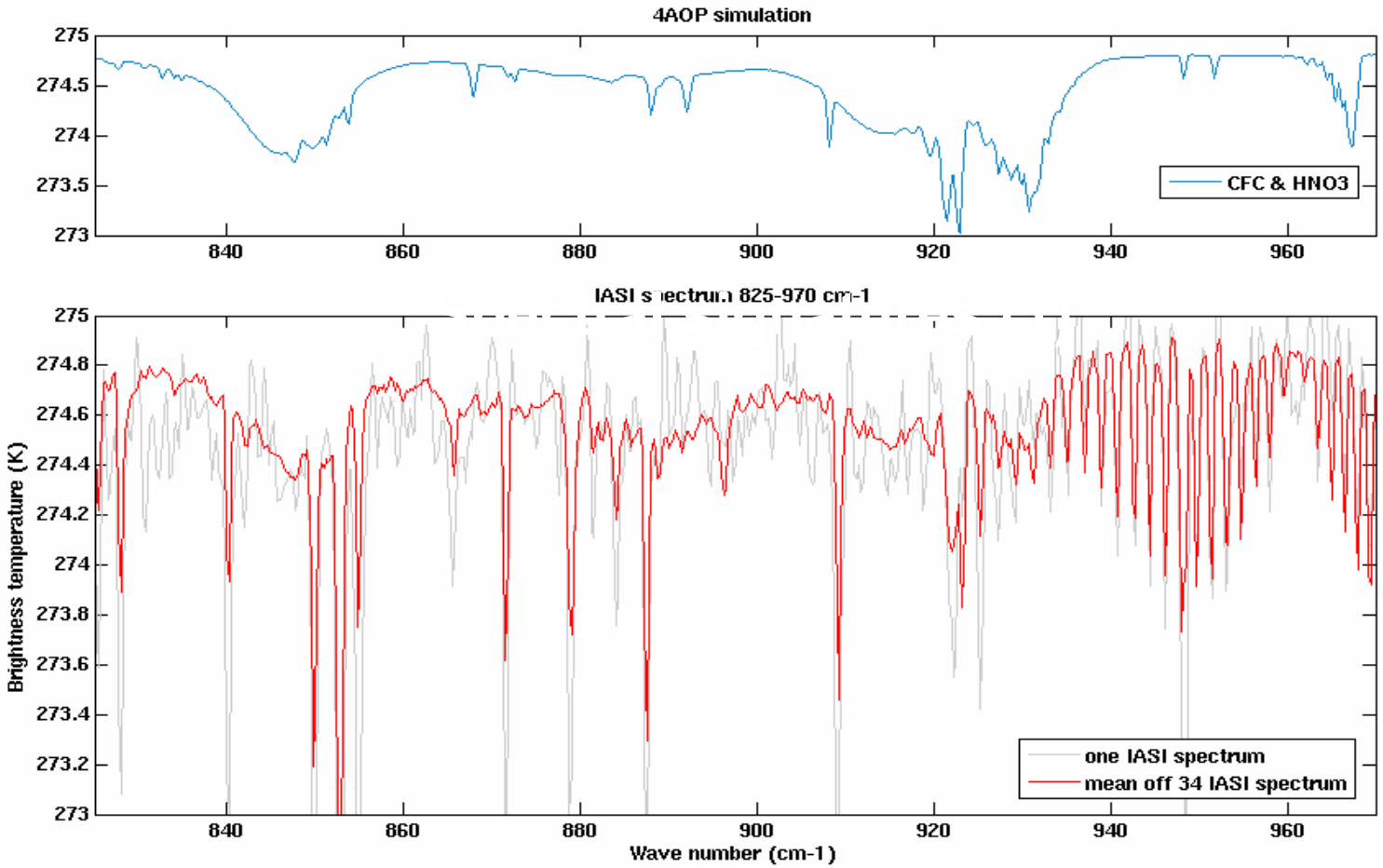


Results at CNES

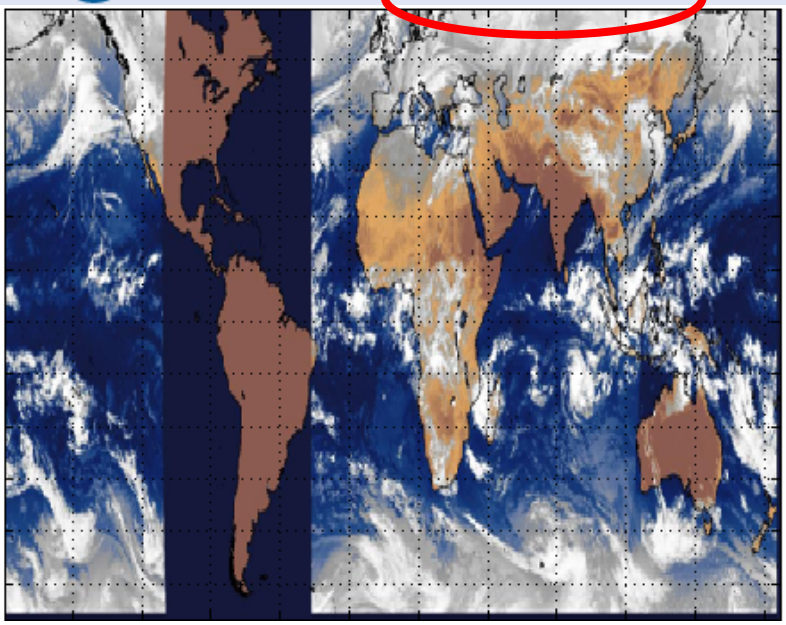
- CFCs
- Cloud mask
- Aerosols (Sand outbreak)

Spectral signatures (2)

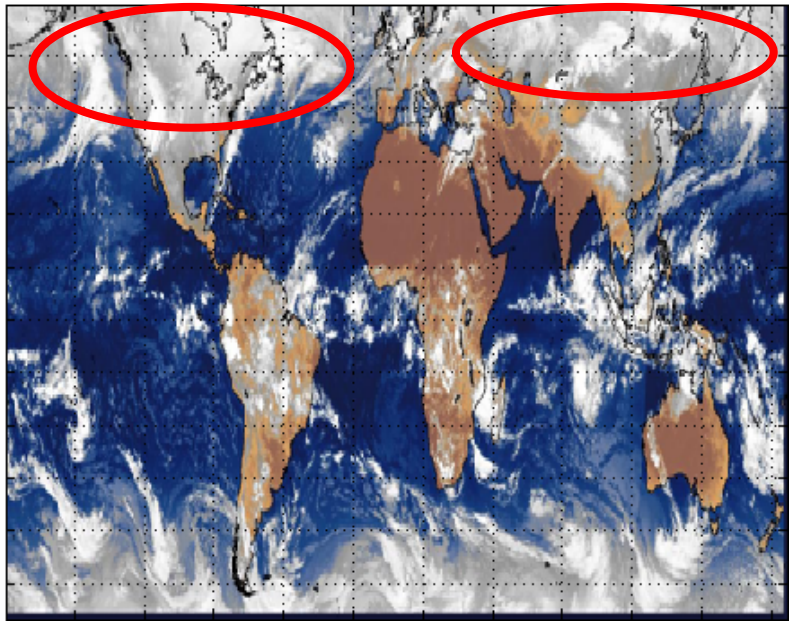
CFC and HNO_3



06H

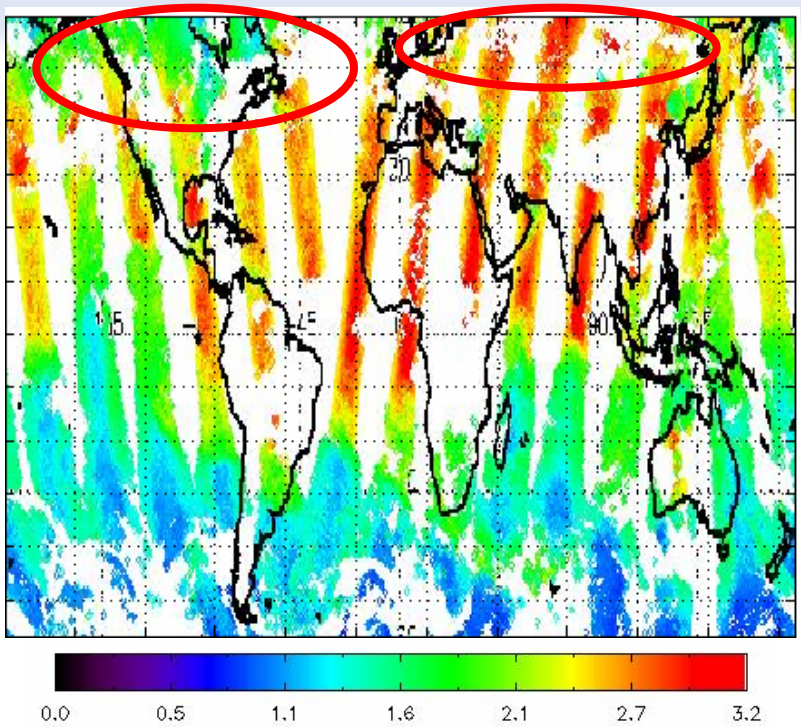


12H



IASI L2 CO column*1e18, molecules/cm^2

12H

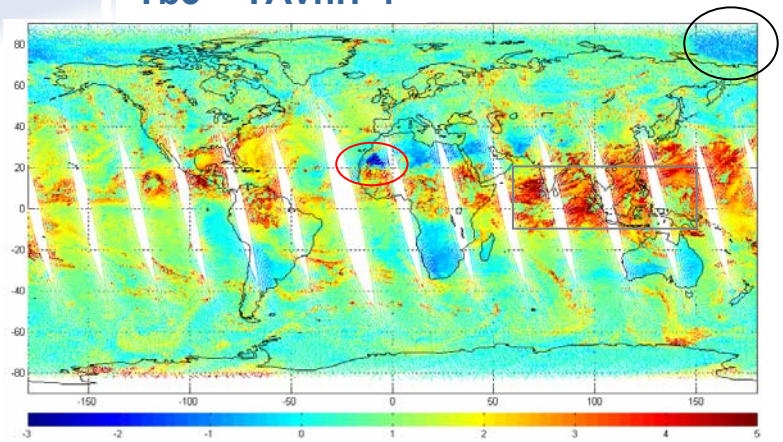


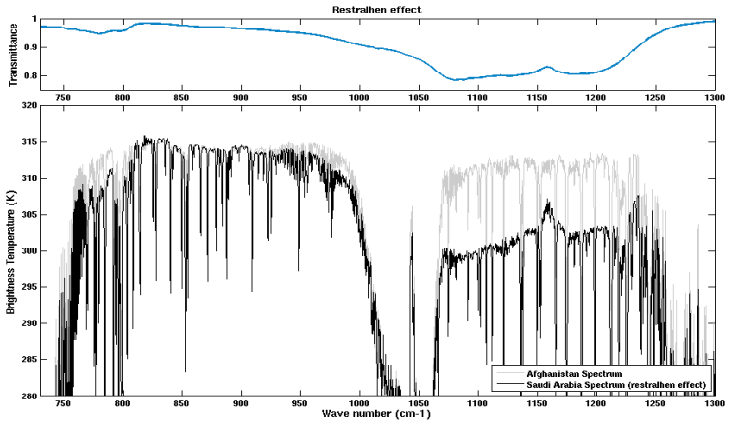
- High cloud cover over Russia where strong apparent CO column

- High cloud cover over North Americawith low CO column

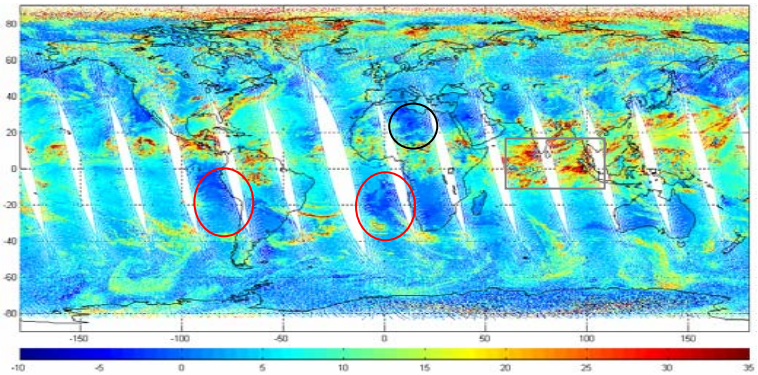
15 July 2007 (night)

Tb3 – TAvhrr 4





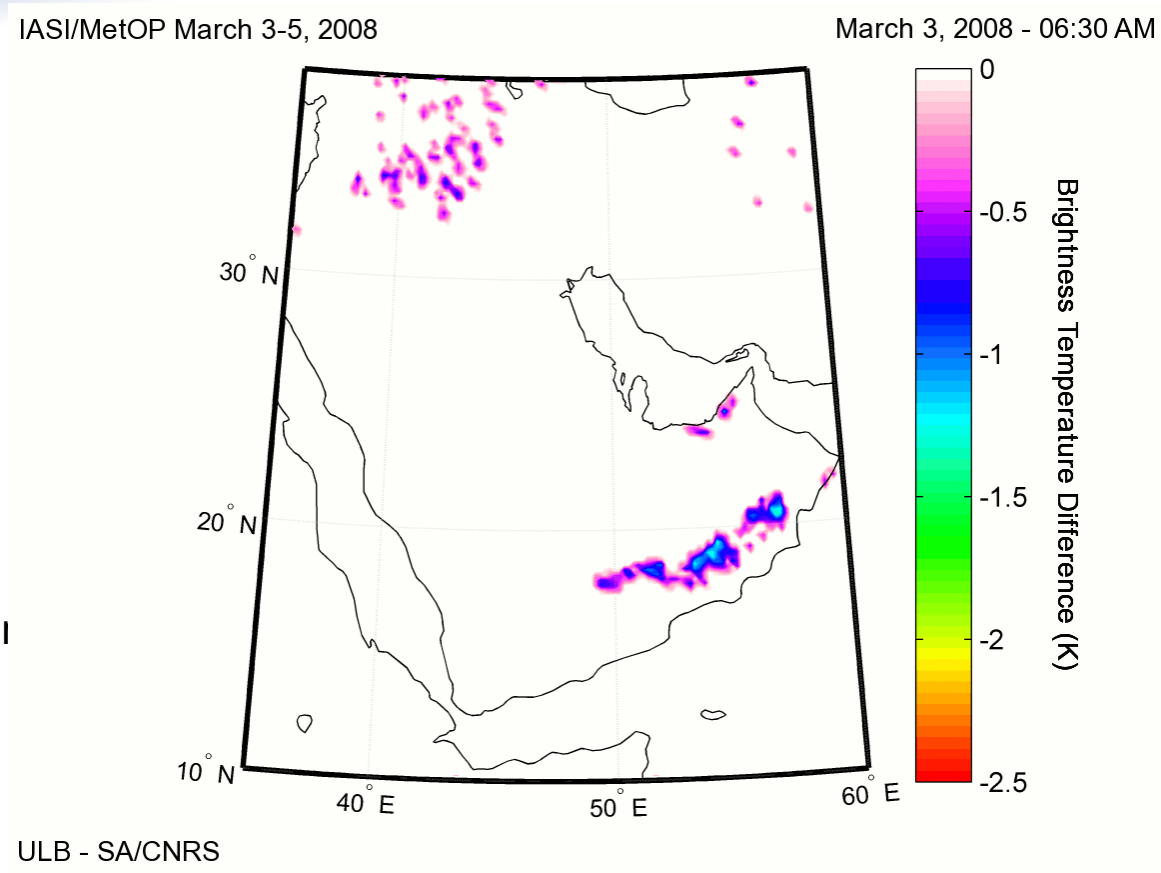
Tb3 – TAvhrr 5



MODIS, March 4

Dust storm in Middle East, Mar

IASI



Courtesy P. Coheur

ΔBT (K)= BT(●)-[BT(●)+BT(●)]/2

ΔBT (K)= BT(●)-[BT(●)+BT(●)]/2

Future activities

- Validation to be continued
- Some problem to fix in fast inversion method (emissivity, large scan angle)
- Compare with Eumetsat products
- Treatment of heterogenities (Cloud contaminated IFOVS)
- CH_4, CFCs, CO_2 and others

Conclusions

- Intercomparison of products (including Eumetsat L2)
- Feedback on spectroscopy
- Improve product screening
- Incorporate information on heterogenity
- Work on combination with other sensors (AMSU for T- profile, Gome 2)
- Assimilation

- **More information on**
  - http://smsc.cnes.fr/IASI
  - http://www.eumetsat.int/

Thank you