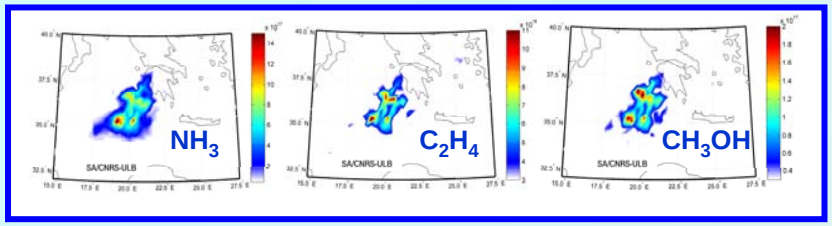
IASI measurements of short-lived species



Pierre Coheur, Lieven Clarisse,
Daniel Hurtmans, Catherine Wespes

Spectroscopie de l'Atmosphère,
Chimie Quantique et Photophysique,
Université Libre de Bruxelles, Belgique

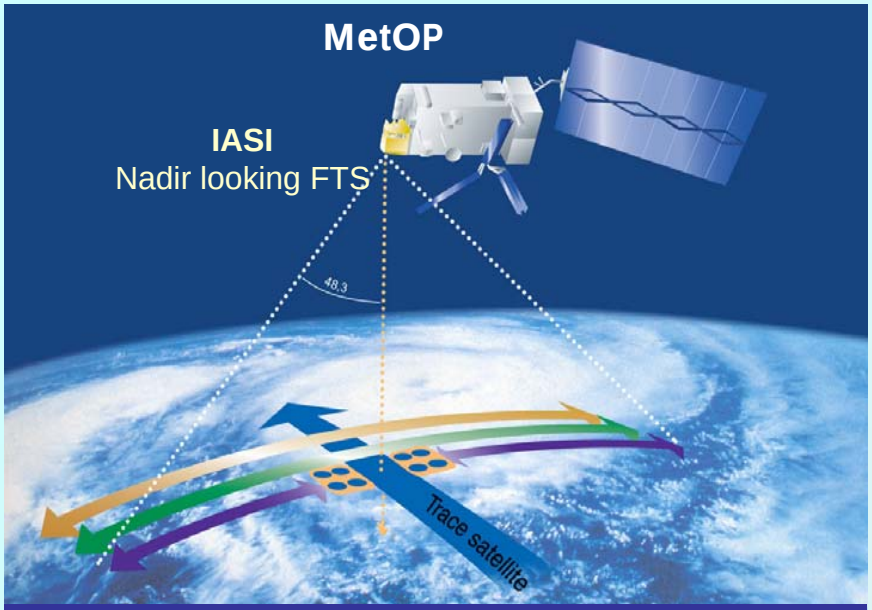
Cathy Clerbaux, Solène Turquety,
Juliette Hadji-Lazaro

Service d'Aéronomie / CNRS,
IPSL, Université Paris 6
Paris, France

IASI

- Instrument and status
- Measurements and products
- Measuring short-lived species: 4 examples
  - HNO_3
  - Trace species in biomass burning plumes
  - SO_2/Aerosols in volcanic plumes
  - Dust storms

IASI instrument and status

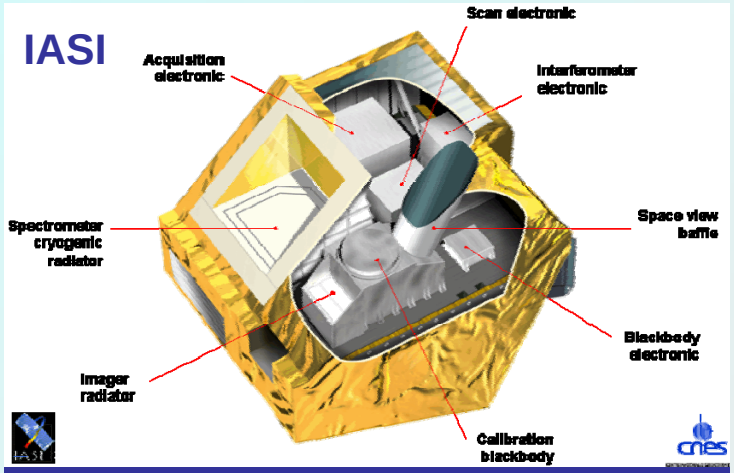


- 12 km pixel x 4 @ nadir
- 120 spectra along the swath (±48.3° Scan →2400 km), each 50 km along the trace

Small ground pixel size

Global coverage twice daily (1.3×10^6 spectra). Morning and evening orbits

MetOp: First European meteorological platform on polar orbit (EPS system)



- Spectral coverage = 645-2760 cm^{-1}
- Spectral resolution = 0.5 cm^{-1}
- Radiometric noise ~ <0.1-0.2 K

Broad spectral coverage without gaps

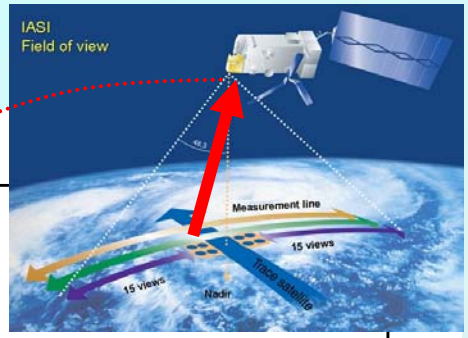
Medium spectral resolution

Excellent radiometric performances

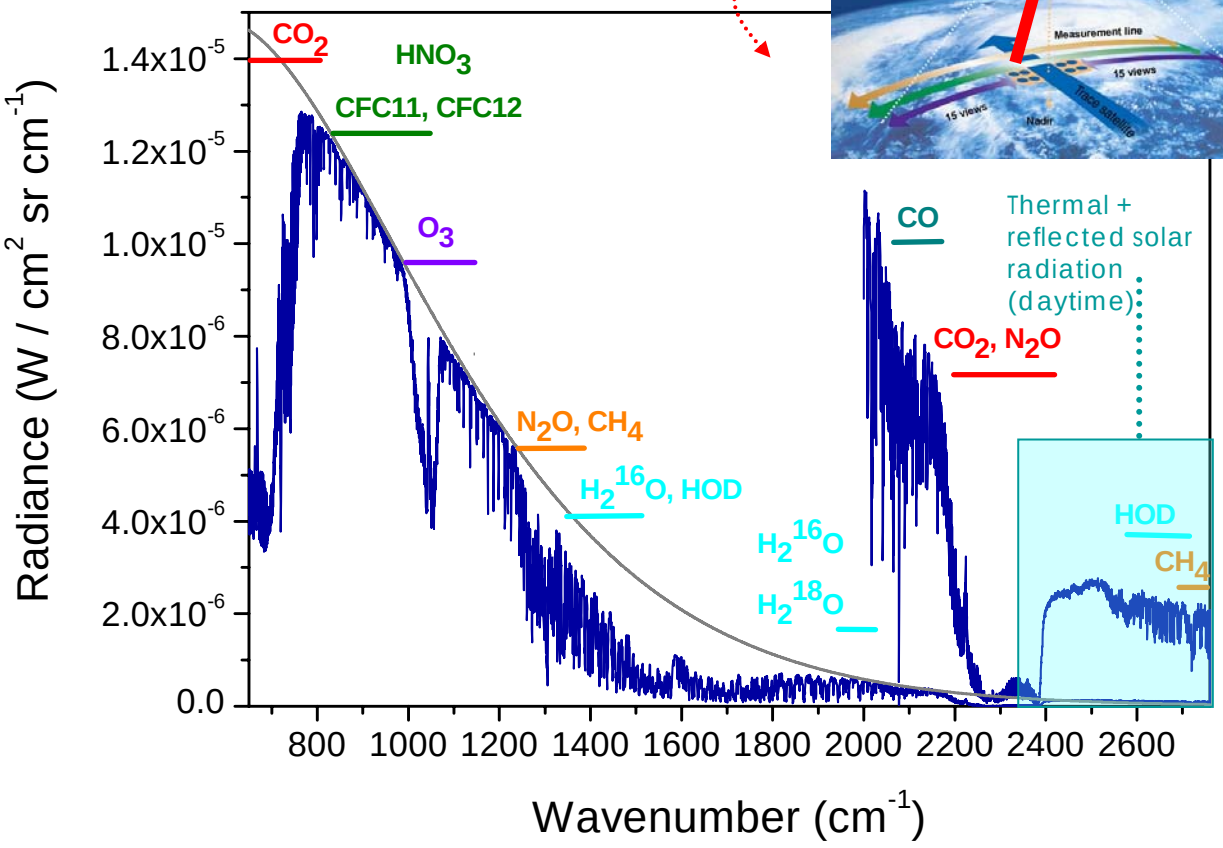
Jun. 4, 2007	L1C Operational dissemination
Sep. 27, 2007	L2 (P, T, clouds) operational dissemination
Mar. 1, 2008	L2 (trace gases) operational dissemination

Measurements and Products

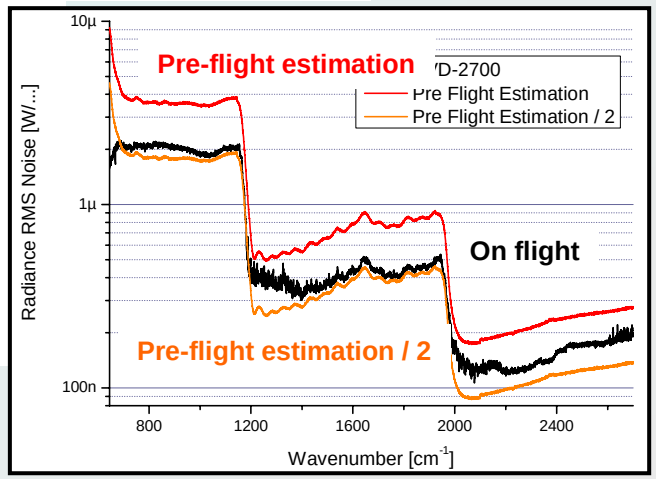
IASI radiance spectrum



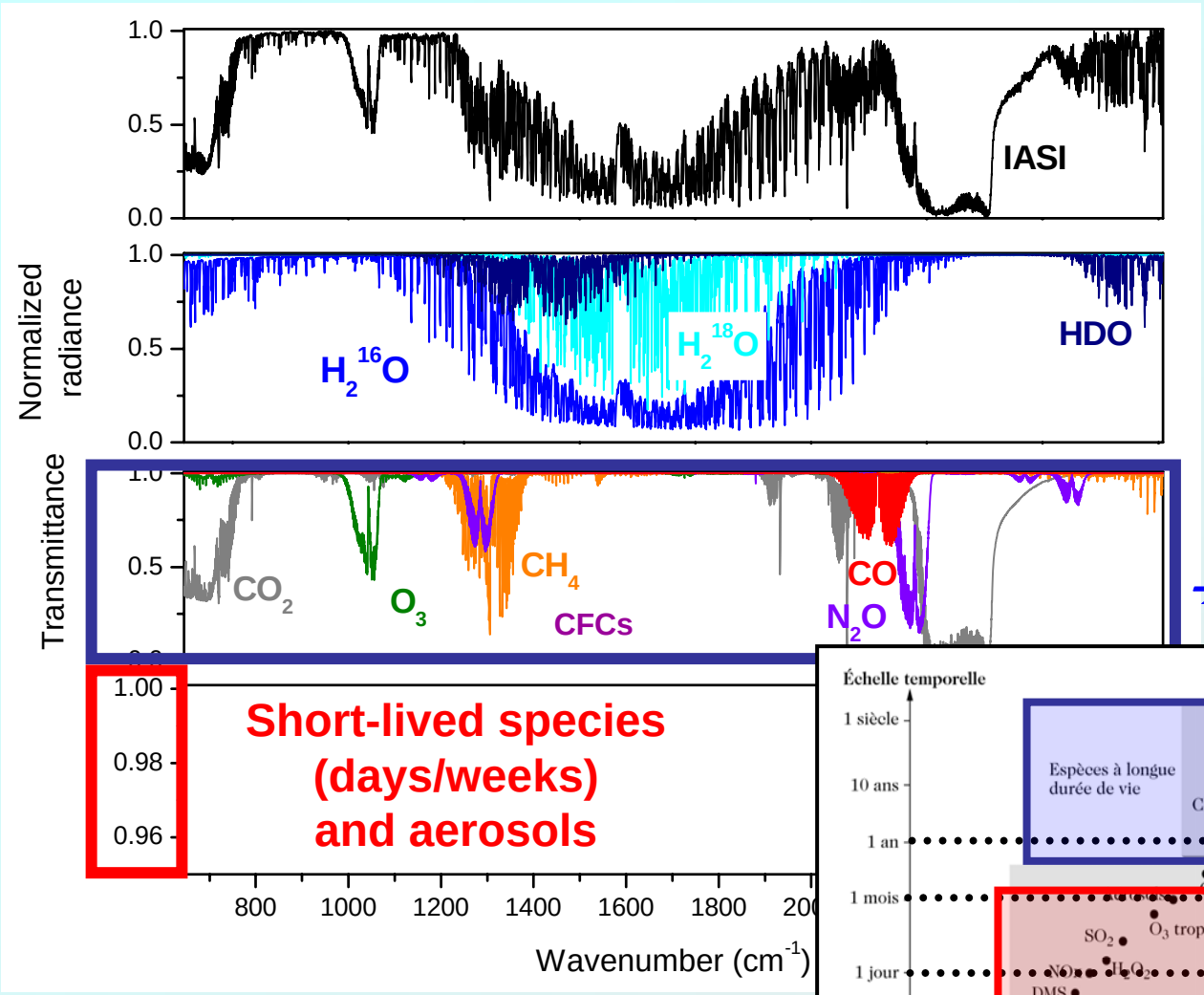
SA/CNRS – ULB



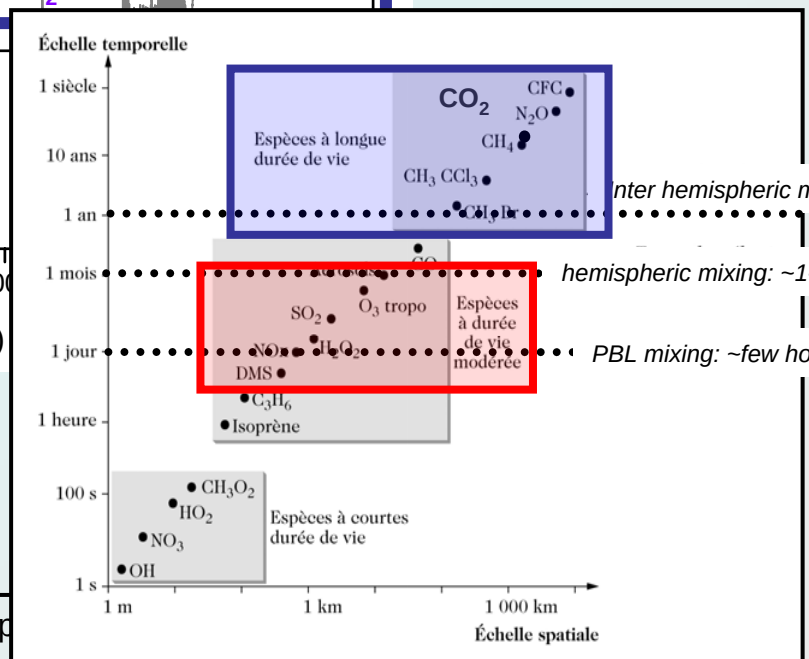
Noise estimation



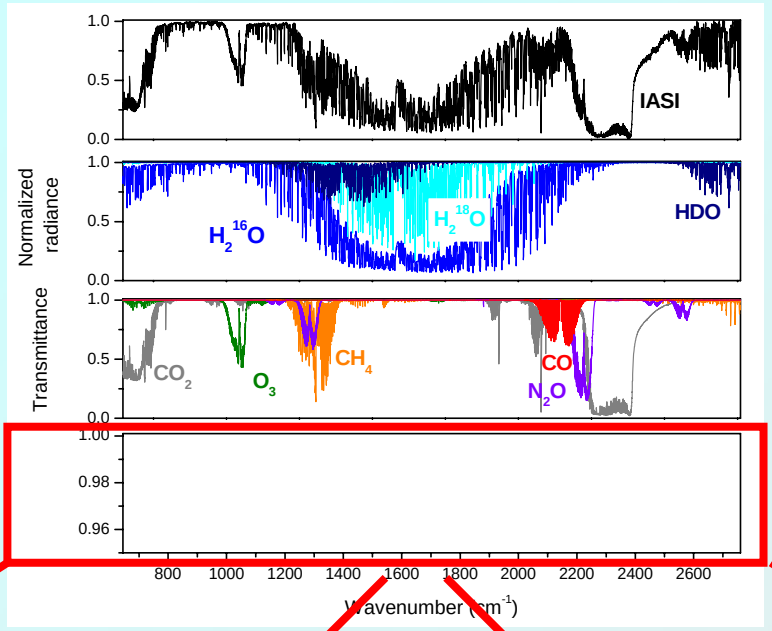
Measurements and Products



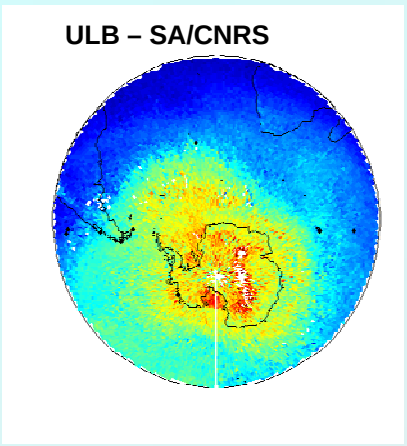
Long-lived species (years)
→ *Climate*
+ CO, O_3 (months)
→ *Chemistry (C. Clerbaux tuesday)*



IASI measurements of short-lived species



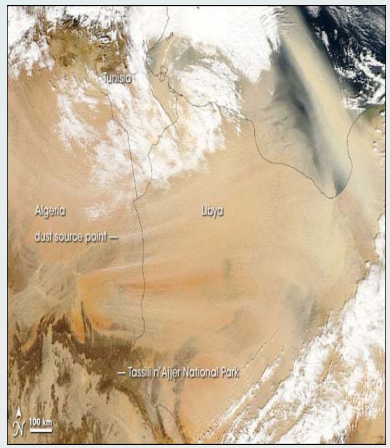
Nitric acid



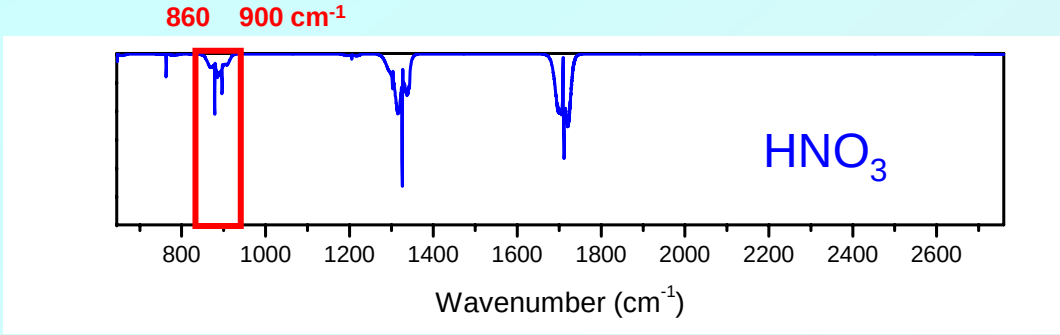
Trace species in biomass burning plumes

SO_2/aerosols in volcanic plumes

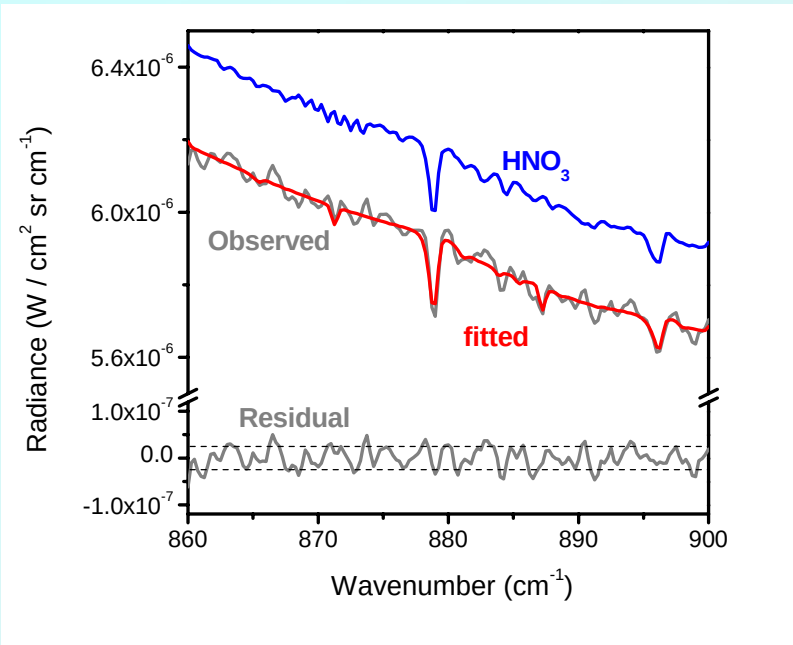
Dust storms

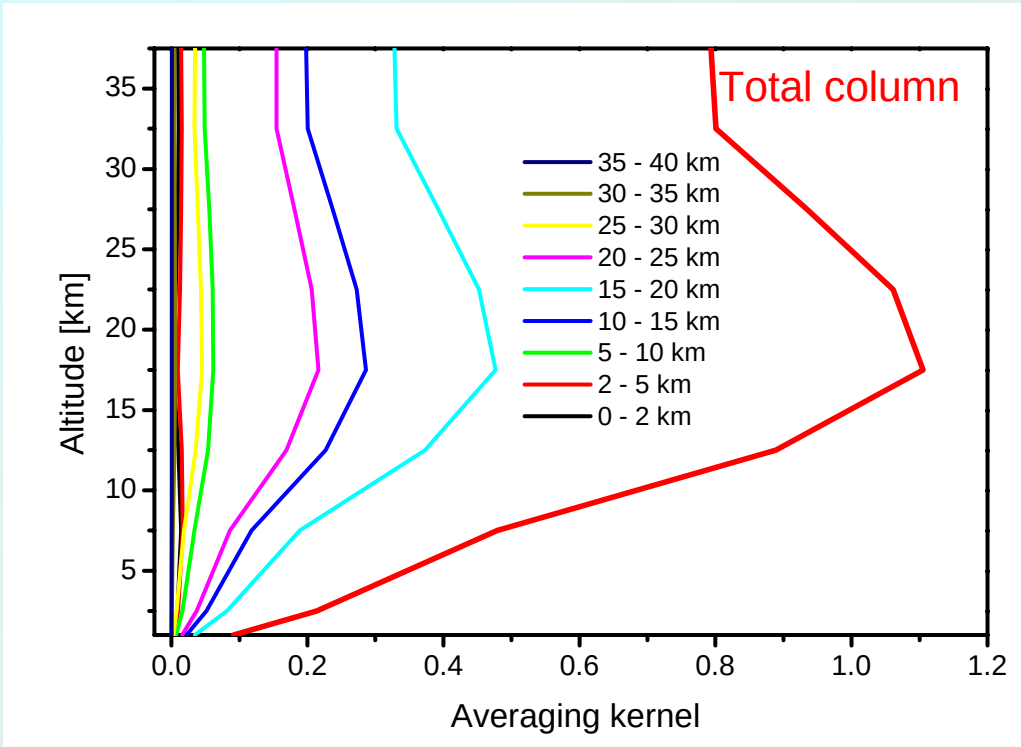


HNO_3



Profile/Column retrievals based on the Optimal Estimation Theory; NRT processing

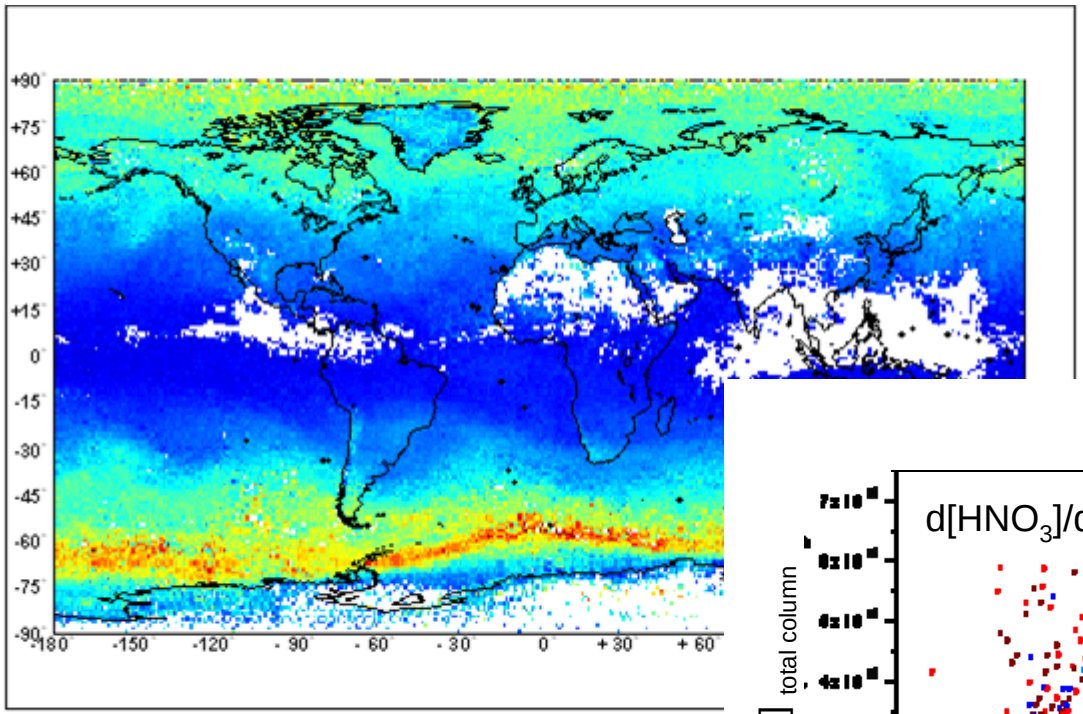


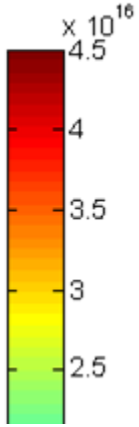


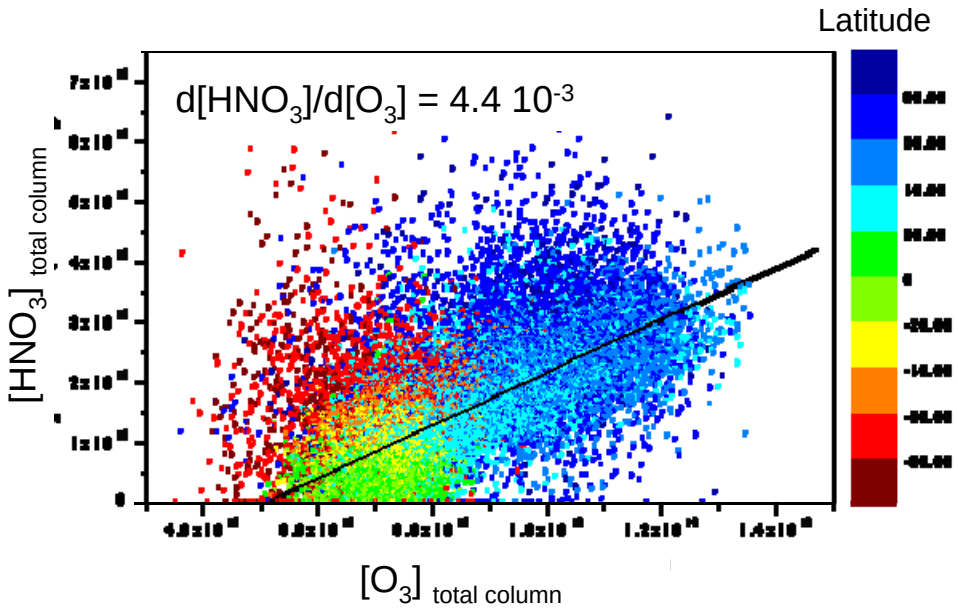
For HNO3, total column mostly relevant

Total columns

Weakly average, July 2008



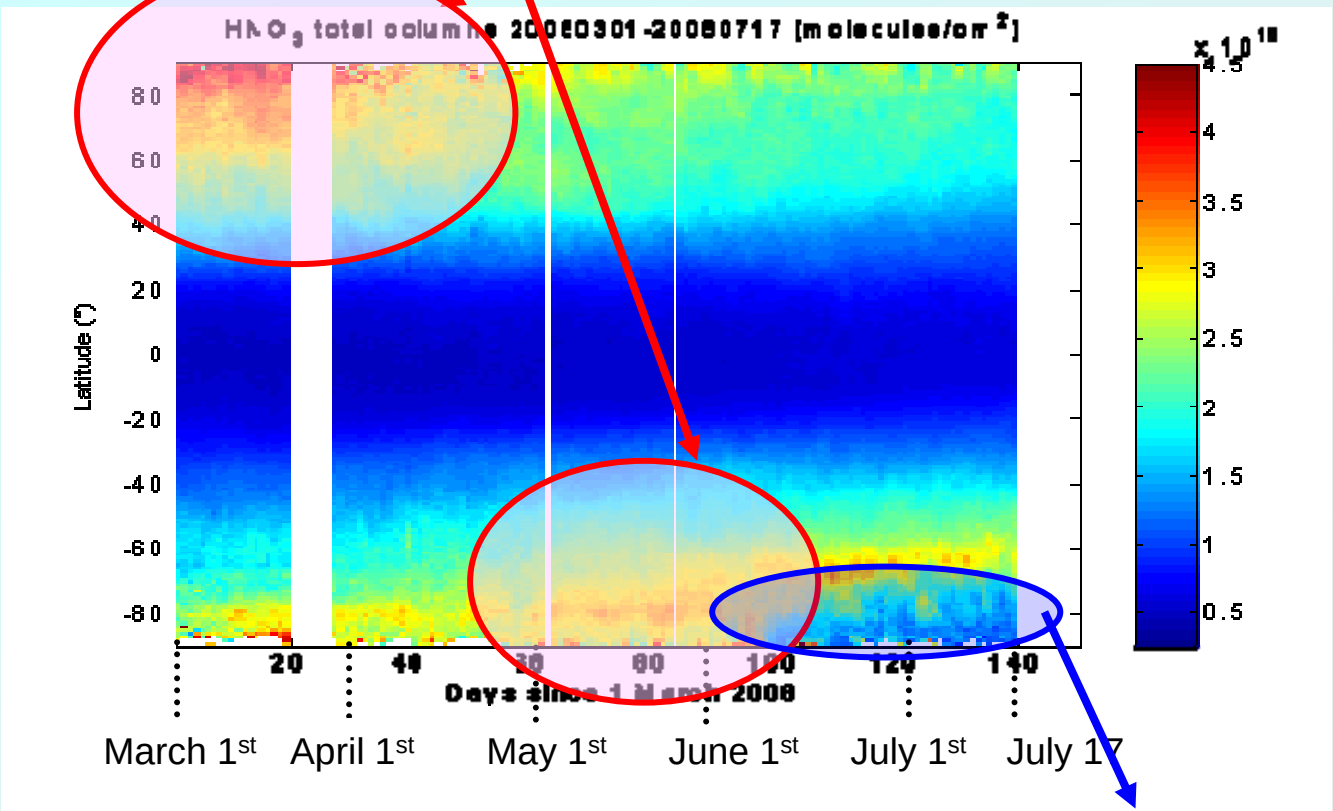




Total columns

Preliminary time series

Polar enhancements Autumn to spring



PSCs formation / denitrification during Antarctic polar night

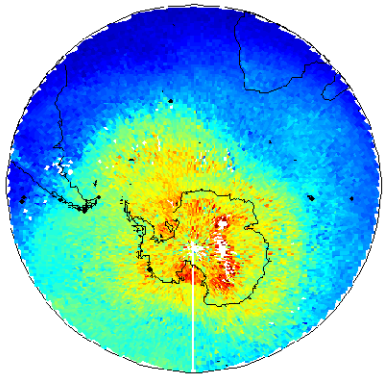
HNO_3

Total columns

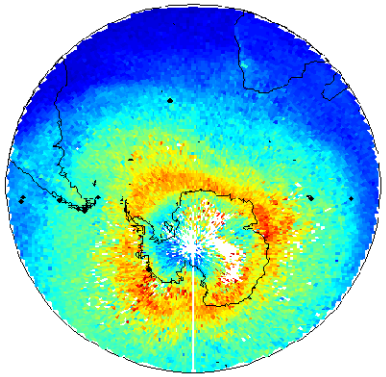
Preliminary time series

ULB – SA/CNRS

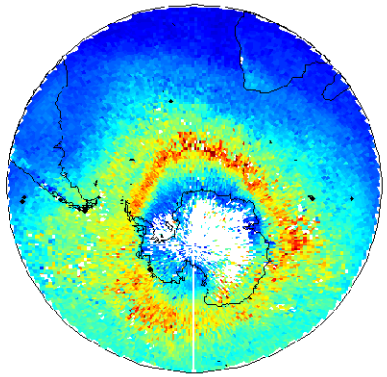
HNO3 total column / Weakly average



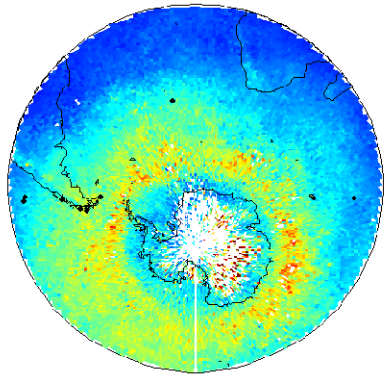
May



June



July

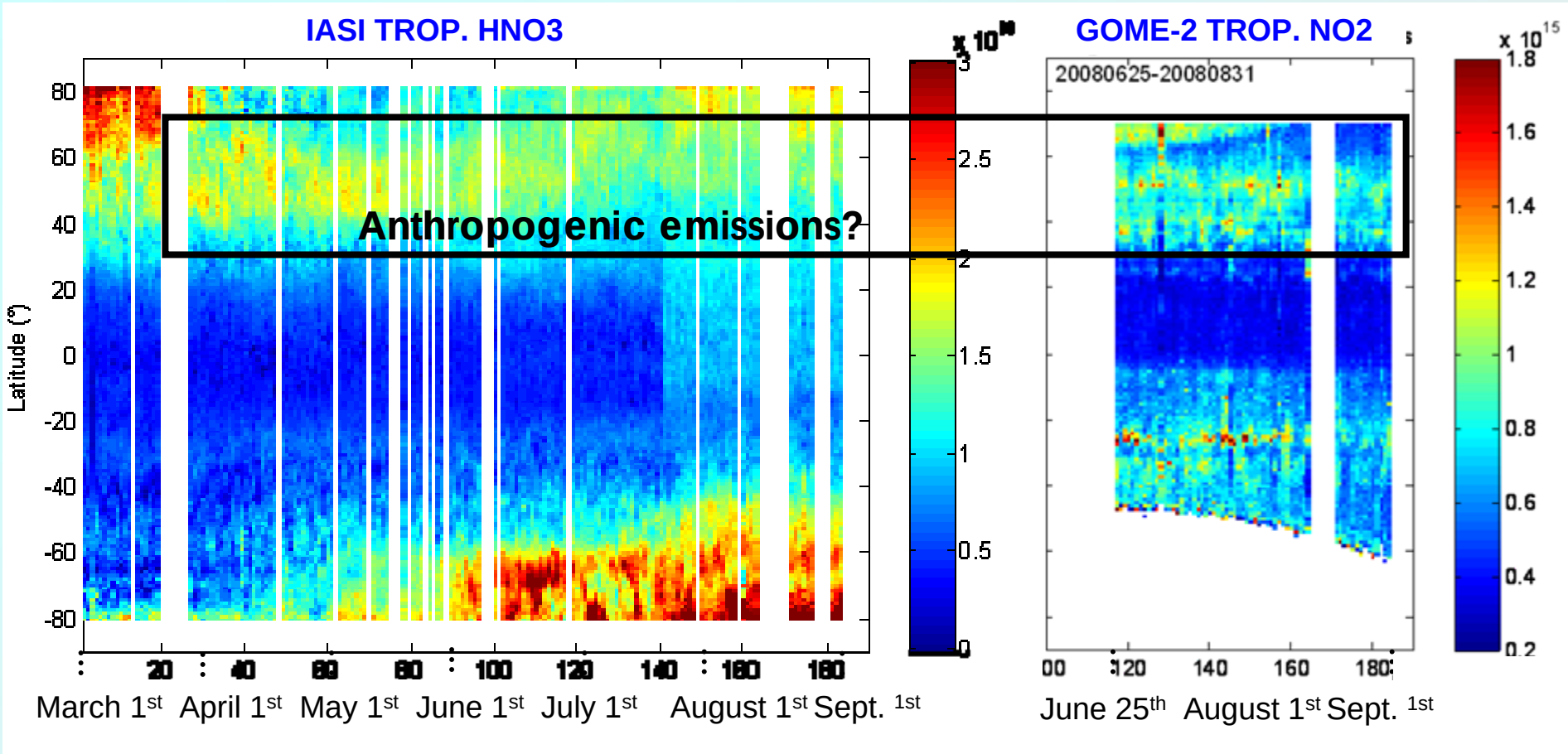


August

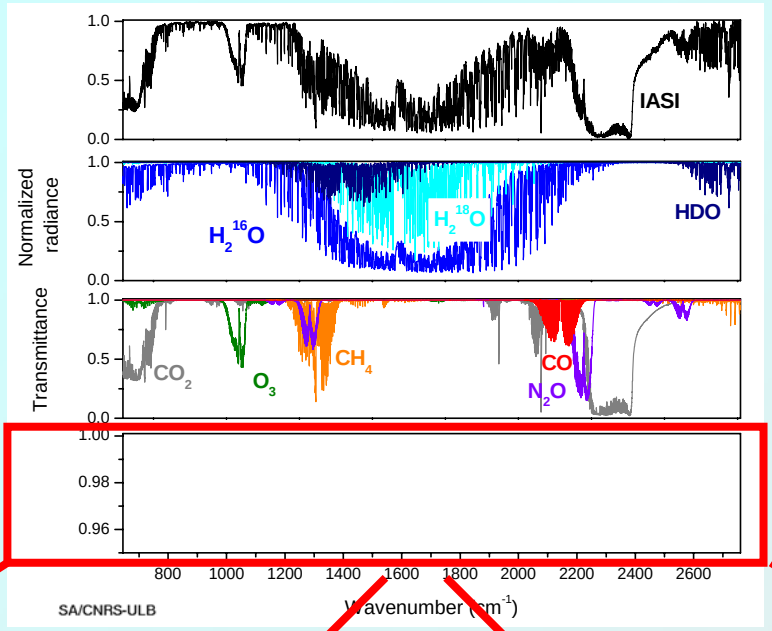
HNO_3

Towards tropospheric columns ….

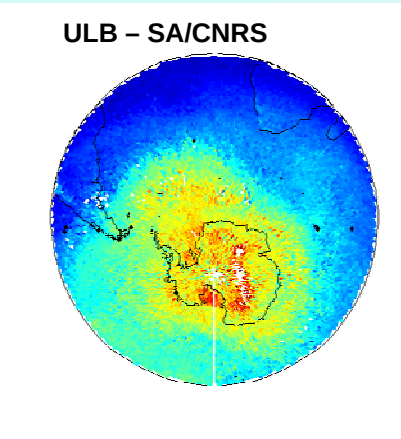
$$[HNO_3]_{tropo} = [HNO_3]_{total}^{IASI} - [HNO_3]_{strato(215 \rightarrow 2hPa)}^{MLS}$$



IASI measurements of short-lived species



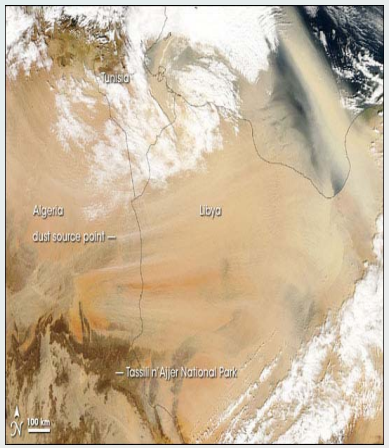
Nitric acid



Trace species in biomass burning plumes

SO_2/aerosols in volcanic plumes

Dust storms



Fire plumes

Fires in Southern Europe in Summer 2007

868 252 ha burned in 14 countries (EFFIS/JRC)

Burnt areas

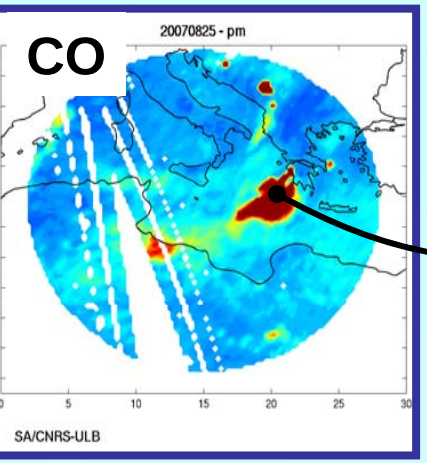
Countries most affected: **Greece**: 270 563 ha;

Italy: 153 884 ha; **Albania**: 127 880 ha;

Bulgaria: 67 747 ha; **Spain**: 55956 ha

Fire plumes

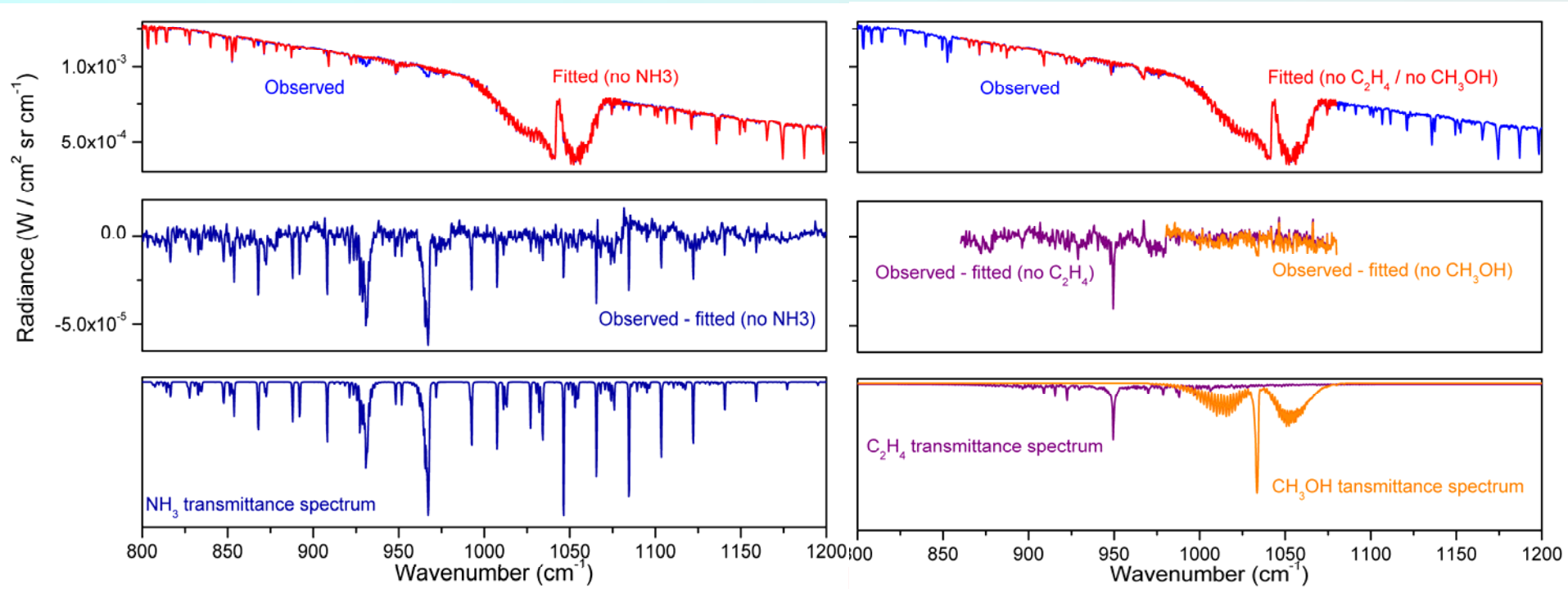
Fires in Southern Europe in Summer 2007



Plume composition

Ammonia (NH_3)

Ethene (C_2H_4) and methanol (CH_3OH)

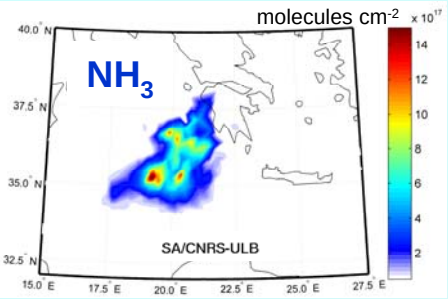


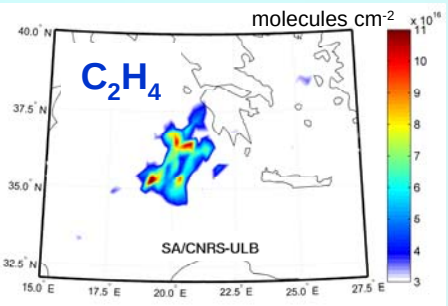
Fire plumes

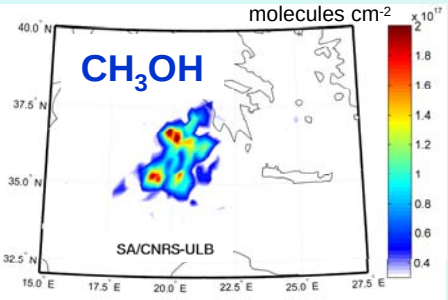
Fires in Southern Europe in Summer 2007

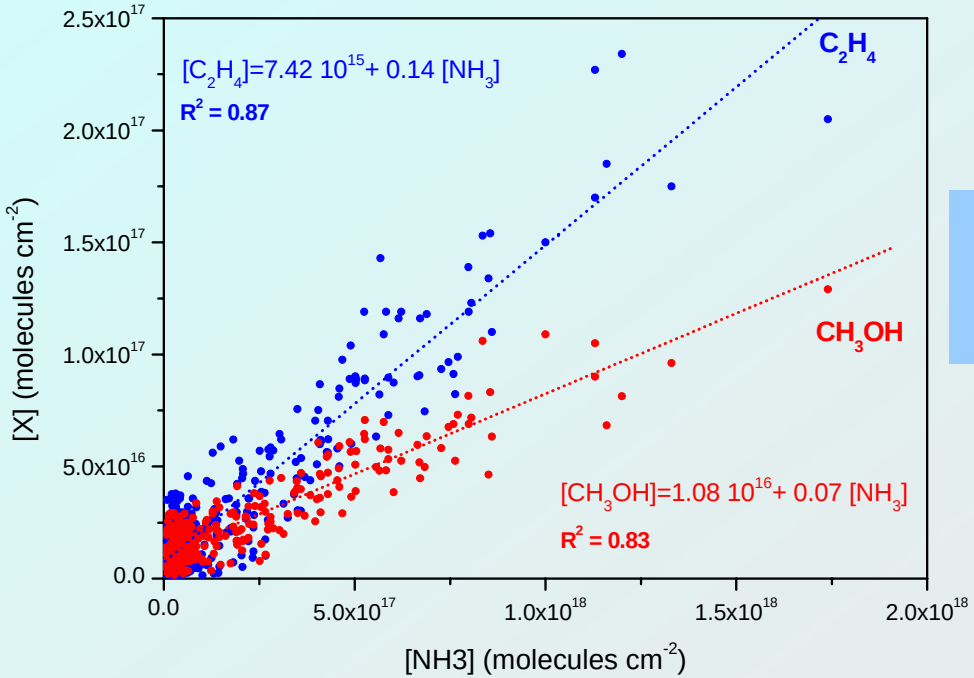
Plume composition

Total column retrievals for August 25









→ Chemistry in the fire plume

Total emitted mass:

NH_3 = 40 kTons

C_2H_4 = 6.5 kTons

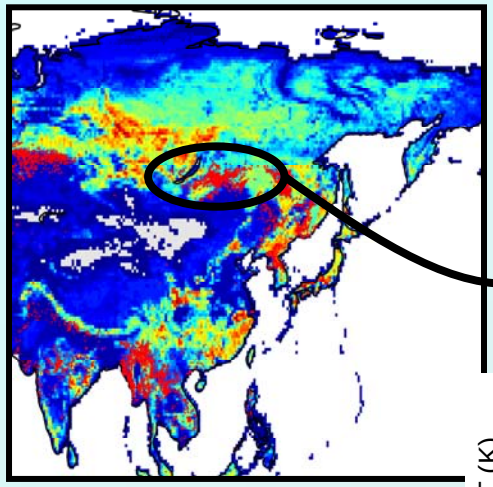
CH_3OH = 7 kTons

→ Atmospheric budgets

Fire plumes

Fires in Boreal regions in Spring/Summer 2008

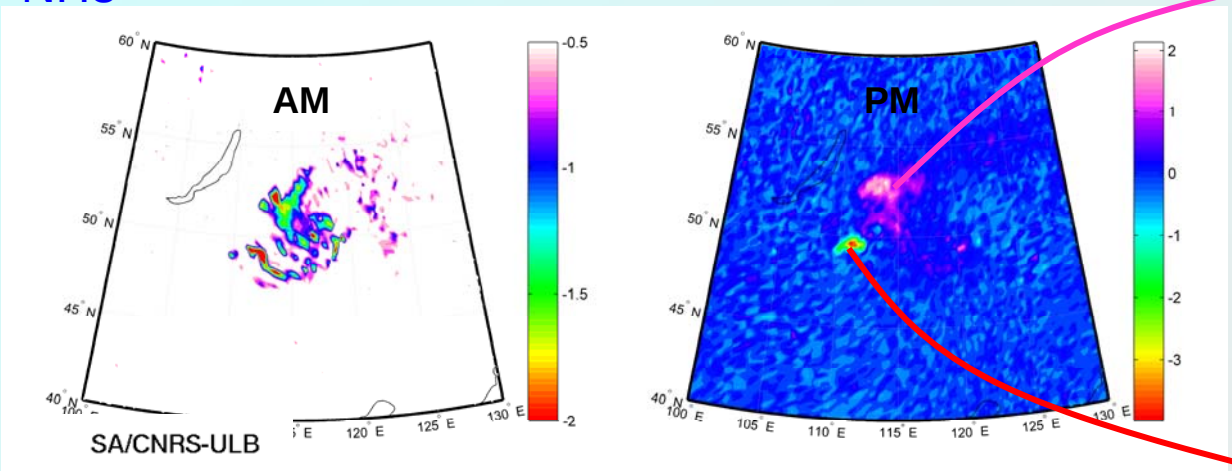
April/May 2008: Russia worst forest fires in 30 years

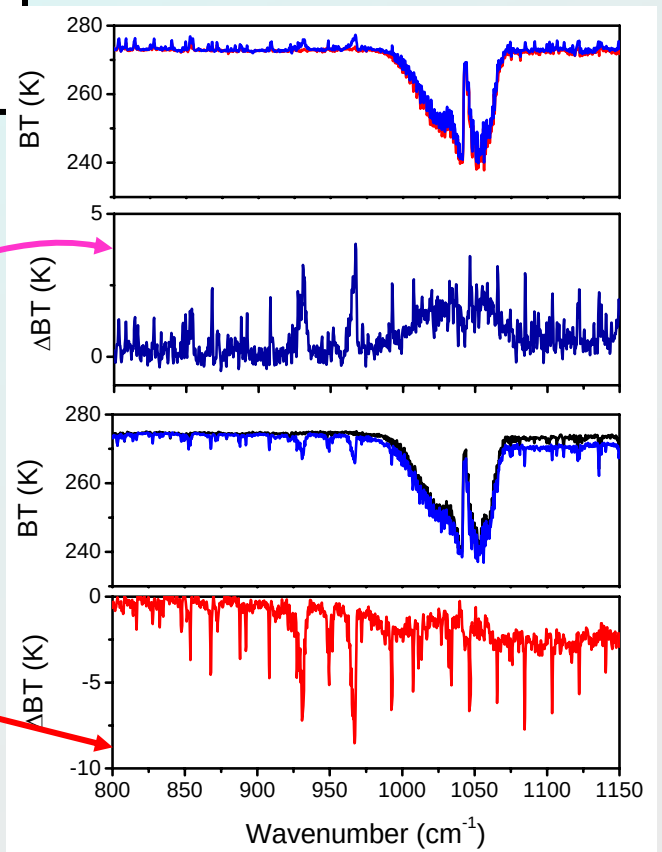


MODIS fire counts (red dots) for April 18, 2008

IASI short-lived species in the fire plume

NH3





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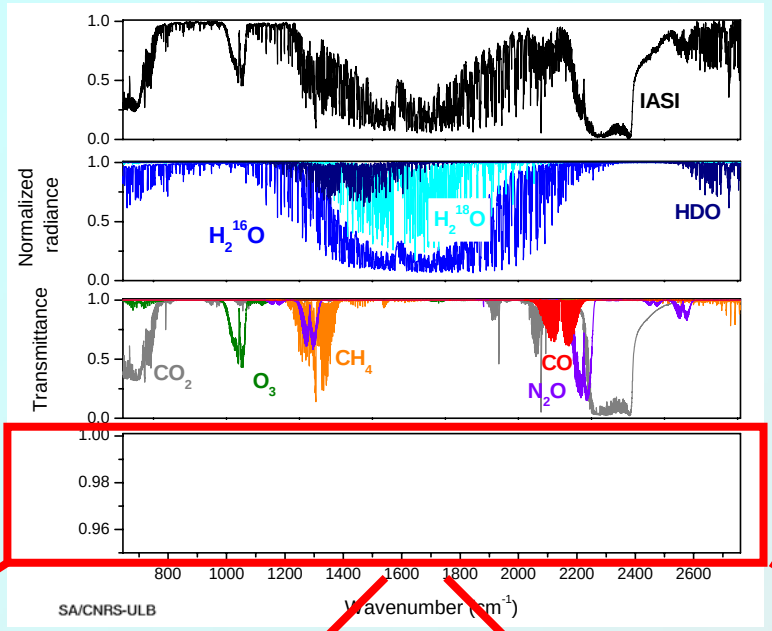
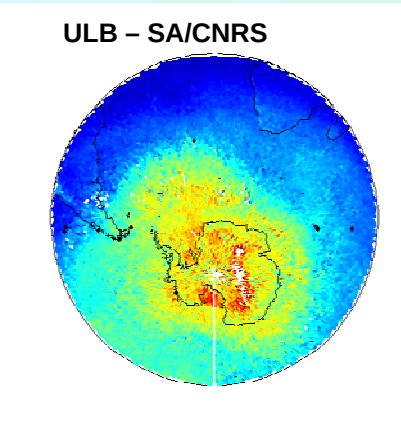


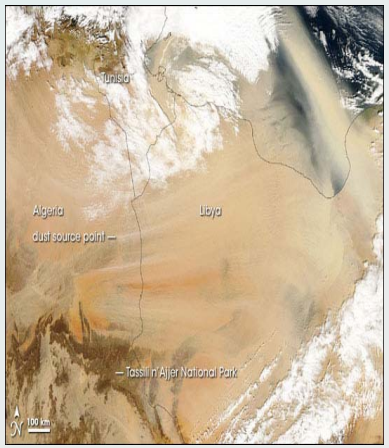
Nitric acid



Trace species in biomass burning plumes

SO_2/aerosols in volcanic plumes

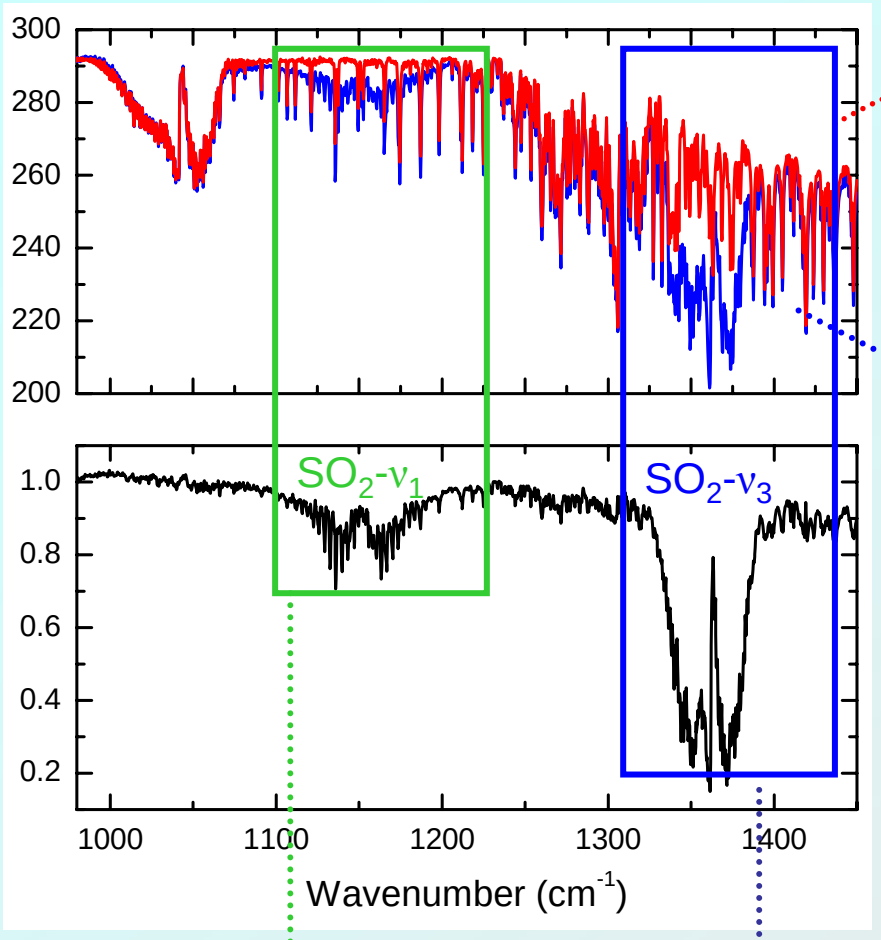
Dust storms



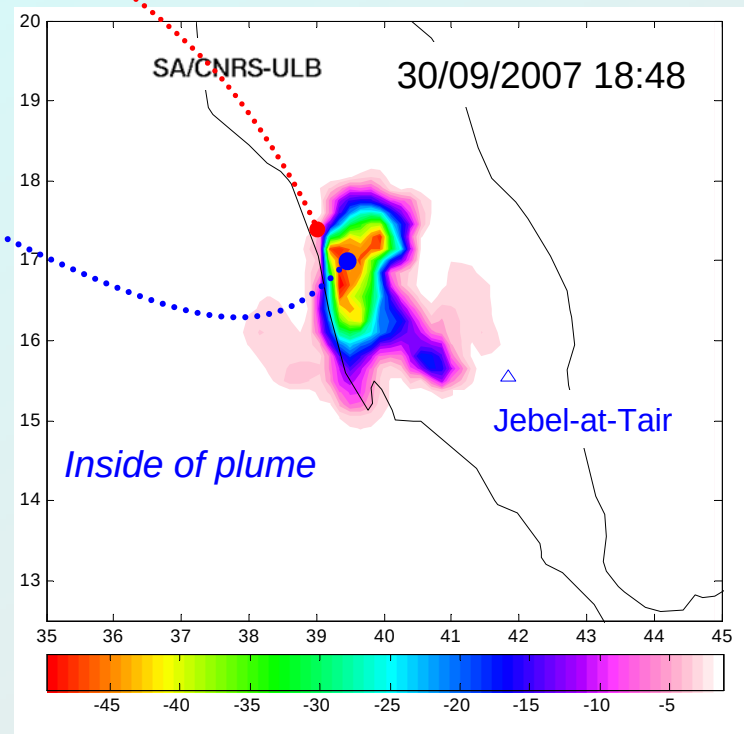
Volcano plumes

Plume composition SO_2

L. Clarisse, ACPD, 2008



Outside of plume



Sensitive to high and low altitude plumes

Sensitive –highly– to high altitude plumes only → Use for aerial security

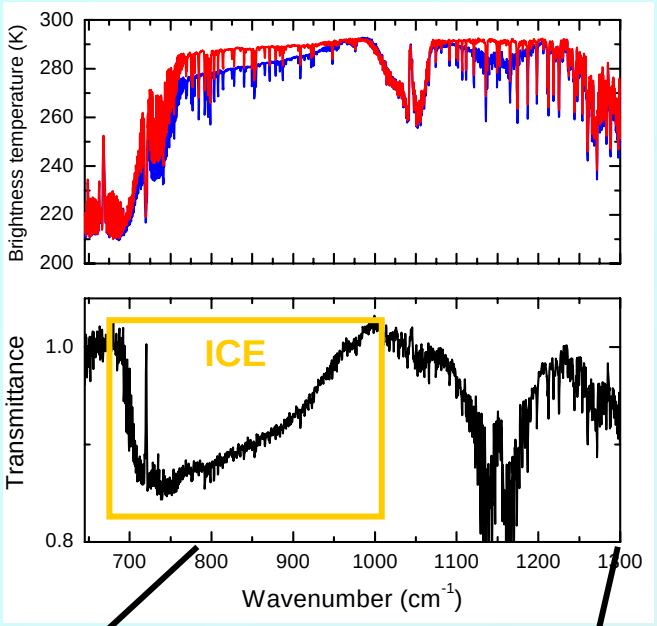
Vertical profile retrievals with 3 km height-resolution

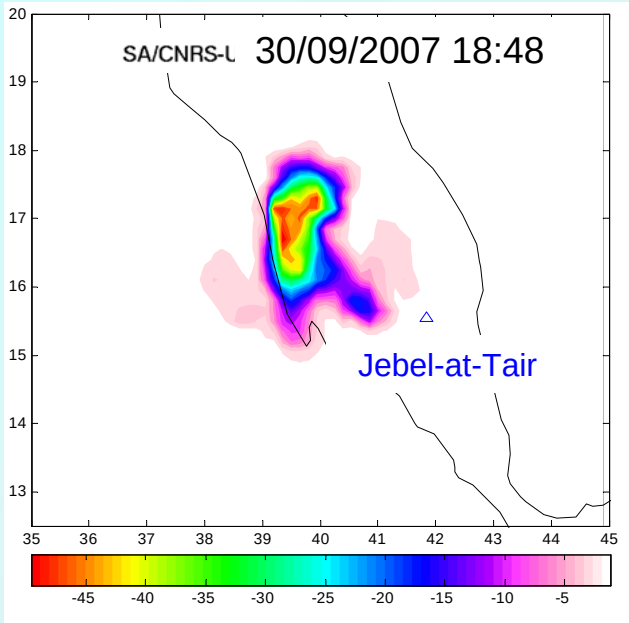
Volcano plumes

Plume composition

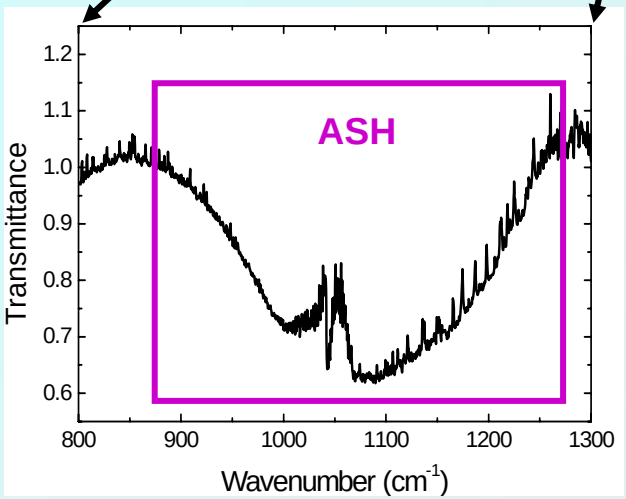
Aerosols

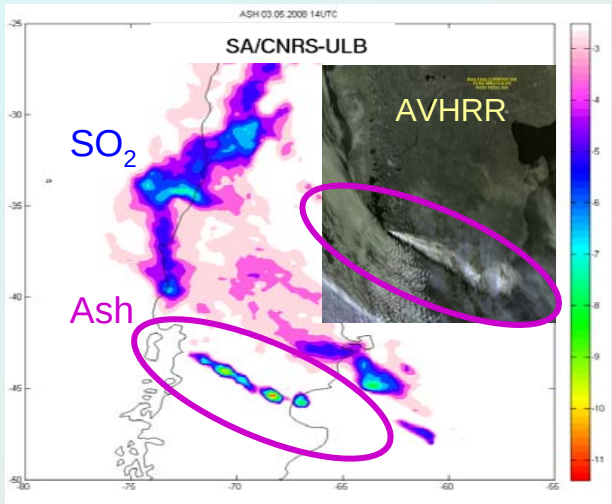
L. Clarisse, ACPD, 2008





Jebel-at-Tair
Sept./Oct. 2007





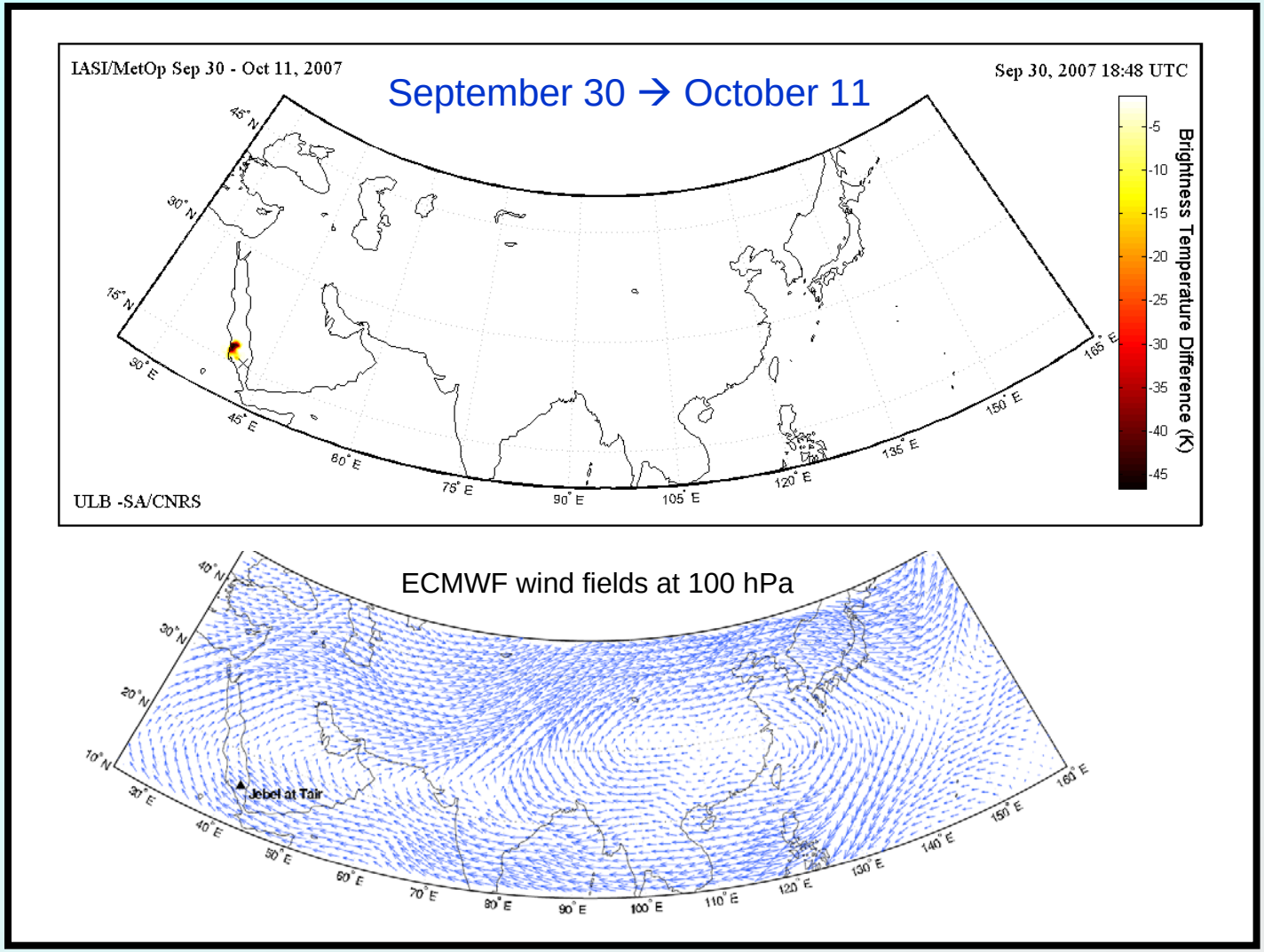
Chaiten, Chile
May 2008

Volcano plumes

Tracking SO_2 plumes

Jebel-at-Tair, September 2007

L. Clarisse, ACPD, 2008

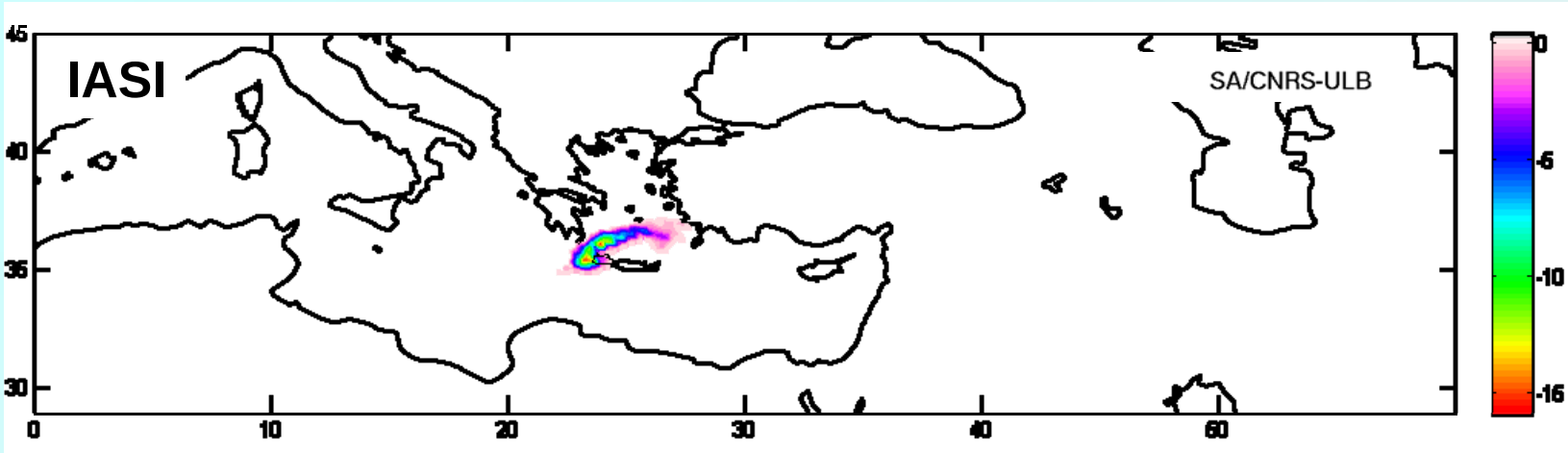


Volcano plumes

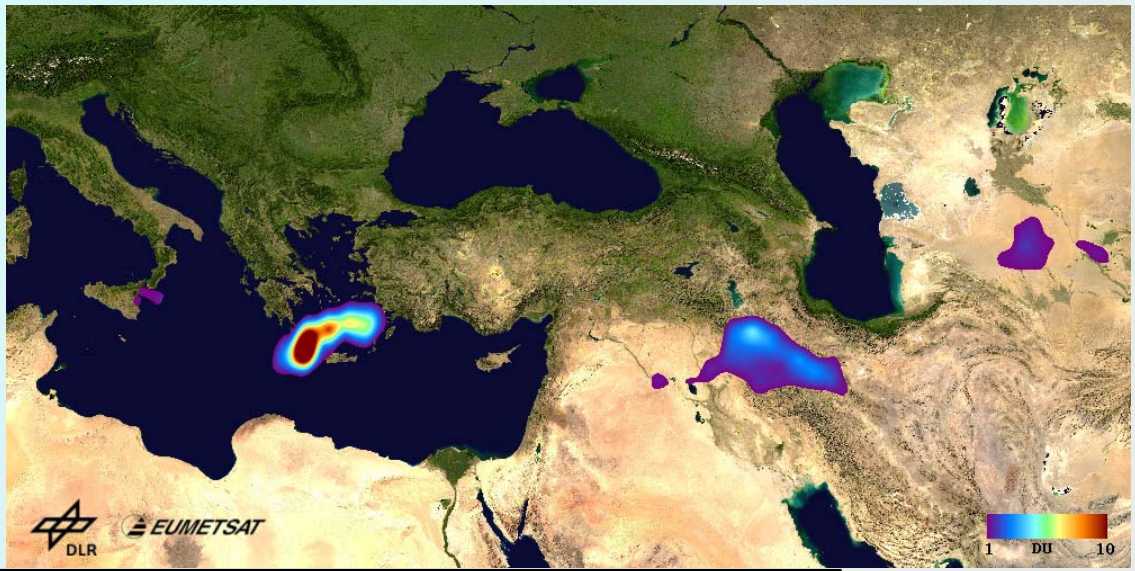
Tracking SO_2 plumes

Etna (Sicily), July 2008

May 10 → May 12, 2008



GOME-2

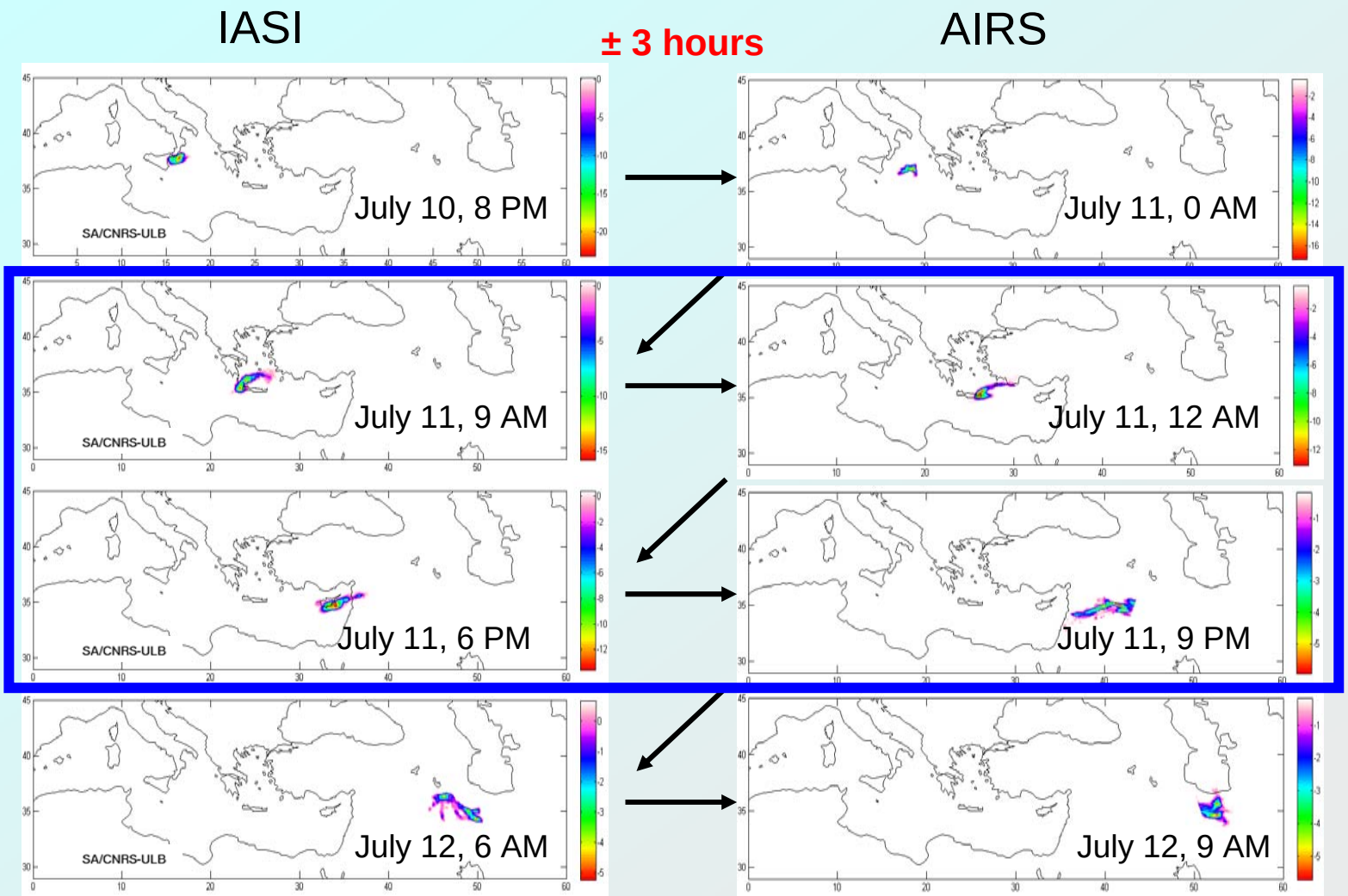


Volcano plumes

Tracking SO2 plumes

Benefit of different platforms

Etna (Sicily), May 2008

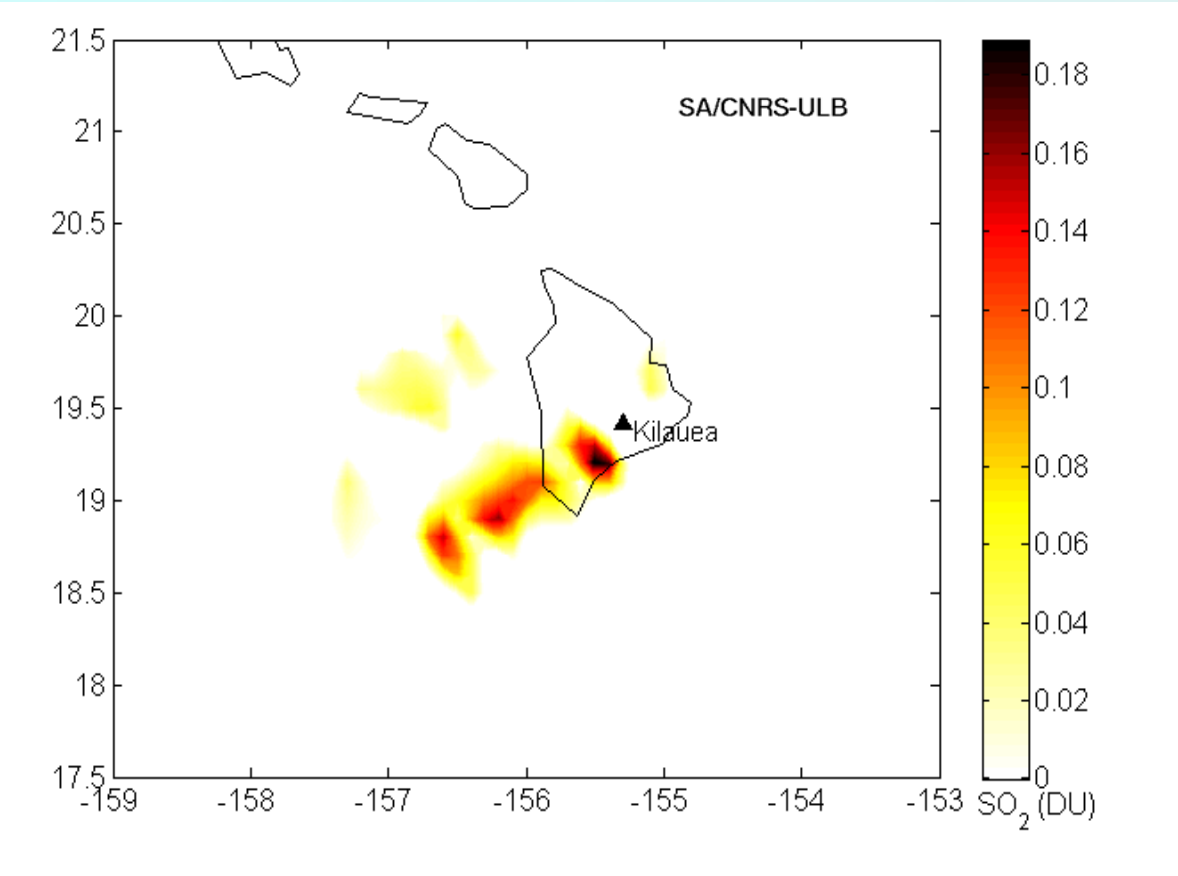


Volcano plumes

Tracking SO_2 plumes from **degassing** volcanoes

Kilauea (Hawaii), May 2008

Use of SO_2 ν_1 to increase sensitivity to the surface (<5 km)
Sensitivity down to less than 1 DU



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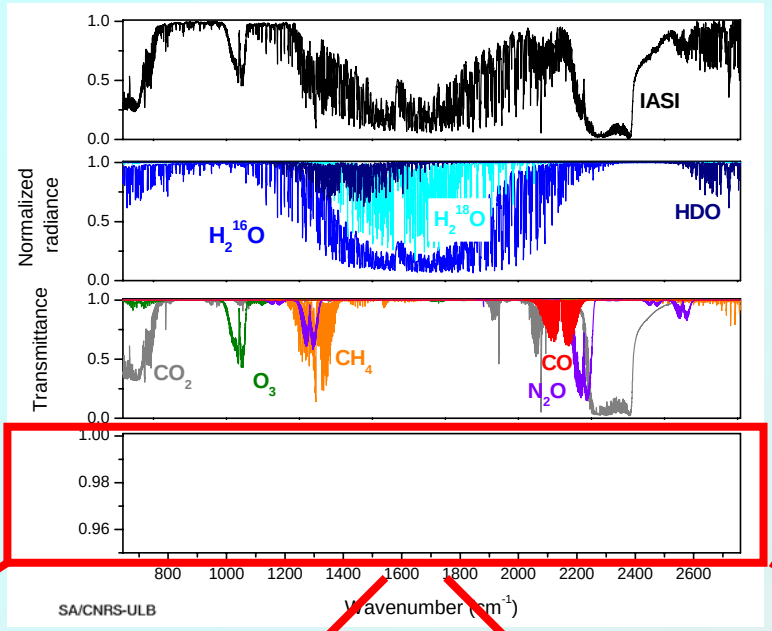
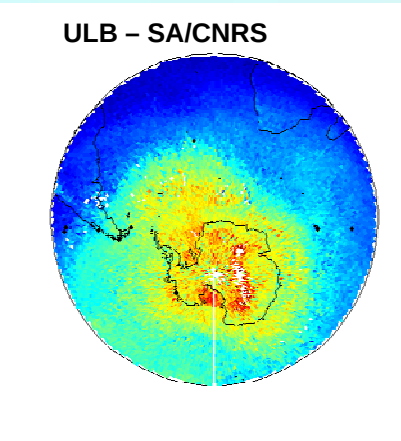


Nitric acid



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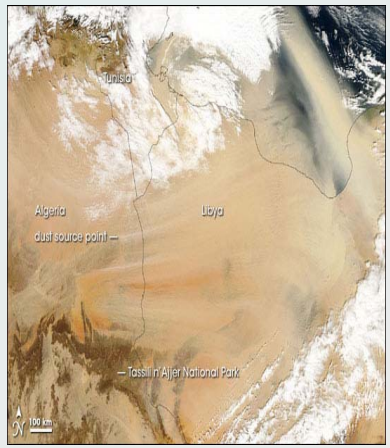
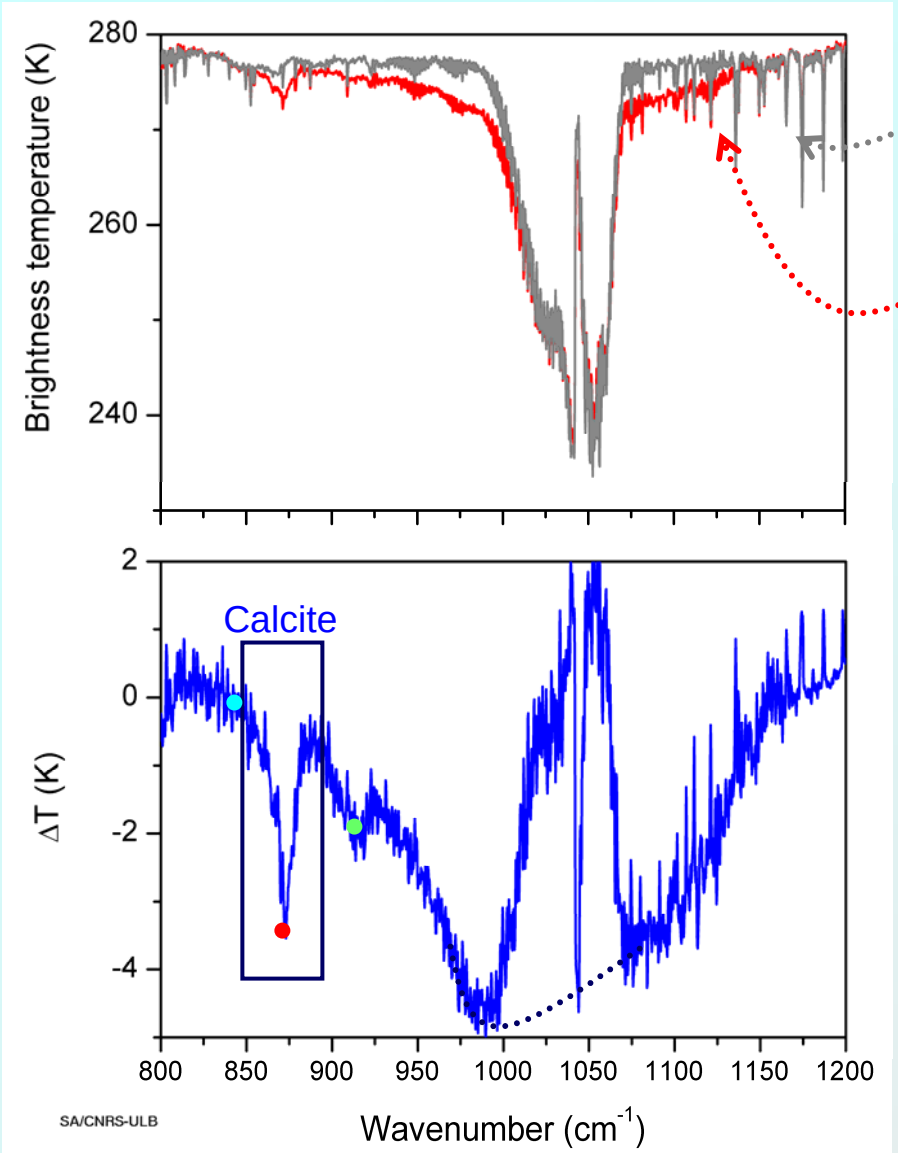
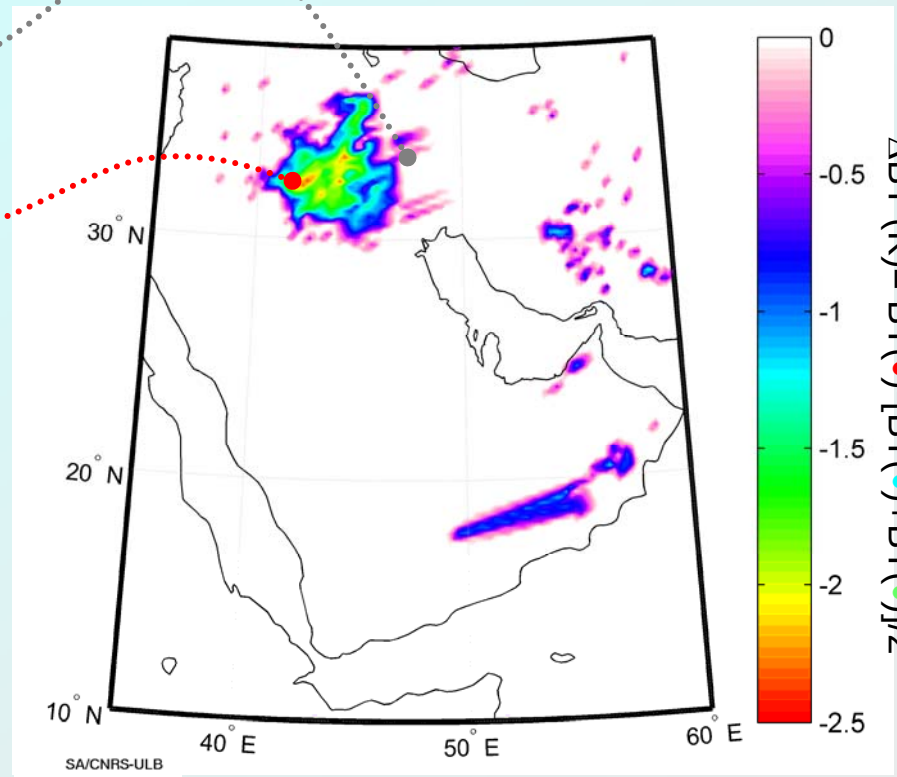


Dust plumes

IASI observation on March 3, PM



Middle East, March 2008



Broadband extinction from 800 to 1200 cm^{-1}

Sharp spectral feature between 850 and 900 cm^{-1}

Computation of ΔBT= BT(●)-[BT(●)+BT(●)]/2

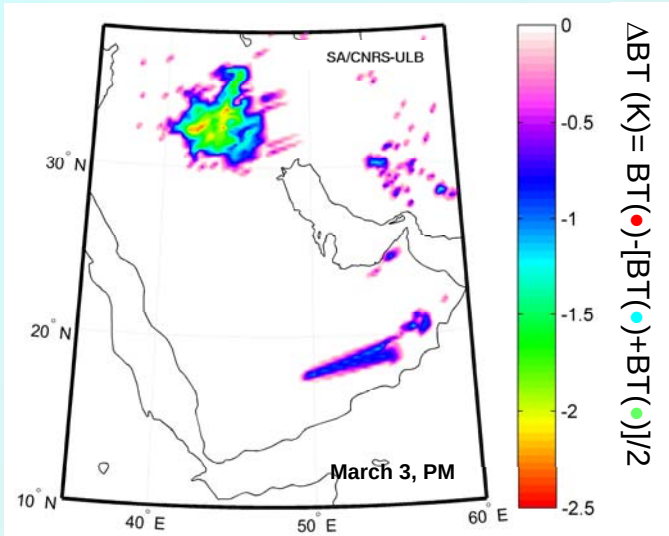
Dust plumes

Middle East, March 2008

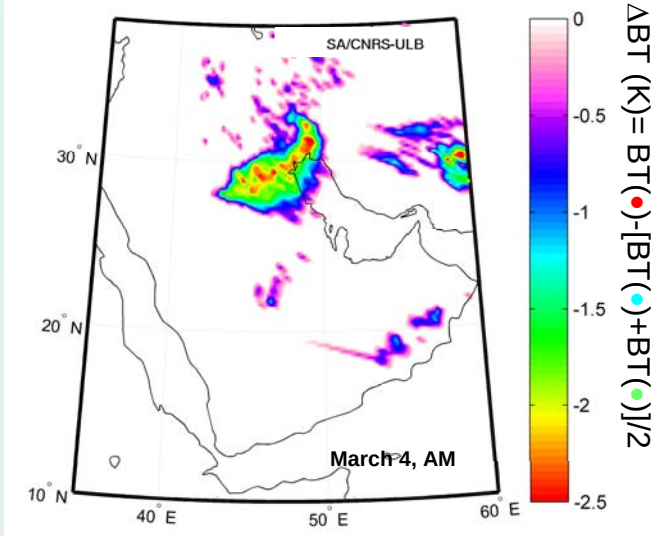
MODIS

IASI

March 3



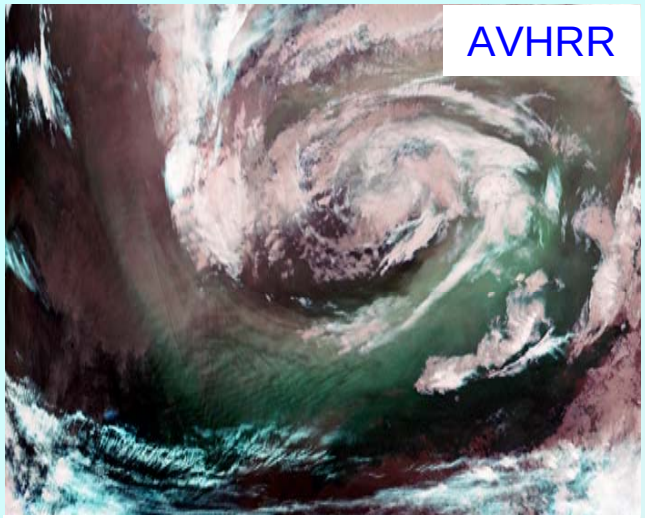
March 4



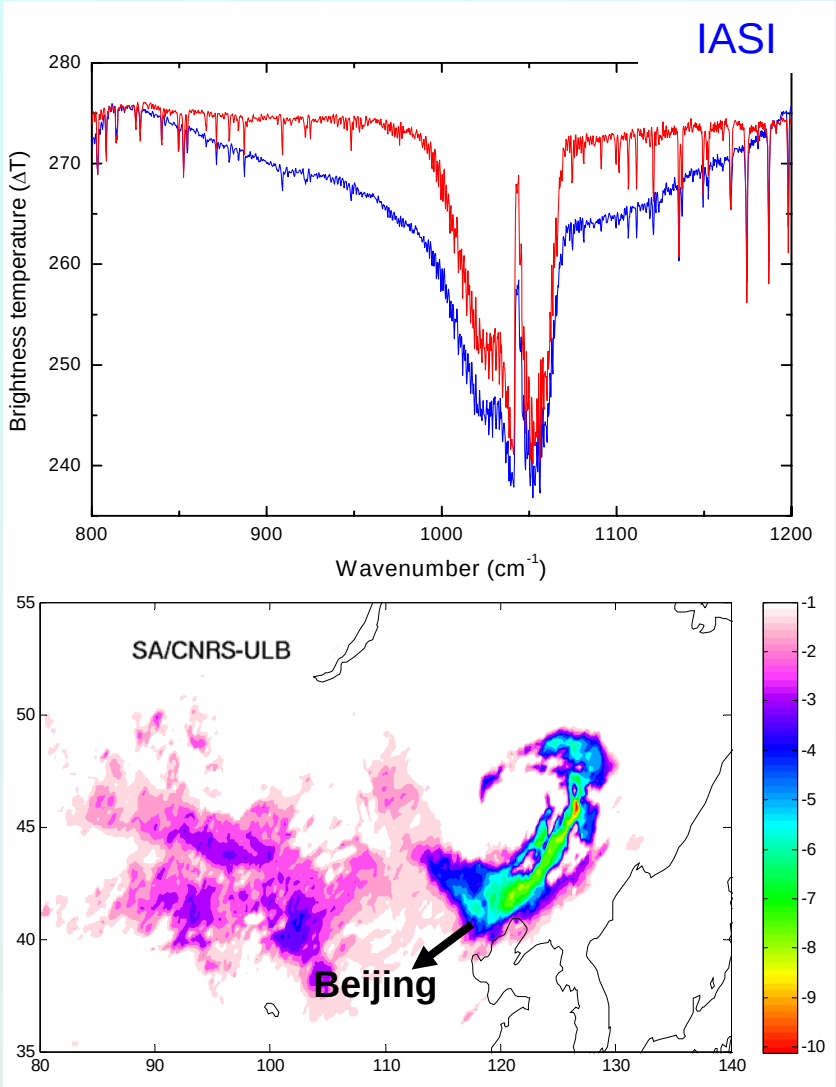
Dust plumes

Dust storm (L. Clarisse)

China, May 2008



Sand storm in China (May 27, 2008)



Conclusions

IASI is doing great!

Small pixel size
Global Earth's coverage twice daily
Wide spectral coverage
Low radiometric noise

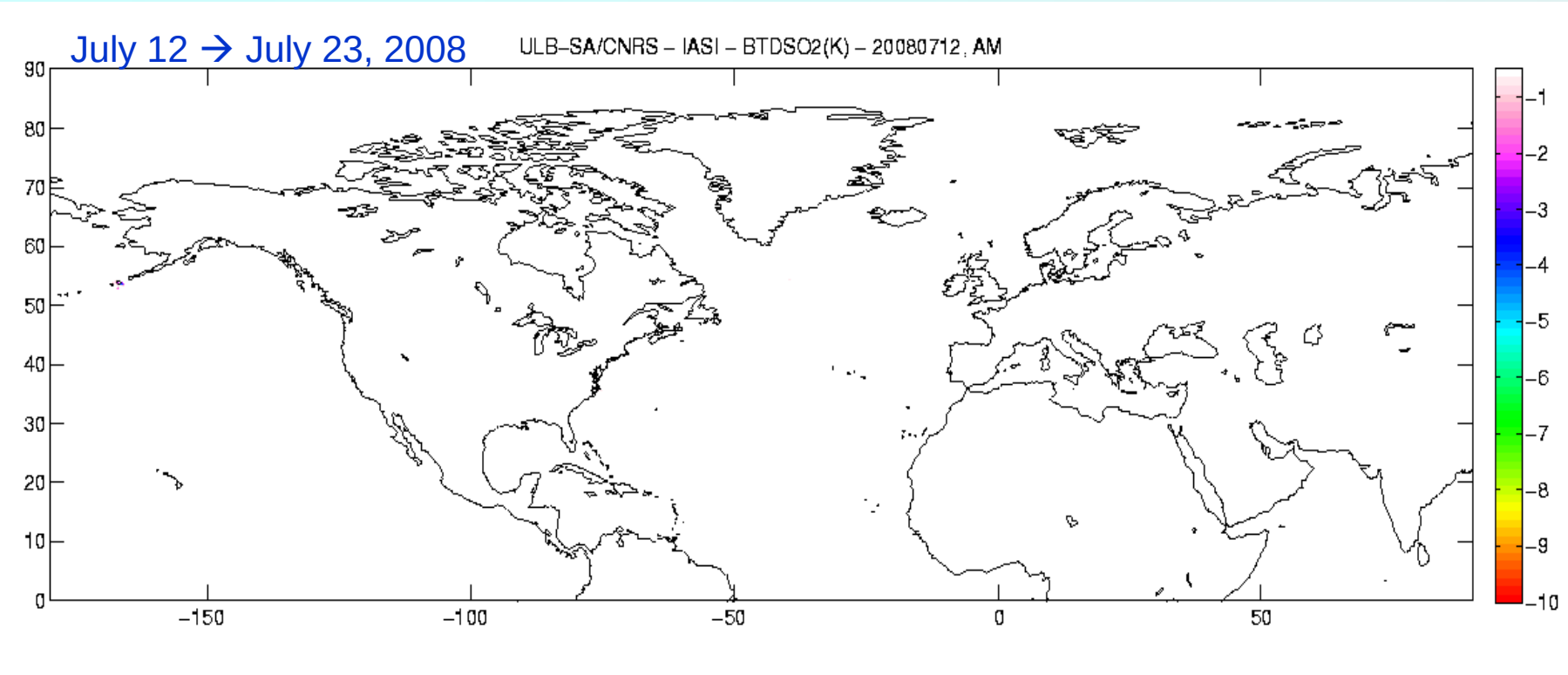
} *NRT-identification* and *tracking* of pollution plumes

Nominal operations since May 2007
10→15 species are monitored with applications in

- Climate (H_2O and isotopologues, CO_2, CH_4, N_2O)
- Ozone chemistry in the stratosphere (O_3, CFCs, **HNO_3**)
- Tropospheric chemistry (O_3, CO, CH_4, **HNO_3, VOCs**) including **chemistry and budgets for short-lived species (NH_3, VOCs) and aerosols**
- Operational monitoring (fires, volcanoes, dust storms…)

July 2008 eruptions in Alaska

Okmok



Kasatochi plume still to be seen, more than a month after the eruption