Atmospheric Composition Measurements from EUMETSAT's Current and Future Satellites

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European Organisation for the Exploitation of Meteorological Satellites (EUMETSAT)

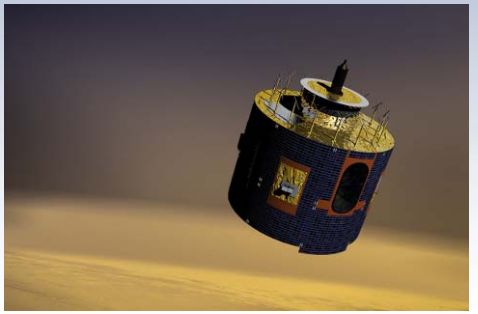
Outline

- Introduction
- EUMETSAT satellite and programmes
- Current EUMETSAT Missions
- Future EUMETSAT Missions
- Summary and Conclusion

Providing data for operational meteorology and climate monitoring

Past and Current Satellites and Programmes:

- Meteosat: since 1977, second generation since 2002
- EPS/Metop: since 2006
- Jason-2: since 2008, continuing Jason-1 and TOPEX Poseidon



Future Satellites and Programmes:

- MTG: from 2015 (imaging platform) and 2018 (sounding platform carrying Sentinel 4)
- Post-EPS: from 2020, carrying Sentinel 5

www.eumetsat.int/Home/Main/Access_to_Data/index.htm?l=en

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Current EUMETSAT Missions

Meteosat Second Generation (MSG)

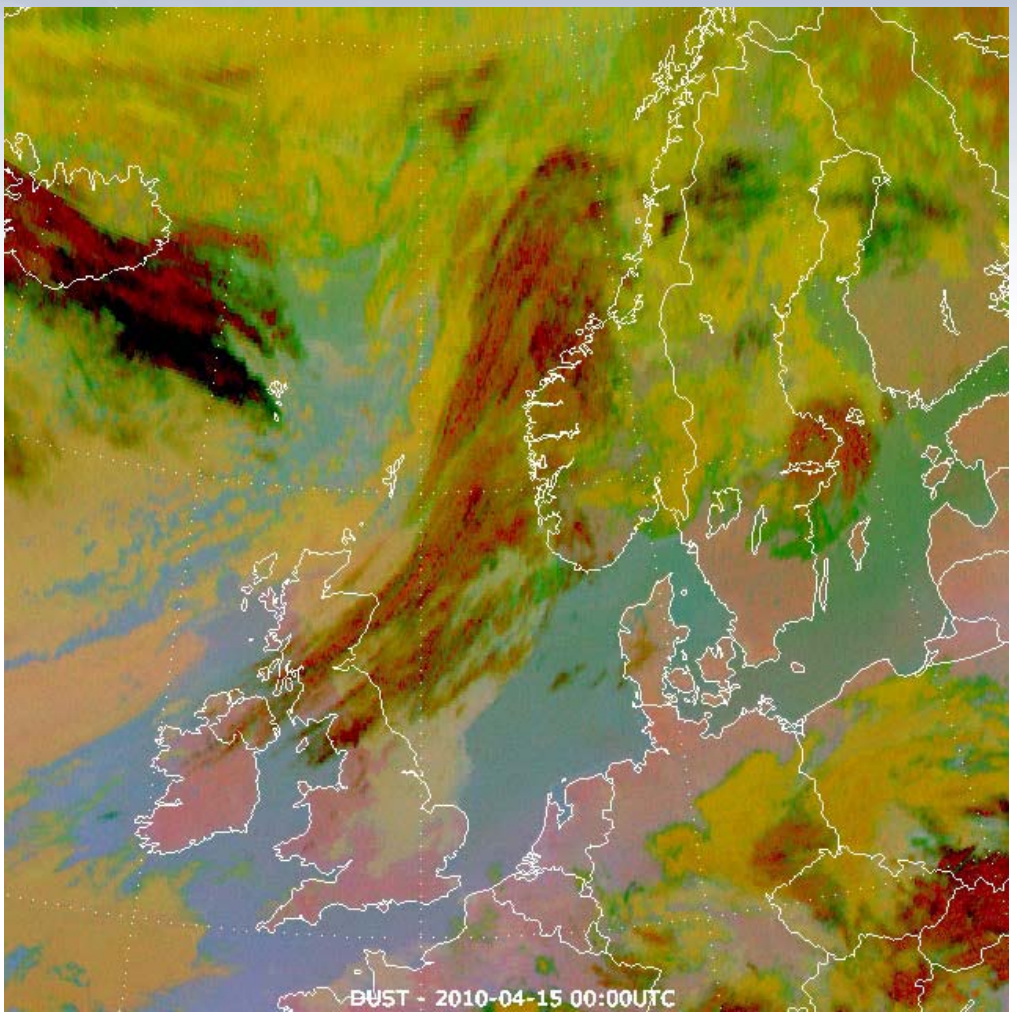
SEVIRI

EUMETSAT Polar System (EPS/Metop)

GOME-2

IASI

MSG Image Products



Eruption of Icelandic volcano Eyjafjallajökull beginning in the early morning hours of 13 April 2010

Dust RGB

Spatial sampling distance 3 km

Temporal resolution 15minutes

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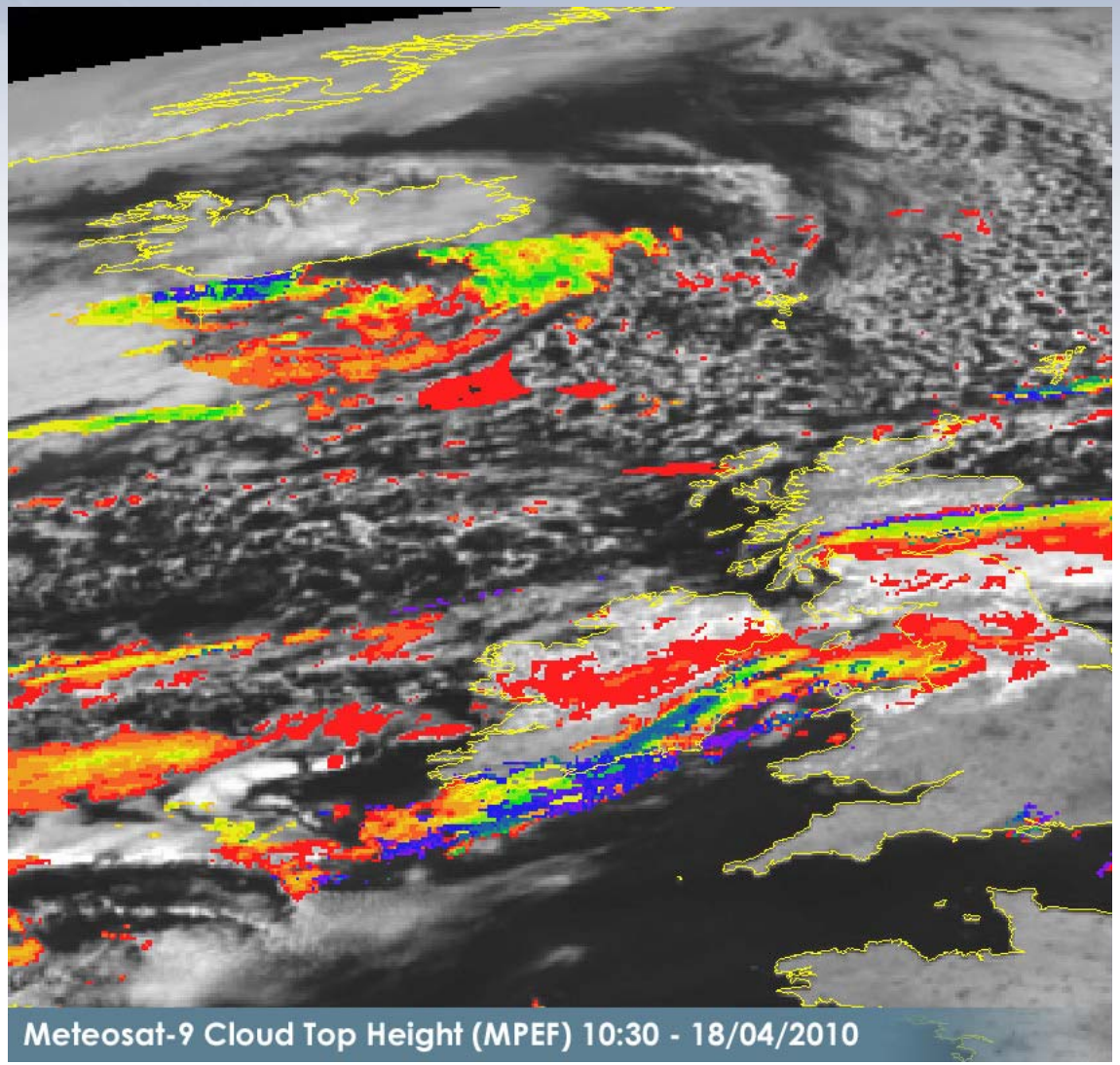
MSG Cloud Information



CLA – Cloud Analysis
Cloud coverage, type, temperature & height (16x16 pixels derived from an intermediate product at full resolution)

CLAI – Cloud Analysis Image
A compressed version of intermediate CLA (3x3 pixels) and disseminated every 3 hours

CLM – Cloud Mask
(3x3 pixels)

CTH – Cloud Top Height
Graphical representation of cloud height in eight classes

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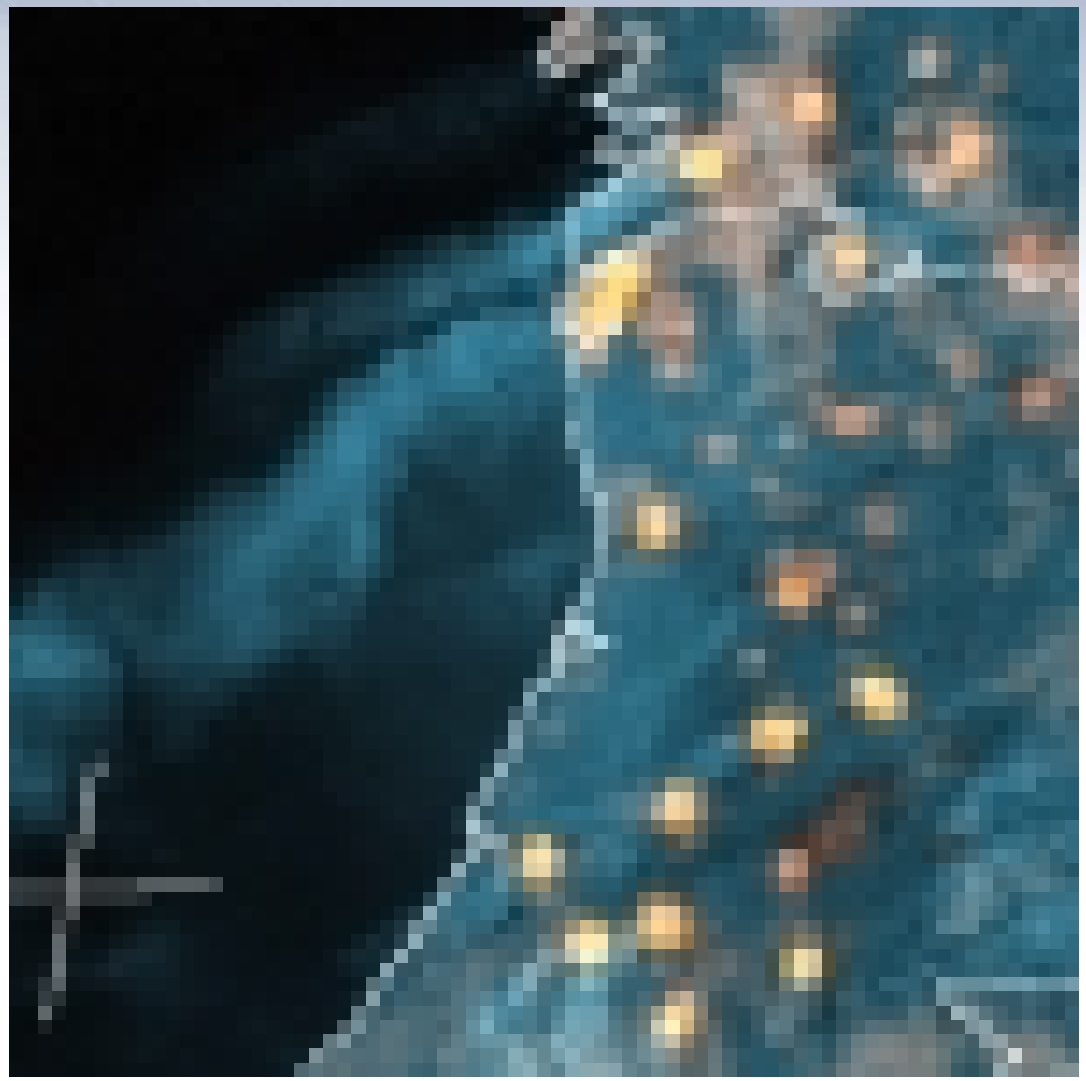
MSG Fire Information

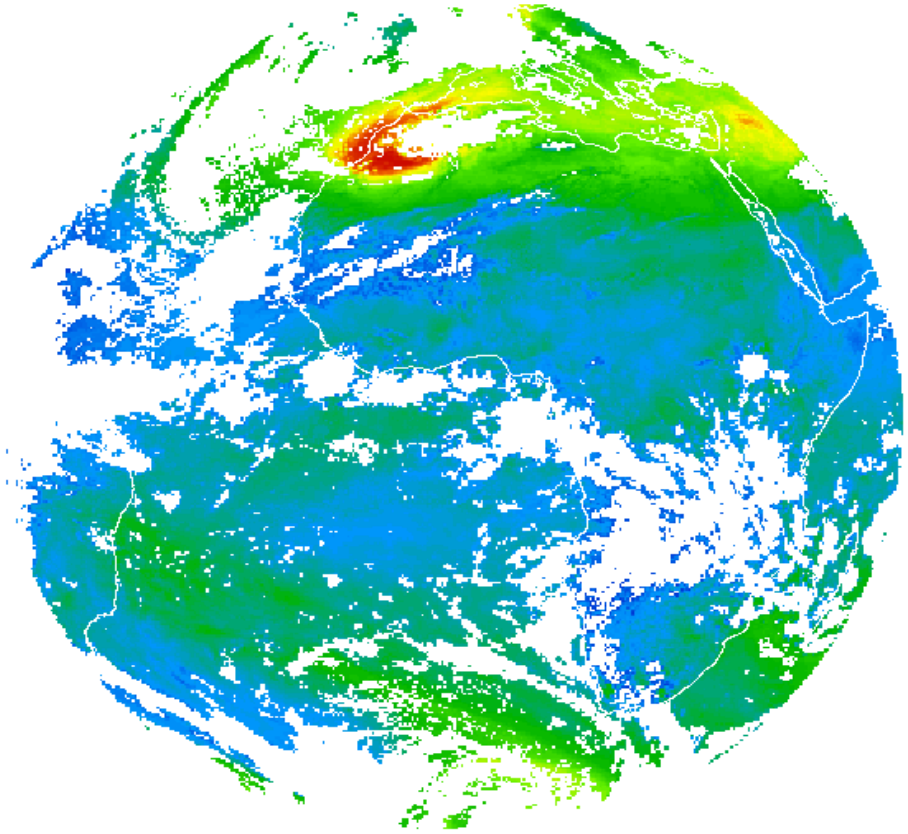


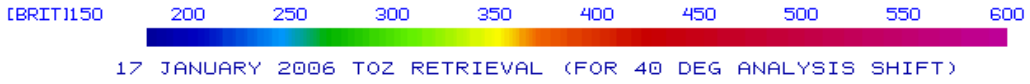
FIR – Active Fire Monitoring
Image based product in full resolution (3x3 km) that displays presence of fire within a pixel

FRP – Fire Radiative Power
provides information (in megawatts) on the measured radiant heat output of detected fire (3x3 km)

FRE – Fire Radiative Energy
An integral of the FRP over the duration of the fire

MSG Ozone Information



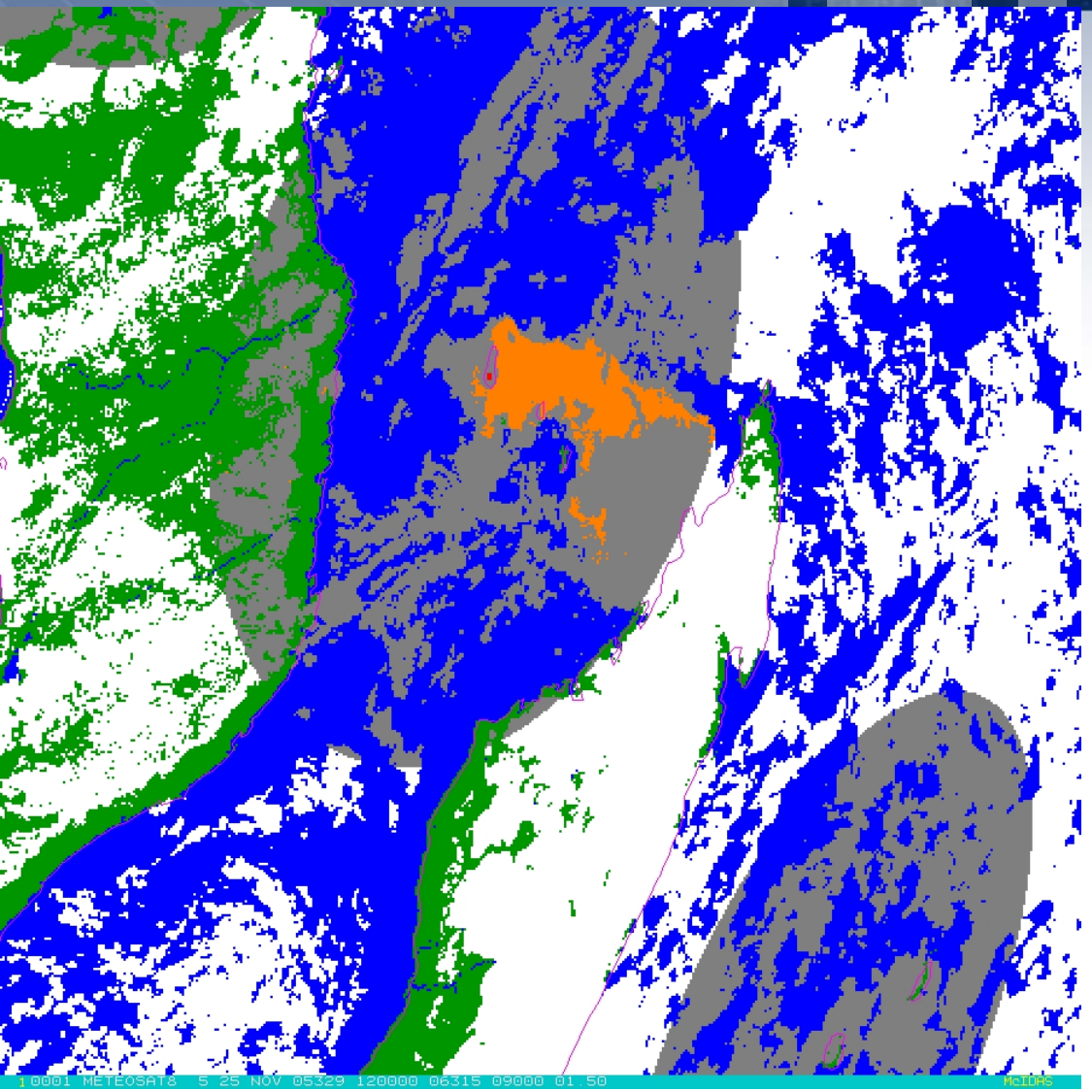


TOZ – Total column Ozone
Produced hourly at 16x16 pixel resolution

Climatology prescribed 30hPa and TOA

Improvements to the algorithm in development

MSG Volcanic Ash



VOL –Volcanic Ash Detection Product
An image-based product in full pixel resolution that displays information on the presence of volcanic ash within a cloudy pixel

Karthala eruption on November 25, 2005

Volcanic Ash Flag also produced by the NWC-SAF

SO2 products under development

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MSG Aerosol Optical Depth

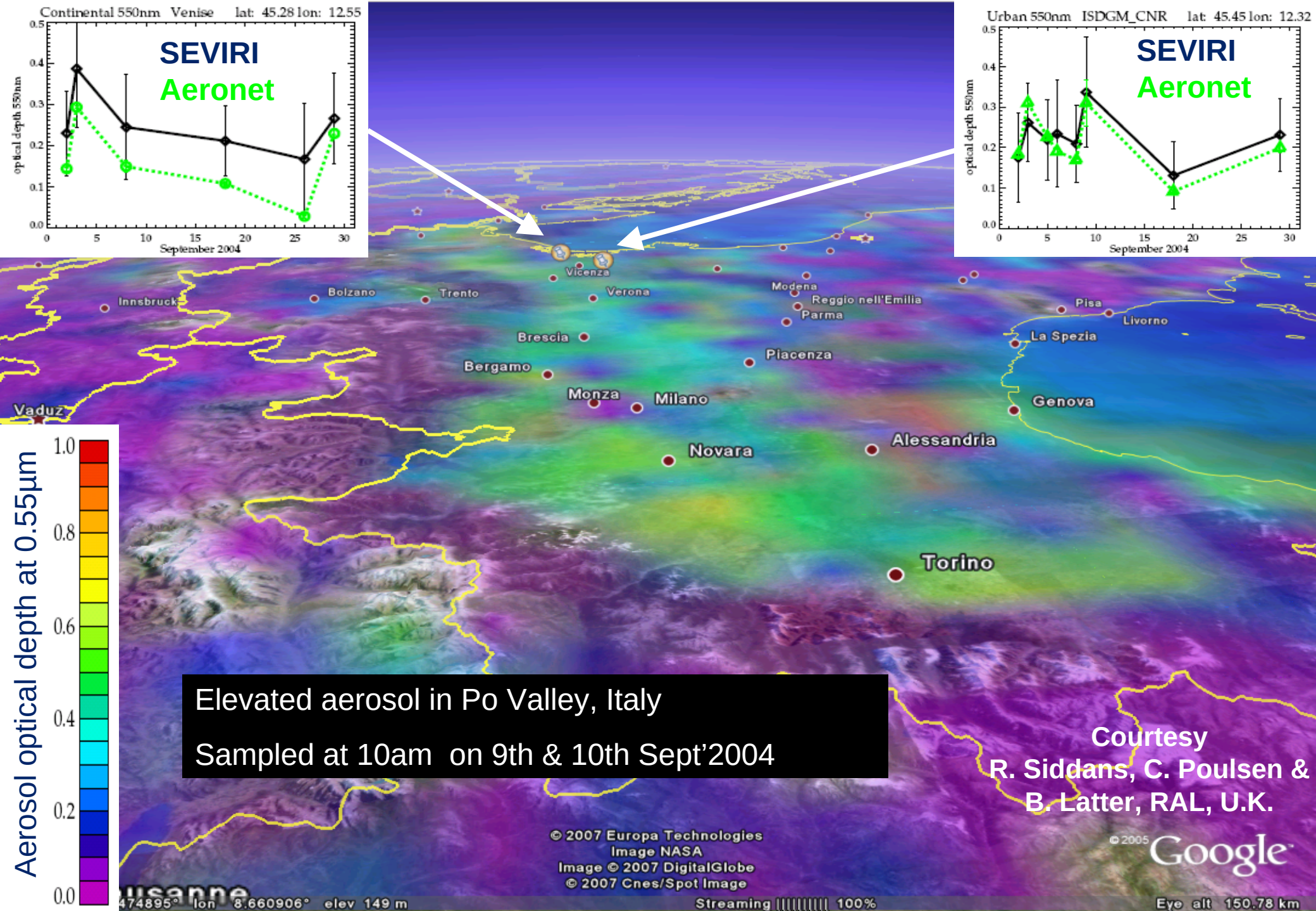
Aerosol Optical Depth Over Sea

- implementation and validation completed
- CPU currently a limiting factor – upgrades to hardware underway
- operational dissemination expected in Q3 2010
- currently a daily product on 3x3 pixel resolution available from the archive

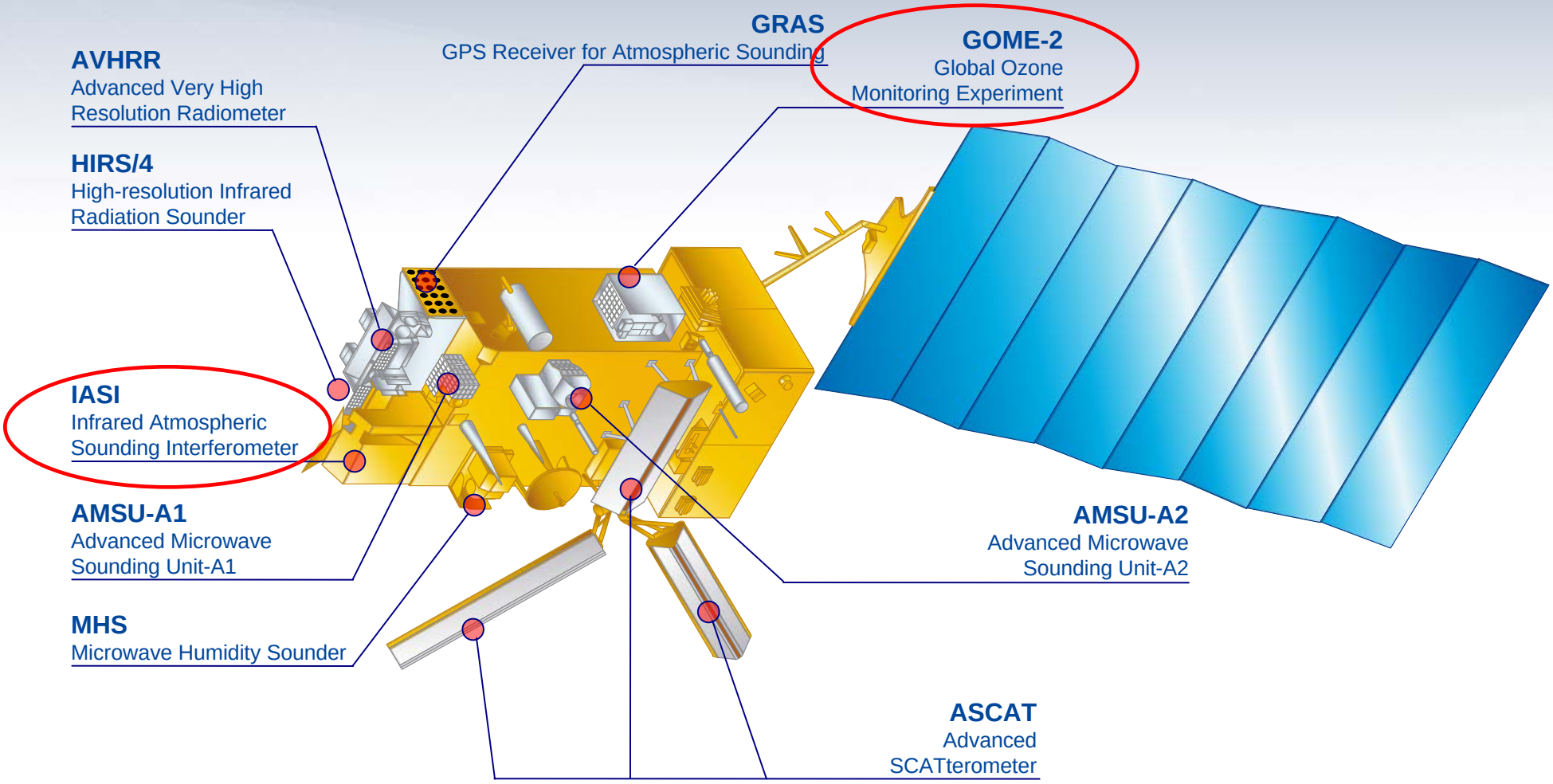
Aerosol Optical Depth Over Land (LDA – Land Daily Aerosol)

- will be first introduced in a reprocessing environment to generate a three year data set (2004 – 2007) with the focus on 2004
- optimal estimation algorithm

Govaerts, Y. M., S. Wagner, A. Lattanzio, and P. Watts (2010) "Joint retrieval of surface reflectance and aerosol optical depth from MSG/SEVIRI observations with an optimal estimation approach: 1. Theory", J. Geophys. Res., 115, D02203, doi:10.1029/2009JD011779


Continental 550nm Venise lat: 45.28 lon: 12.55
optical depth 550nm
September 2004
SEVIRI
Aeronet
Urban 550nm ISDGM_CNR lat: 45.45 lon: 12.32
optical depth 550nm
September 2004
SEVIRI
Aeronet
Vicenza
Innsbruck
Bolzano
Trento
Verona
Modena
Reggio nell'Emilia
Parma
Pisa
Livorno
La Spezia
Brescia
Piacenza
Bergamo
Monza
Milano
Vaduz
Genova
Novara
Alessandria
Torino
Aerosol optical depth at 0.55µm
1.0
0.8
0.6
0.4
0.2
0.0
Elevated aerosol in Po Valley, Italy
Sampled at 10am on 9th & 10th Sept'2004
Courtesy
R. Siddans, C. Poulsen &
B. Latter, RAL, U.K.
© 2007 Europa Technologies
Image NASA
Image © 2007 DigitalGlobe
© 2007 Cnes/Spot Image
© 2005 Google
Streaming 100%
Eye alt 150.78 km

EUMETSAT Polar System



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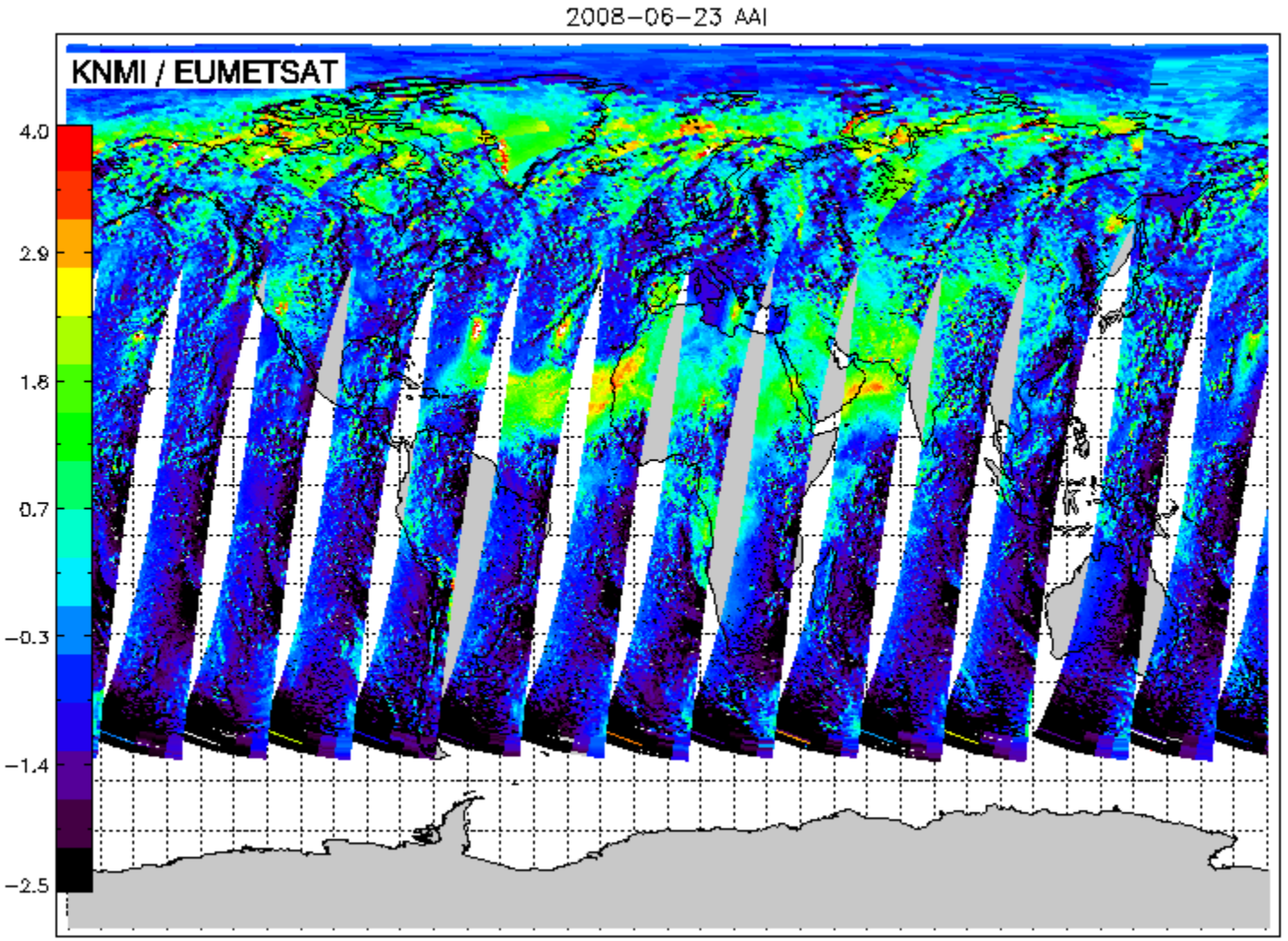
O3MSAF GOME-2 Aerosol Products (KNMI)



- Benefits applications related to Pollution & Air Quality and Composition-Climate Interaction
- Status operational
- Aerosol Optical Depth product under development

Dust storm event over the Atlantic Ocean as seen by GOME-2 20—23 June 2008 Courtesy O. Tuinder

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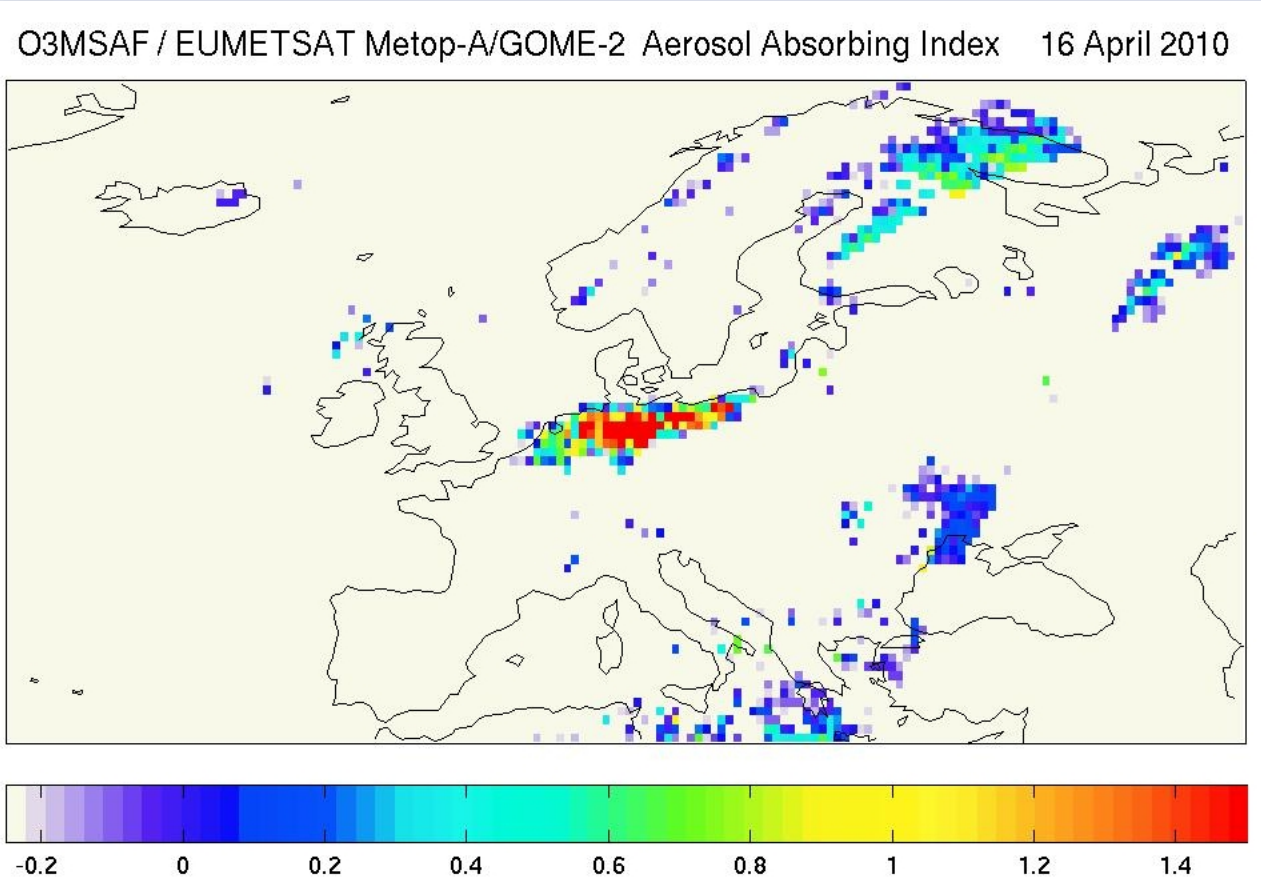
O3MSAF GOME-2 AAI (KNMI)

Eruption of Eyjafjallajökull – April 2010

- Benefits applications related to Pollution & Air Quality (Aviation Forecasting)
- Status operational



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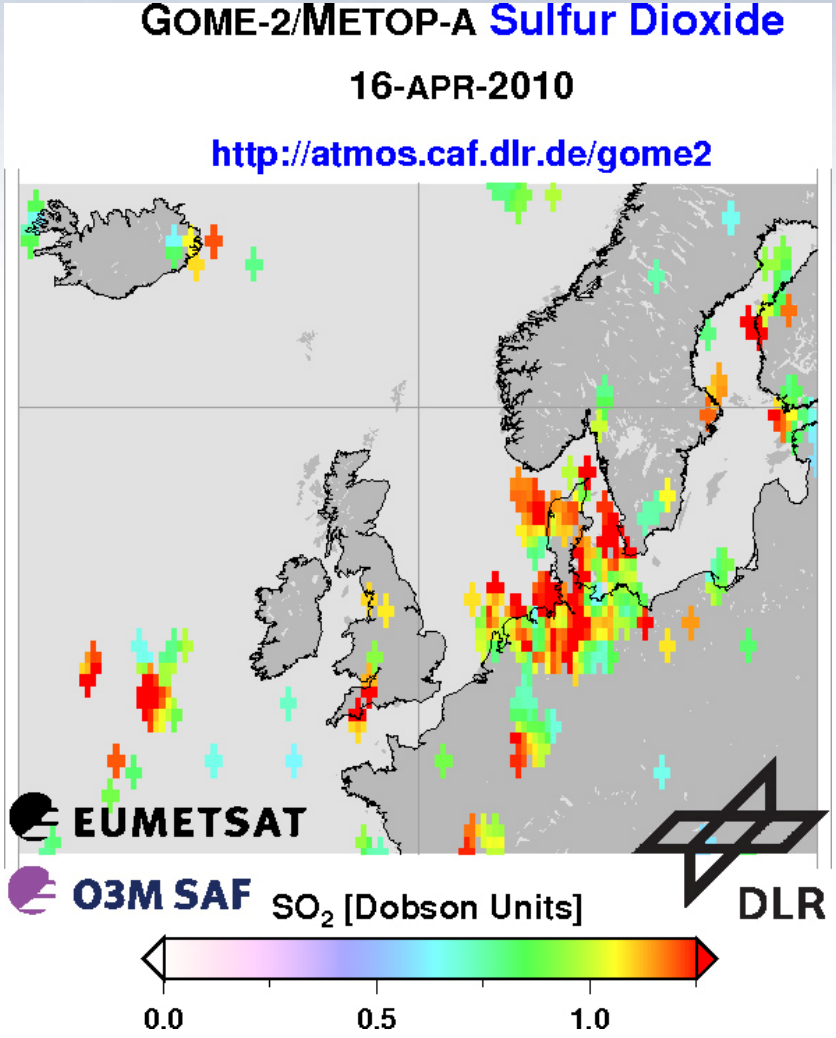
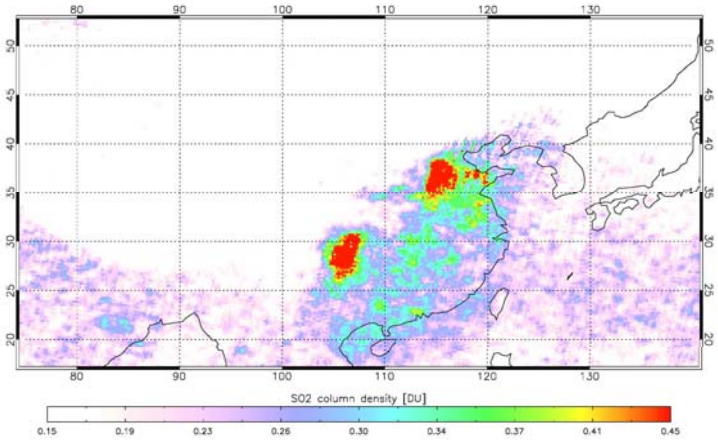
O3MSAF GOME-2 SO2 (DLR)

Eruption of Eyjafjallajökull – April 2010

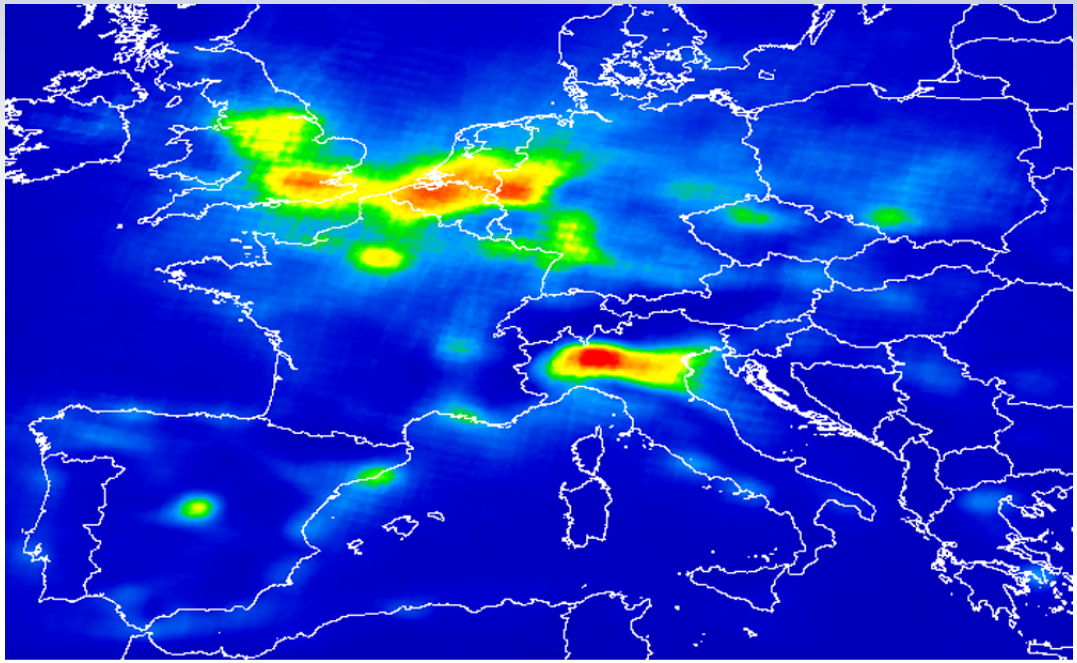


SO2 over China – November 2007



- Benefits applications related to Pollution & Air Quality (Aviation Forecasting)
- Level 3 and 4 products available from www.wdc.dlr.de
- Status operational

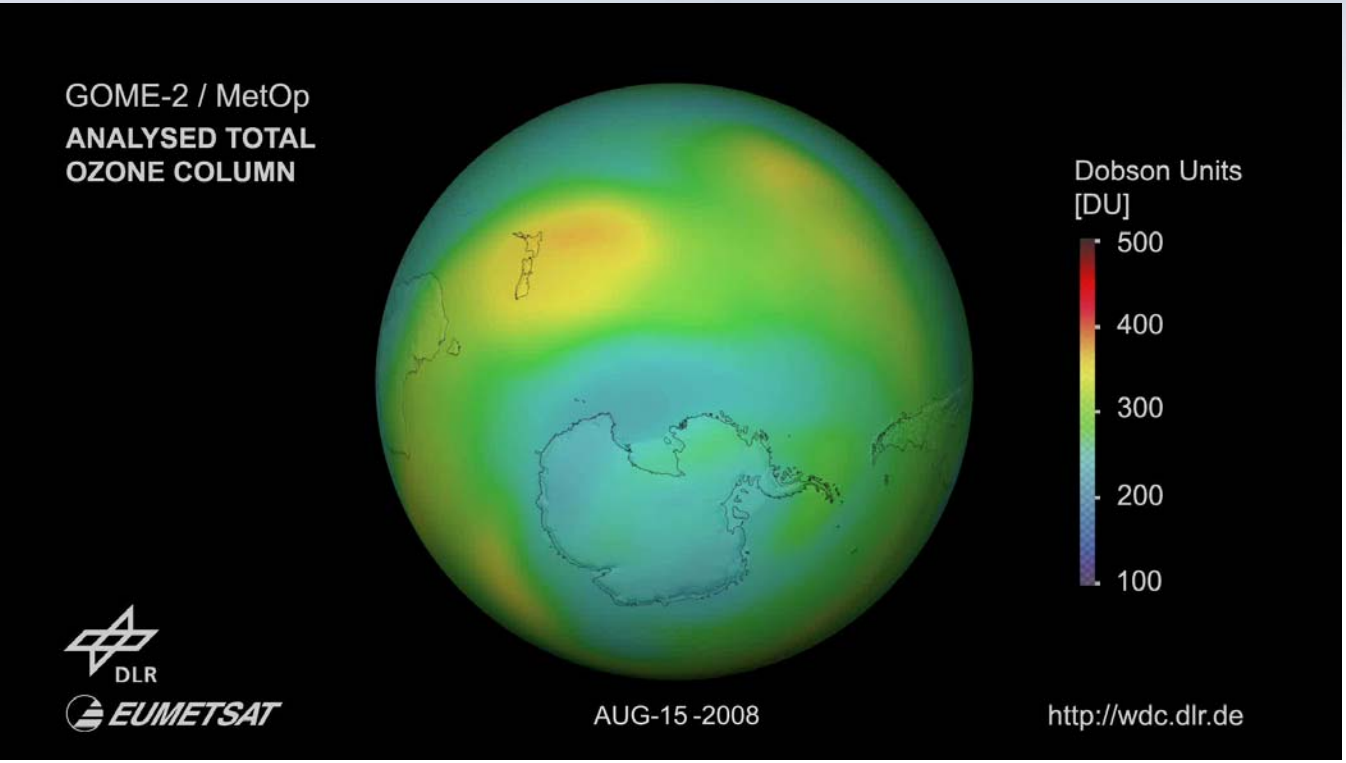
O3MSAF GOME-2 Total Column & Tropospheric NO2 (DLR)



Tropospheric NO2 over Europe

- **Benefits applications related to Pollution & Air Quality**
- **Available via EUMETCast and EUM archive**
- **Level 3 and 4 products available from www.wdc.dlr.de**
- **Status operational**

O3MSAF GOME-2 Total Column Ozone (DLR)



- Benefits applications related to Ozone Layer and Surface UV & Chemistry – Climate Interaction

- Available via EUMETCast and EUM archive
- Level 3 and 4 products available from www.wdc.dlr.de
- Status operational
- Quality very good – within ± approx. 2-3% of ground-based data

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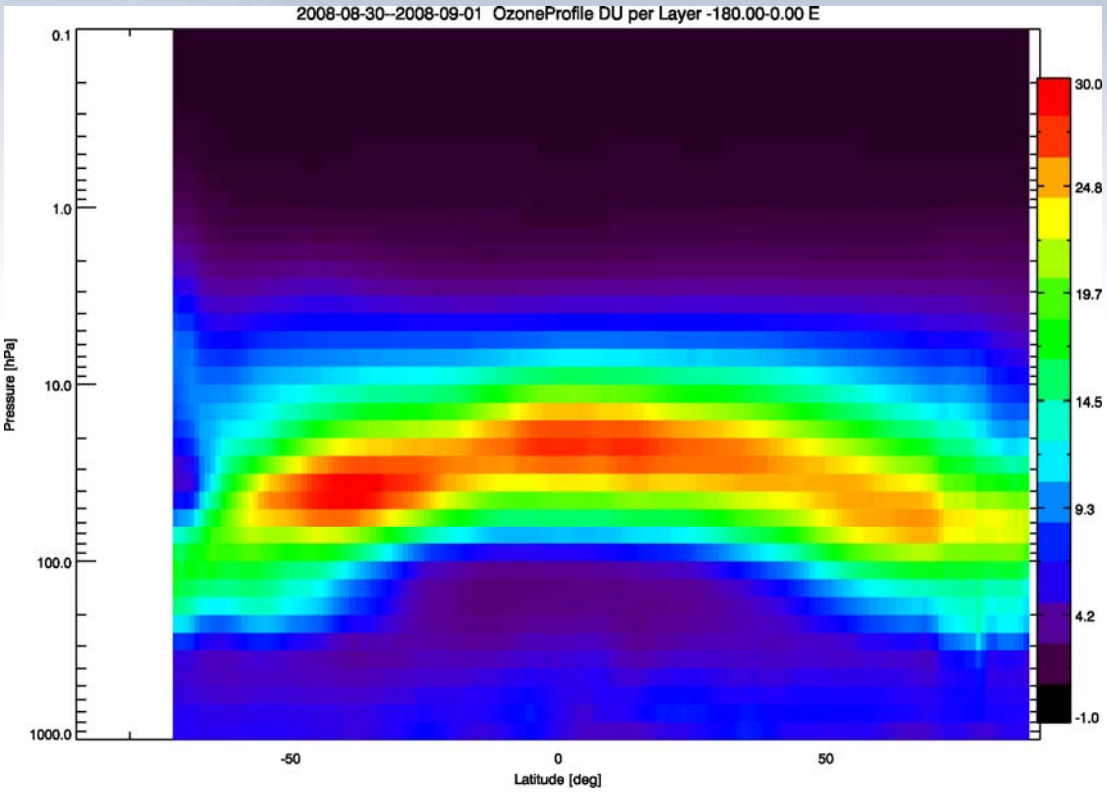
O3MSAF GOME-2 Ozone Profile (KNMI)



Latitudinal cross section of ozone profiles, averaged over 180W to 0.0E – 31 August 2008

- Benefits applications related to Ozone Layer and Surface UV & Chemistry – Climate Interaction
- Available via EUMETCast and EUM archive
- Status operational

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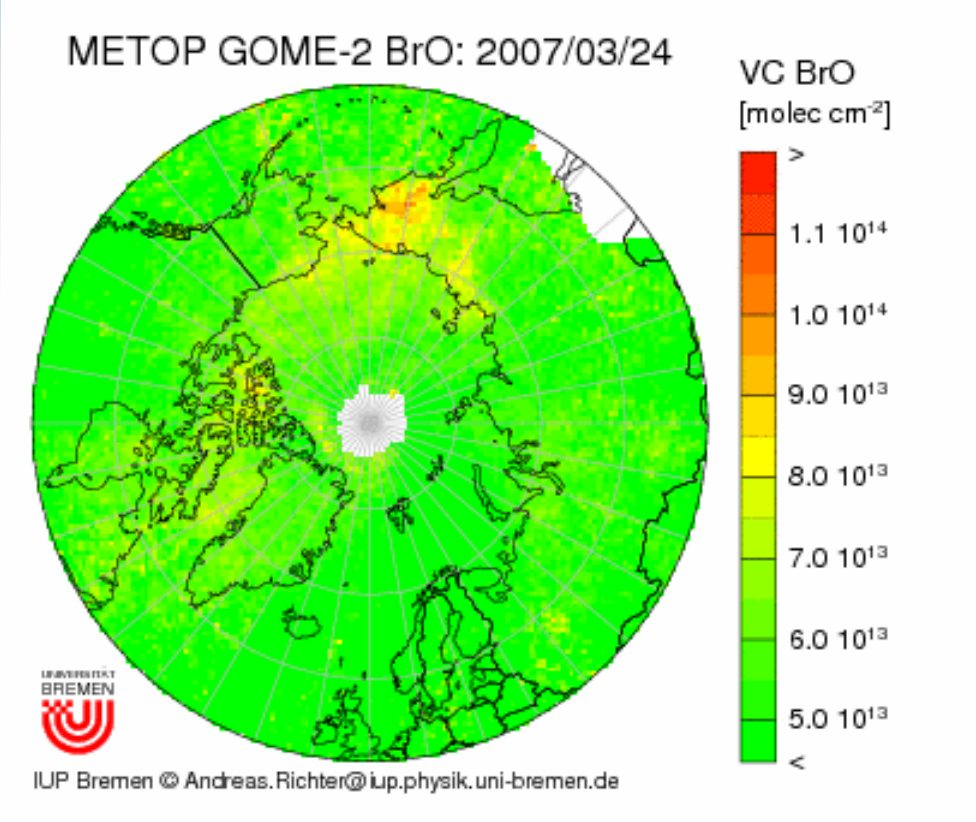
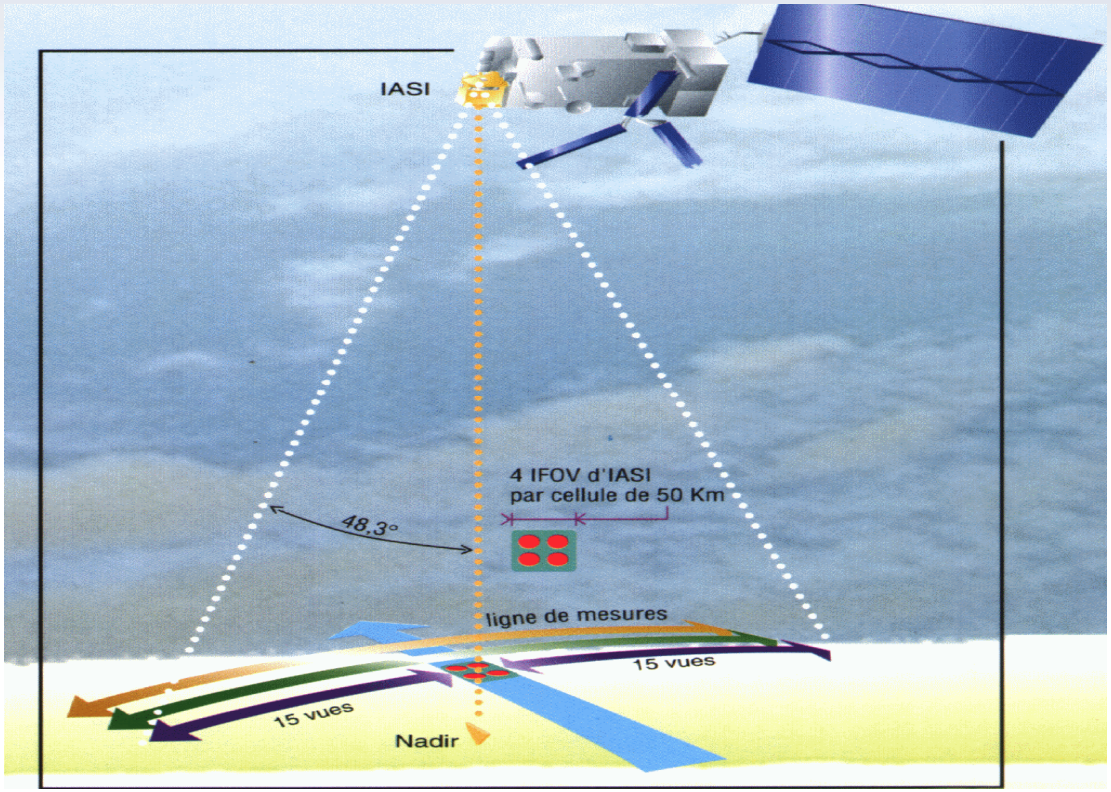
O3MSAF Offline Products & GOME-2 Scientific Products



- O3MSAF Offline Total Column products (DLR) under development include total column BrO, HCHO, OClO .....
- Offline products when pre-operational available from o3msaf.fmi.fi or the UMARF

- Products also developed within the scientific community
- Availability varies per institute

IASI Mission and Measurements



Mission

Primary mission objective → temperature and humidity profiles with improved accuracy and vertical resolution (1K and 10% @ 1 km vertical resolution, respectively)

Further mission objectives are related to the measurement of trace gases (ozone, methane, carbon monoxide, ...) as well as surface and cloud properties

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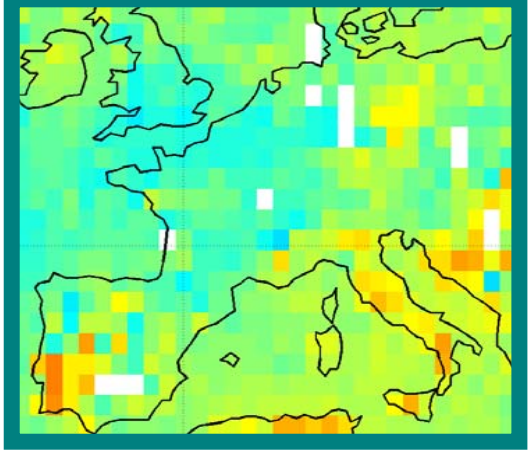
IASI – Operational applications

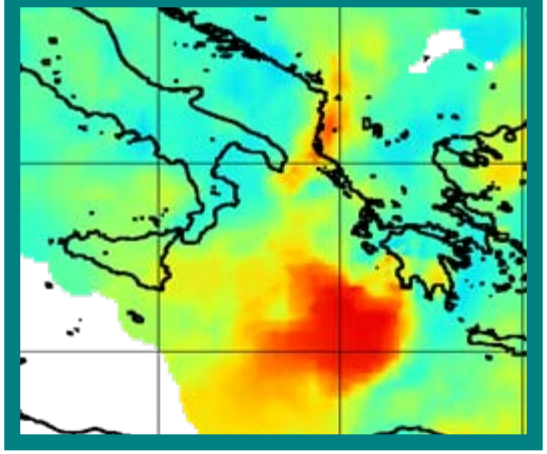
Pollution forecast



Ozone peaks

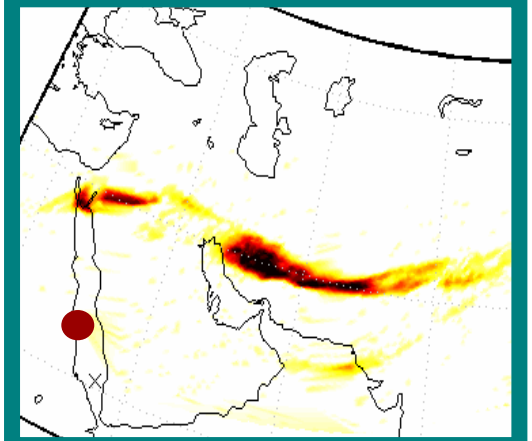
Courtesy C. Clerbaux (CNRS)

Fire detection



Long-range pollution

Volcanic plumes



Aviation threat

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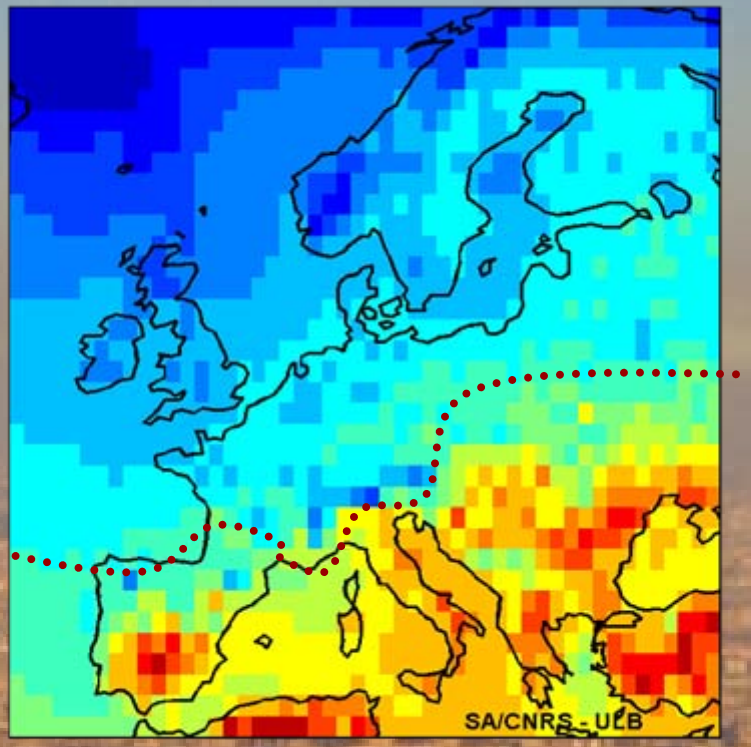
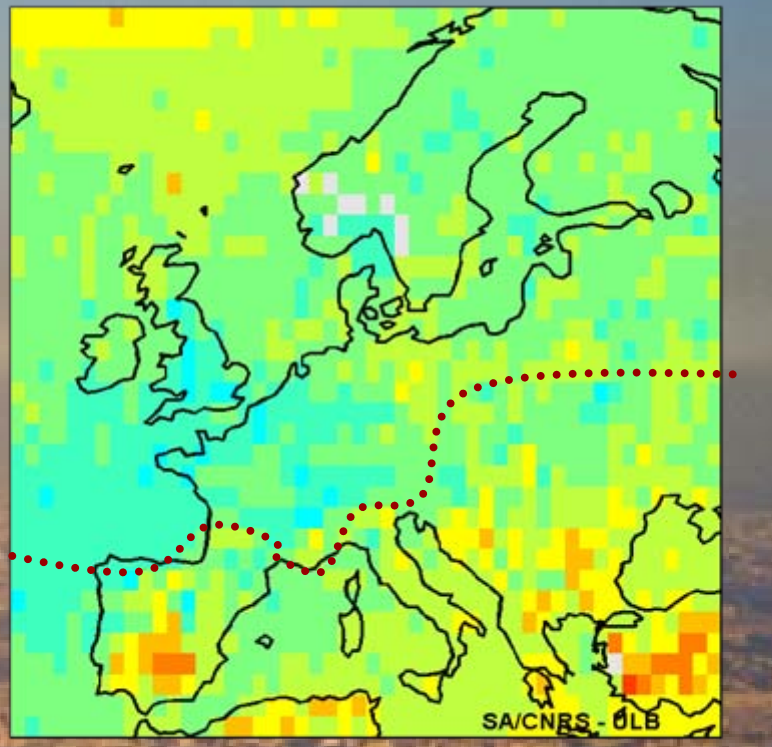
Ozone (O_3) – Pollution Peaks, South of Europe, 22-26 July 2007

Courtesy A. Boynard/C. Clerbaux (CNRS)



ECMWF Temperature Data

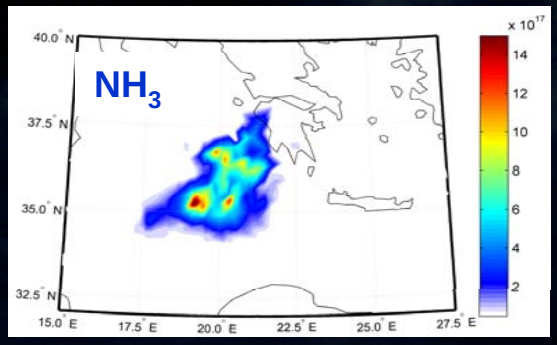


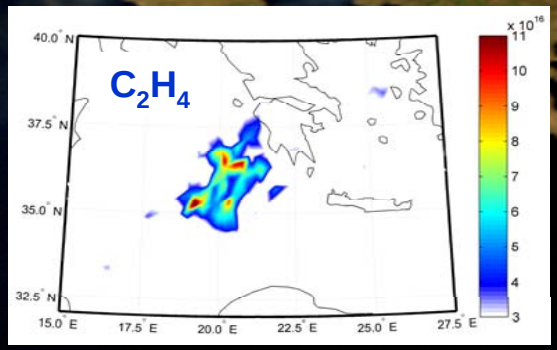
IASI data: Ozone 0-6 km

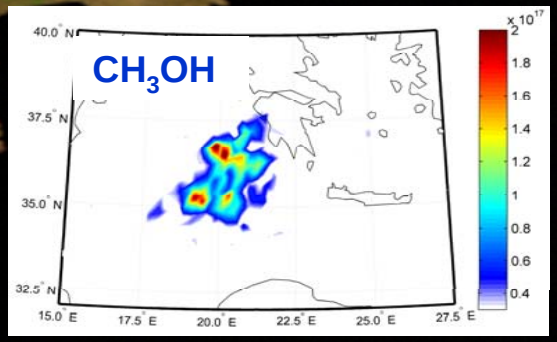
Carbon monoxide (CO) – Fires

Greece, 25-28 August 2007

Courtesy D. Hurtmans/ S. Turquety/ C. Clerbaux

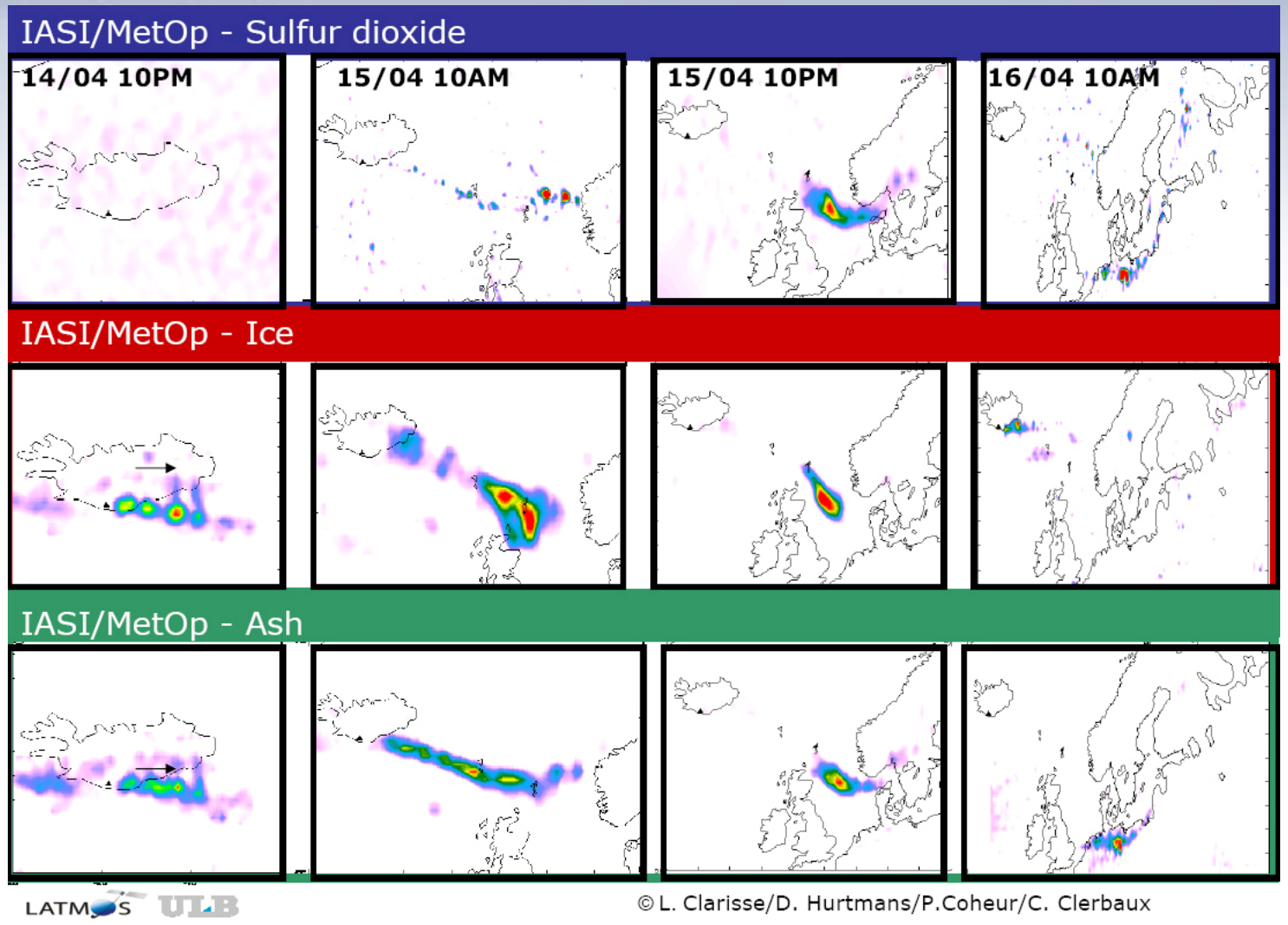






Courtesy P. Coheur

Absorbing Species in the Infra-red



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Future EUMETSAT Missions

Meteosat Third Generation (MTG)

Post-EPS

Sentinels 4&5

Meteosat Third Generation (MTG)

- **Five candidate observation missions identified for MTG:**
  - **High Resolution Fast Imagery (HRFI) mission (MTG-I)**
  - **Full Disk High Spectral Imagery (FDHSI) mission (MTG-I)**
  - **Lightning Imagery (LI) mission (MTG-I)**
  - **Infrared Sounding (IRS) mission (MTG-S)**
  - **UV-VIS Sounding (UVS) mission (MTG-S)**

Meteosat Third Generation (MTG) & Sentinel 4

- **Twin satellite configuration endorsed by EUMETSAT council with the second platform the MTG-S carrying the IRS. With this, a UVS Mission (Sentinel 4) shall be accommodated within the design margins offered by the MTG Sounding Satellites**

- **The Infra-Red Spectrometer (IRS) primarily targets meteorological applications but is also expected to provide information on O3 and CO; reduced performance compared to IASI**

- **A UV-VIS spectrometer (Sentinel 4) mission is expected to provide measurements of ozone, NO2, SO2, BrO, formaldehyde and aerosol over Europe with hourly sampling at 8x8 km (best case)**

Post-EPS
Atmospheric Chemistry User Requirements

- **Ozone & Surface UV**
  - **Priority 1 (protocol/forecast): O3 stratosphere/UT profile & column**
  - **Priority 2 (assessment): stratospheric ClO, BrO, HNO3 & aerosol (heterogeneous chemistry)**

- **Composition – Climate Interaction**
  - **Priority 1: O3 & H2O profiles; trop CH4 (emissions)**
  - **Priority 2: CO2 (emissions); trop CO & NO2 (chemistry); stratospheric N2O/CH4 (circulation); AOD & cirrus**

- **Pollution & Air Quality**
  - **Priority 1 (regulation/AQ index) O3, NO2, CO, SO2, AOD**
  - **Priority 2 (forecast): H2O, H2CO, aerosol type**

Post-EPS Atmospheric Chemistry Missions

- **IRS**
  - **IASI-NG currently under study by CNES; twice the spectral resolution and half the radiometric noise for O3, CO and CH4 profiles and HNO3 + others**

- **3MI**
  - **Aerosol mission based on POLDER heritage**
  - Total and small particles optical thickness (aerosol load); Angström exponent; non-sphericity index; effective radius and refractive index of the small particles mode; refractive index of large spherical particles; altitude range

- **Sentinel 5**
  - **UV-VIS-NIR-SWIR spectrometer for O3, NO2, SO2, H2CO, CH4, CO, aerosol**

Conclusions

- EUMETSAT is committed to continue to make available relevant data products and services from MSG and EPS/Metop, from both Central Facilities and the SAF Network

- All necessary steps taken to ensure accommodation of GMES S4 on MTG, with full support of EUMETSAT Delegations. MTG Ground Segment will provide all necessary processing elements and data dissemination capabilities.

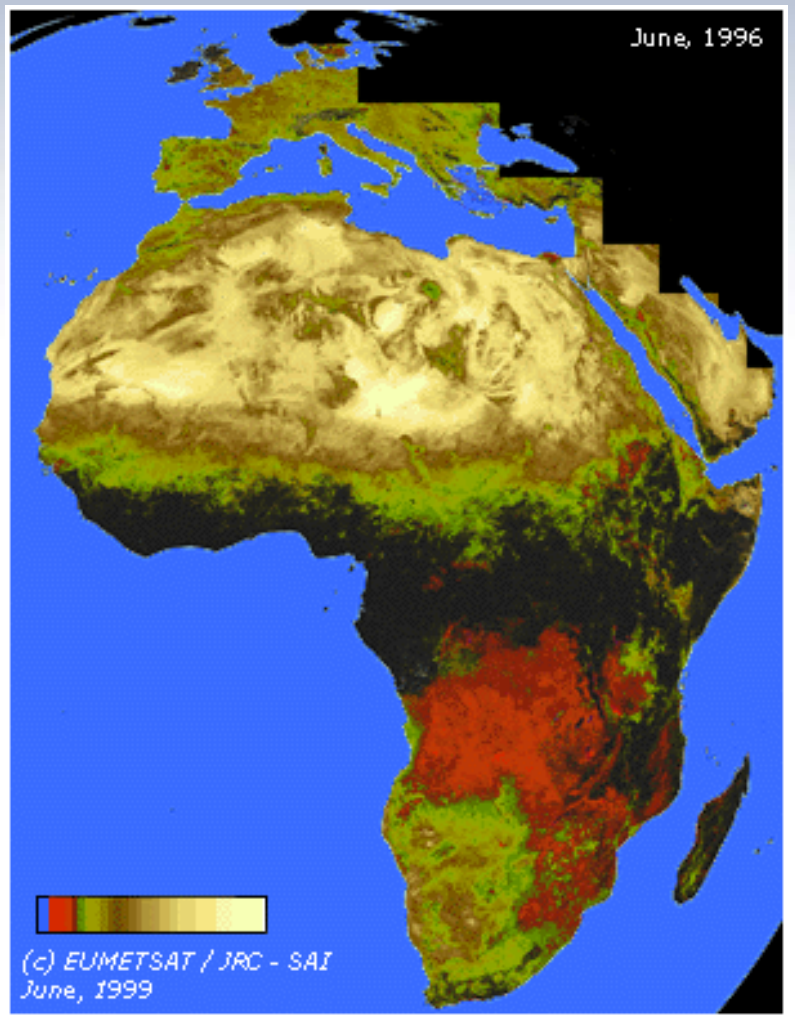
- Same approach has been taken for GMES Sentinel 5

MSG Surface Albedo

Meteosat Surface Albedo Product:

- Meteosat-2 to Meteosat-7: 1981 – 2006 from the 0^0 Service
- Meteosat-5: 1998 – 2007 from the Indian Ocean Data Coverage Service

Cooperation with JMA (and in the future possibly with NOAA) to generate a Global GEO Surface albedo Level 3 data set in the SCOPE-CM framework.



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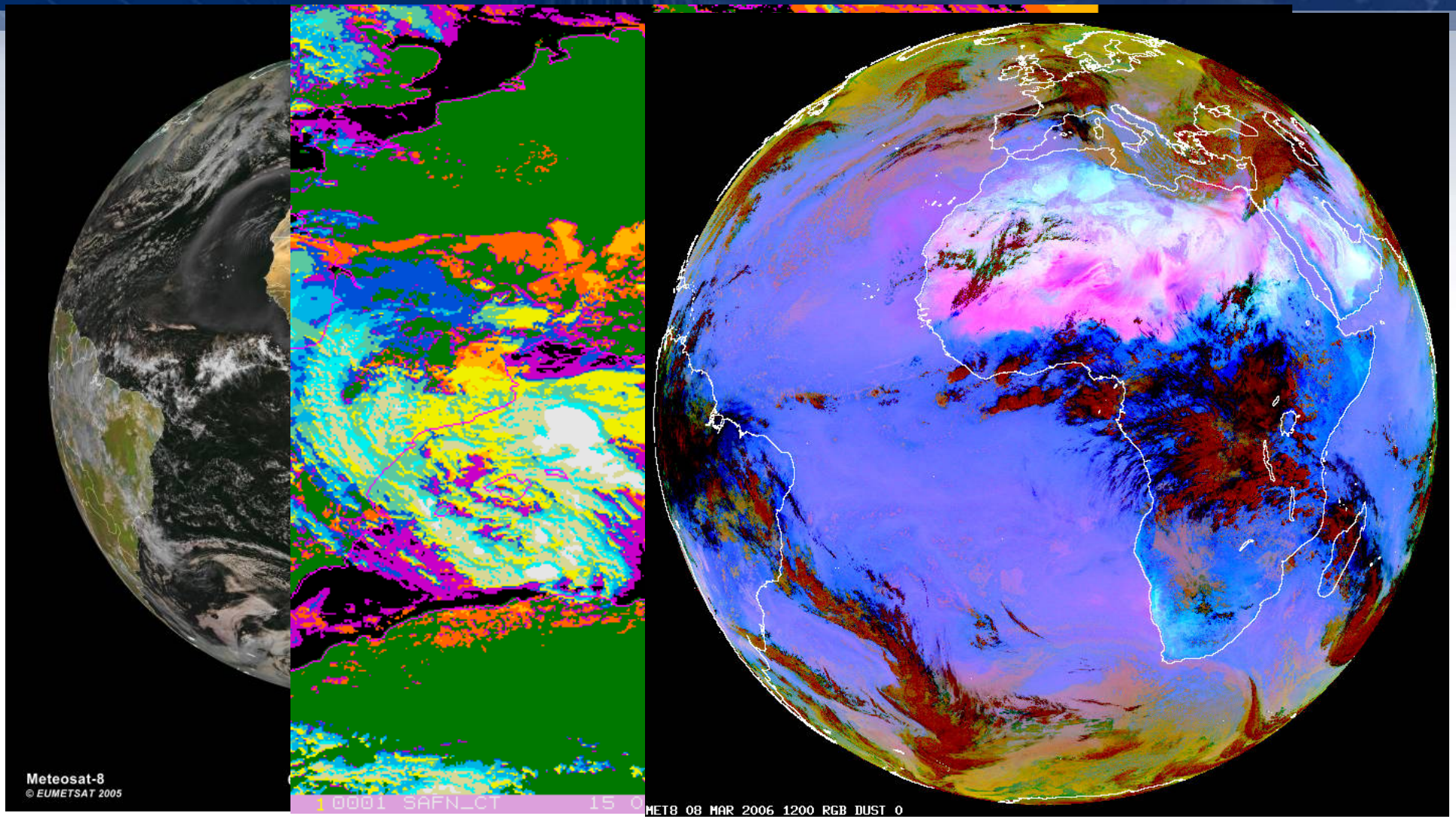
Meteosat Second Generation (MSG)



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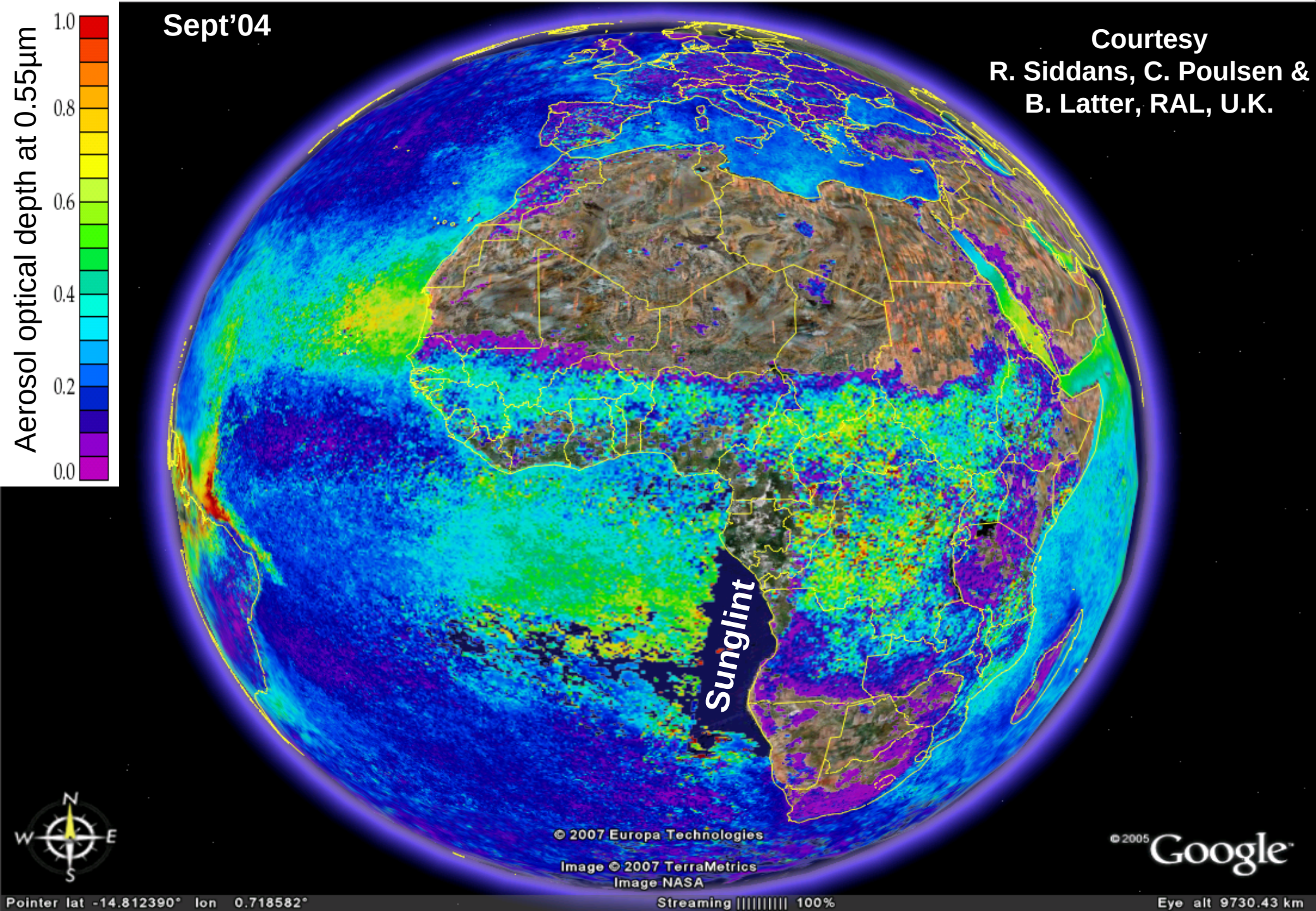
Sept'04
Courtesy
R. Siddans, C. Poulsen &
B. Latter, RAL, U.K.
Aerosol optical depth at 0.55µm
1.0
0.8
0.6
0.4
0.2
0.0
Sunglint
© 2007 Europa Technologies
Image © 2007 TerraMetrics
Image NASA
© 2005 Google
Pointer lat -14.812390° lon 0.718582°
Streaming 100%
Eye alt 9730.43 km