



The EUMETSAT Polar System (EPS)



**EPS Programme
Scientist**

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Presented by

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Initial Joint Polar System (IJPS)

Fairbanks, Alaska

Wallops Island, MD

Suitland, MD

Svalbard, Norway

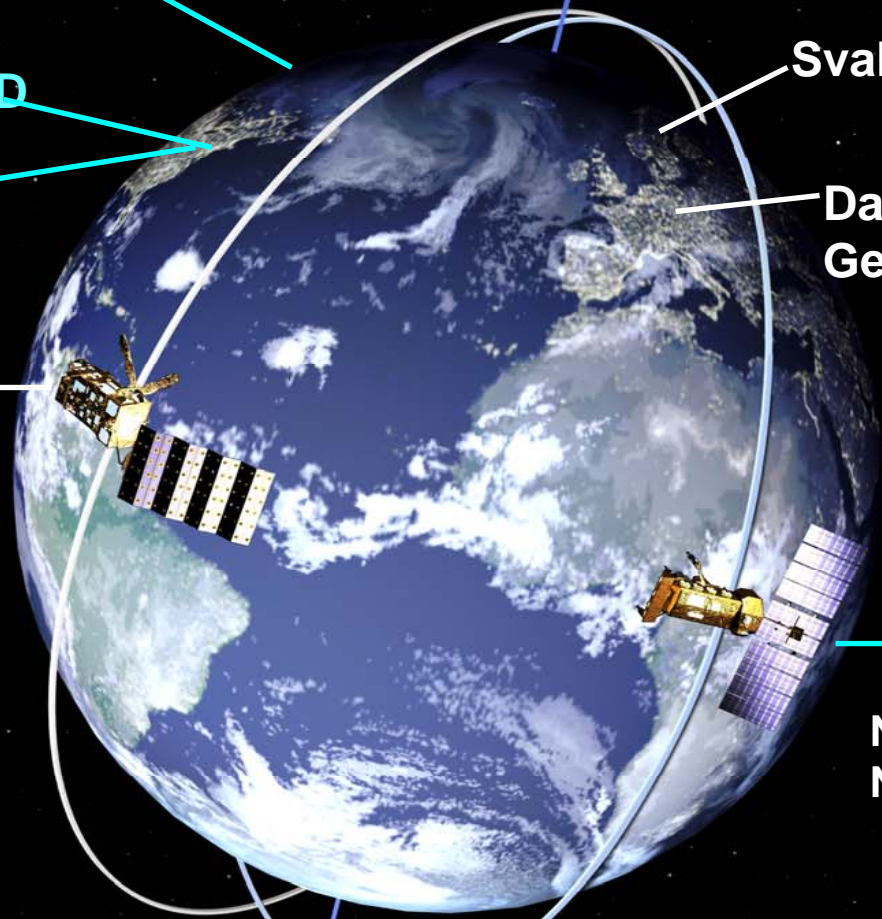
Darmstadt, Germany

Metop

METOP-A (in orbit)
METOP-B (2010)
METOP-C (2014)

POES

NOAA-18 (in orbit)
NOAA-N' (2009)



- EUMETSAT-NOAA coordinated programmes
- Exchange of instruments (ATOVS from NOAA, MHS from EUMETSAT)
- Coordinated operations, data and services
- Extended agreement in 2003 to include Metop-C

**Sun-synchronous
Orbit of 102 minutes
14.1 orbits per day**

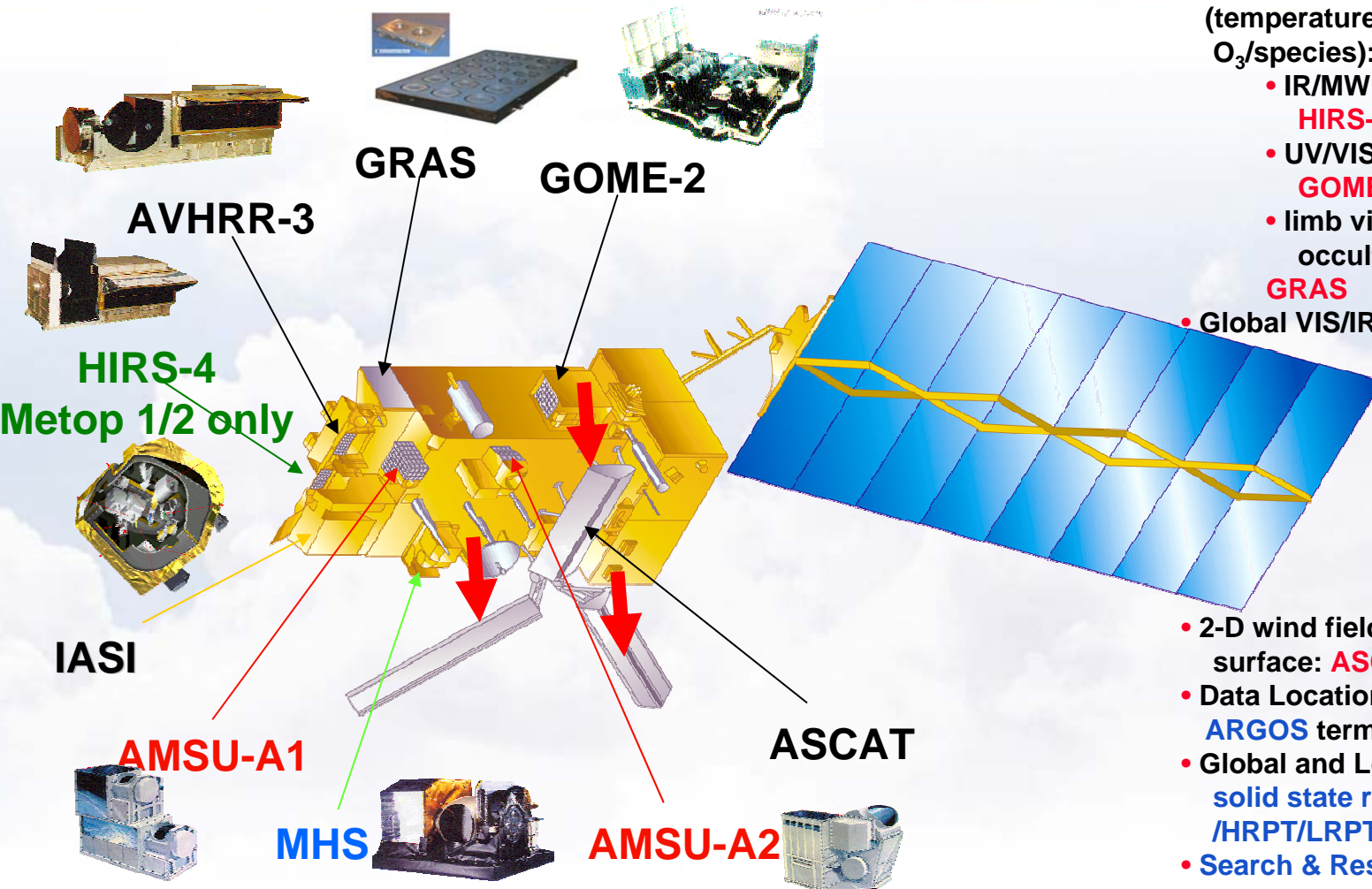


Ground Station in Svalbard



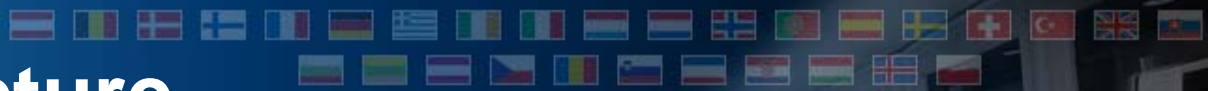


Instruments

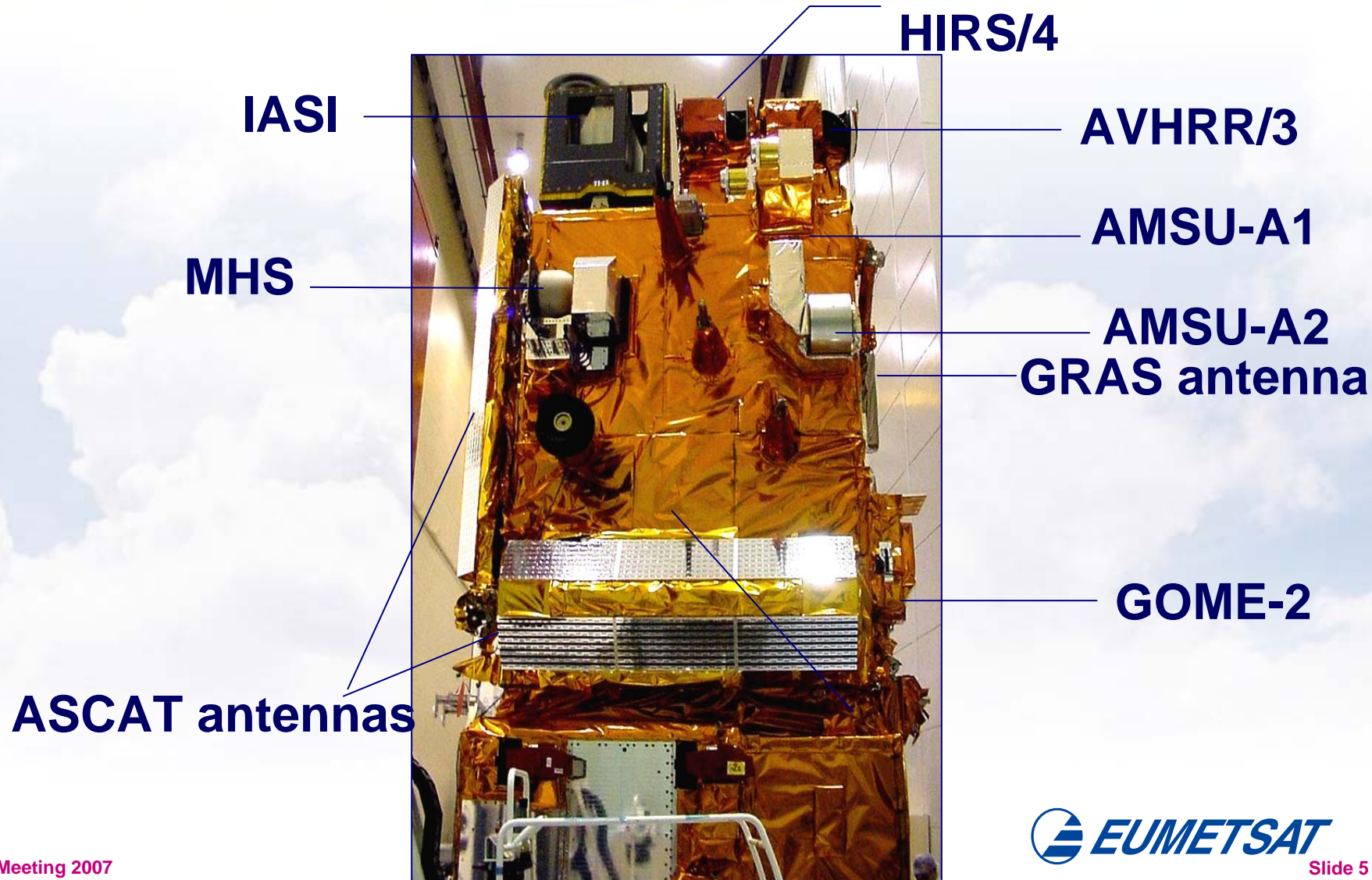


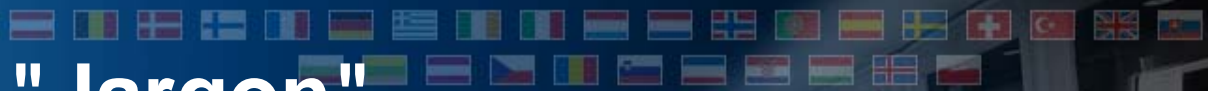
- Atmospheric Sounding (temperature, moisture, O₃/species):
 - IR/MW imaging sounders: **HIRS-4/IASI, AMSU-A/MHS**
 - UV/VIS imaging sounder : **GOME-2**
 - limb viewing radio-occultation sounder: **GRAS**
- Global VIS/IR Imagery: **AVHRR/3**

- 2-D wind field at the ocean surface: **ASCAT**
- Data Location and Collection: **ARGOS** terminal
- Global and Local Data Access: **solid state recorder /HRPT/LRPT**
- Search & Rescue Terminal



And a Real Picture ...





Product Level "Jargon"

Level 0:

Raw data after restoration of the chronological data sequence (e.g. removal of overlap)

Level 1a:

Instrument data in full resolution with radiometric and geometric information appended, but not applied

Level 1b:

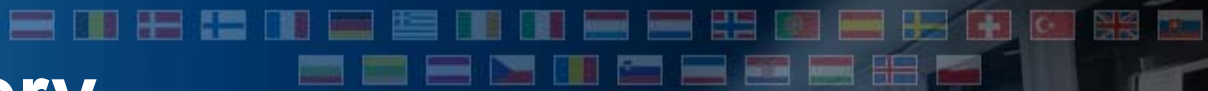
Calibrated, earth located and quality controlled data, in the original pixel resolution, together with needed ancillary data

Level 1c:

(IASI only): Level 1b after application of apodization

Level 2:

Derived geophysical quantity, e.g. profile, wind, ..., same spatial and temporal sampling as Level 1b



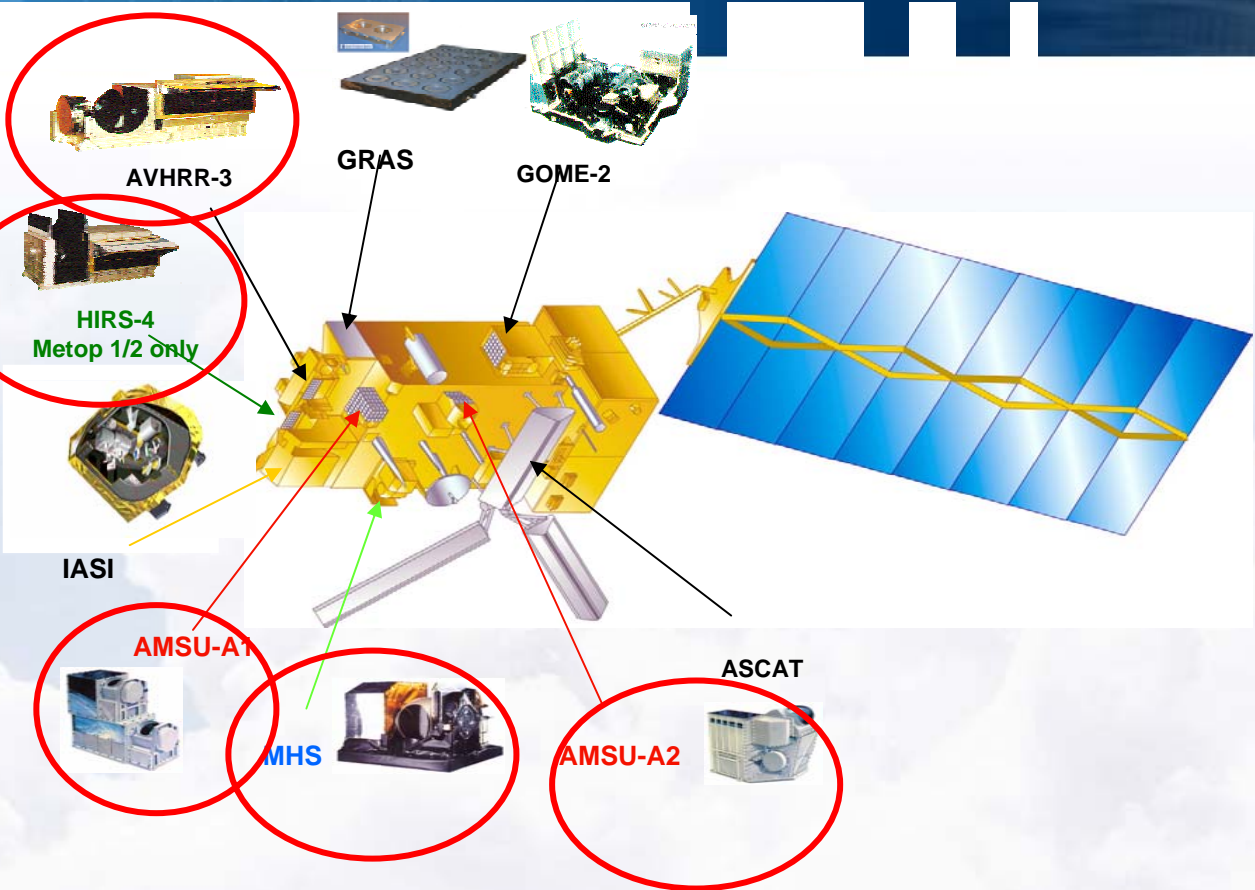
Product Delivery

Summary of EUMETCast Level-1 and Level-2 EPS distribution formats for global products

	EUMETCast		GTS	
	Level 1	Level 2	Level 1	Level 2
ASCAT	BUFR and PFS	BUFR from SAF	BUFR	BUFR from SAF
ATOVS	BUFR	BUFR	BUFR	BUFR
AVHRR	PFS	-	-	-
GOME	PFS	BUFR from SAF (TBC)	-	BUFR from SAF
GRAS	BUFR and PFS	BUFR from SAF (TBC)	-	BUFR from SAF
IASI	BUFR	BUFR	BUFR	BUFR



Instruments AVHRR and ATOVS



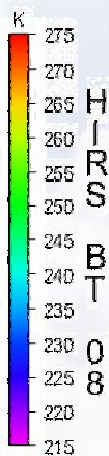
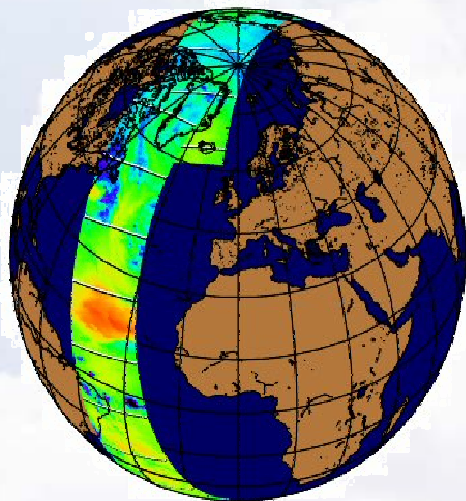
ATOVS and AVHRR

Provide continuity with the current system – imagery and soundings

AVHRR and ATOVS

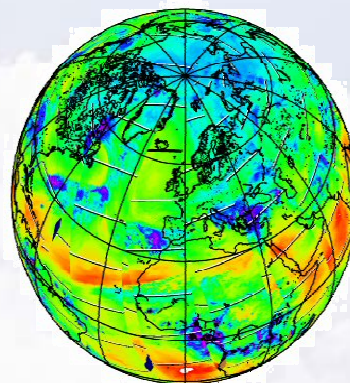
Level 1 NRT Products (2h15min)
Level 2 NRT Products (3h)

NOAA/NESDIS SAA



NOAA17 26022005

NOAA/NESDIS CLASS

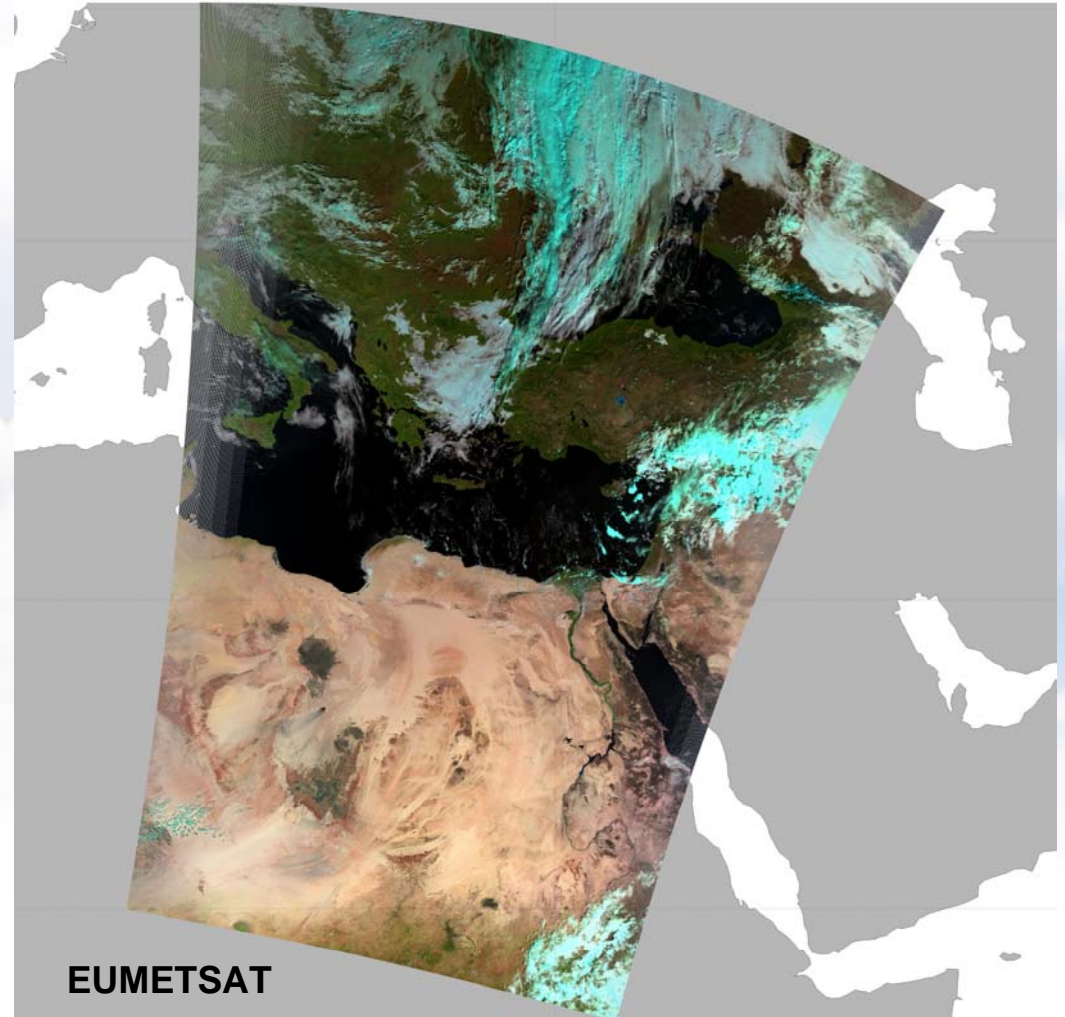
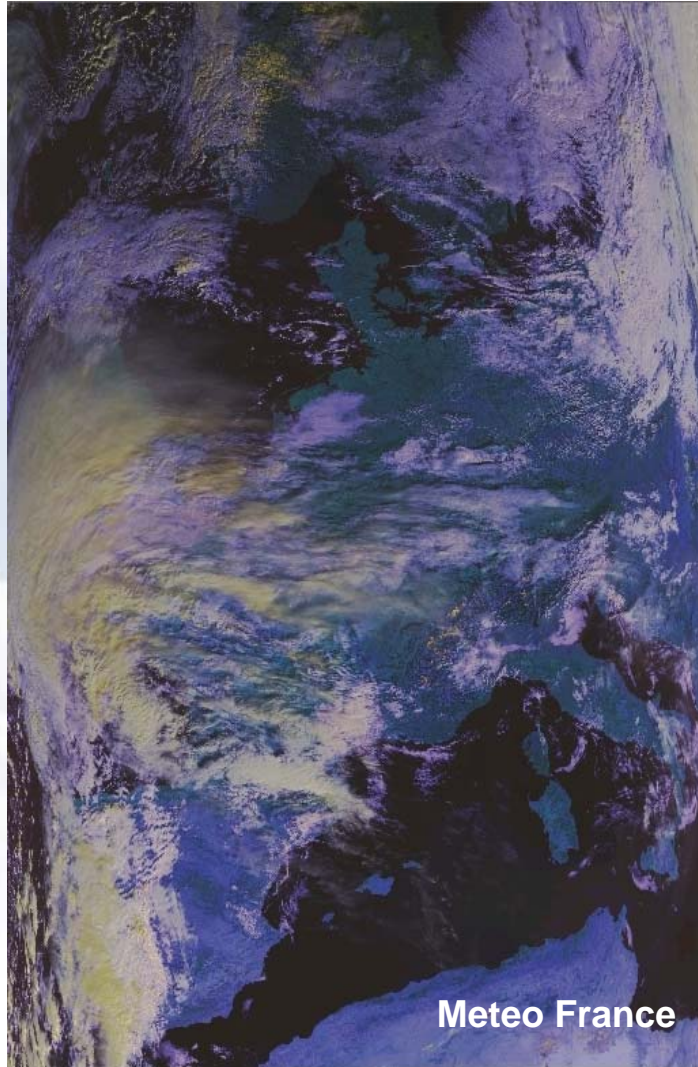


Composite of
14 level-1b products
of one day
from HIRS covering
the Earth twice

NOAA/NESDIS SAA

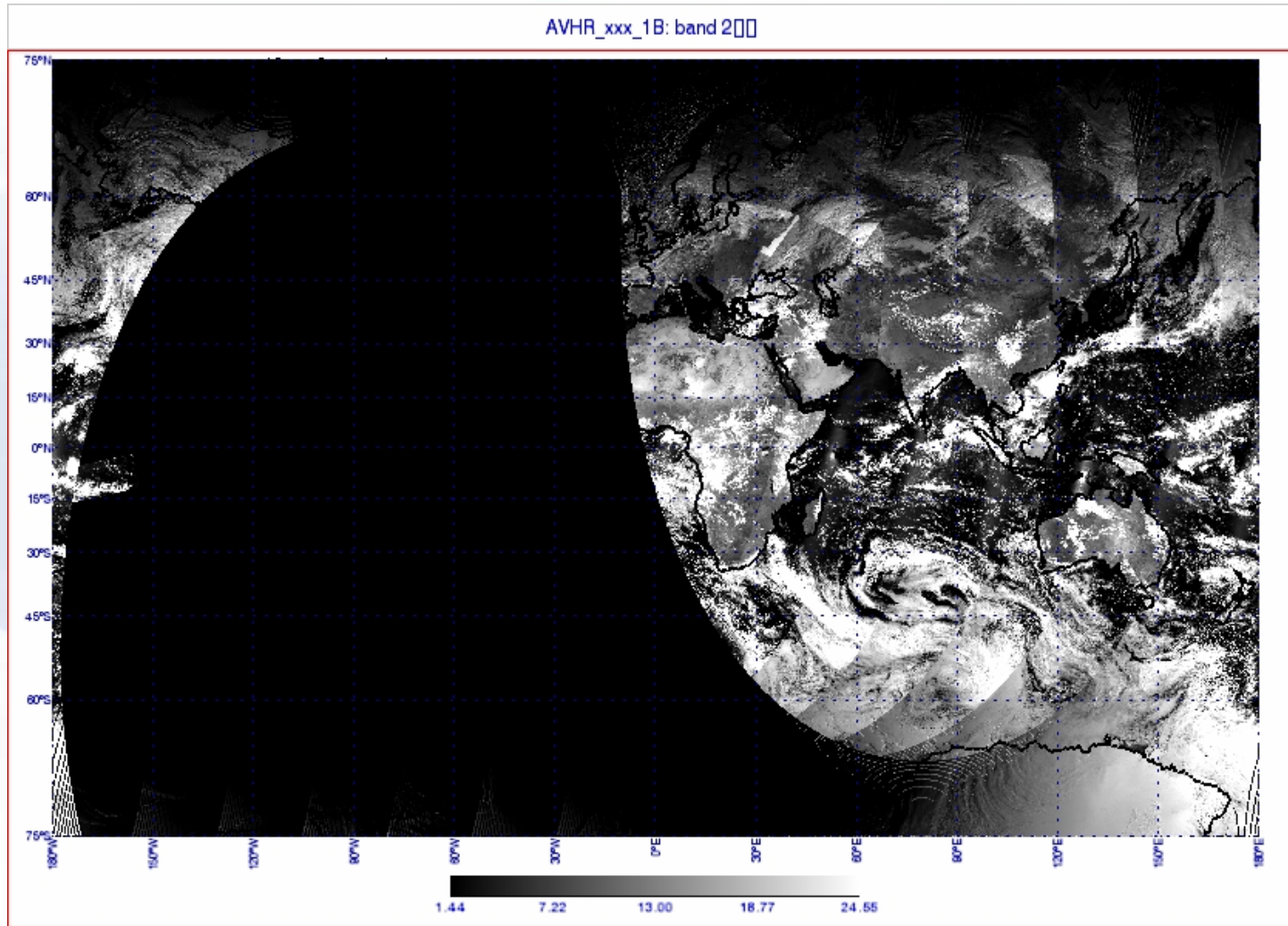
NOAA/NESDIS CLASS

AVHRR since 25 Oct 2006 (VIS channels)



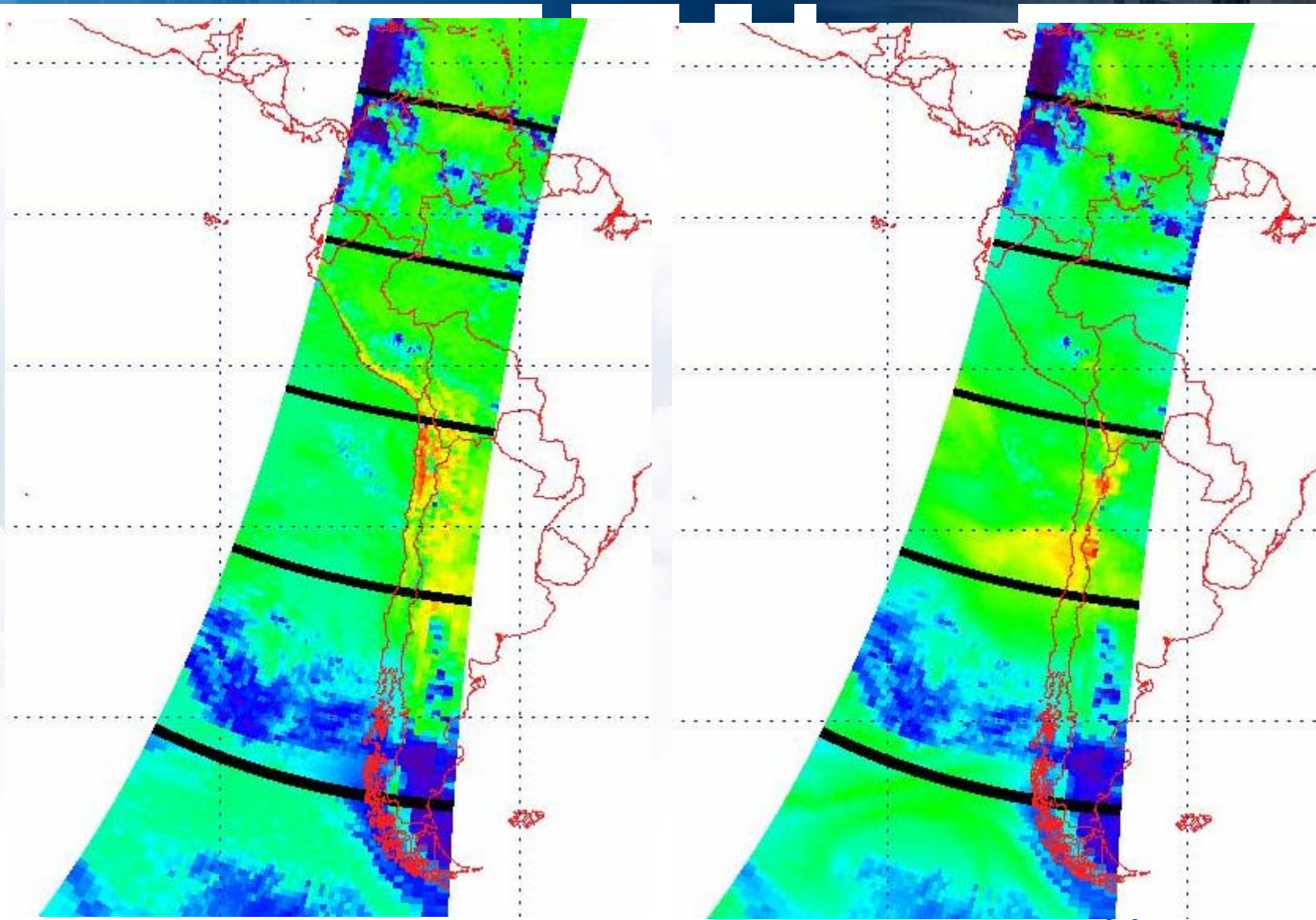


Global AVHRR





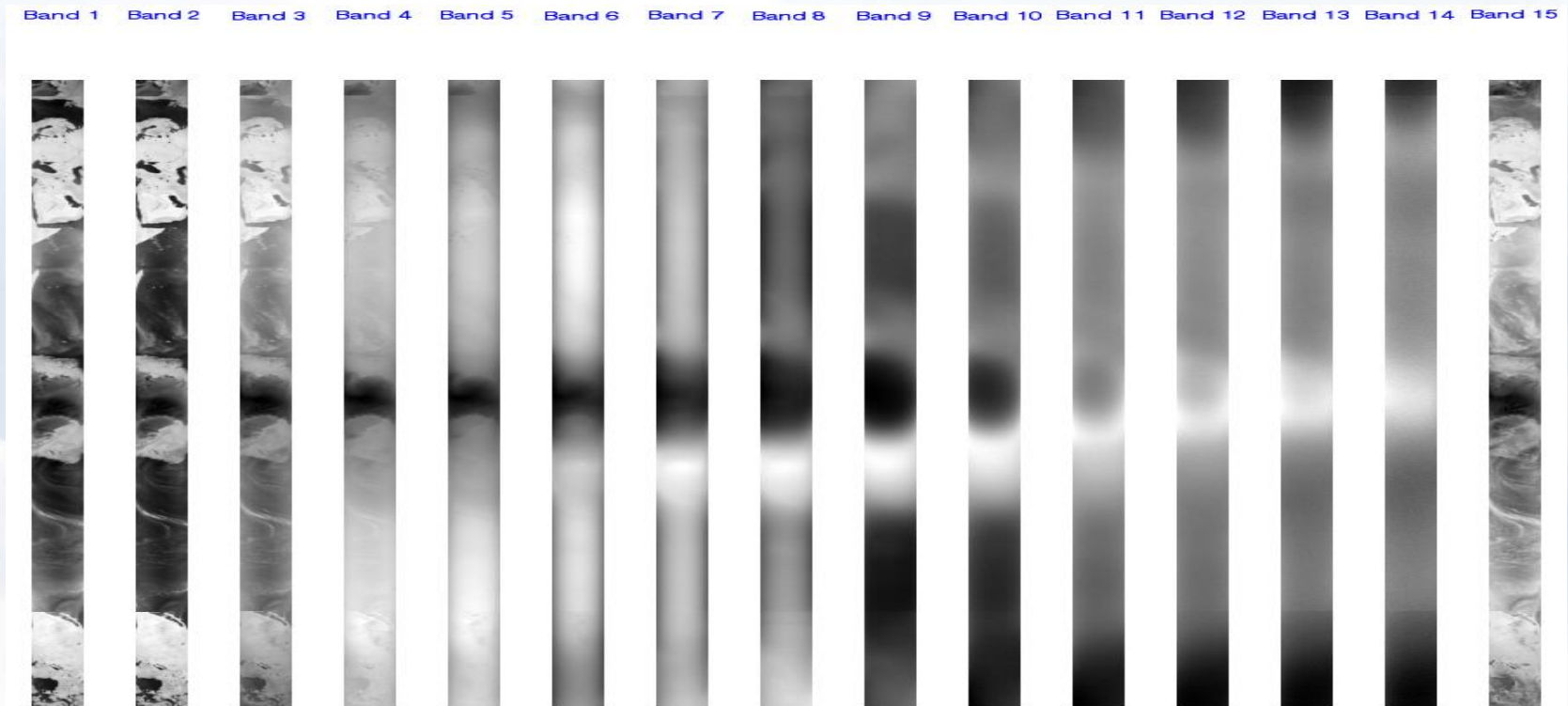
HIRS Channels 8 and 11 (11 μm and 7.3 μm)



AMSU A1 and A2 (23 – 90 GHz)

Instruments switched on on 24 Oct 2006

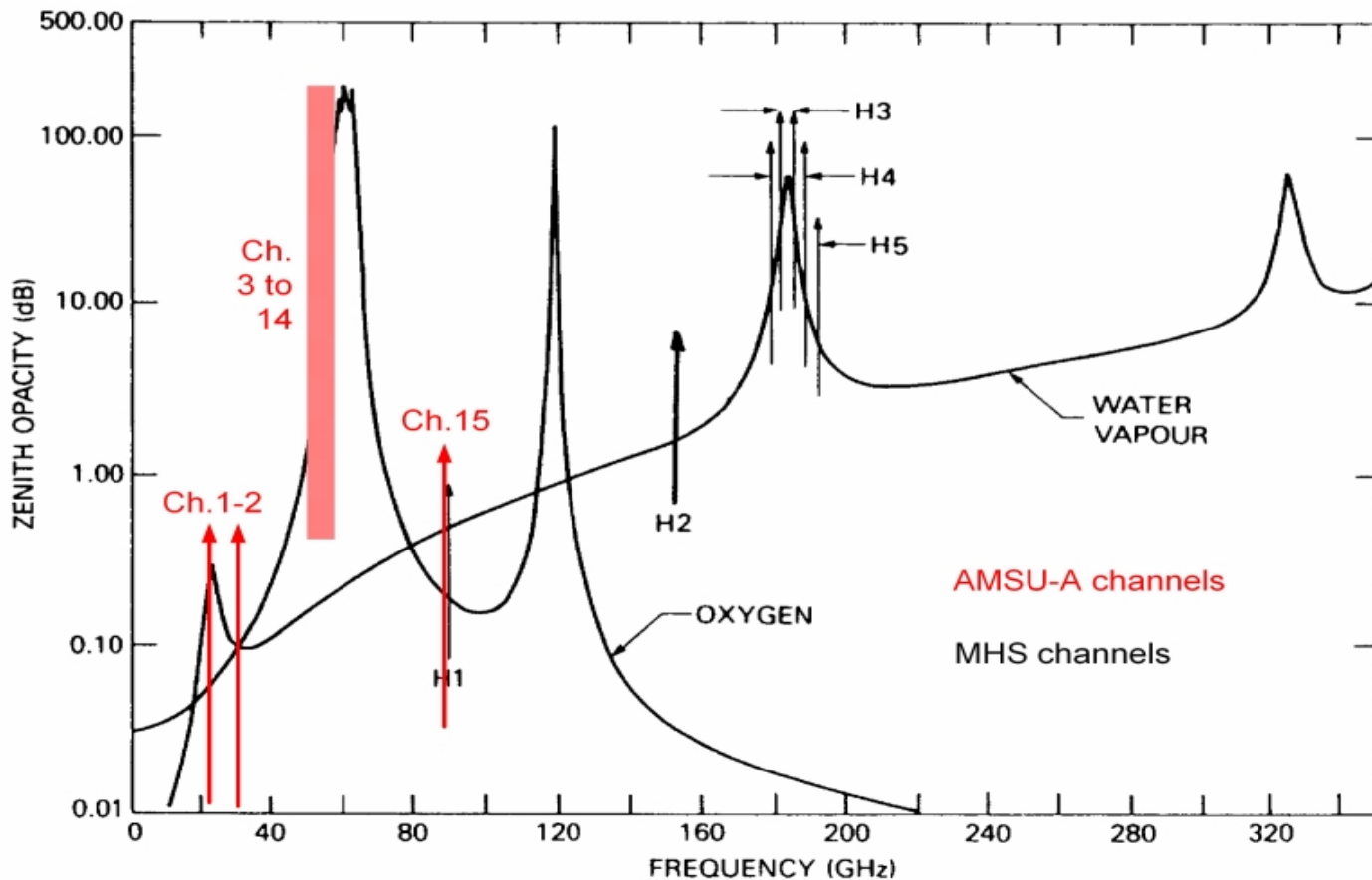
Nominal performance



First AMSU-A Level 0 data

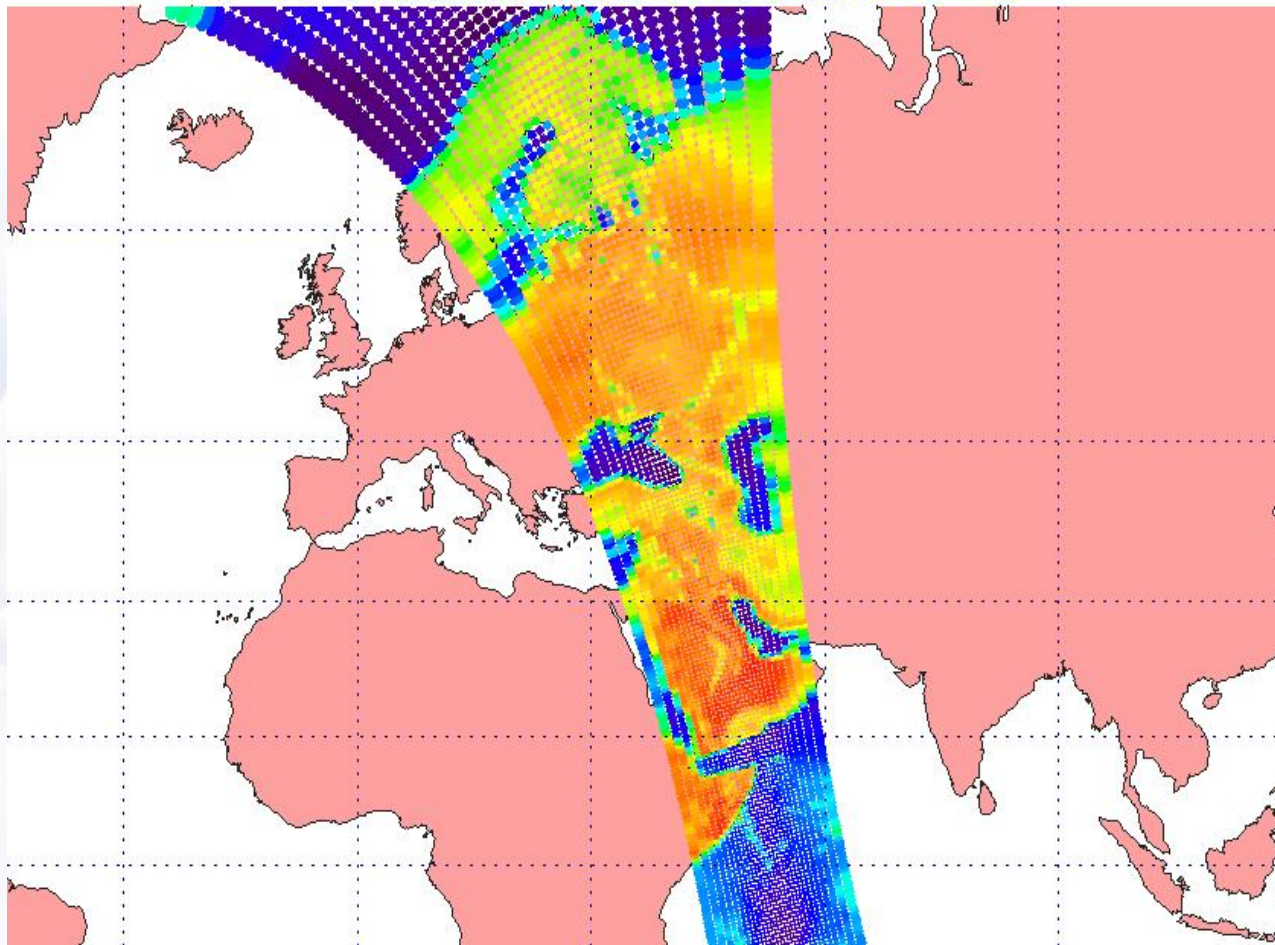
(AMSU A2: Bands 1 and 2, AMSU A1: all other bands)

AMSU and MHS Channels



AMSU A2 Level 1 Product Example

AMSA_xxx_1A_M02_20061024164619Z_20061024182523Z_N_C_20061024182450Z





MHS Products (NOAA-18)

First MHS Images 31 May 2005

Channel H1
(89 GHz)



Channel H2
(157 GHz)



Channel H5
(190.3 GHz)



Channel H4
(183.3+/-3 GHz)



Channel H3
(183.3+/-1 GHz)



Measurements from the **MHS** instrument are critical for deriving profiles of moisture and quantifying precipitation

MHS can also provide information on low level moisture and surface features

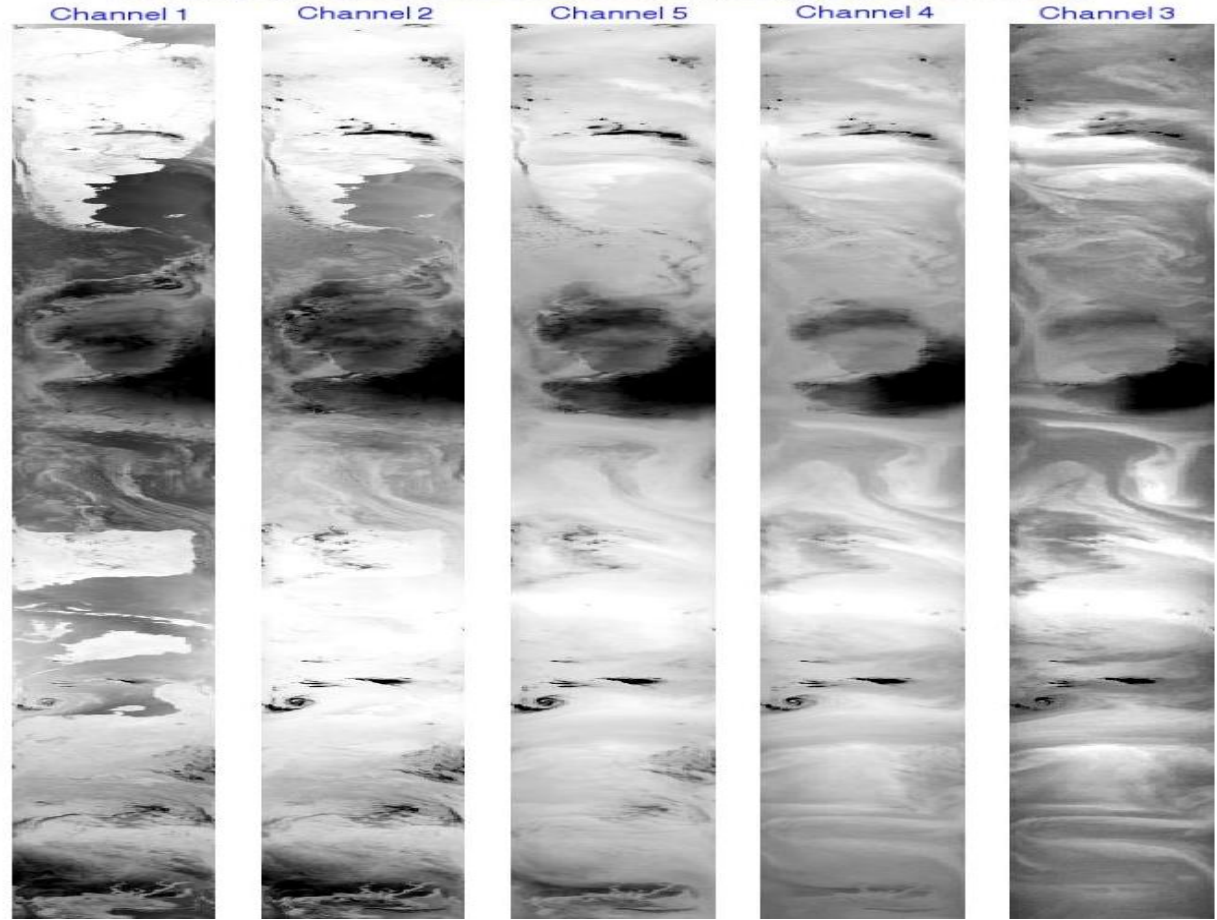


MHS from Metop: First Data

Instrument in measurement mode on 31 October 2006

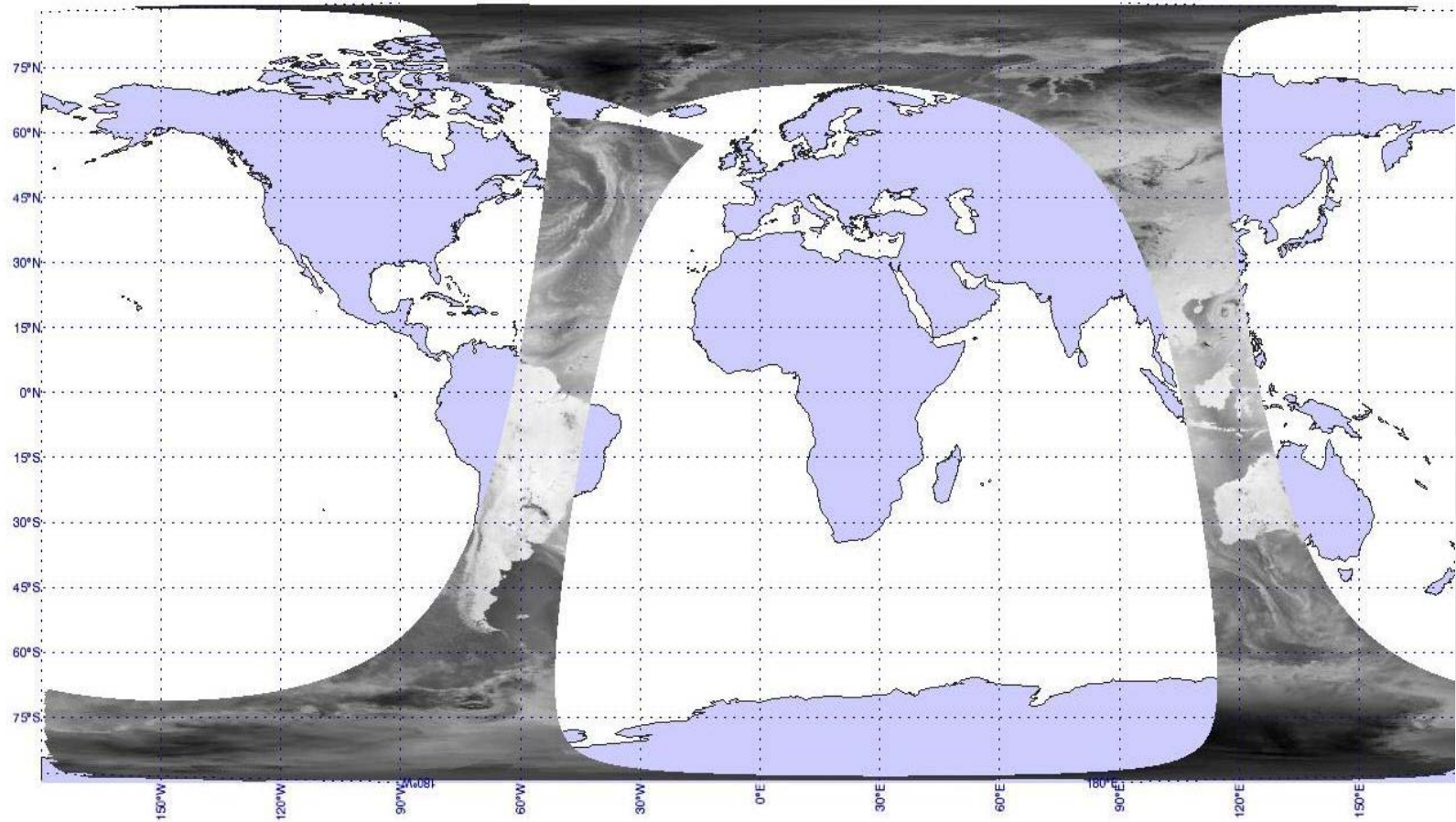
Nominal Performance

MHSx_xxx_00_M02_20061031123900Z_20061031141800Z_N_C_20061031141551Z



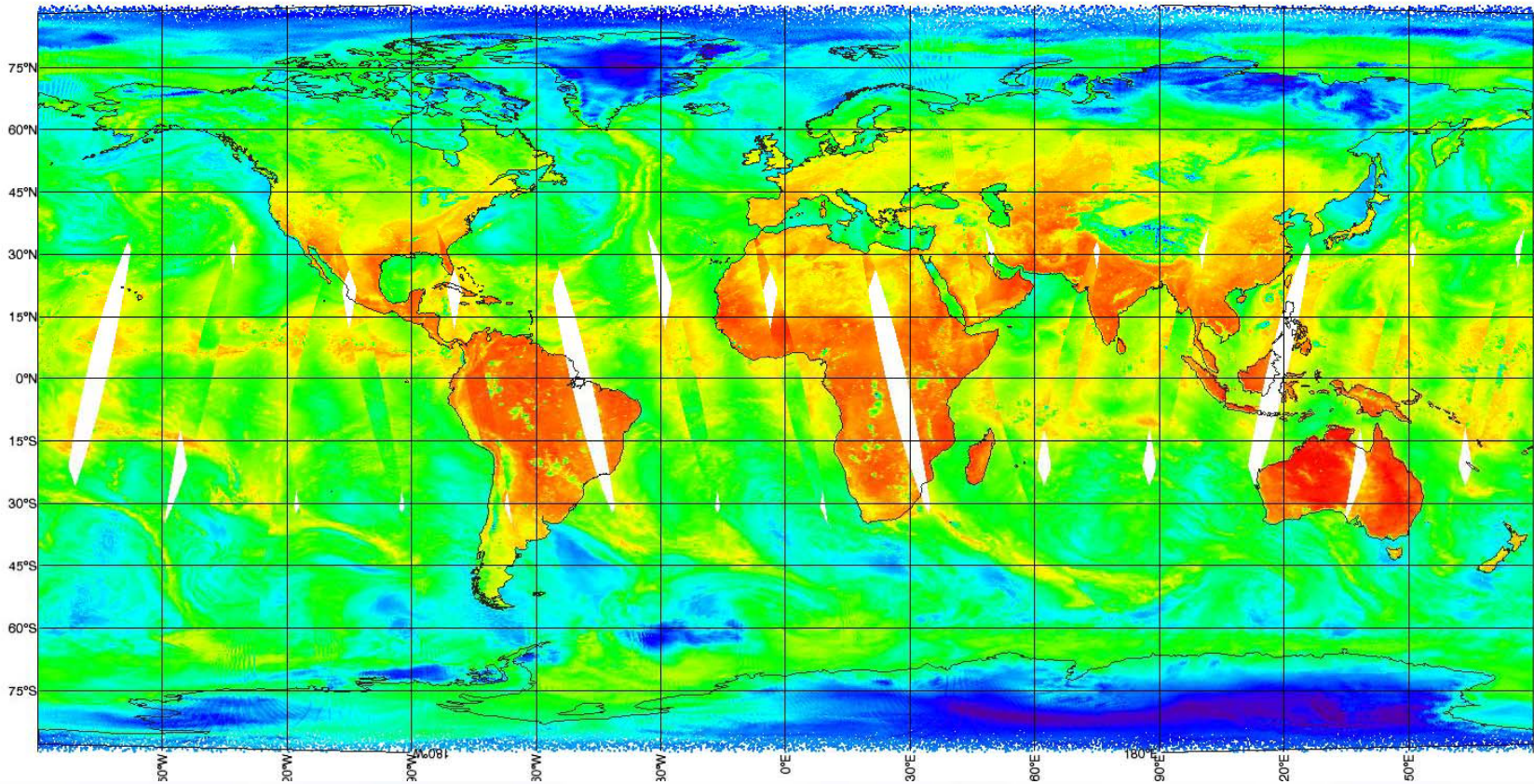


First Level 1 Product (Calibrated & Navigated)



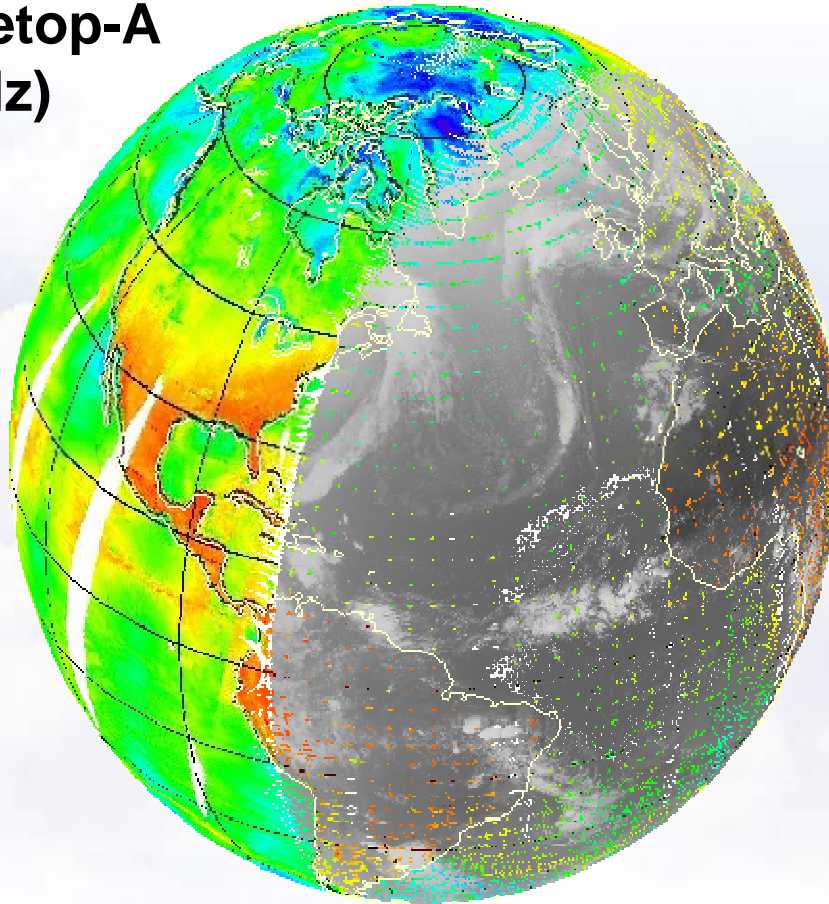


Global MHS



EUMETSAT has a global view now: Polar and Geostationary Orbits

**MHS on Metop-A
(89 GHz)**

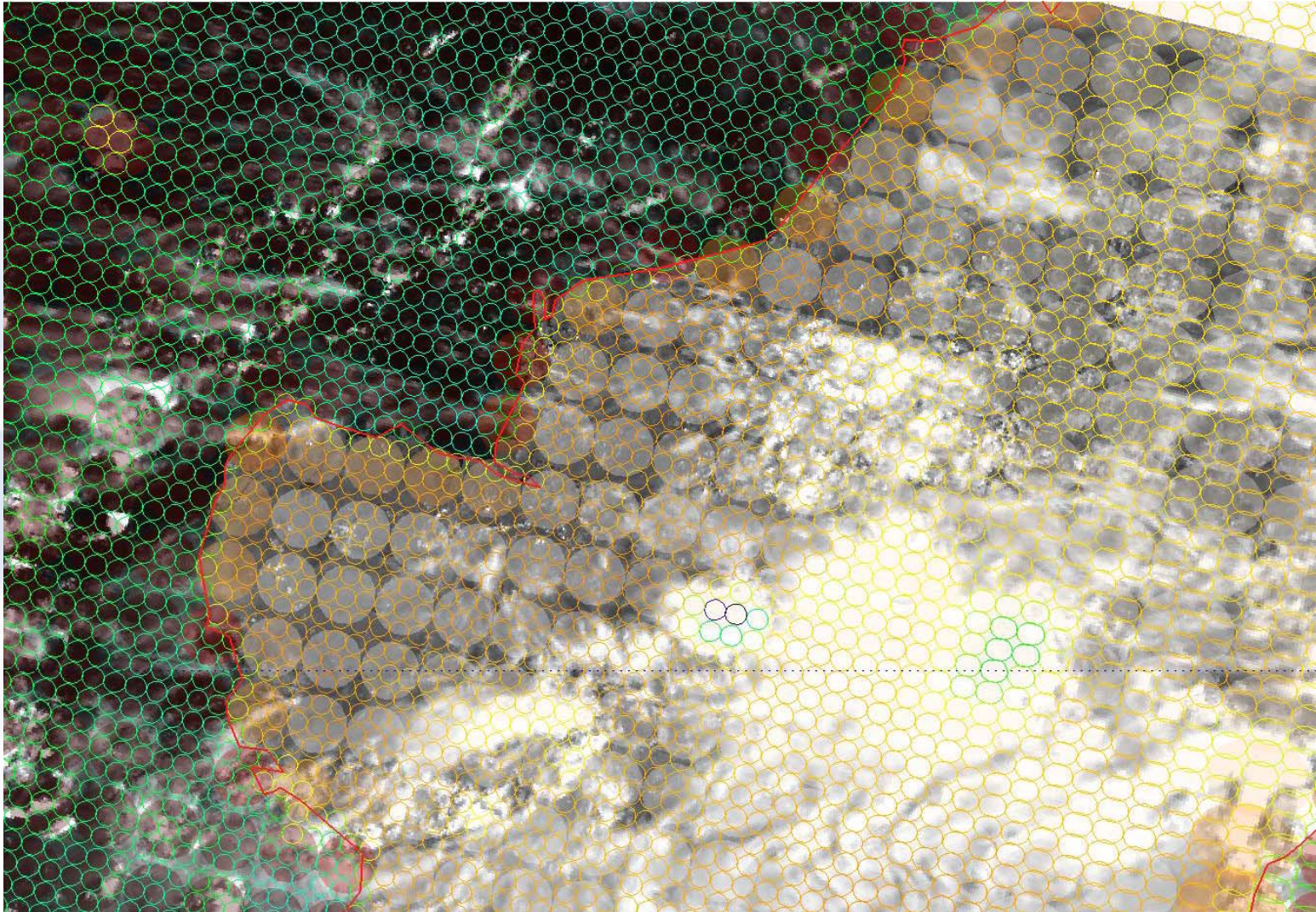


**Meteosat 8
IR**

Roesli, 2006

Collocation AVHRR, MHS, AMSU

Channel 1 (AVHR_1B,AMSA_1B,MHSX_1B) M02_20061102014625Z_20061102033121Z_N_C_20061102032919Z





AVHRR / ATOVS / MHS Status

**AVHRR imagery for scene interpretation and navigation
HIRS, AMSU and MHS for temperature and humidity sounding,
cloud information (water/ice, precipitation)**

MHS declared ready for operation 07 Dec 2006

AVHRR declared ready for operation 14 Dec 2006

HIRS declared ready for operation 14 Dec 2006

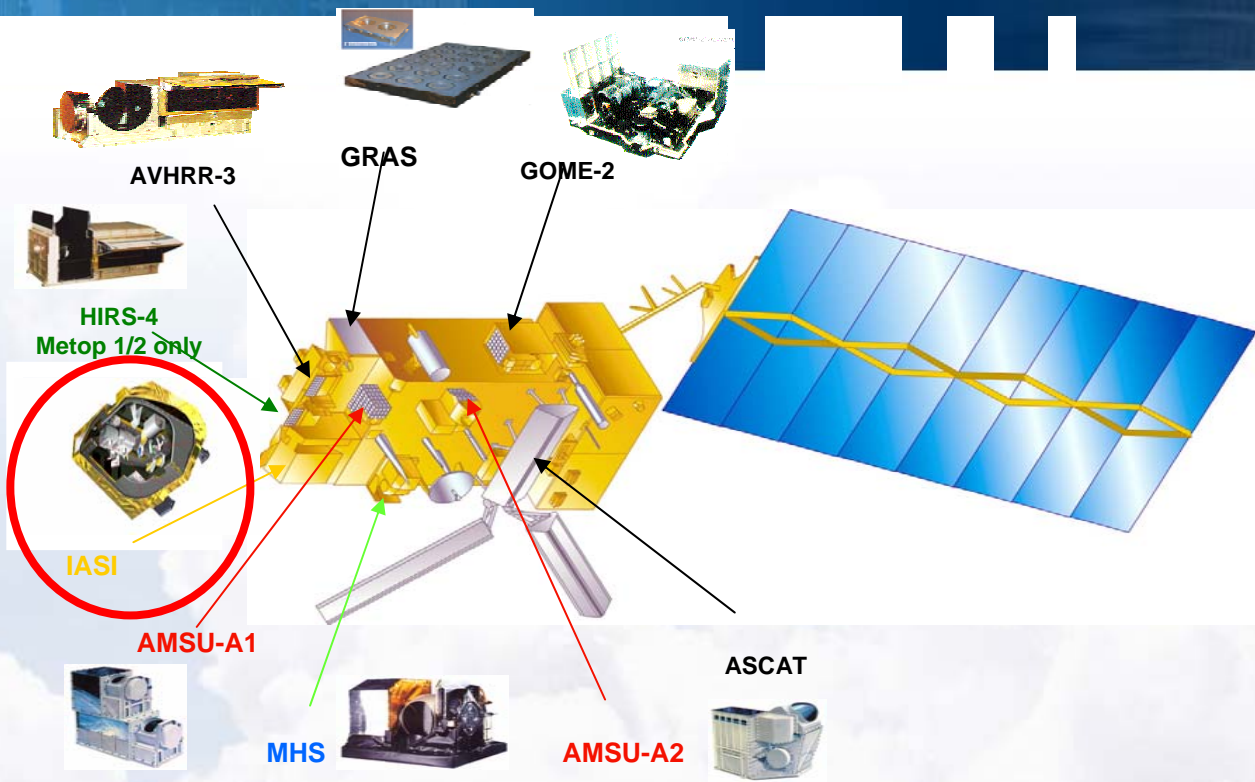
AMSU-A declared ready for operation 18 Jan 2006

Products (Level 1) available via EUMETCast

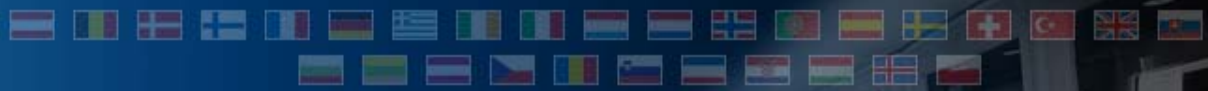
Products (Level 2) available since June 2007



IASI – Atmospheric Sounding

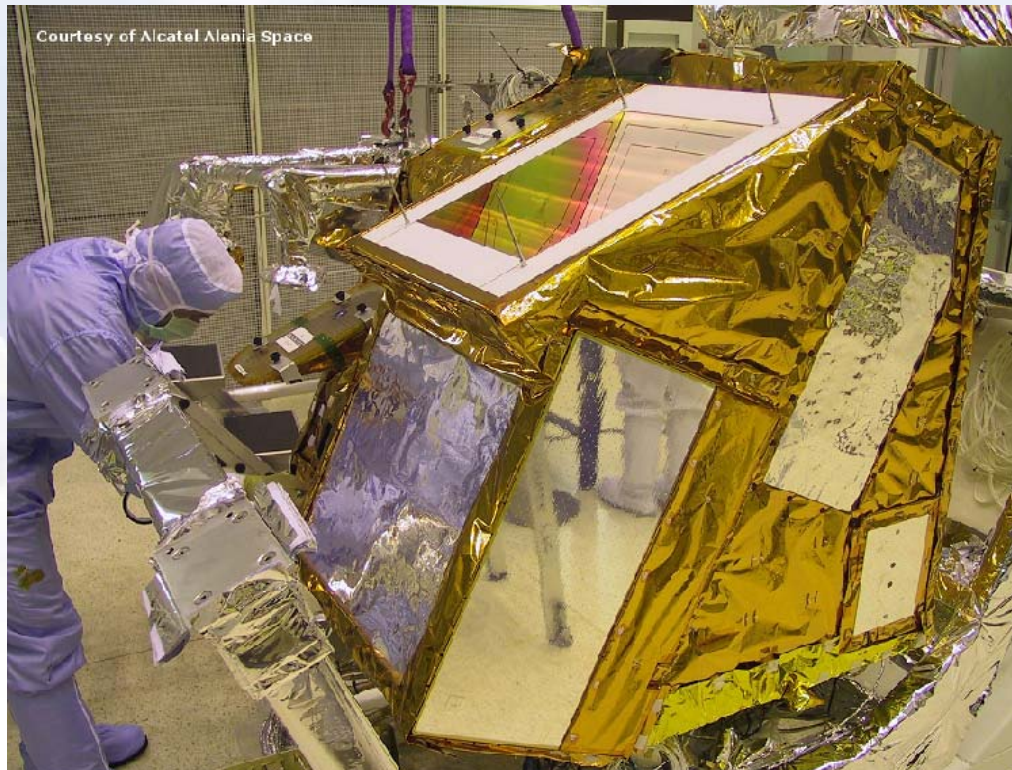


**IASI = Infrared Atmospheric Sounding Interferometer
(EUMETSAT/CNES Cooperation)
(Michelson Interferometer with moving mirror)**

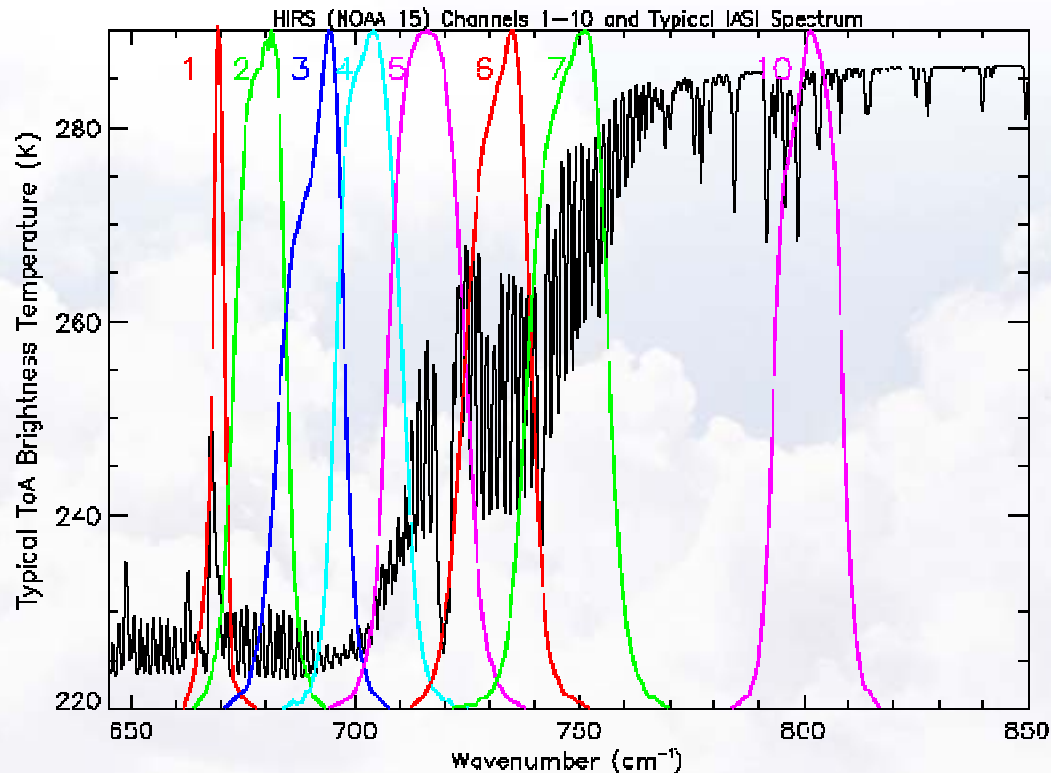


IASI Concept

The interferometer measures an interferogram, onboard processing (Fourier transform) derives an atmospheric spectrum from the interferogram



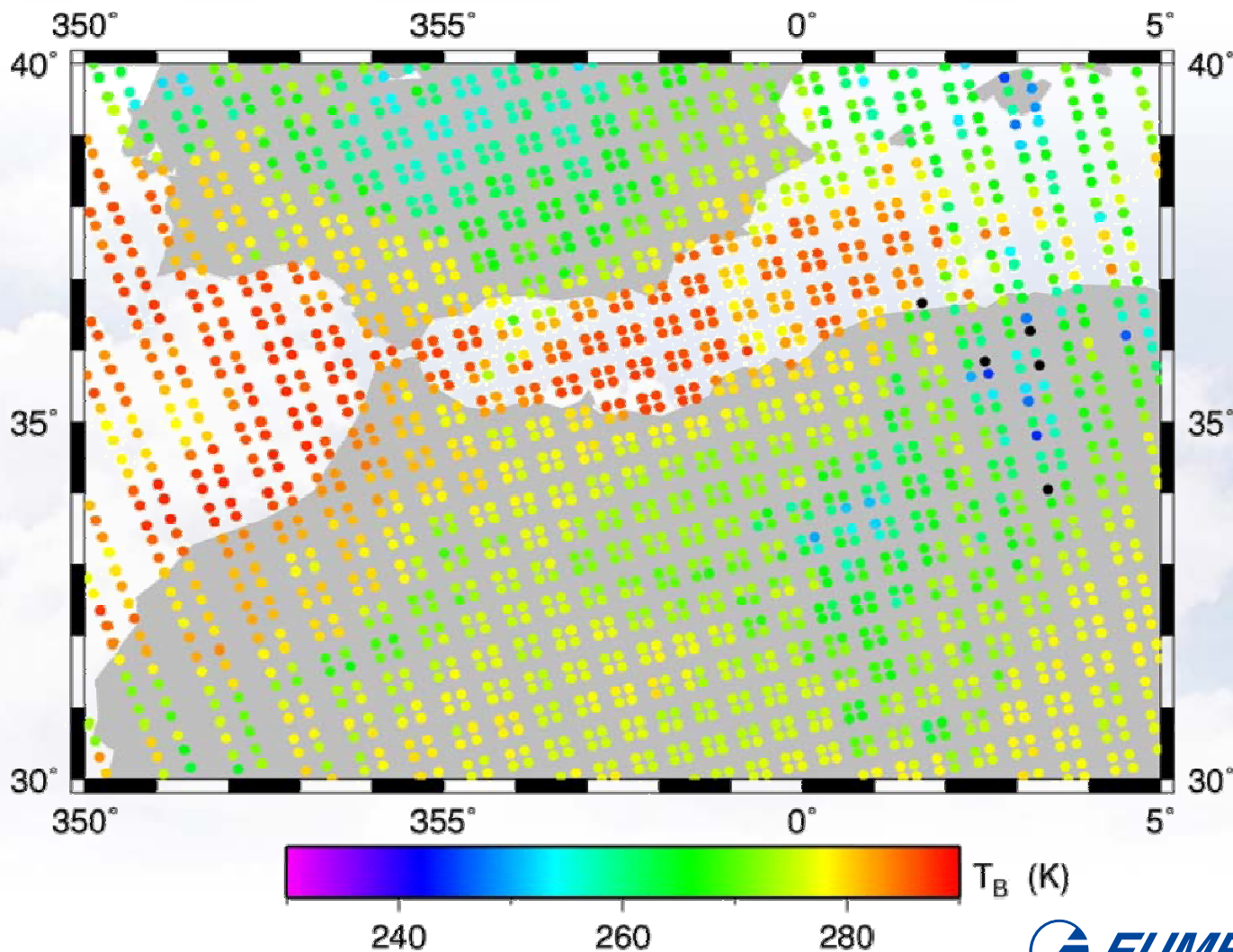
IASI Compared to HIRS Spectral Resolution

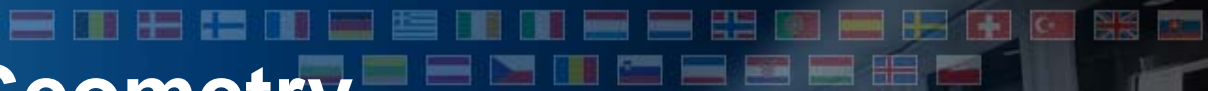


8461 "Channels", spectral resolution 0.25 cm^{-1}

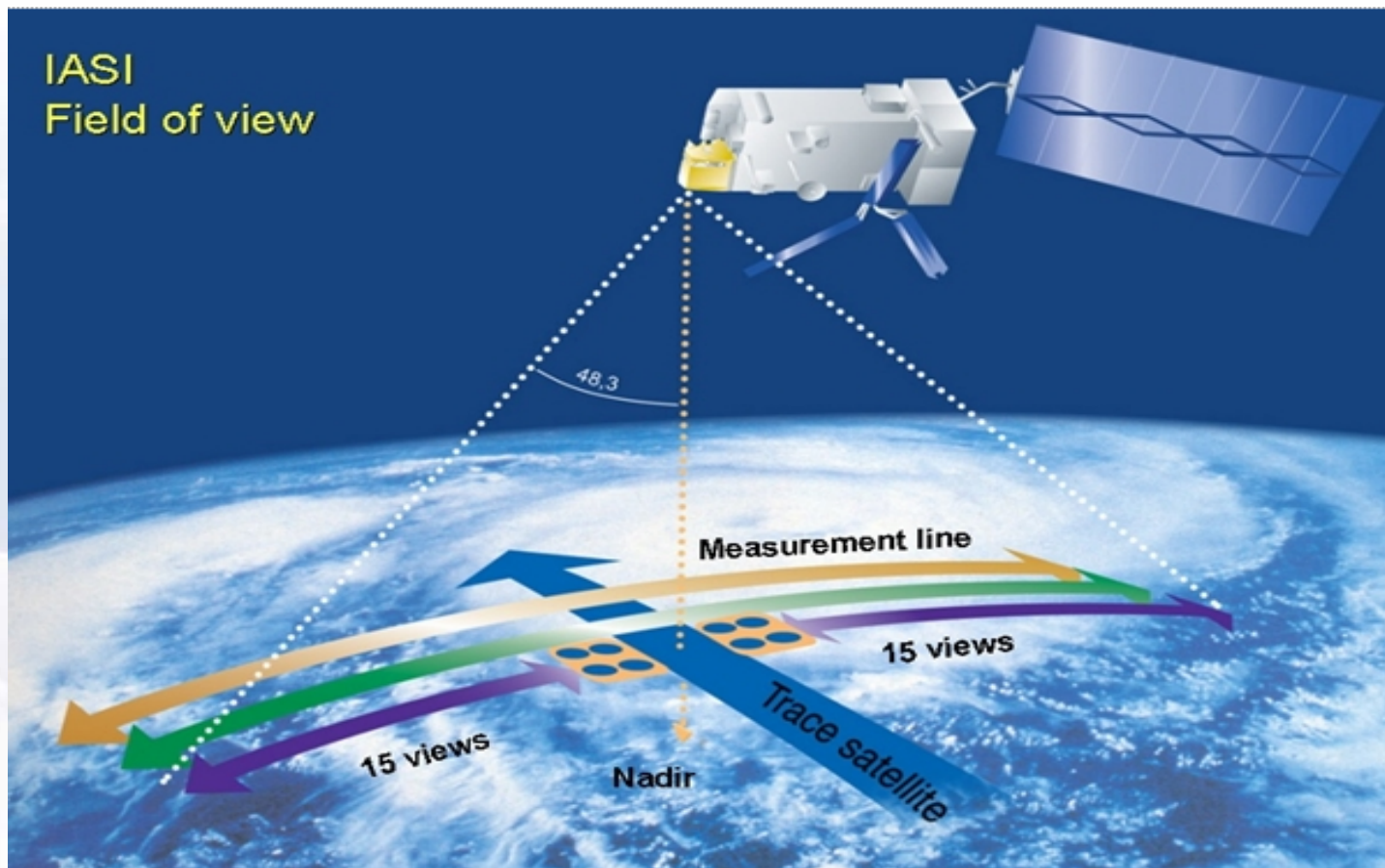


IASI Geolocation: 4 IFOV in 1 AMSU Pixel



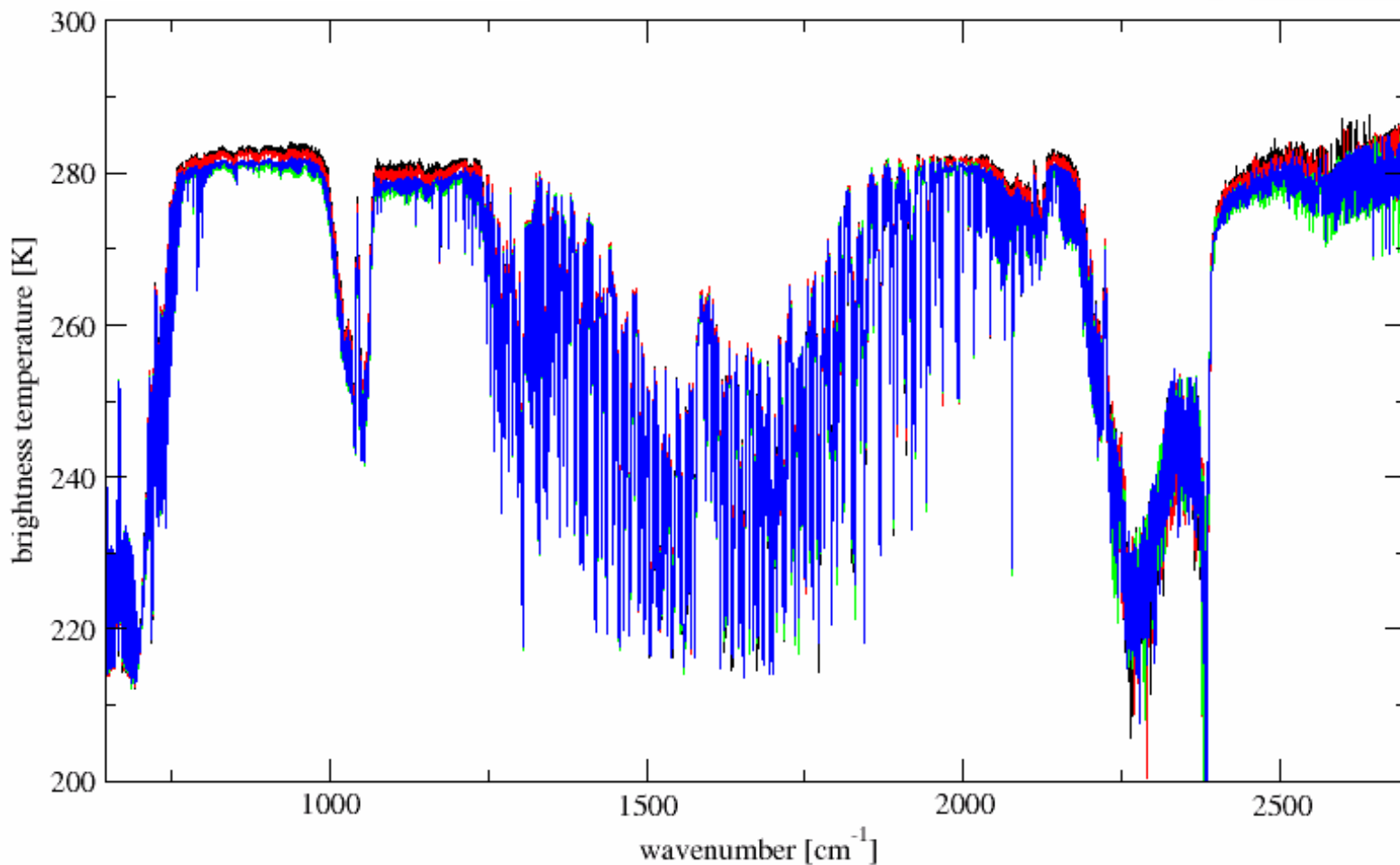


IASI Viewing Geometry



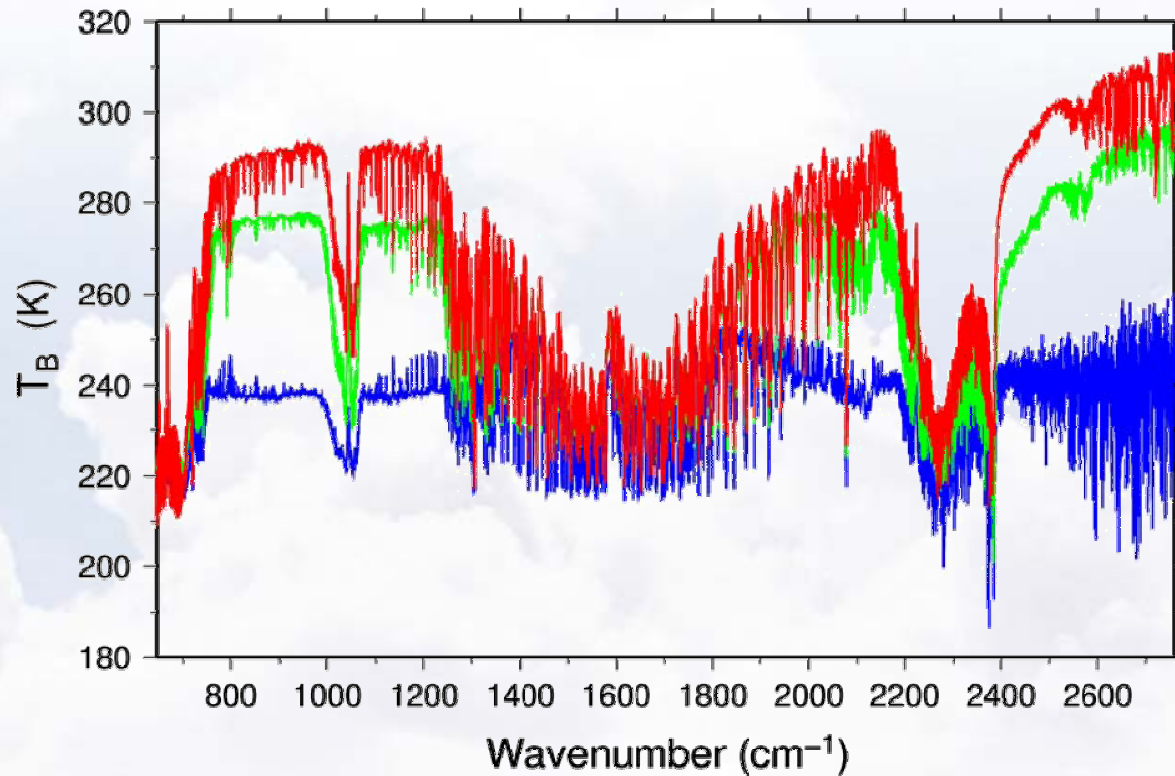


First IASI Spectrum: 29 Nov 2006, 13:42:11





IASI Spectra



polar

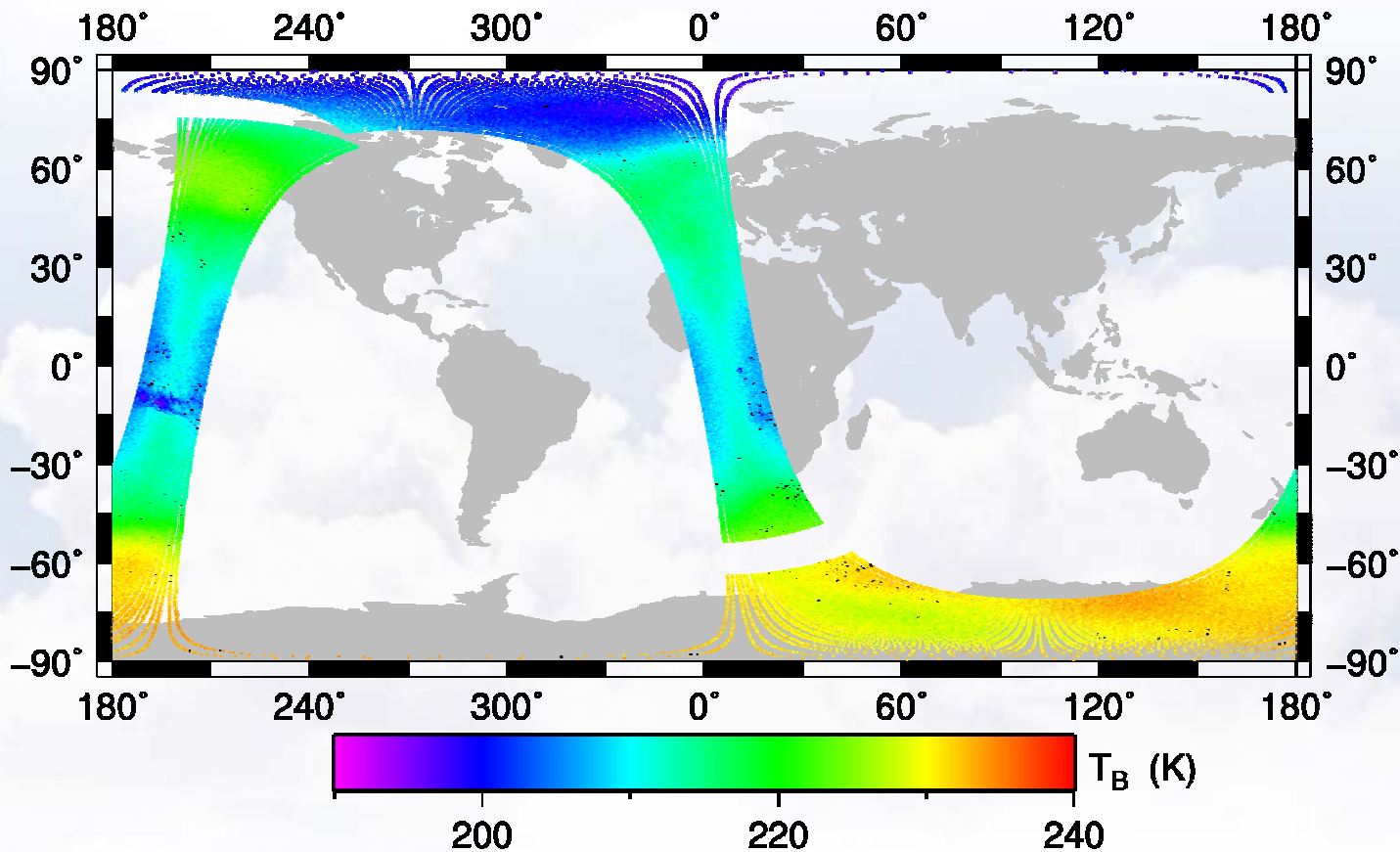
midlatitude

tropical



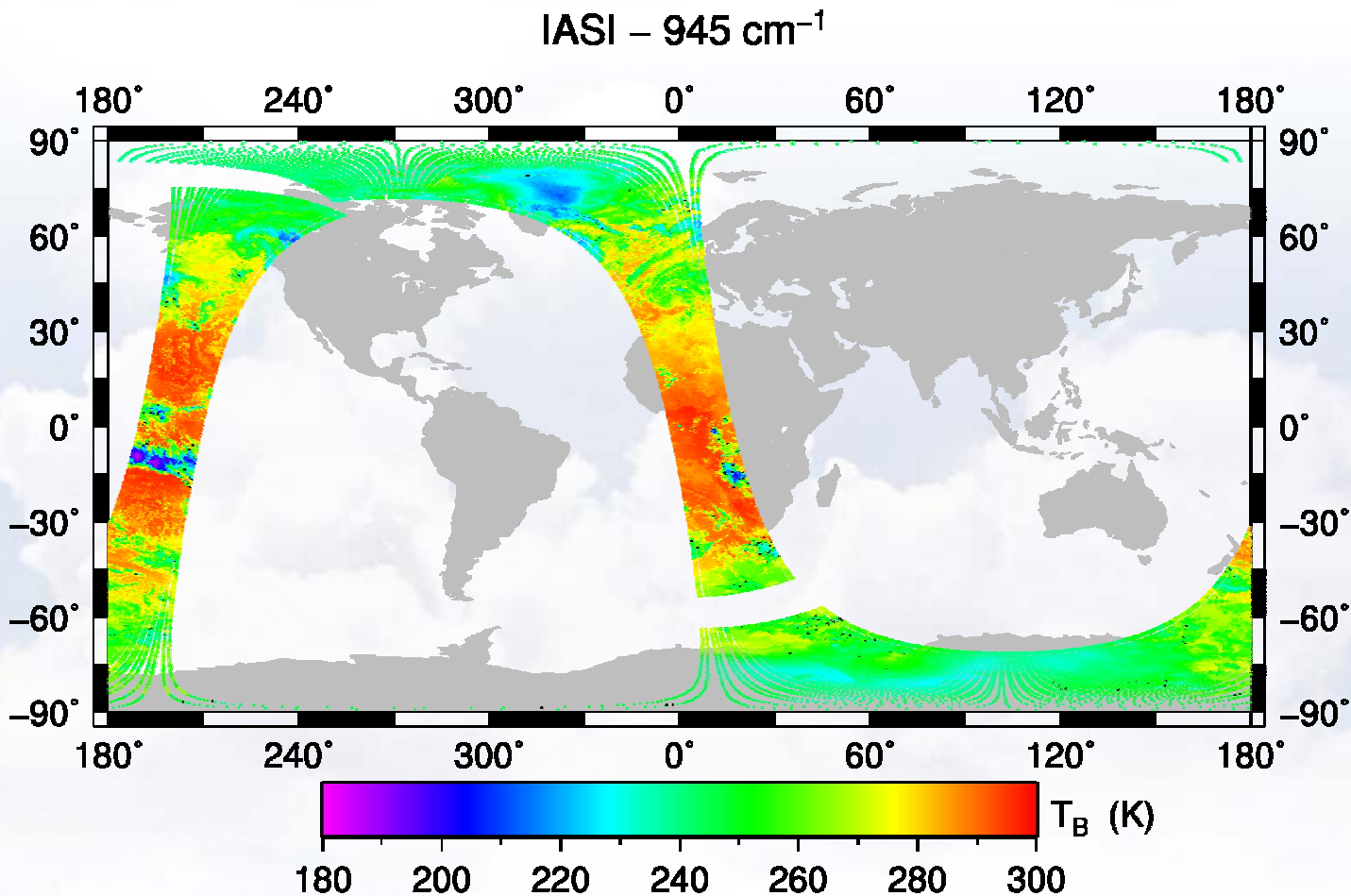
Channel Visualisation Example

IASI – 645 cm^{-1}





Channel Visualisation Example

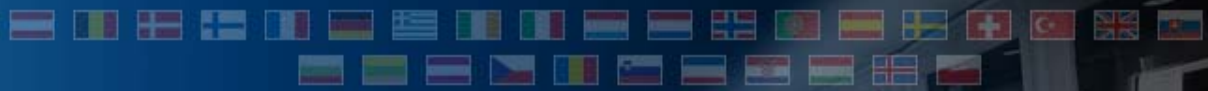




IASI Processing

Separation of cloud information from spectral information:

Use of AVHRR together with the internal IASI imager (64 by 64 pixel for 1 IASI FOV, IR window range) – same focal plane (AVHRR is then mapped to the correct IFOV and is then used for cloud detection)



IASI Products

IASI level 2 products

<i>Parameter</i>	<i>Coverage</i>	<i>H. Sampling</i>	<i>V. Sampling</i>	<i>Frequency</i>
Temperature Sounding	Global	IASI	90 levels	orbit repeat cycle
Humidity Sounding	Global	IASI	40 levels	orbit repeat cycle
Ozone Profile	Global	IASI	TBD	orbit repeat cycle
N2O Total Column	Global	IASI	N/A	orbit repeat cycle
CO Total Column	Global	IASI	N/A	orbit repeat cycle
CH4 Total Column	Global	IASI	N/A	orbit repeat cycle
Surface Temperature	Global	IASI	N/A	orbit repeat cycle
Surface Emissivity	Global	IASI	N/A	orbit repeat cycle
Fractional Cloud Cover	Global	IASI	N/A	orbit repeat cycle
Cloud Top Temperature	Global	IASI	N/A	orbit repeat cycle
Cloud Top Pressure	Global	IASI	N/A	orbit repeat cycle
Cloud Phase	Global	IASI	N/A	orbit repeat cycle

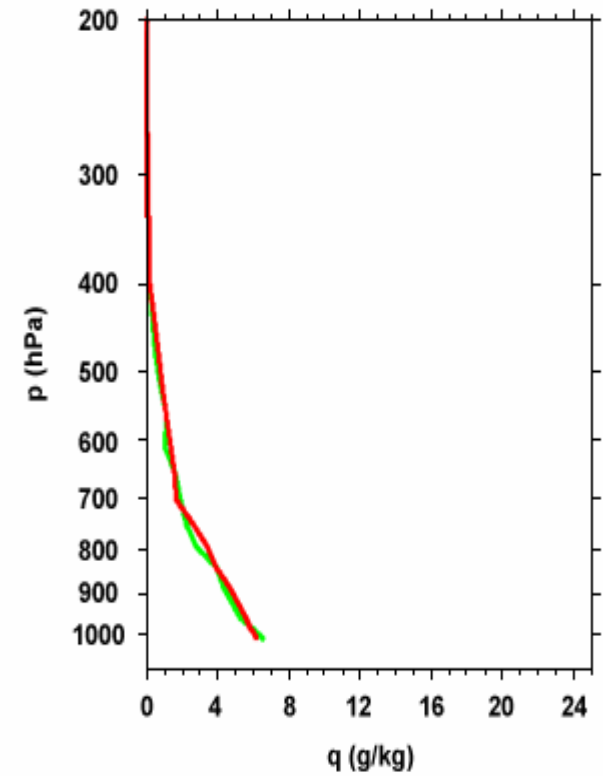
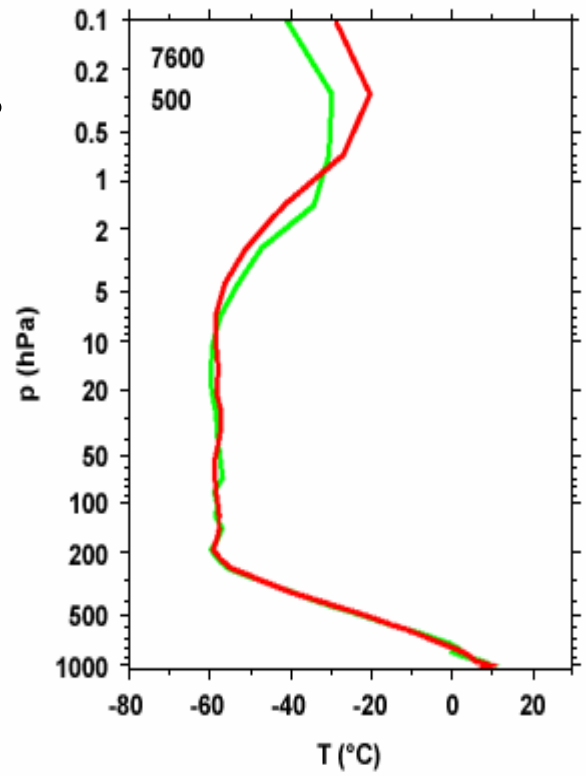


IASI Products

Vertical temperature and humidity soundings

Ozone and trace gas amounts

IASI Simulated Retrieval



©EUMETSAT, 2006



IASI Products

IASI can map trace gases such as SO₂

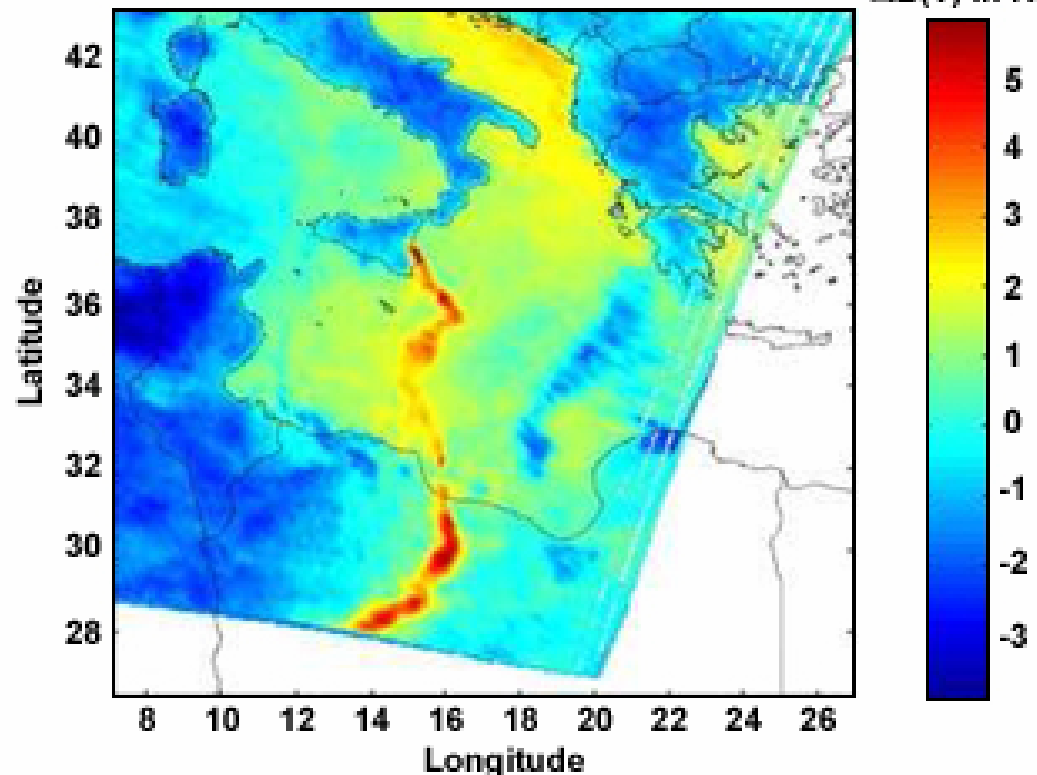
Volcanic plumes are a severe hazard to aviation

Sinking of low-level plumes can also be a serious health hazard

SO₂ produces acid rain with long-term impact on vegetation and water supplies.

Mt. Etna SO₂ Plume using AIRS 28 Oct 2002

AIRS minus ECMWF $\Delta B(T)$ for 1284.9 - 1345.3 cm^{-1} $\Delta B(T)$ in K



Carn, S. A. et al., Quantifying tropospheric volcanic emissions with AIRS: The 2002 eruption of Mt. Etna (Italy). Geophysical Research Letters, Vol. 32, L02301, 2005.



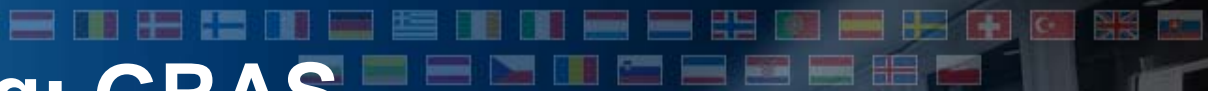
IASI Status

**CNES CAL/VAL Phase A finished (means:
update onboard and on ground software)**

**24 May: all IASI 1c products available to users via
EUMETCast**

Subset of 300 channels on GTS two weeks later

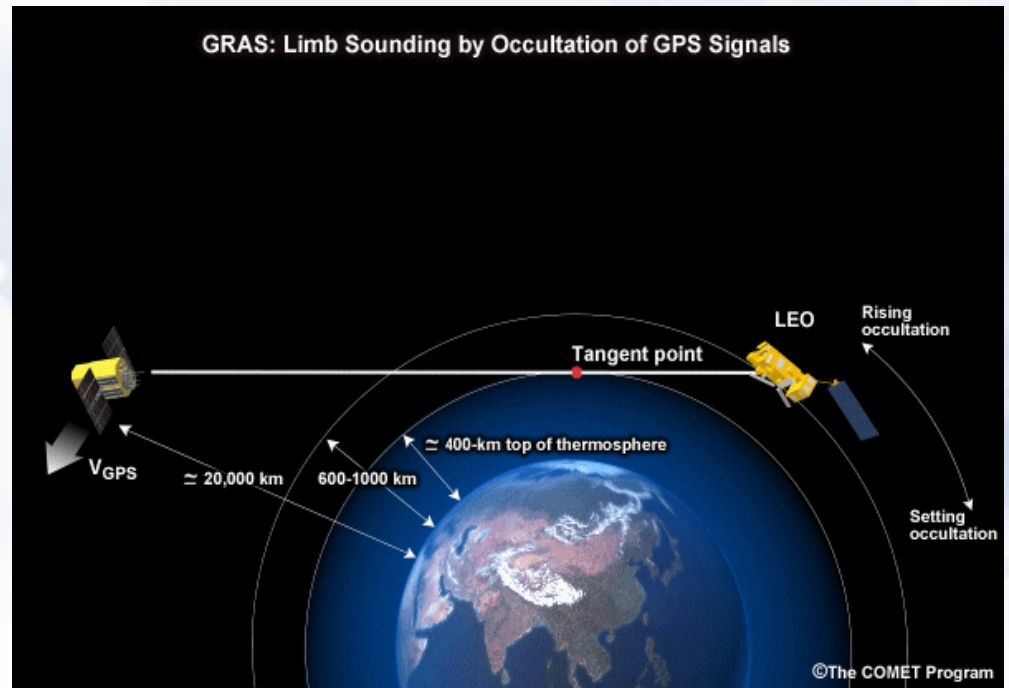
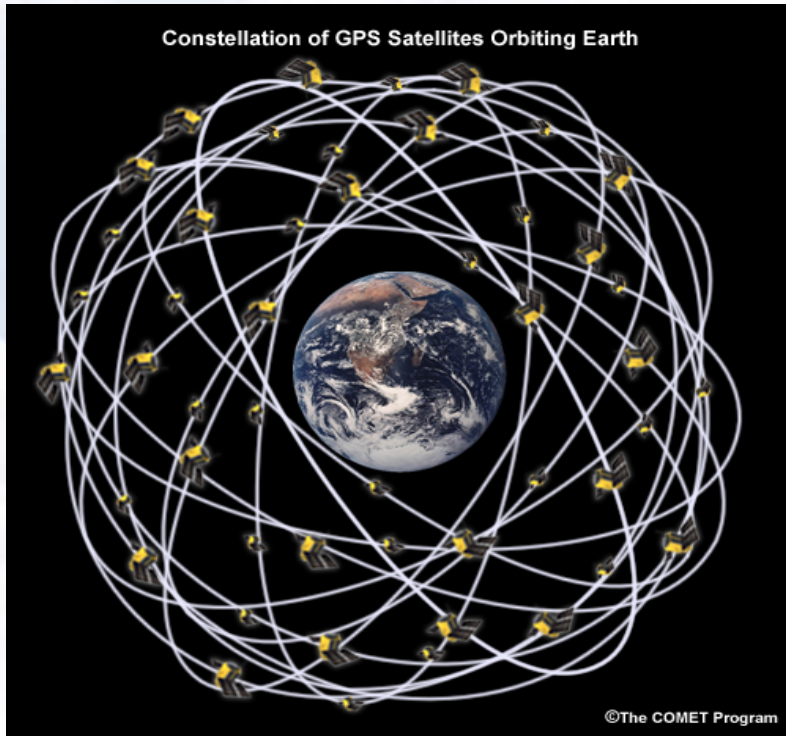
**Level 2 products (profiles) available end of July, via
EUMETCast, subset on GTS**



More Sounding: GRAS

GRAS = GNSS Receiver for Atmospheric Sounding

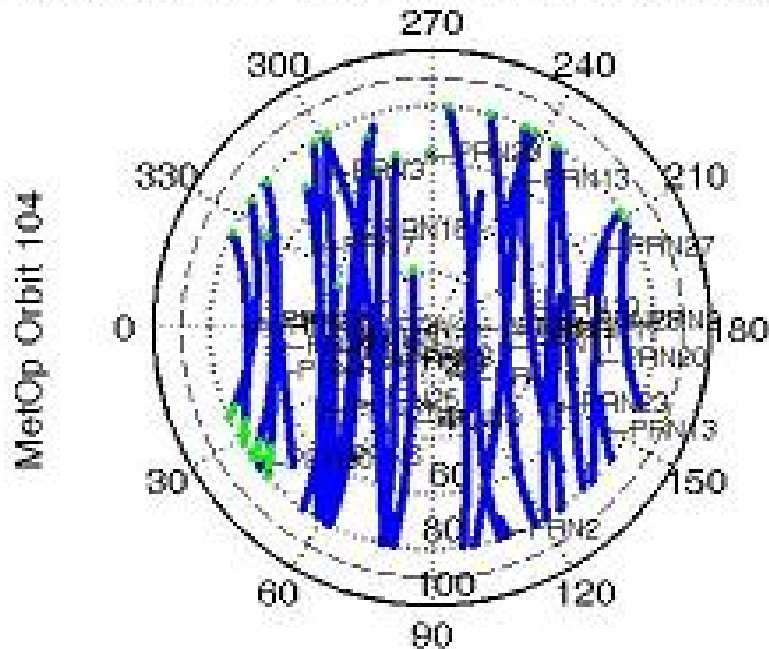
GNSS = Global Navigation Satellite System





GRAS "Sees" the GPS Satellites Above

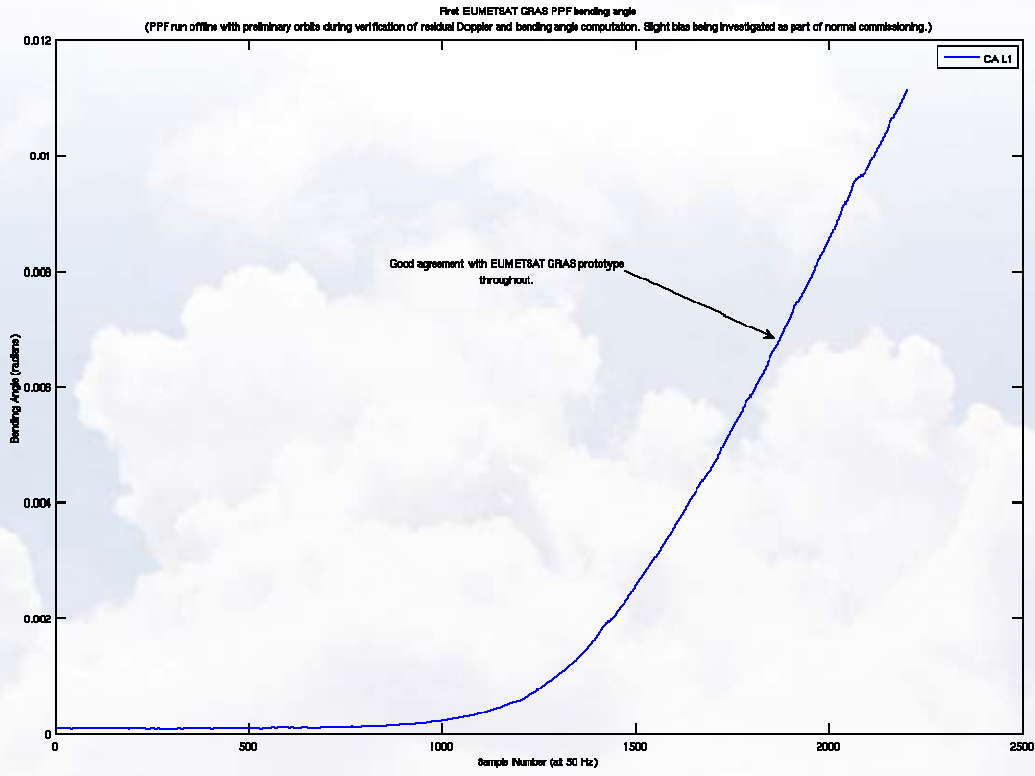
GPS tracked by GRAS Zenith antenna: blue=DF; green=SF



ESA - GPP SIOV 27 Oct 2006 ML



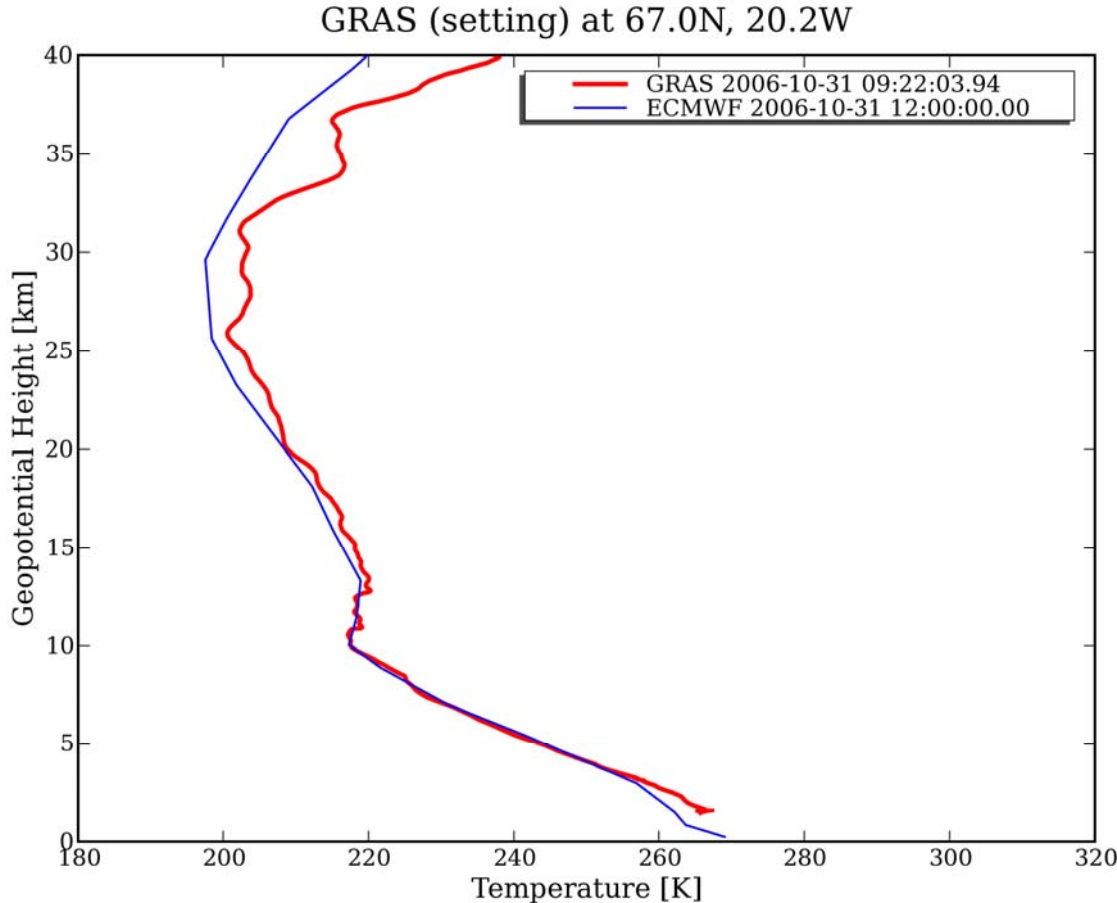
First Good Bending Angle



The first PPF produced bending angle, fresh from the factory (on the morning of the 19 February 2007, 2:05 CET AM...)

Bending angles are then transformed to a temperature / humidity profile

Example of Profile Retrieval (Level 2, Setting Occultation)



“No frills” measurement reconstruction & dry temperature retrieval

No raw sampling

Initialised with CIRA climatology

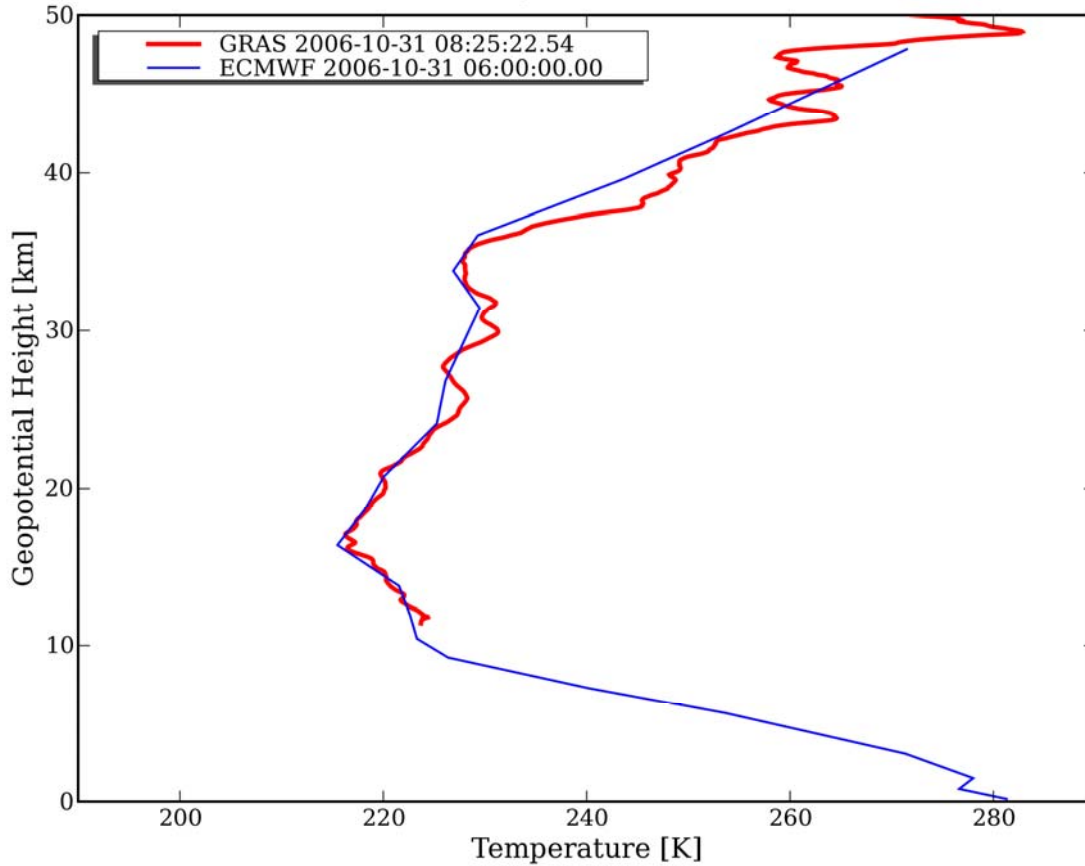
Compared with ECMWF operational analysis on 21 standard pressure levels

Higher altitude biases related to known CIRA biases



Rising Occultation

GRAS (rising) at 39.8S, 131.6W



Also works for GRAS!





GRAS Status

PPF being debugged (geolocation, time stamp, ...)

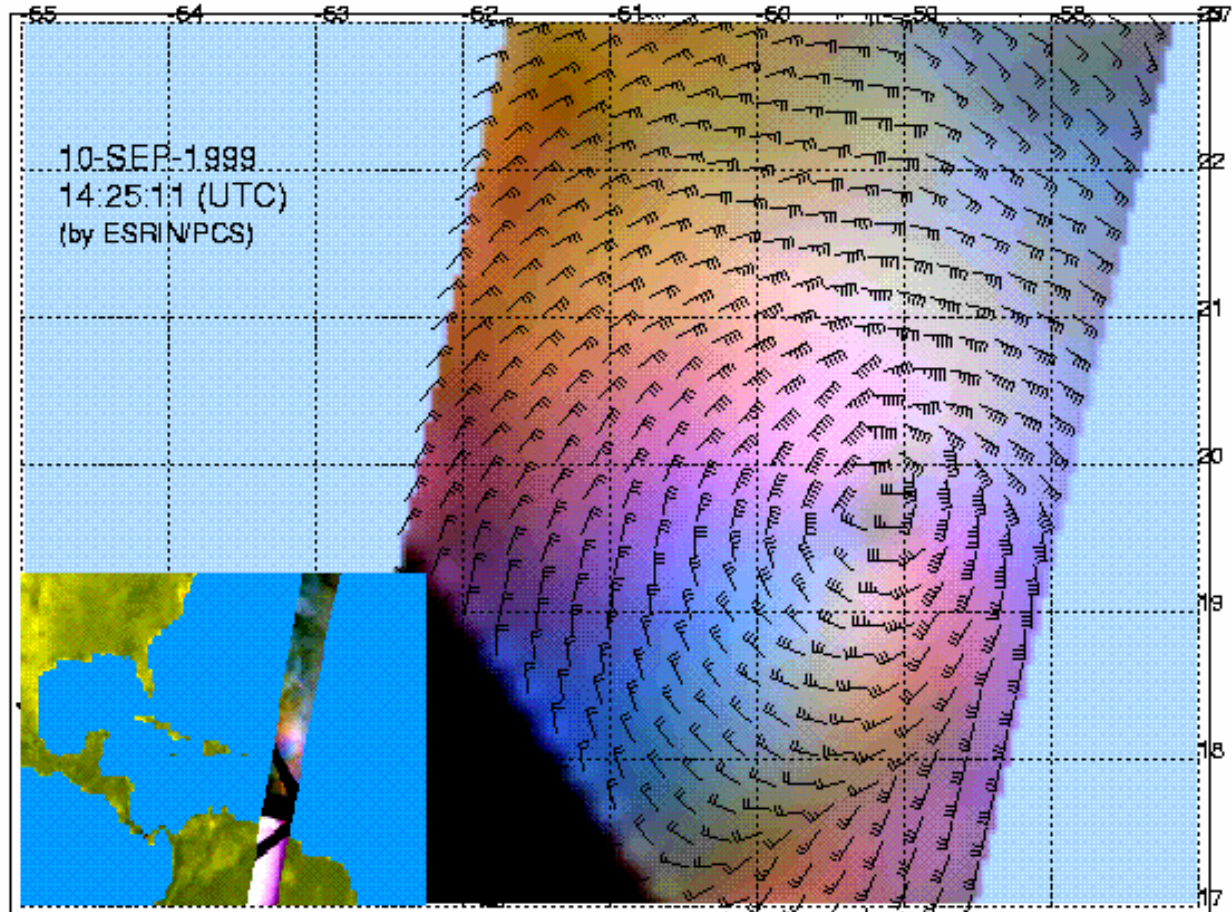
Beginning of June: Trial dissemination (Level 1b, bending angles) via EUMETCast, later GTS

Level 2 by GRAS SAF

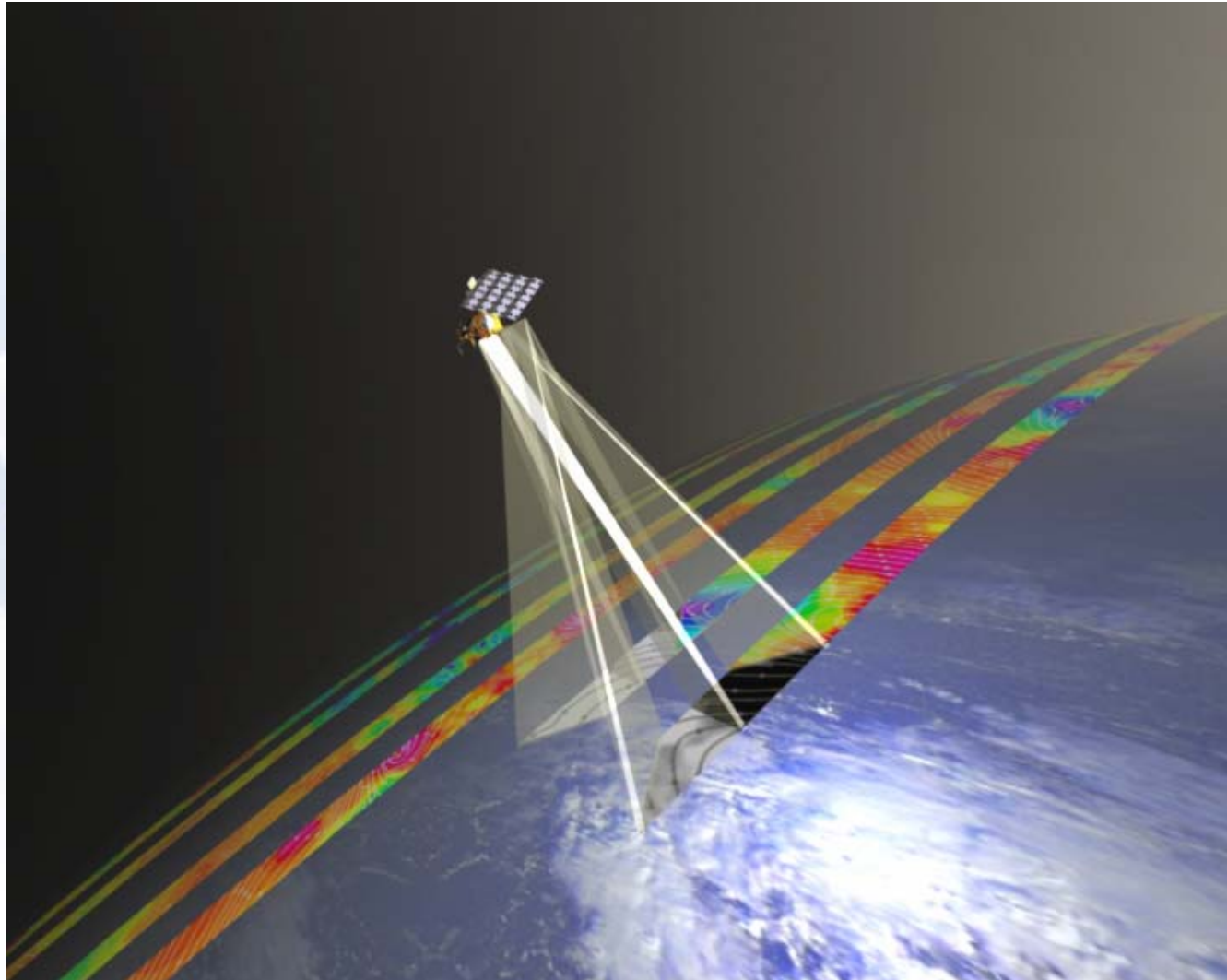
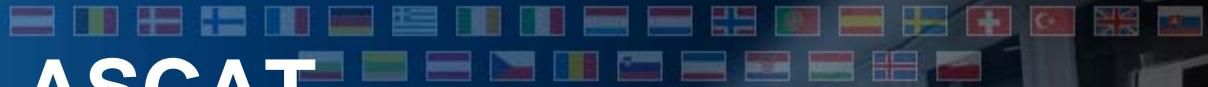


ASCAT: Advanced Scatterometer

**Aim:
Derivation of
near-surface
winds over
oceans**

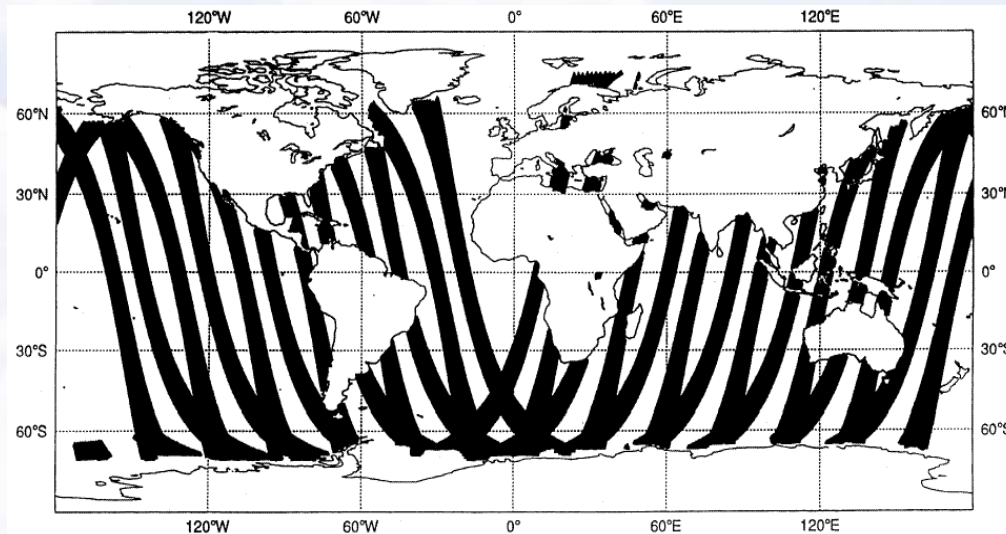


Two Beams of ASCAT



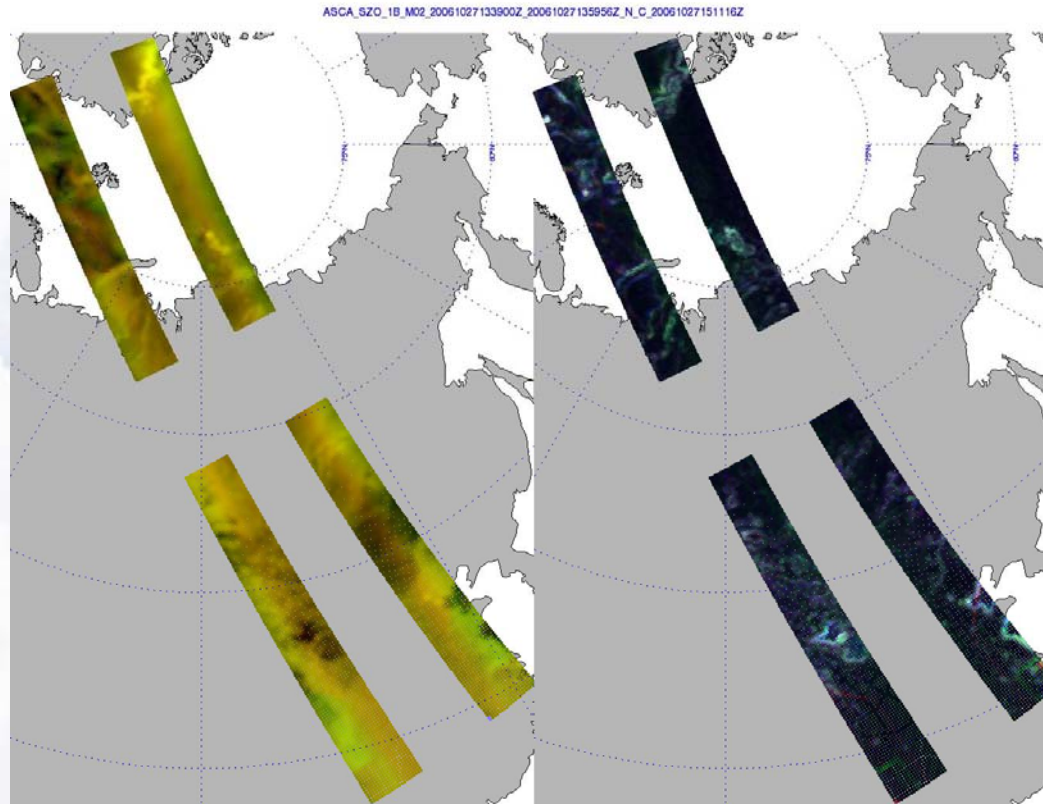


“Ocean surface winds modify the surface roughness, hence, the ocean surface backscatter properties”



**ASCAT ocean observation in half a day
Double coverage compared to ERS SCAT**

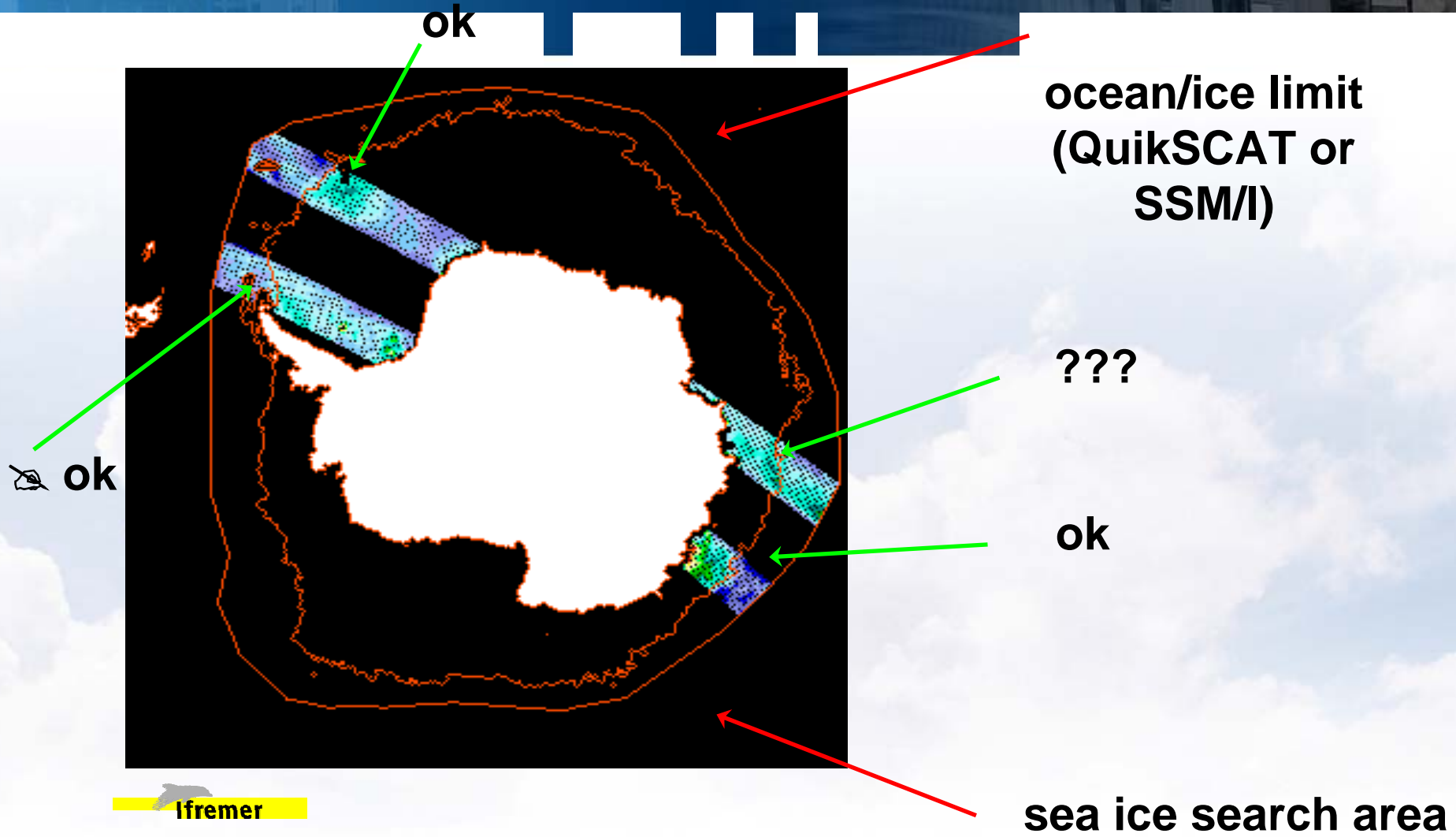
27 Oct 2006: ASCAT was switched on



Backscatter signal sigma and noise

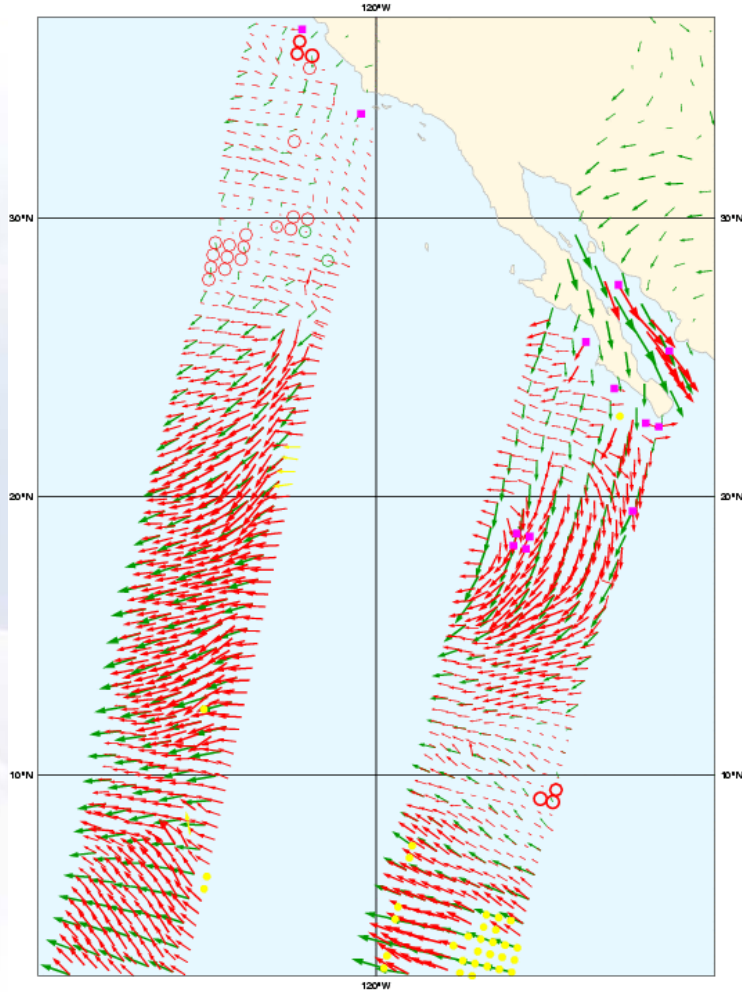


Radar Reflectivities (Ifremer)

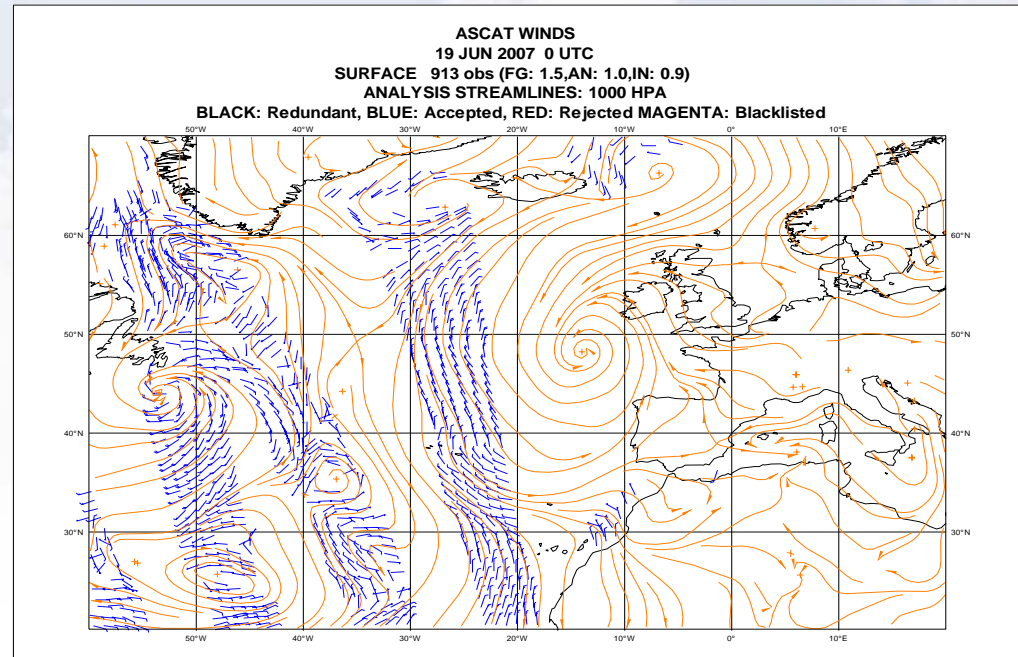


ASCAT Ocean Winds

ASCAT: 20061027 17:30Z lat lon: 20.00 -120.00



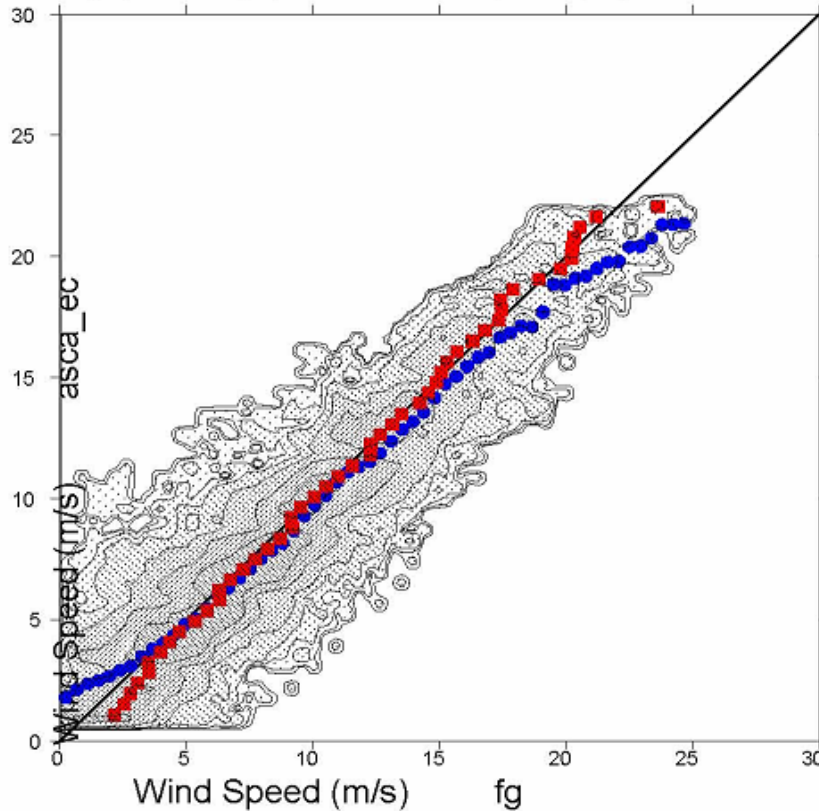
Produced at KNMI (OSI SAF)
(green: ECMWF forecast)



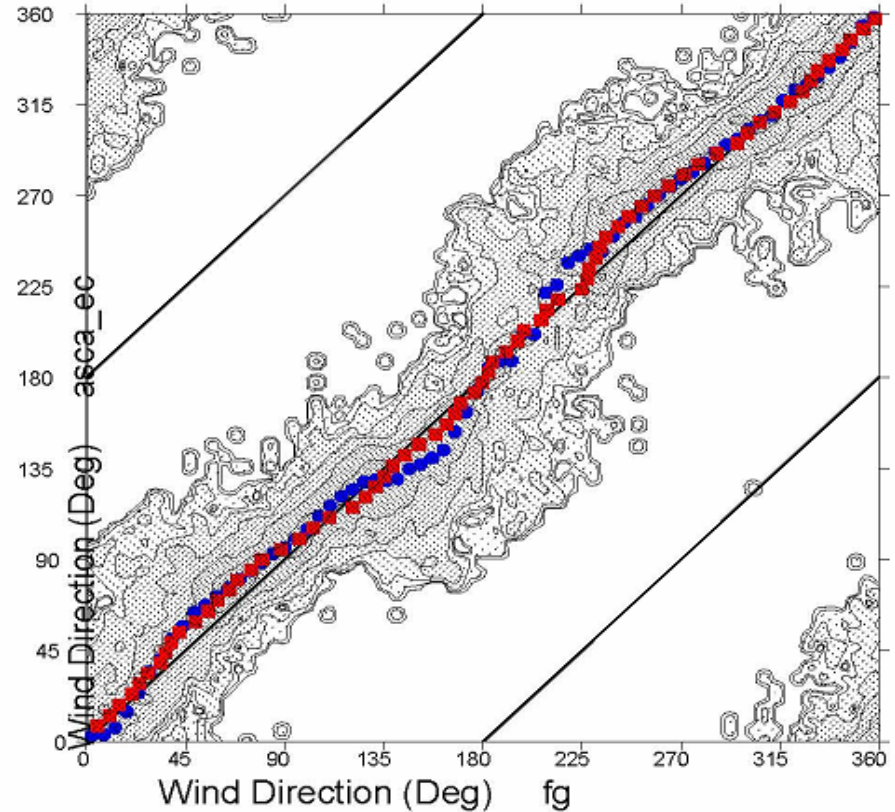


First Comparisons at ECMWF

fg winds versus asca_ec winds
WVC=ALL From 2006102718 to 2006110100
ncol = 70961, 5 db contour steps, 1st level at -6.5 db
m(y-x)= -0.25 sd(y-x)= 1.48 sdx= 3.90 sdy= 3.82 pcxy= 0.962



fg winds versus asca_ec winds
WVC=ALL From 2006102718 to 2006110100
ncol = 54969 (|f| gt 4.00 m/s), db contour steps, 1st level at -7.6 db
m(y-x)= 3.49 sd(y-x)= 19.95 sdx=101.90 sdy=100.77 pcxy= 0.990



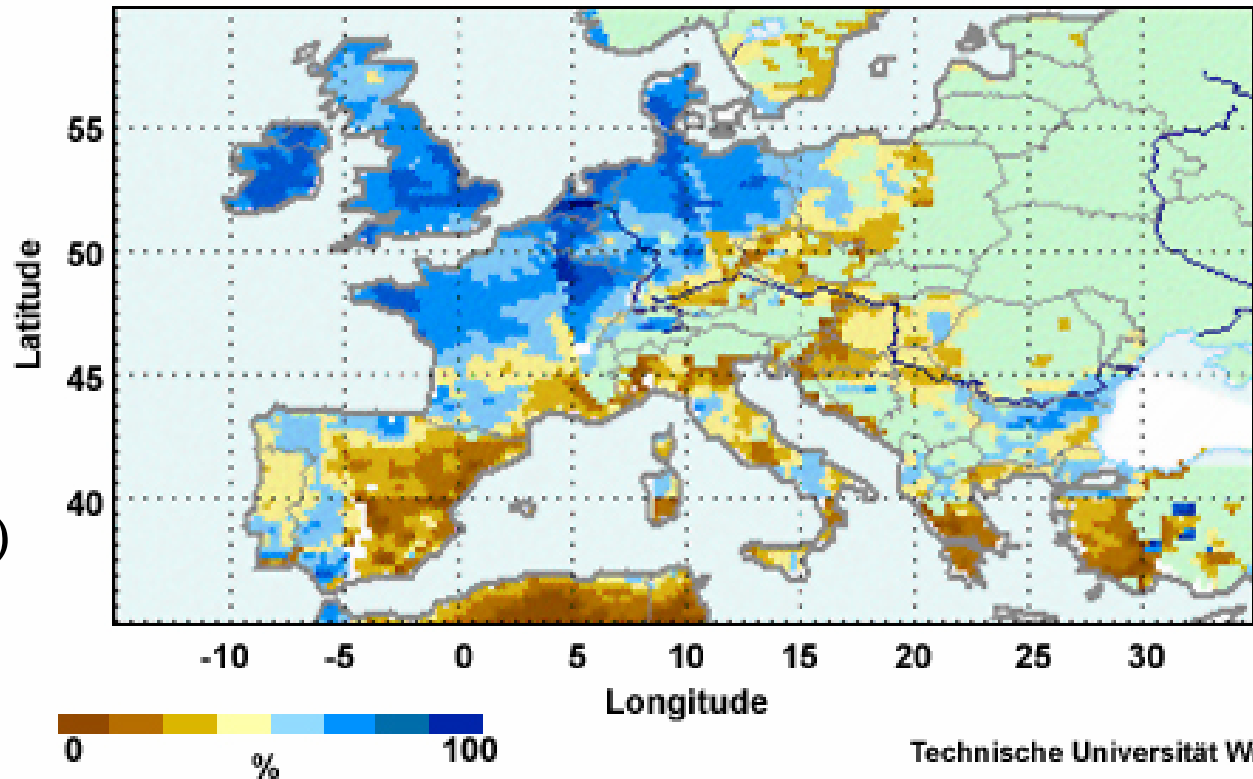
(Blue bias, red standard deviation)



ASCAT: Soil Moisture Application

Soil moisture from ASCAT for use in NWP and agrometeorological applications, and monitoring climatic change (University Vienna)

Soil Moisture
Soil Water Index from ERS 2 Jan 2000



Technische Universität Wien

ASCAT Status



**Trial dissemination of Level 1b via EUMETCast
ongoing**

**Level 2 by OSI SAF
(ongoing, disseminated since 9 May)**

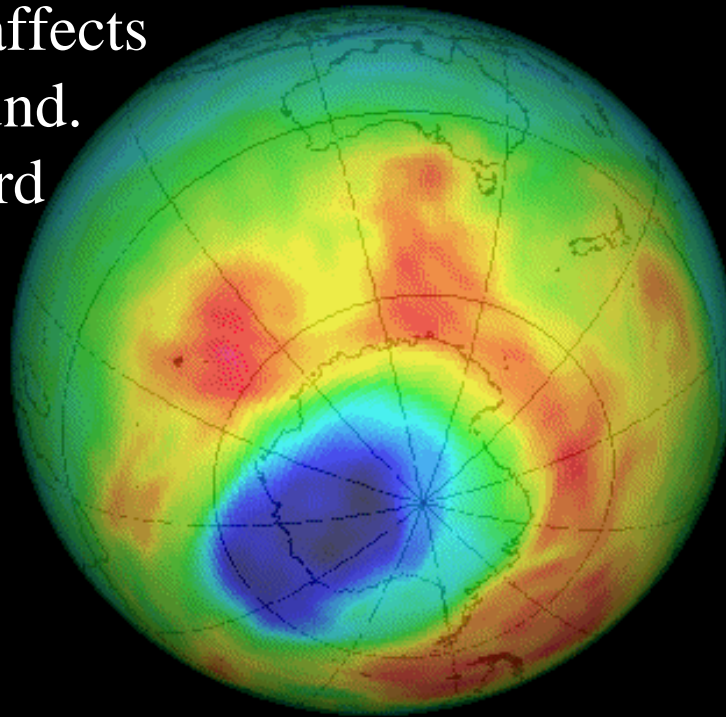


GOME – Global Ozone Monitoring Experiment

Ozone significantly affects
Levels of UV at ground.
Potential health hazard

Monitoring
climate change

At high
concentrations near
the ground regarded
as a pollutant and
health hazard and
damages plants

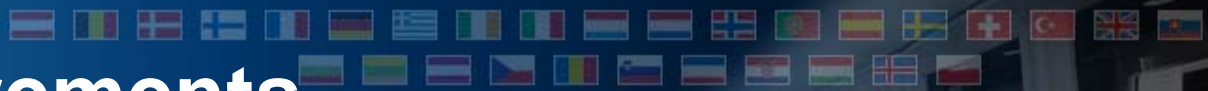


Time: 12:00:00.000000

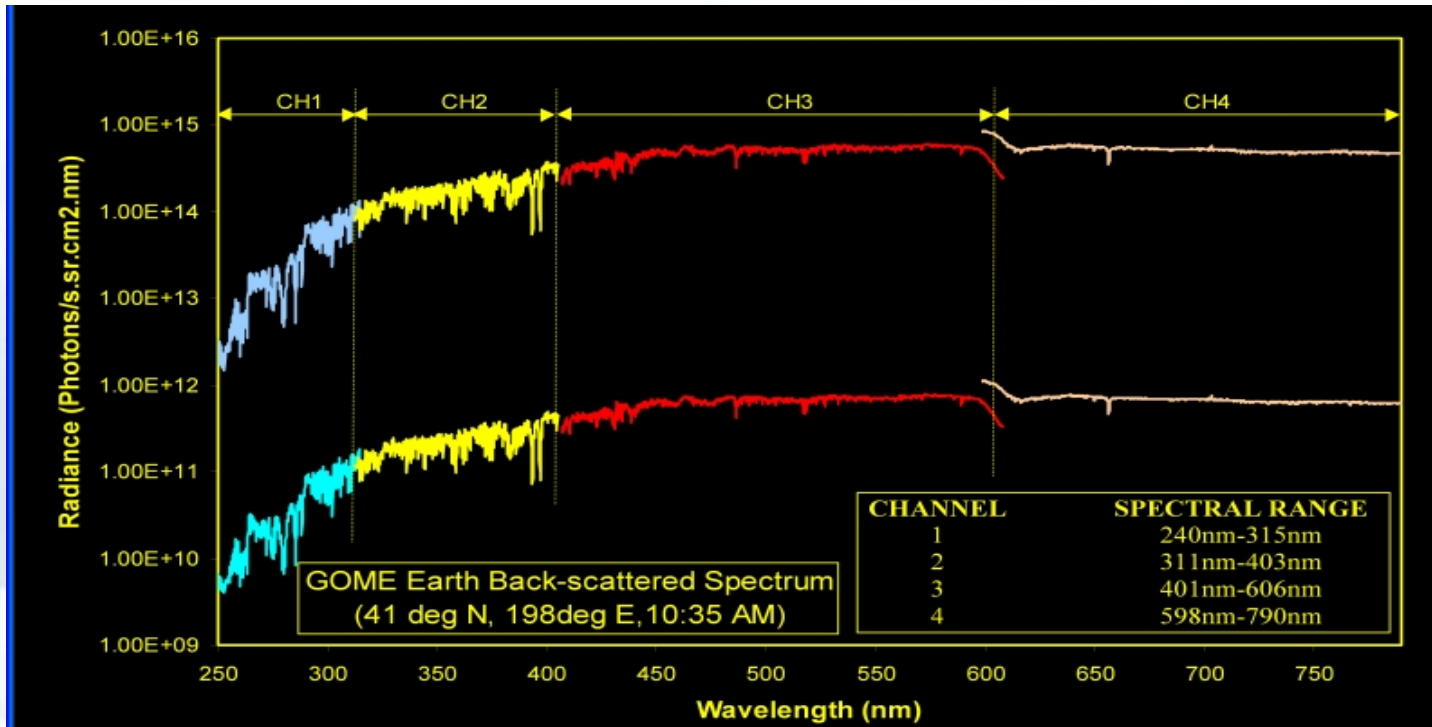
150

Total Ozone (DU) derived from GOME-1 500





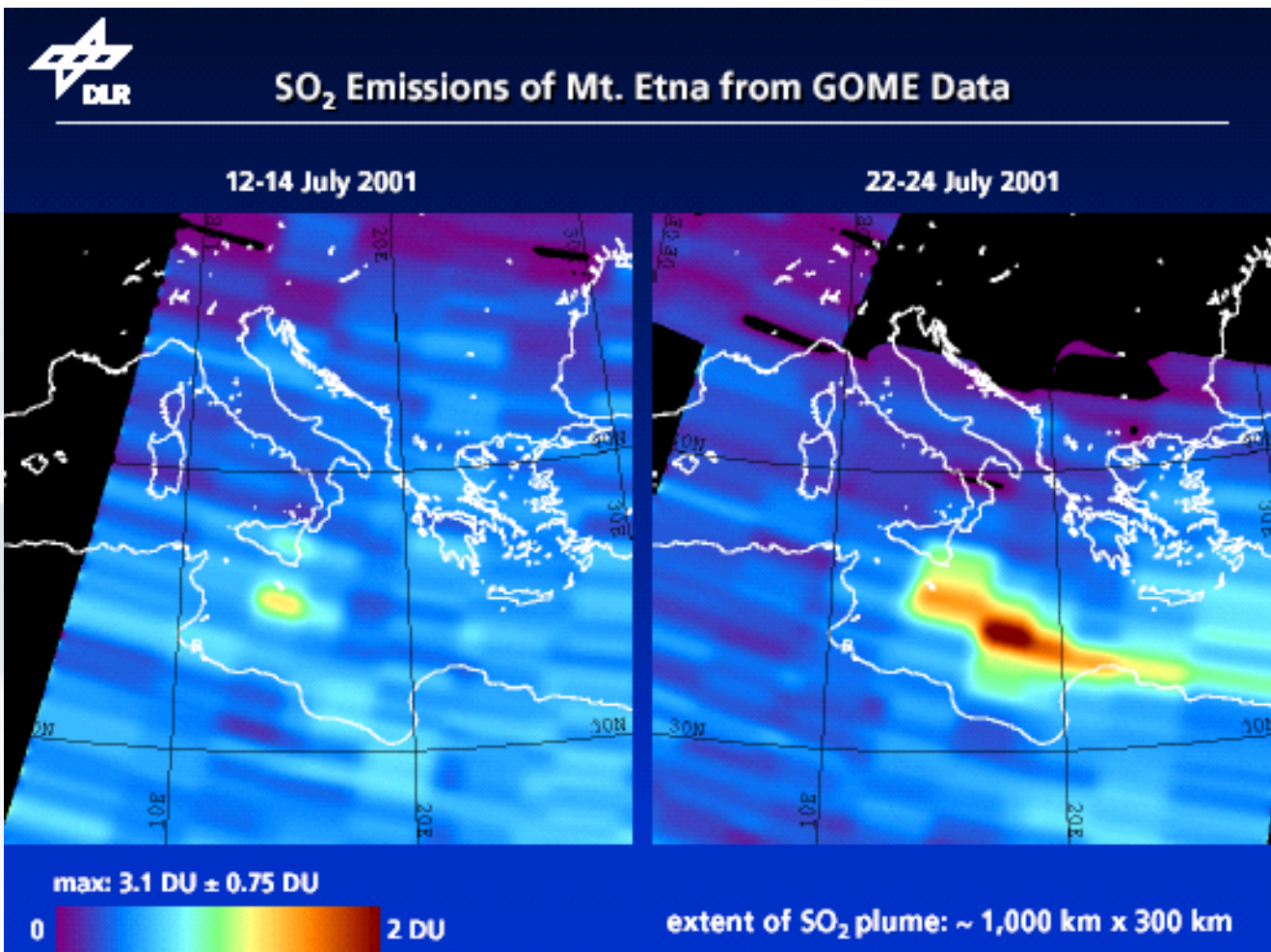
GOME Measurements



GOME measures between 250 and 790 nm the solar irradiance and the backscattered signal by the earth/atmosphere. Products are profiles of ozone and other tracer gases and aerosol information. Measurements are also done in two polarisation directions.

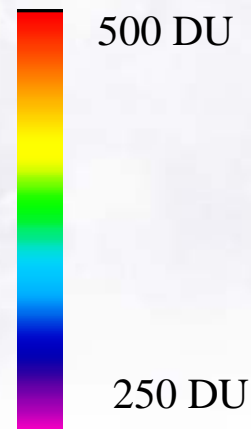
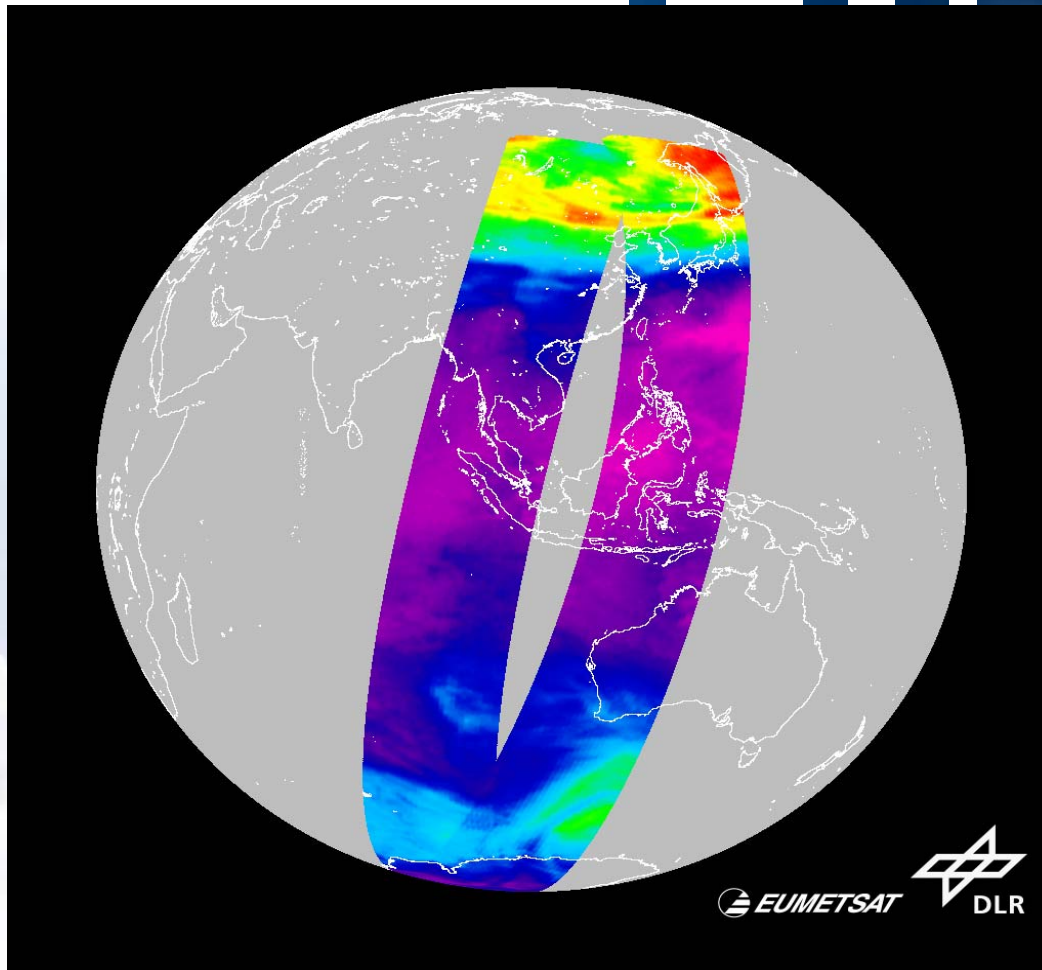


SO₂ from GOME-1 (on ERS)



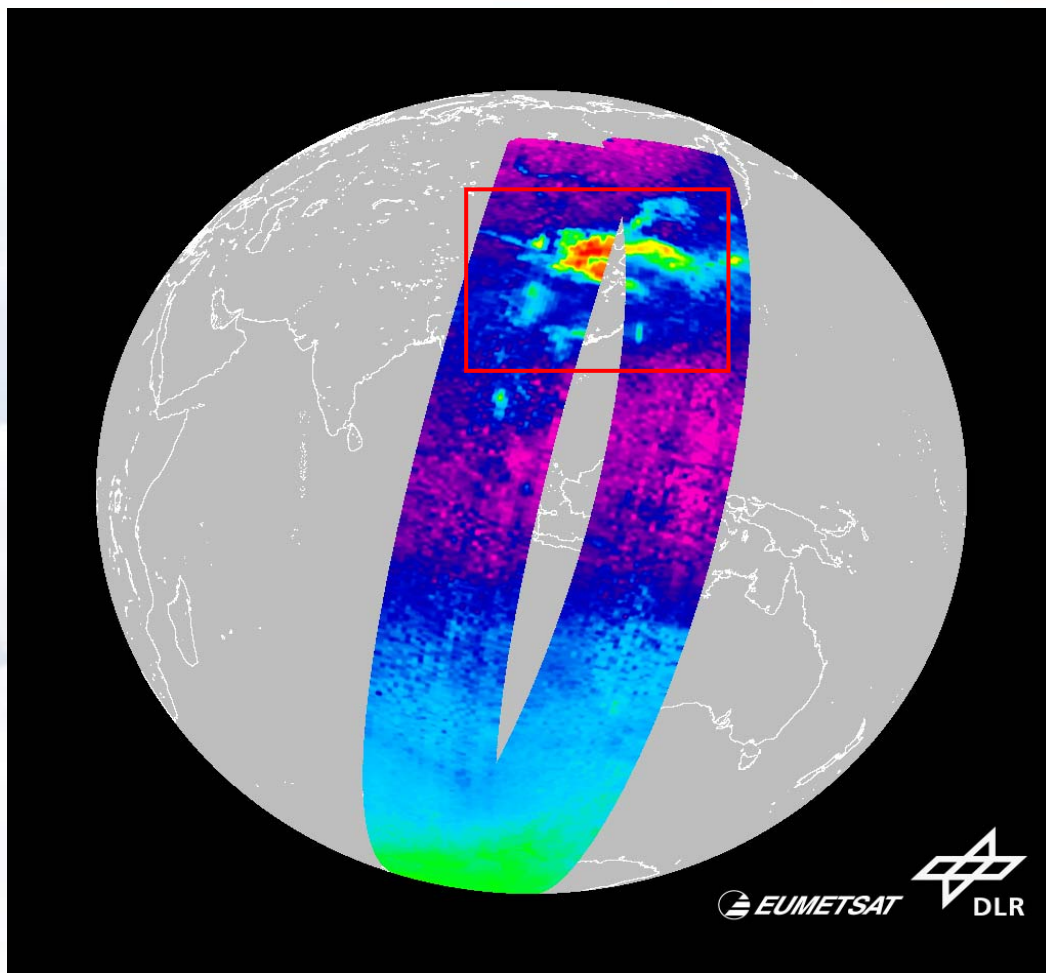


GOME: First TOZ Retrievals (17 Jan 2007)



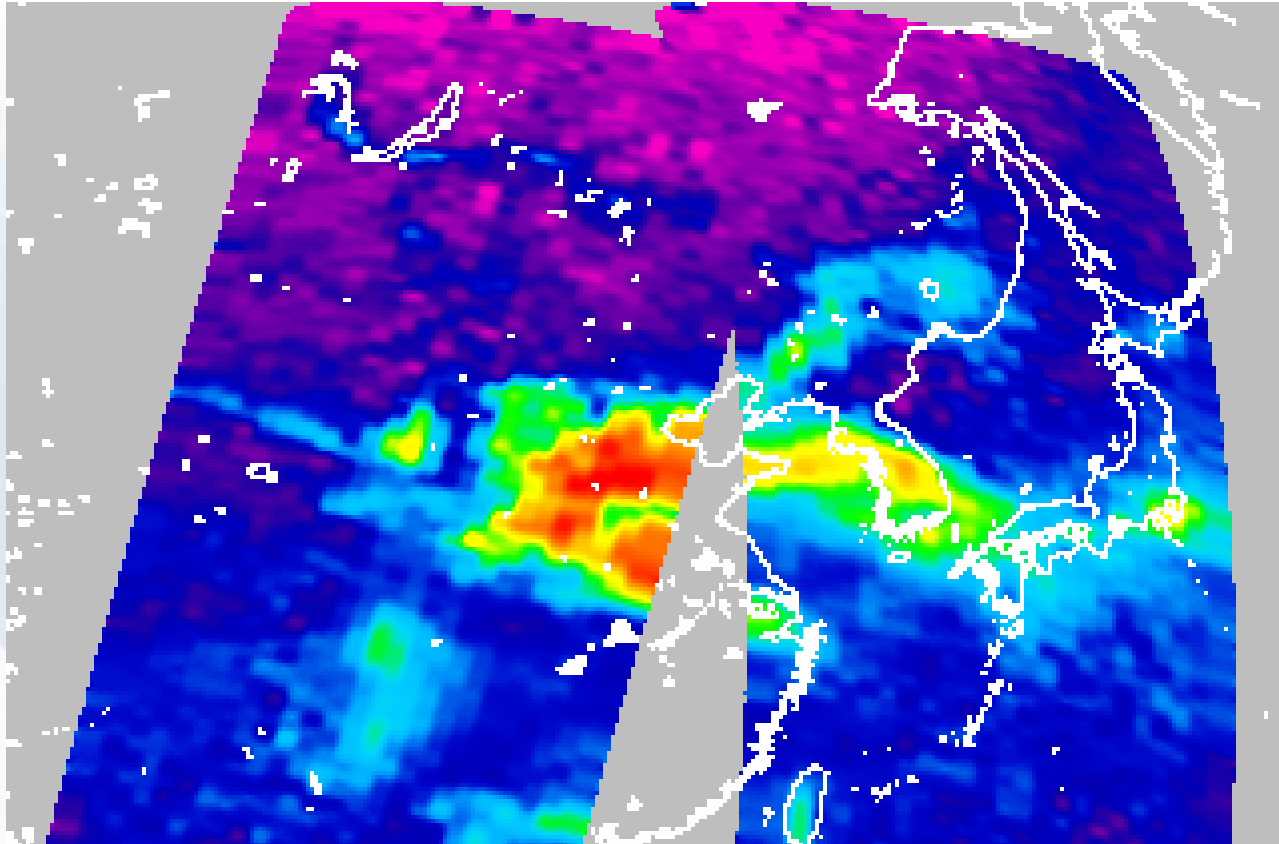


GOME: First NO₂ Retrievals (17 Jan 2007)





GOME: NO₂ over East Asia





GOME Status

Trial dissemination of Level 1 (radiances) ongoing via EUMETCast

TOZ disseminated by SAF

Further trial products under scientific evaluation

Thank you – Merci - Danke



More info: www.eumetsat.int