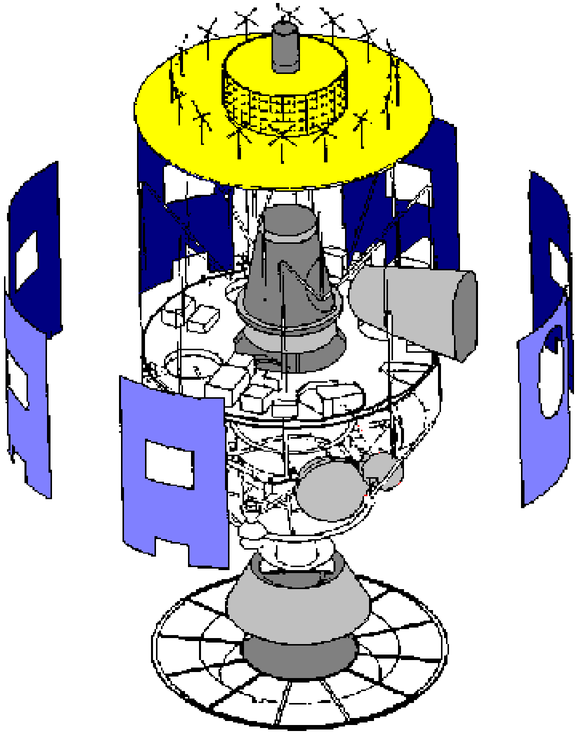
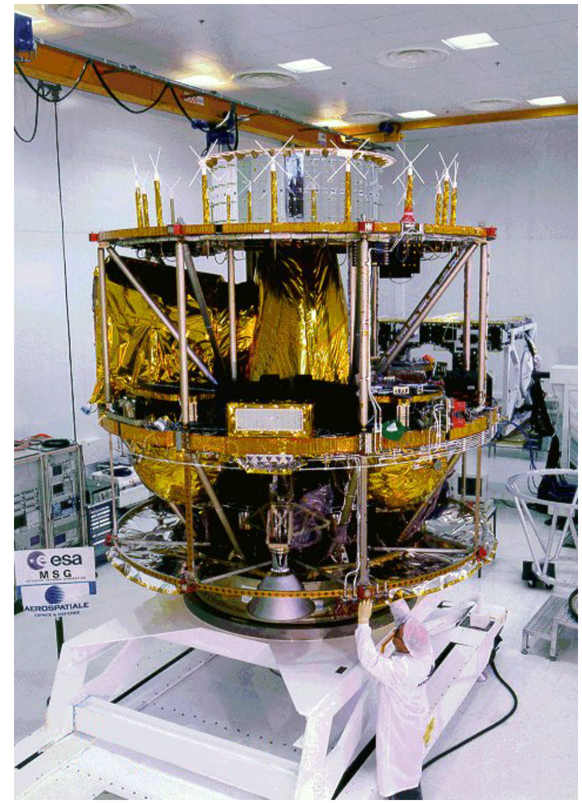
Introducing Meteosat Second Generation

Lectures in Bertinoro
23 Aug – 2 Sep 2004

Paul Menzel
NOAA/NESDIS/ORA

SEVIRI

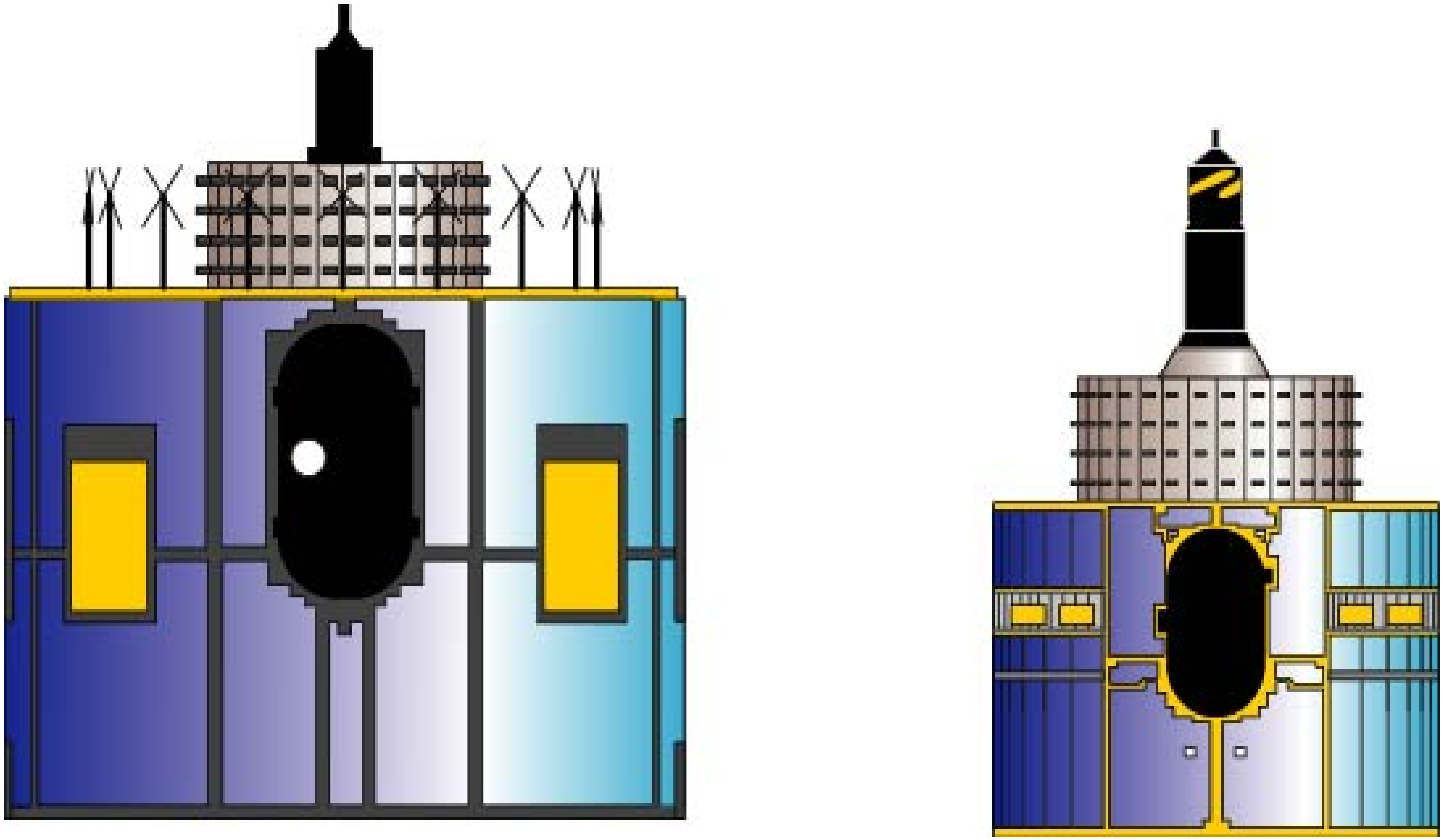




Spinning Enhanced Visible and InfraRed Imager

MSG launch
28 Aug 2002

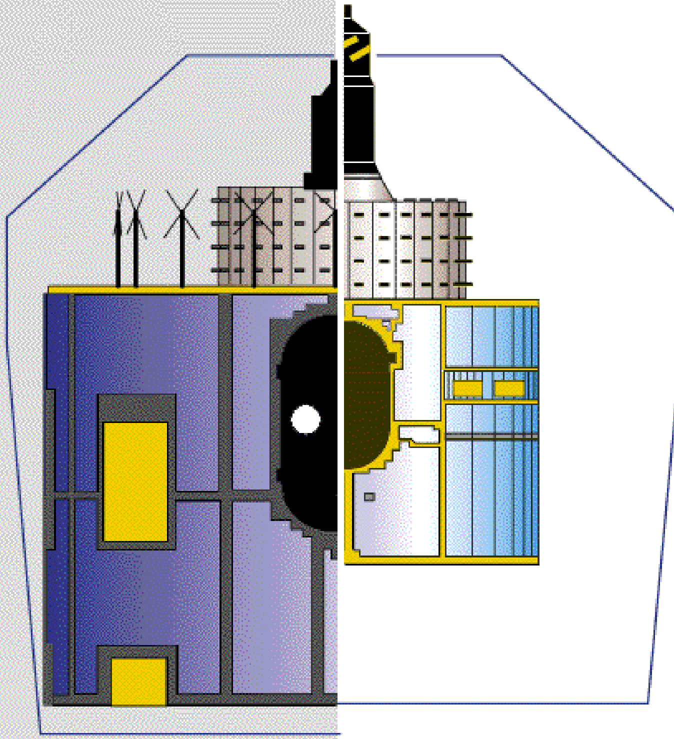
Evolving from Meteosat to MSG



From Meteosat Ops to MSG: comparison

MSG

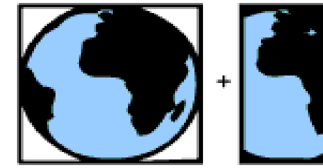
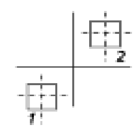
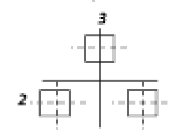
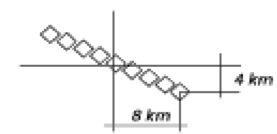
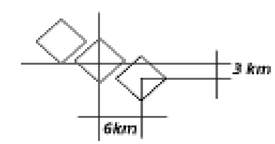
- 12 channels enhanced imaging and pseudo sounding radiometer.
- 100 rpm spin stabilized body
- Bi-propellant unified propulsion system
- 500W power demand
- 2000kg in GTO
- Design compatibility with Ariane 4 (spelda 10) & Ariane 5



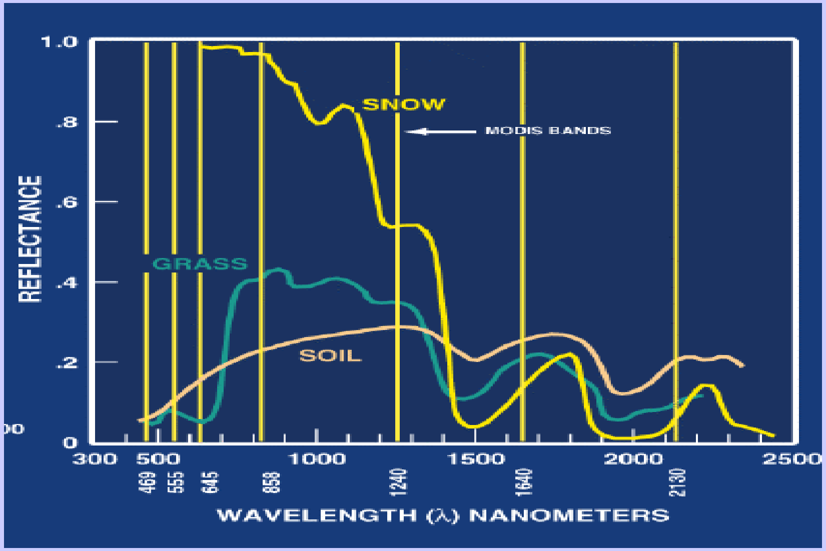
MOP

- 3 channels imaging radiometer
- 100 rpm spin stabilized body
- Solid apogee boost motor
- 200W power demand
- 720 kg in GTO
- Flight qualified with Delta 2914, Ariane 1-3-4

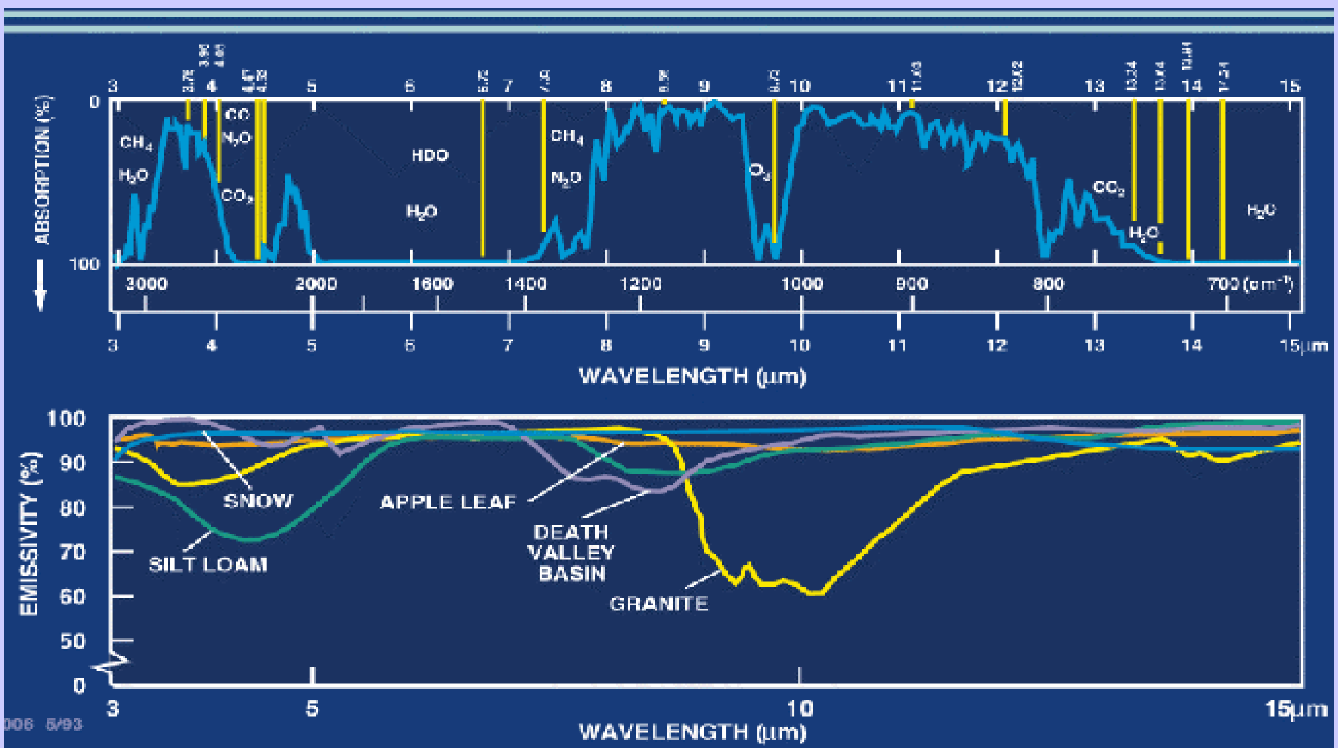
From MOP to MSG: the main improvements

	1 st generation	2 nd generation
IMAGING/PSEUDO SOUNDING MISSION		
Imaging Format Imaging cycle	 30 mn	 + 15 mn
Channels	BROADBAND	
Channels – Visible	0.5 - 0.9	HRV VIS 0.6 VIS 0.8 IR 1.6
Channels – Water Vapour	WV 6.4	WV 6.2 WV 7.3
Channels – IR window	IR 11.5	IR 3.8 IR 8.7 IR 10.8 IR 12.0
Channels – Pseudo sounding		IR 9.7 IR 13.4
Sampling distance	2.25 km (Visible) 4.5 km (IR + WV)	1 KM (HRV) 3 KM (others)
Pixel size	2.25 km (Visible)  5 km (IR + WV) 	1.4 km (HRV)  4.8 km (others) 
Number of detectors	5	42
Telescope diameter	400 mm	500 mm
scan principe	scanning telescope	Scan mirror
DATA CIRCULATION MISSION		
Transmission raw data rate	0.333 Mb/s	3.2 Mb/s
Disseminated image	0.166 Mb/s	1 Mb/s
		Search & Rescue package

	SEVIRI Spectral Bands in µm			Applications
	λ_{cen}	λ_{min}	λ_{max}	
HRV	**Broadband visible 0.4 – 1.1 um**			**Surface, clouds, high resolution wind fields**
VIS0.6	**0.635**	**0.56**	**0.71**	**Surface, clouds, wind fields**
VIS0.8	**0.81**	**0.74**	**0.88**	**Surface, clouds, wind fields**
NIR1.6	**1.64**	**1.50**	**1.78**	**Cloud phase**
IR3.9	3.90	3.48	4.36	Surface, clouds
WV6.2	6.25	5.35	7.15	Water vapour, clouds, atmospheric instability, wind fields
WV7.3	7.35	6.85	7.85	Water vapour, atmospheric instability
IR8.7	8.70	8.30	9.10	Clouds, atmospheric instability
IR9.7	9.66	9.38	9.94	Ozone
IR10.8	10.80	9.80	11.80	Surface, clouds, wind fields, atmospheric instability
IR12.0	12.00	11.00	13.00	Surface, clouds, wind fields, atmospheric instability
IR13.4	13.40	12.40	14.40	High level clouds, atmospheric instability



MSG



HRV	Broadband
VIS0.6	0.635
VIS0.8	0.81
NIR1.6	1.64
IR3.9	3.90
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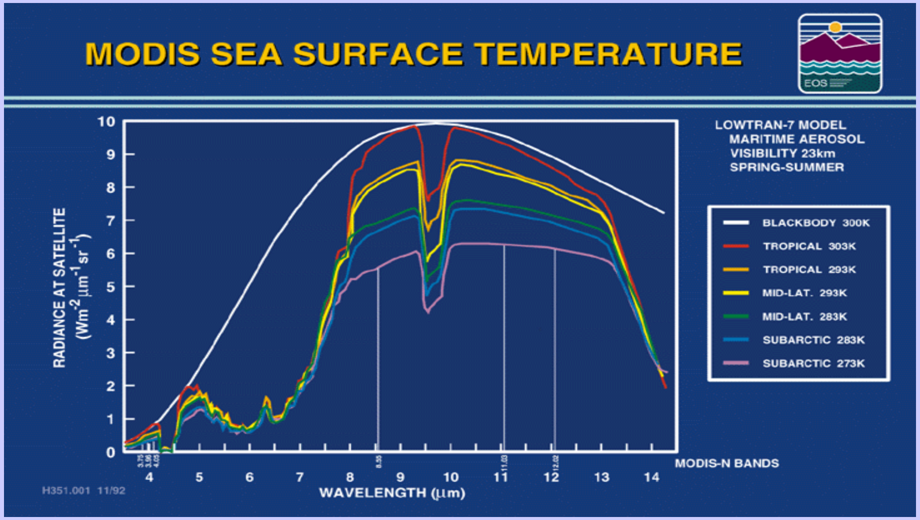
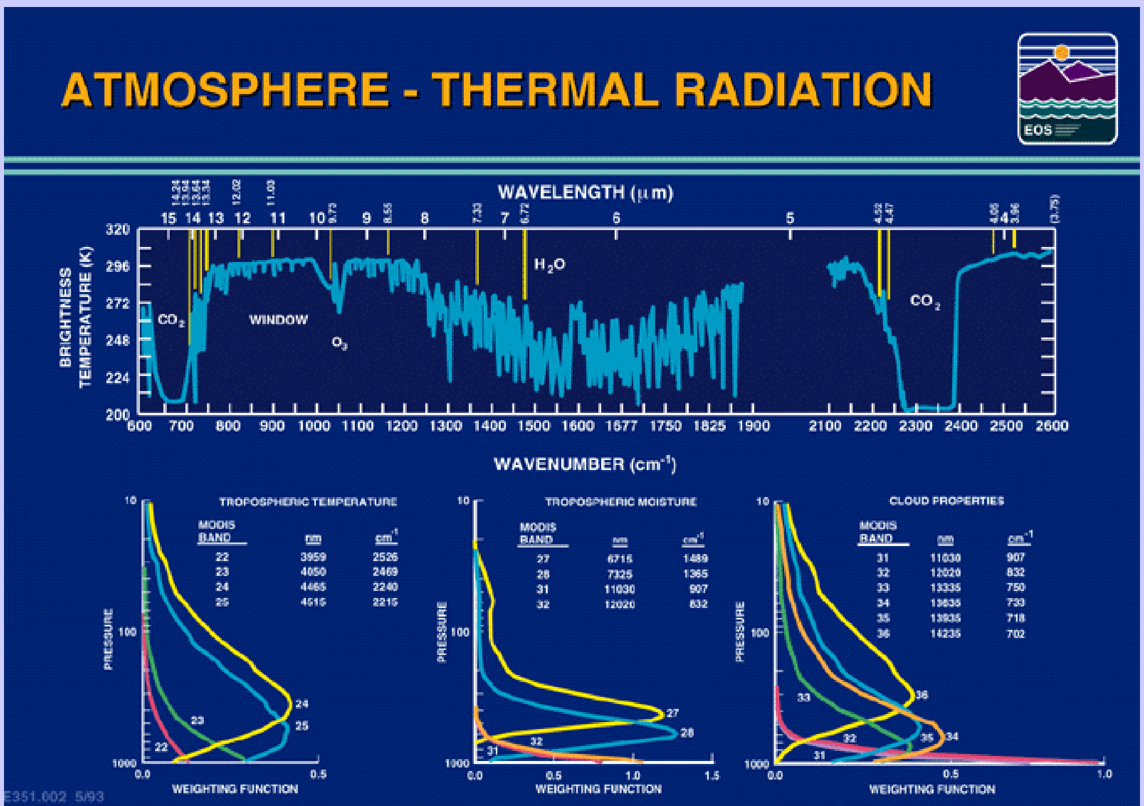
IR8.7	8.70
IR9.7	9.66
IR10.8	10.80
IR12.0	12.00
IR13.4	13.40





MSG

HRV	Broadband
VIS0.6	0.635
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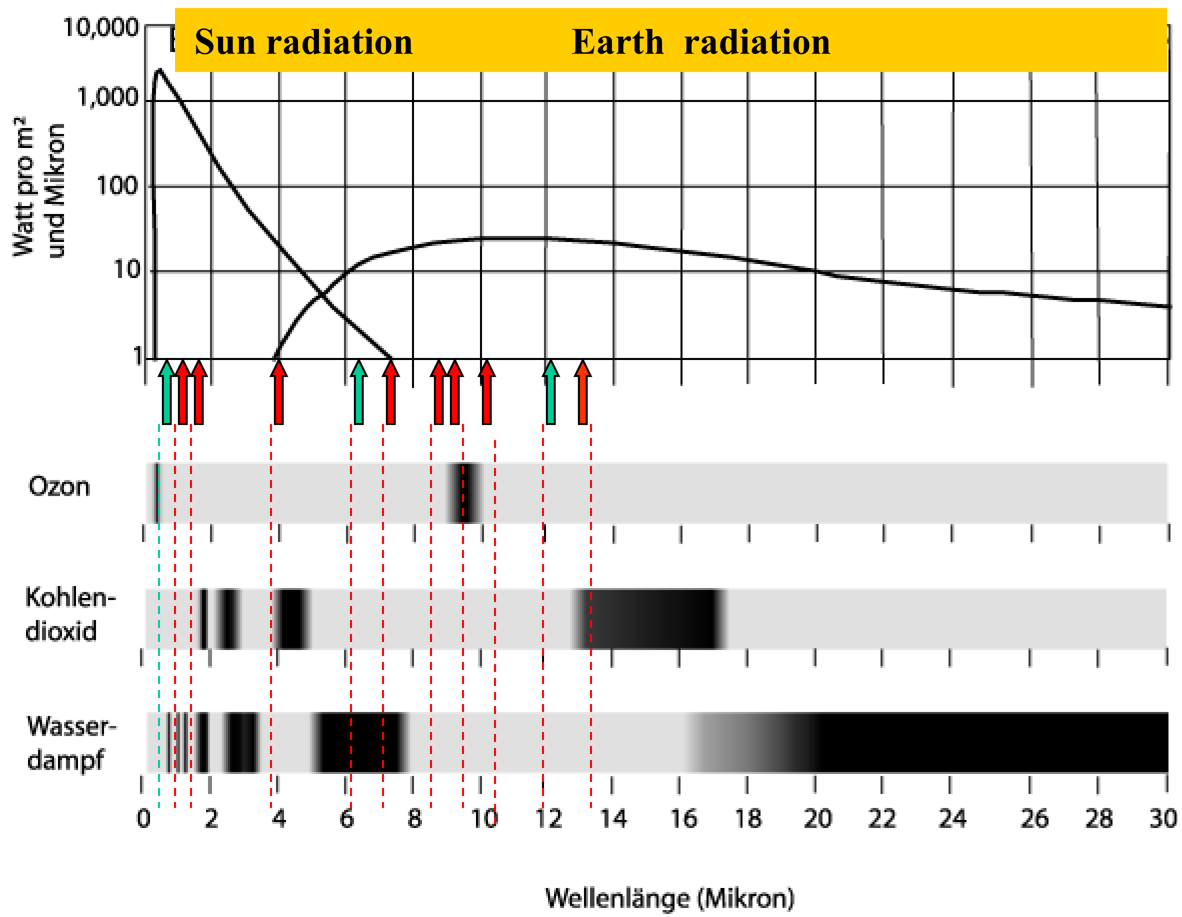
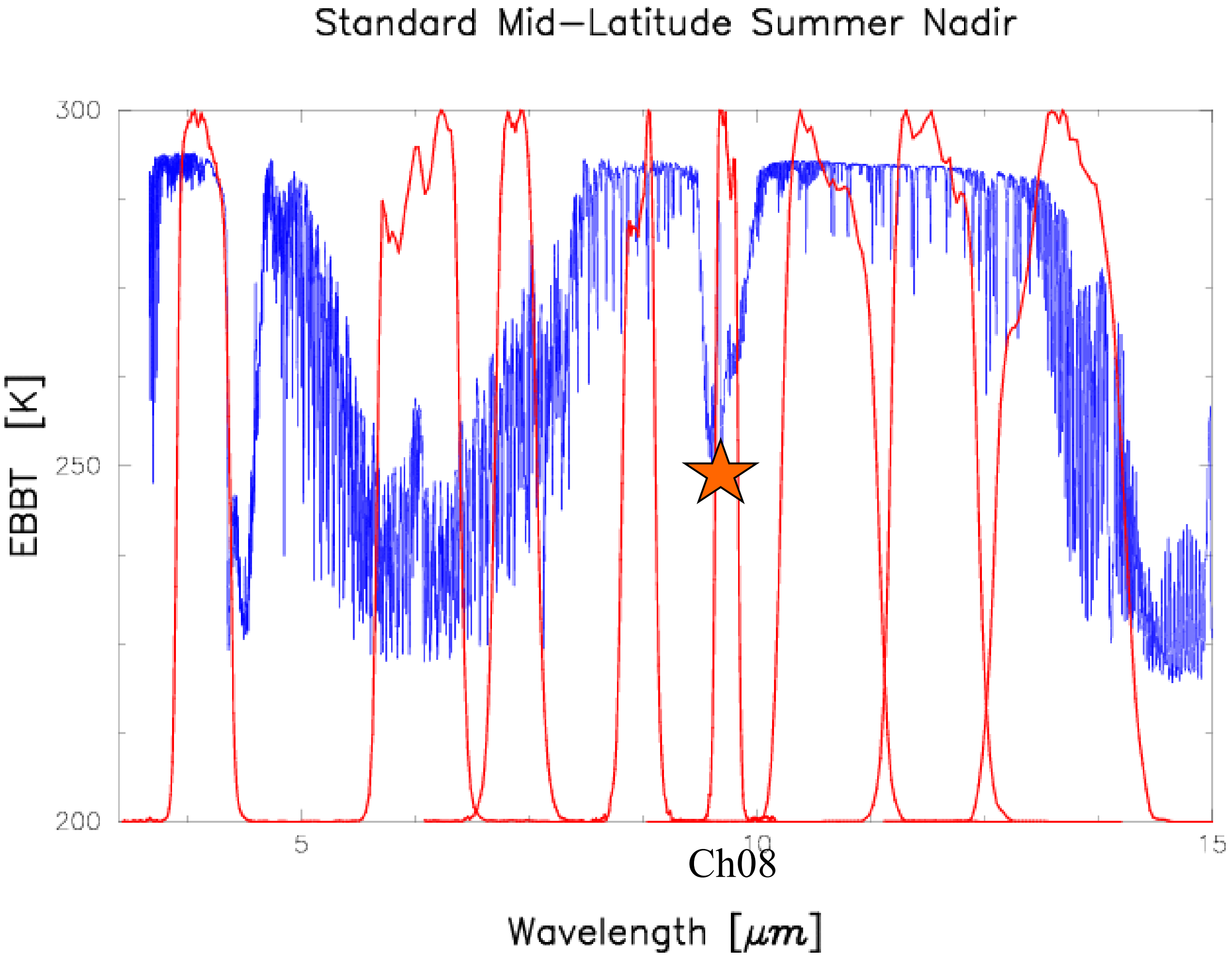
NIR1.6	1.64
IR3.9	3.90
WV6.2	6.25
WV7.3	7.35
IR8.7	8.70
IR9.7	9.66
IR10.8	10.80
IR12.0	12.00
IR13.4	13.40



Sun radiation
Earth radiation
10,000
1,000
100
10
1
Watt pro m²
und Mikron
Ozon
Kohlen-
dioxid
Wasser-
dampf
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
Wellenlänge (Mikron)

Energy spectrum Source: EUMETSAT Schmetz



- Ch08 is in the centre of the O3 absorption band around 9

Max. signal in Ch08 from higher than 100 hPa

Weighting functions
Source: EUMETSAT Schmetz

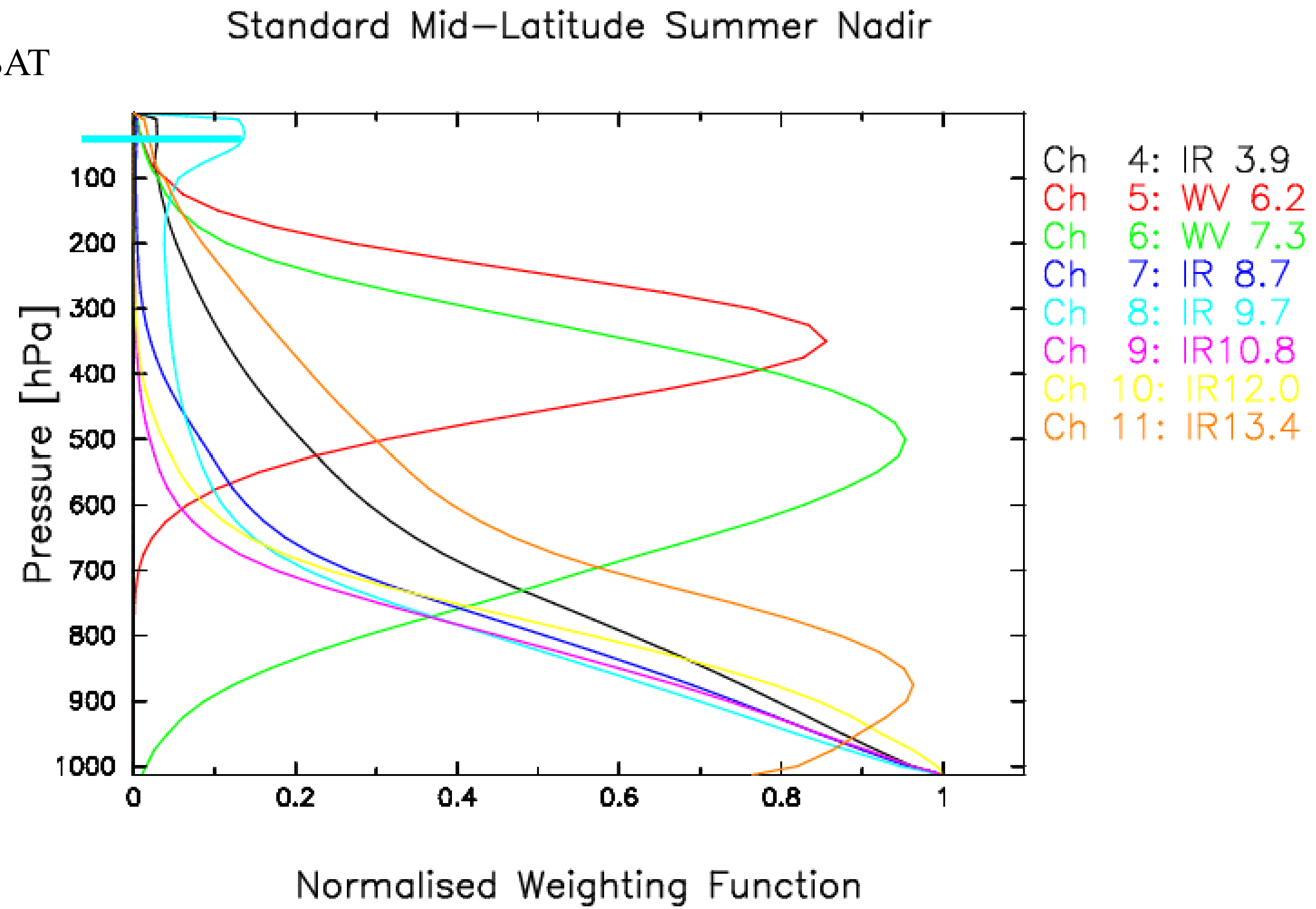


Figure 3c

Max. signal in Ch08 from higher than 100 hPa

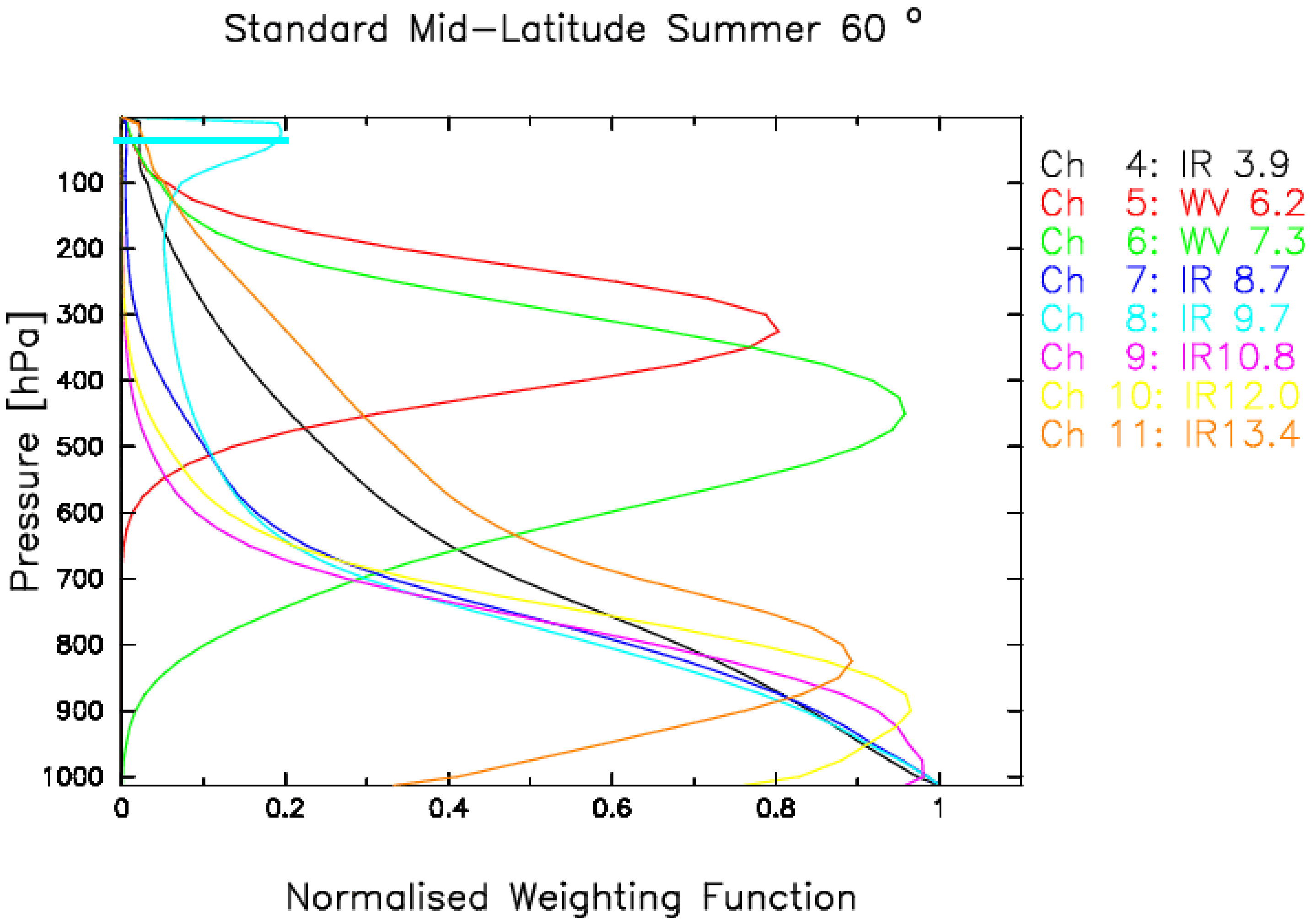
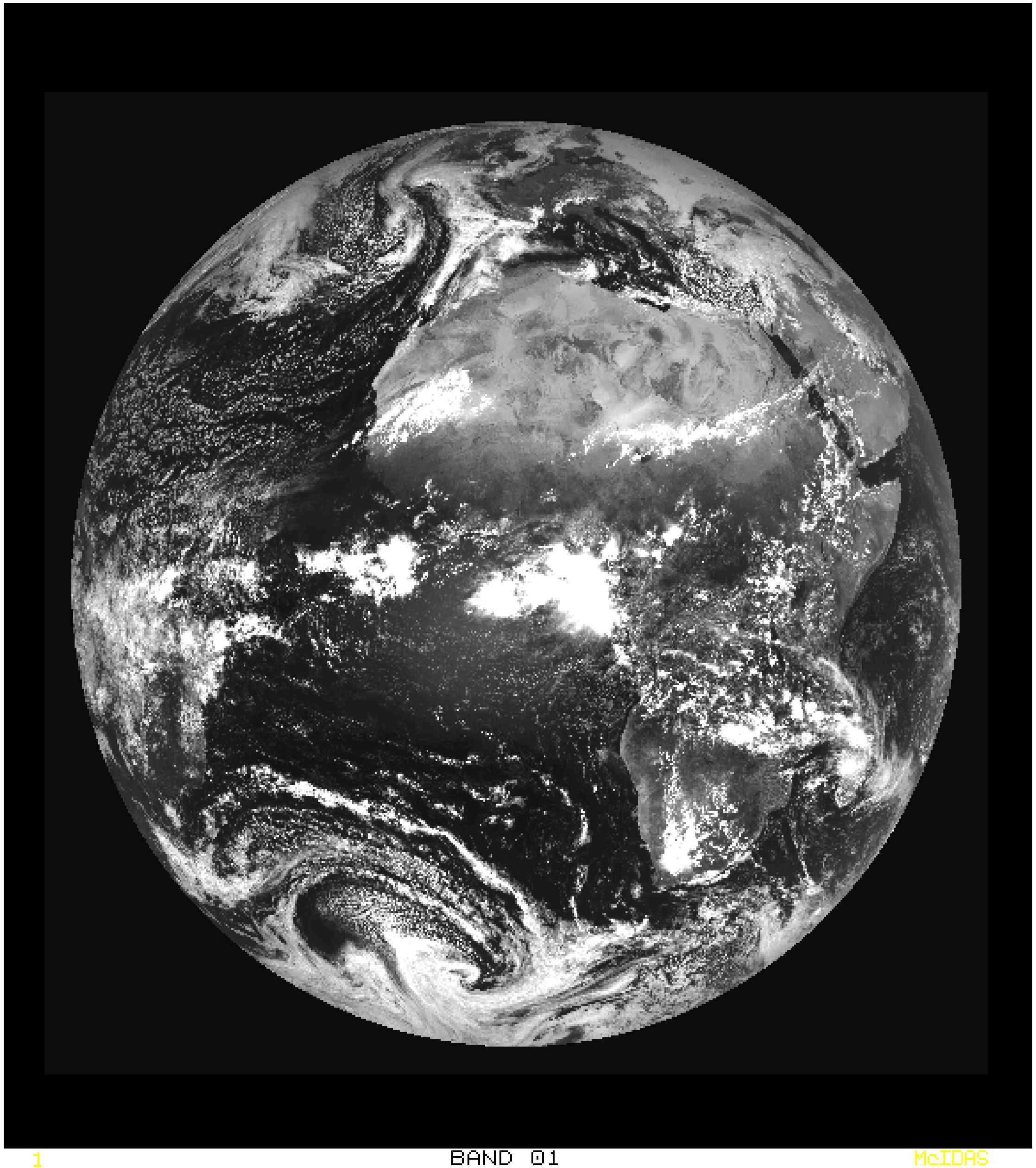
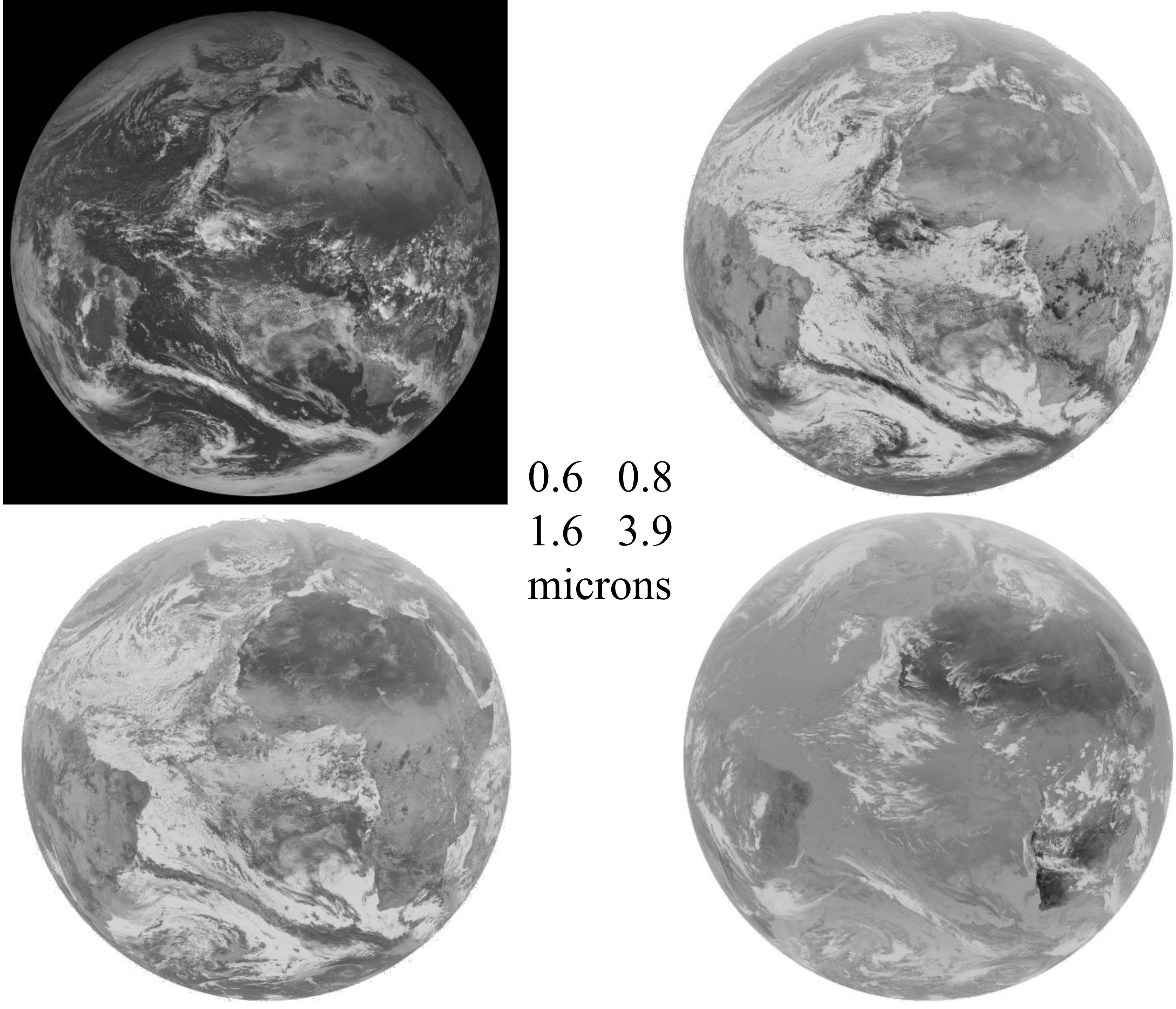
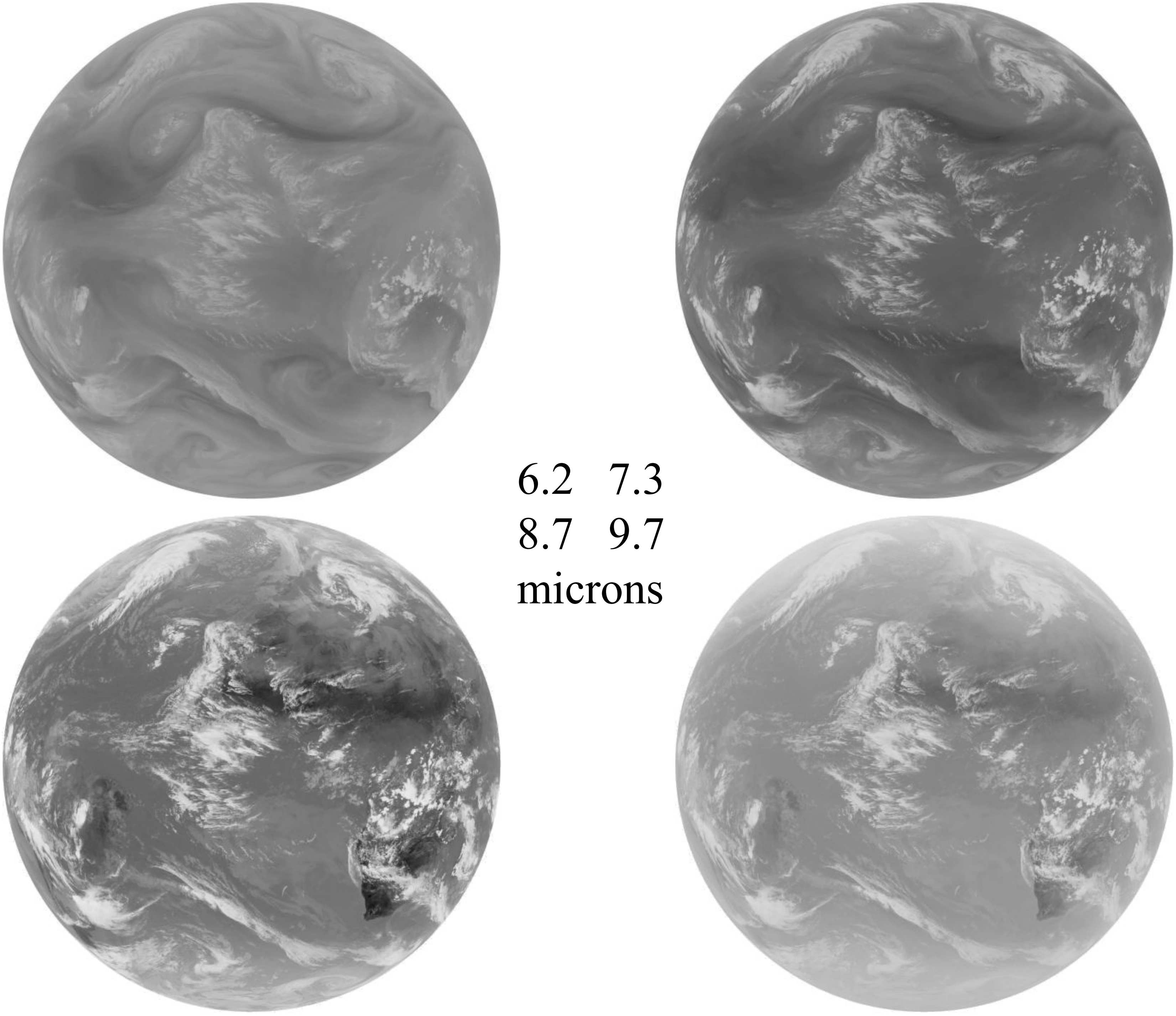


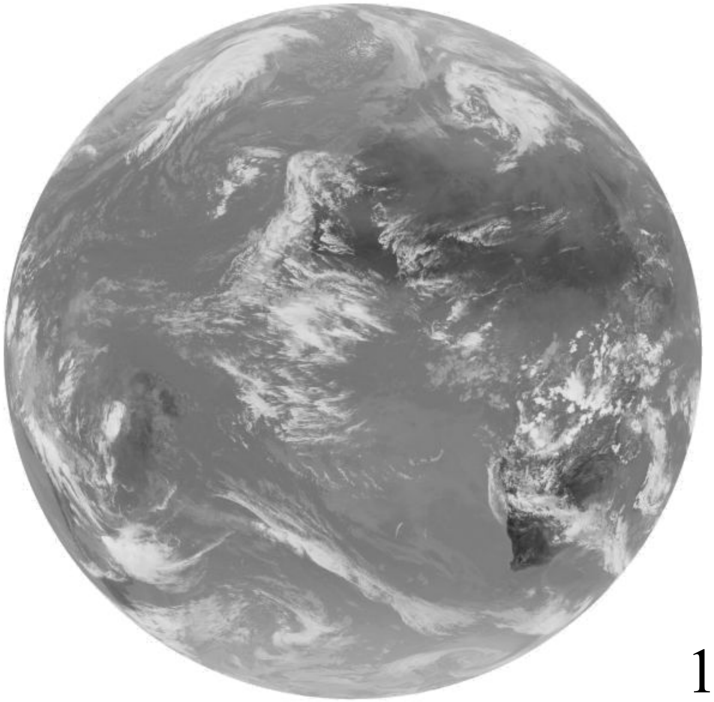
Figure 3d

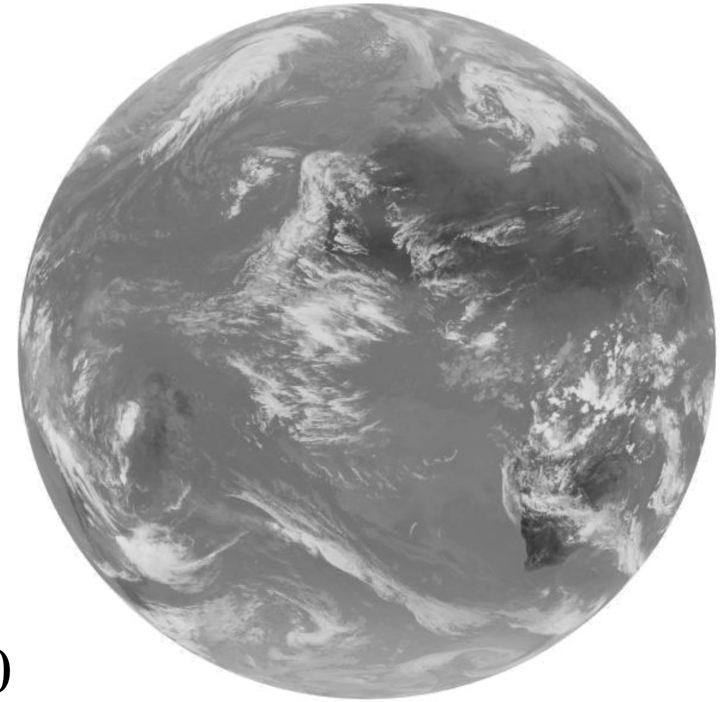


Sequence of all channels

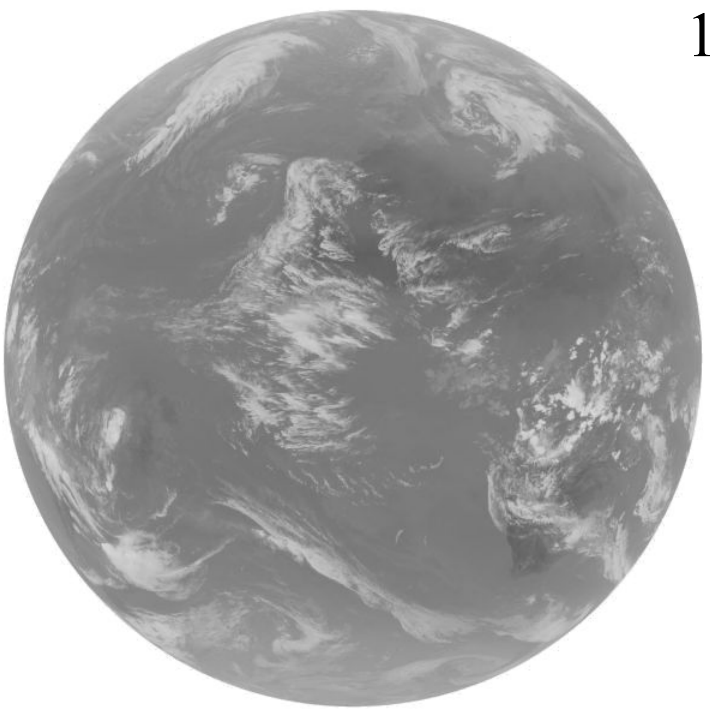

0.6 0.8
1.6 3.9
microns

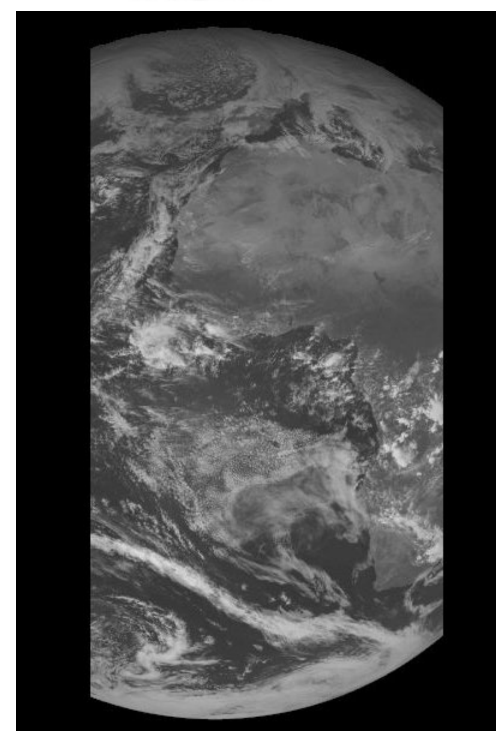

6.2 7.3
8.7 9.7
microns

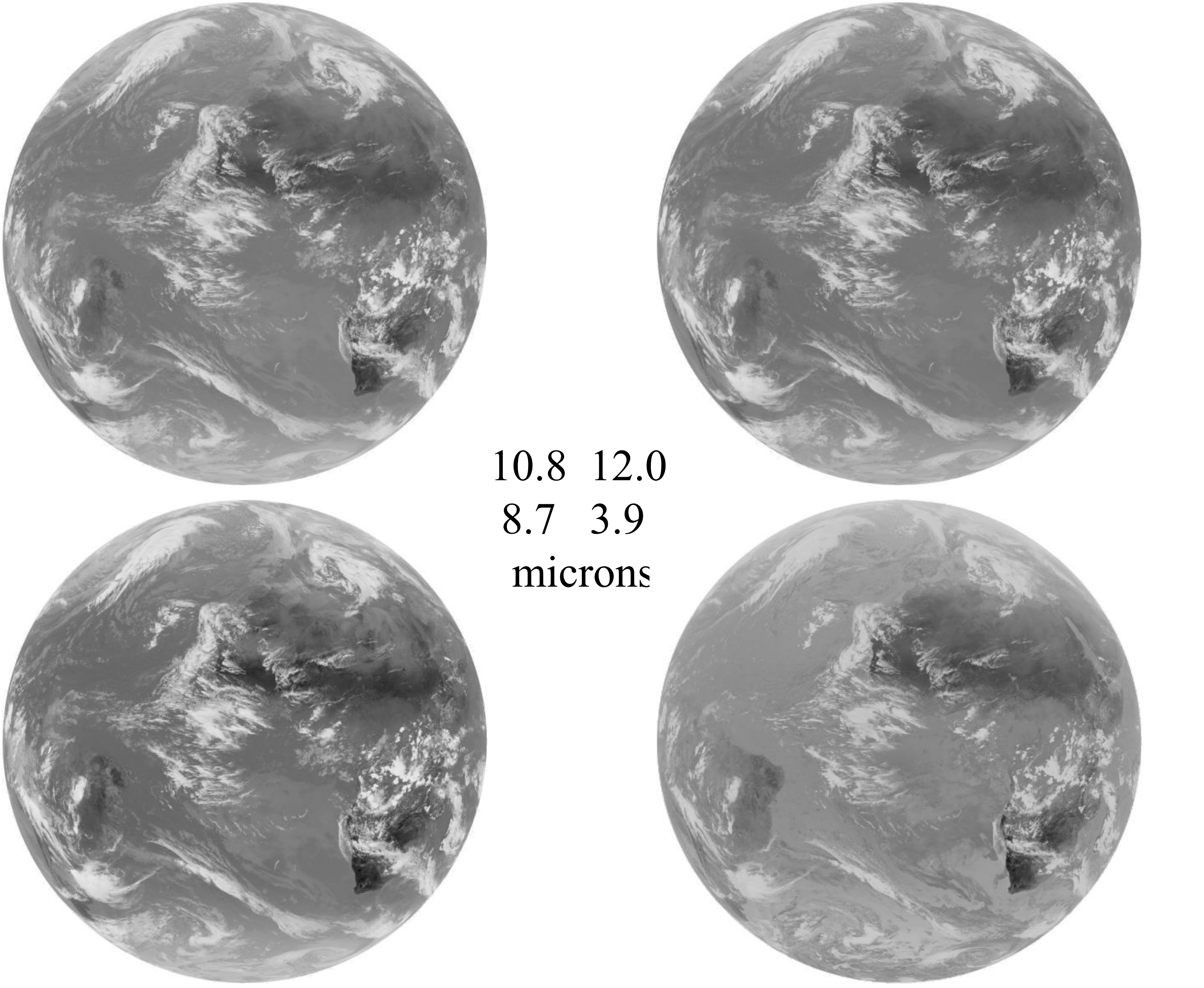


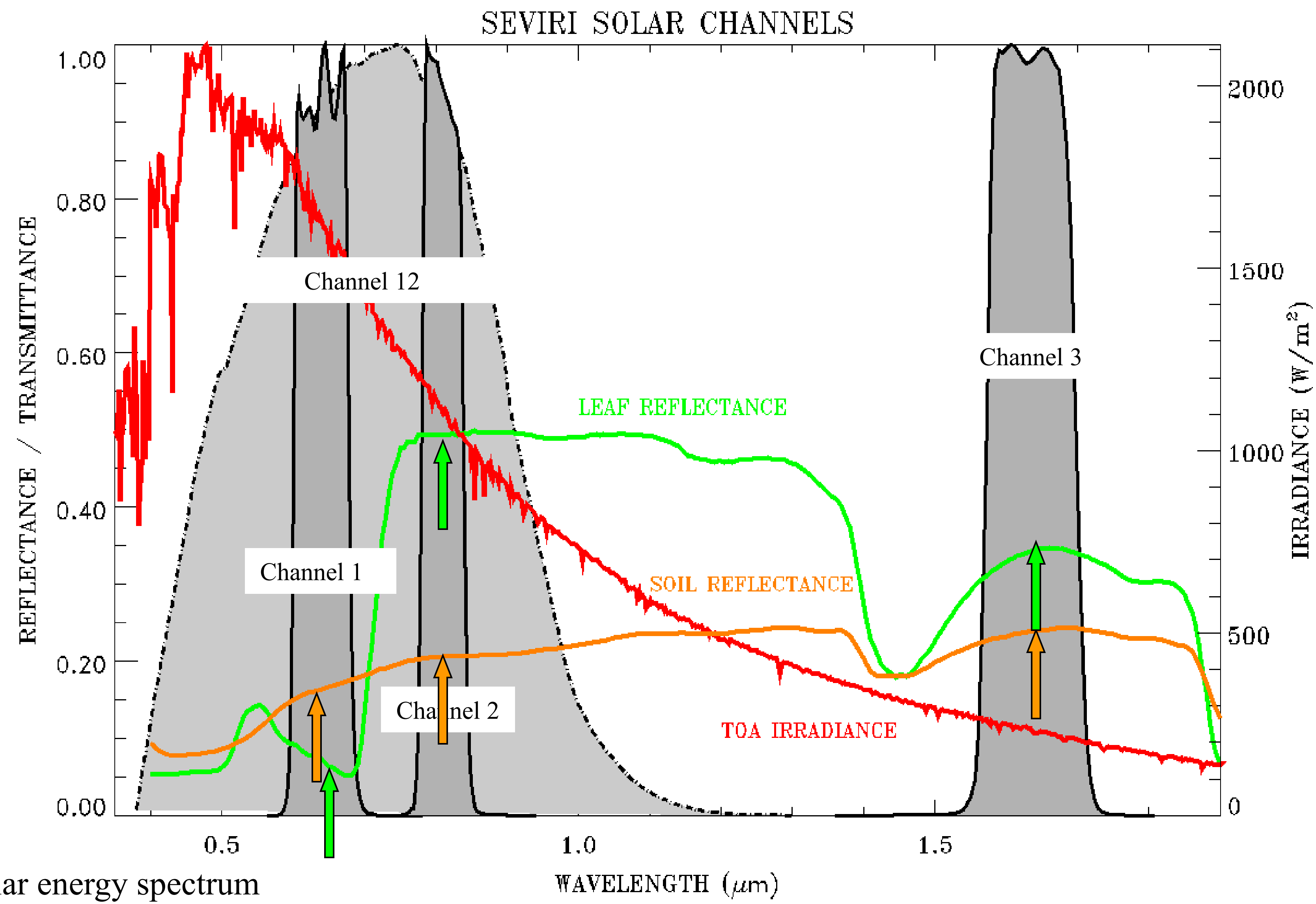


10.8 12.0
13.4 HRV
microns






10.8 12.0
8.7 3.9
microns



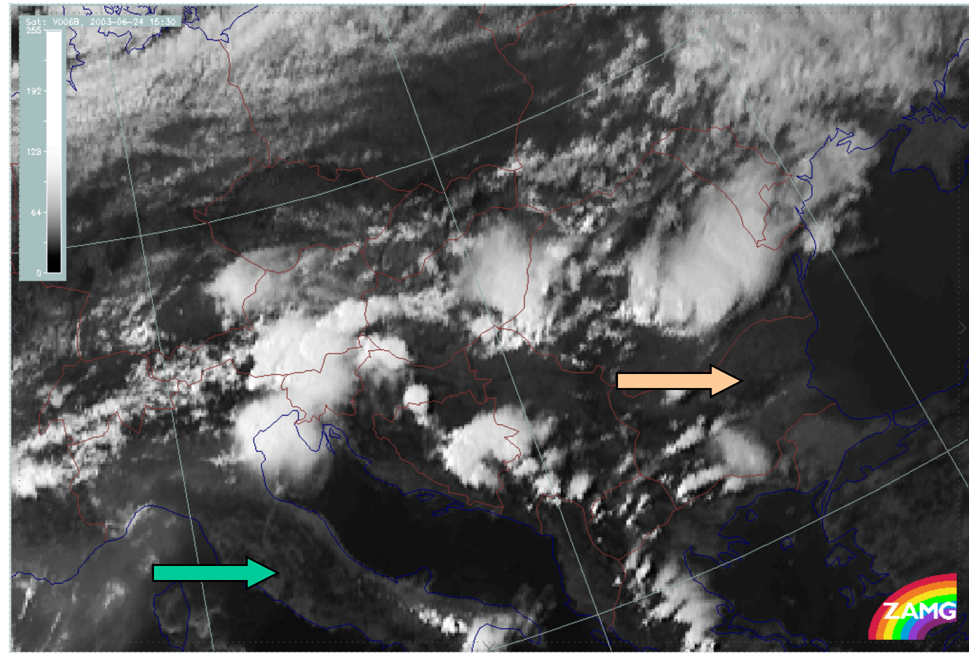
Solar energy spectrum
Source:
EUMETSAT
Schmetz

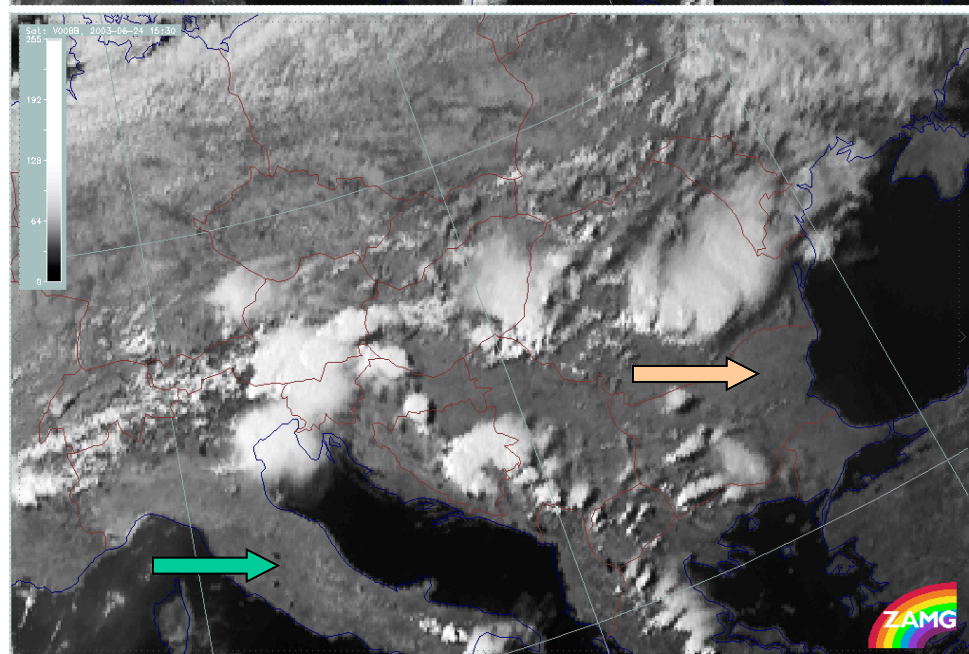
Comparison of soil reflectance in the three VIS channels

Comparison of leaf reflectance in the three VIS channels

Some characteristics: VIS 06 and VIS 08

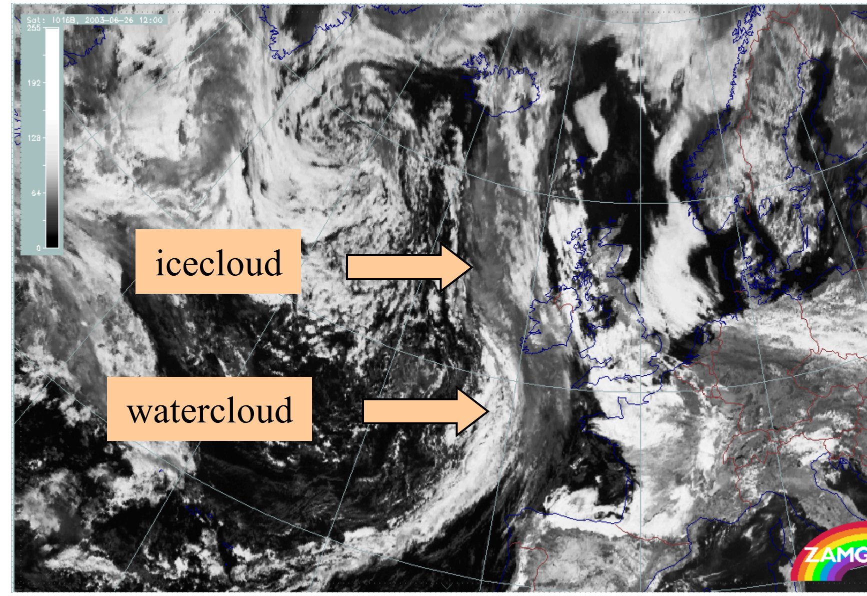
- Both channels are ued to detect clouds
- VIS 08 has better recognition of surface structures
- VIS 0.8 –VIS 0.6 for vegetation index
- For transparent clouds: VIS 0.6 is better (less reflectivity of surface)



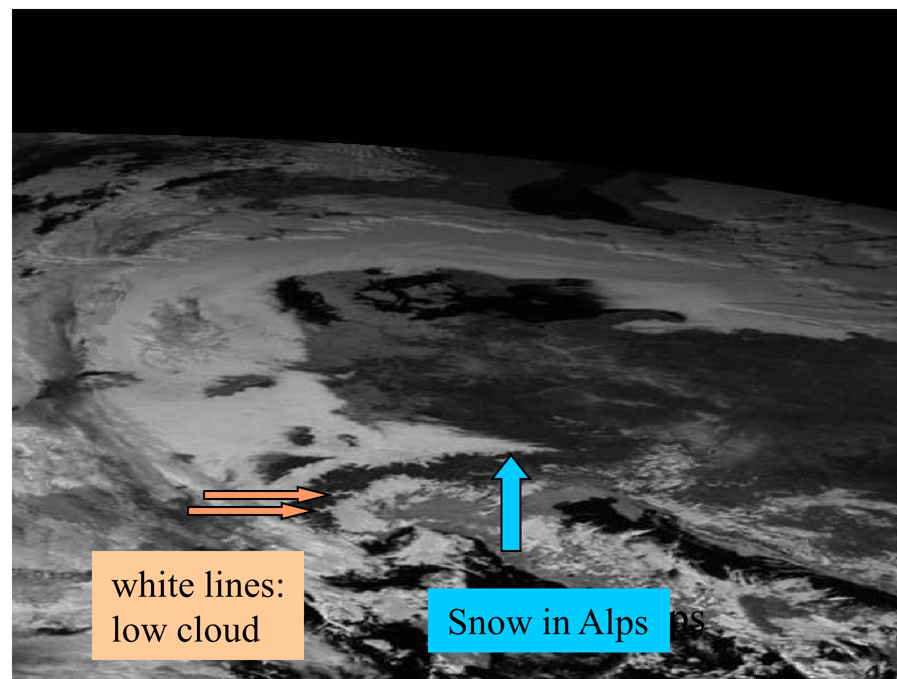


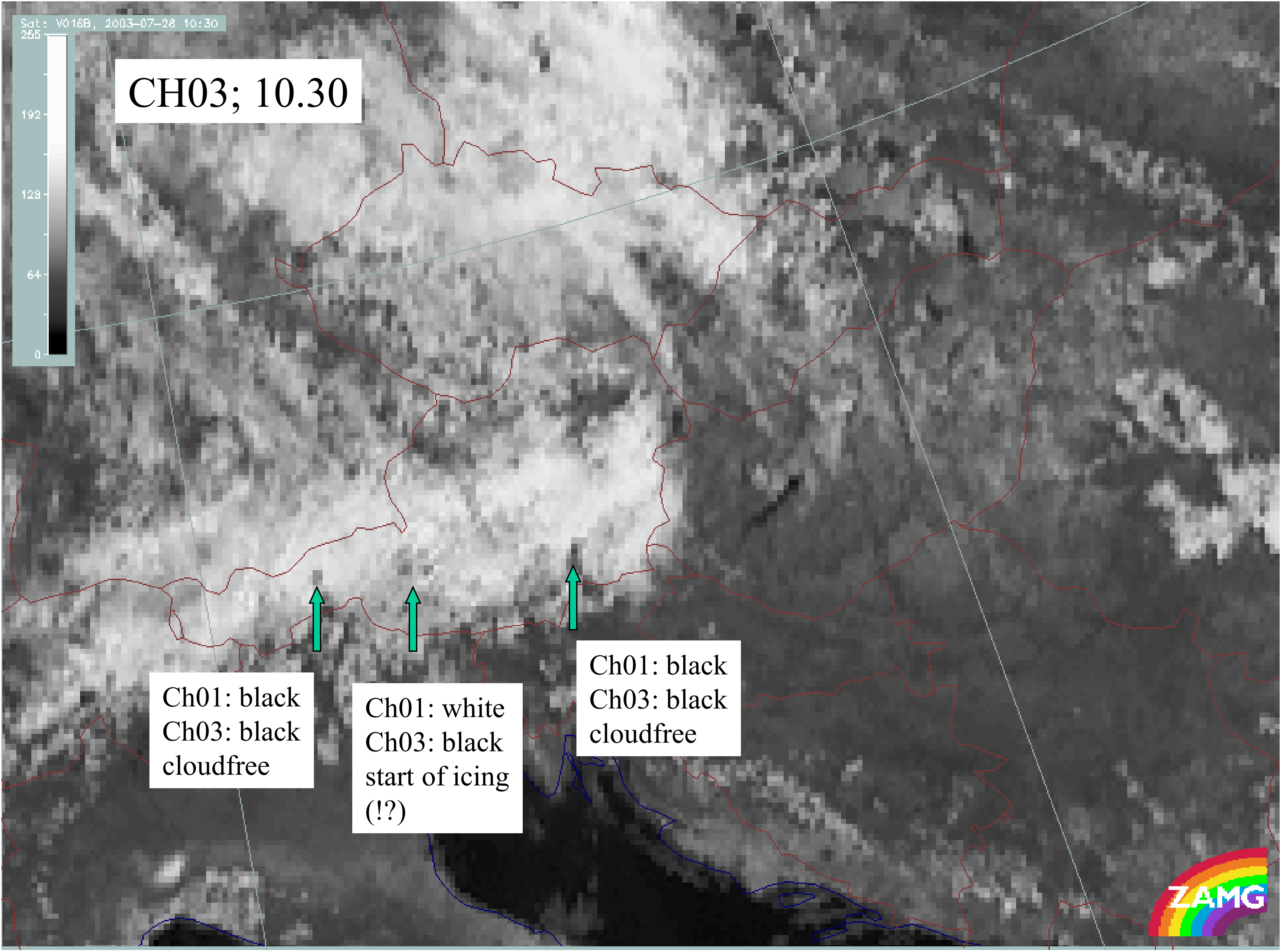
Some characteristics: NIR 1.6

- **Different appearance of ice - and waterclouds (because of stronger absorption in the icephase)**
  - **Waterclouds: white**
  - **Iceclouds: black**

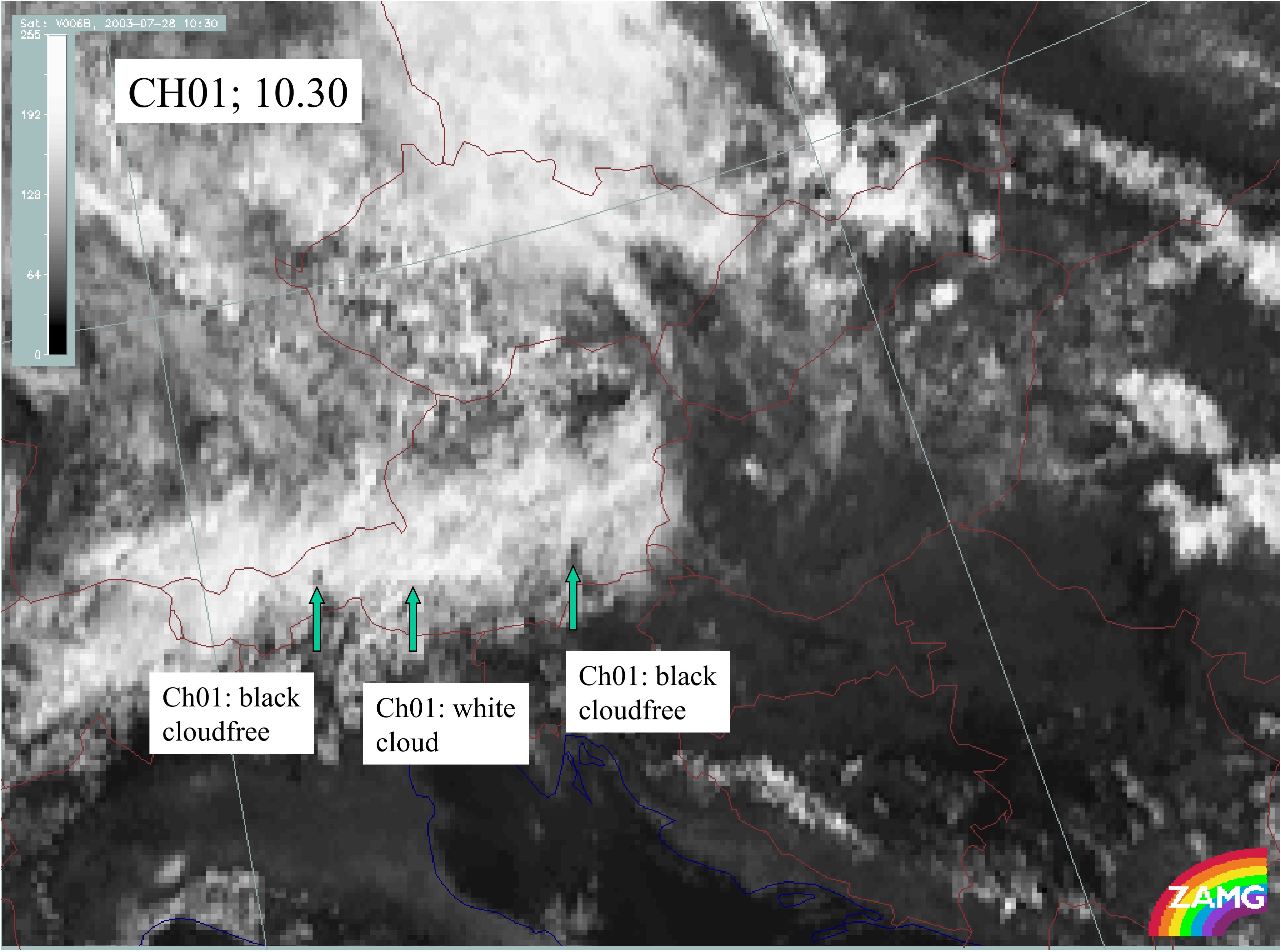


- **Different appearance of water clouds above snow and ice**
  - **Snow + Ice: black**
  - **Waterclouds: white**

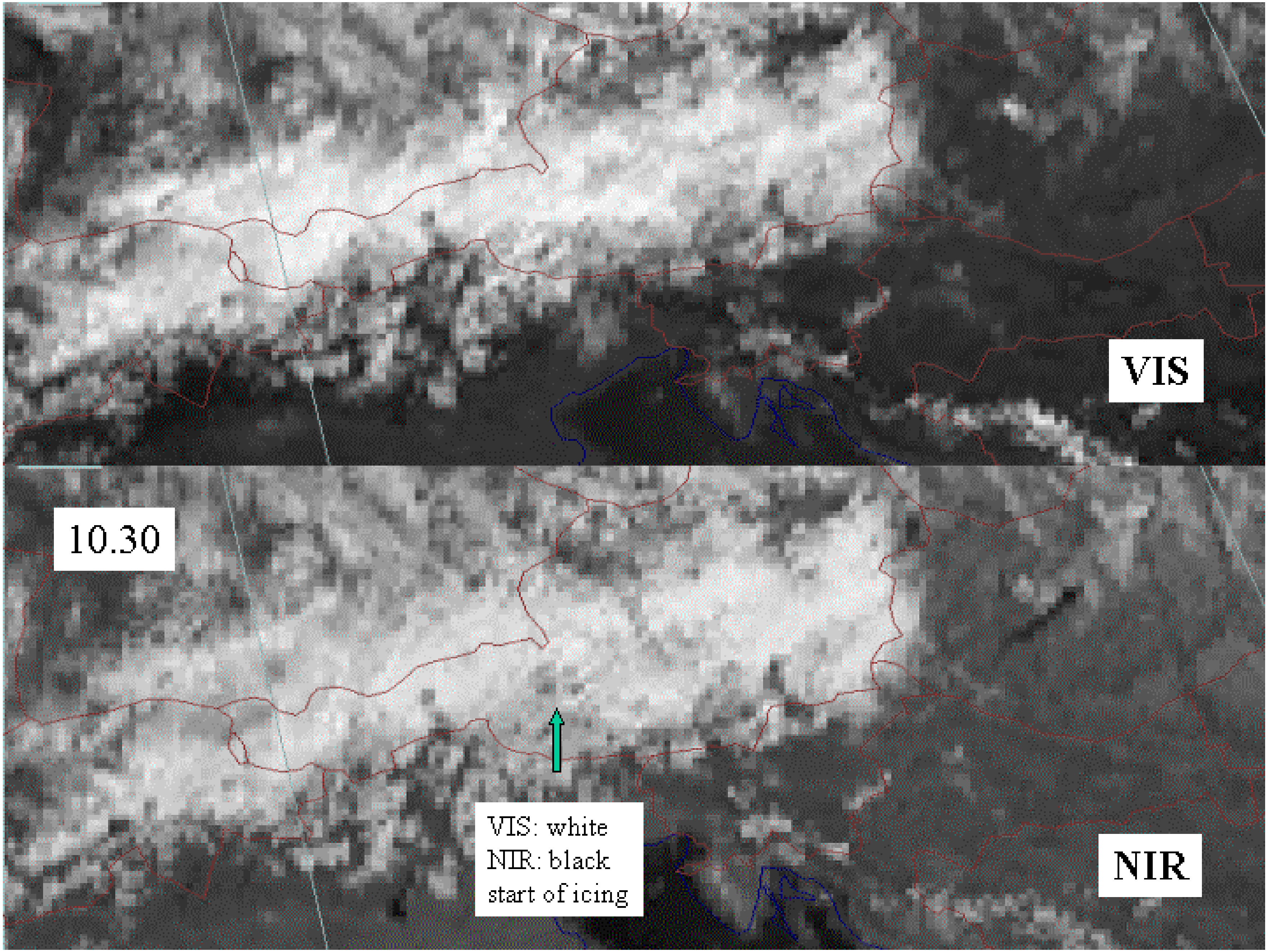




Sat: V016B, 2003-07-28 10:30
255
192
128
64
0
CH03; 10.30
Ch01: black
Ch03: black
cloudfree
Ch01: white
Ch03: black
start of icing
(!?)
Ch01: black
Ch03: black
cloudfree
ZAMG

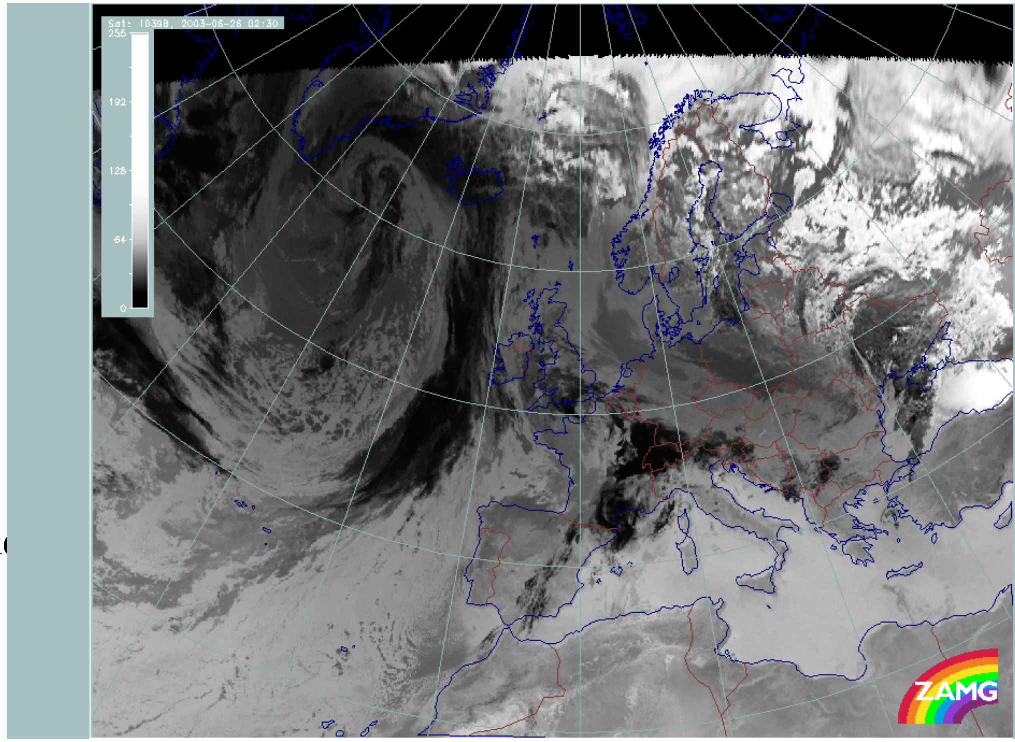

Sat: V006B, 2003-07-28 10:30
255
192
128
64
0
CH01; 10.30
Ch01: black cloudfree
Ch01: white cloud
Ch01: black cloudfree
ZAMG

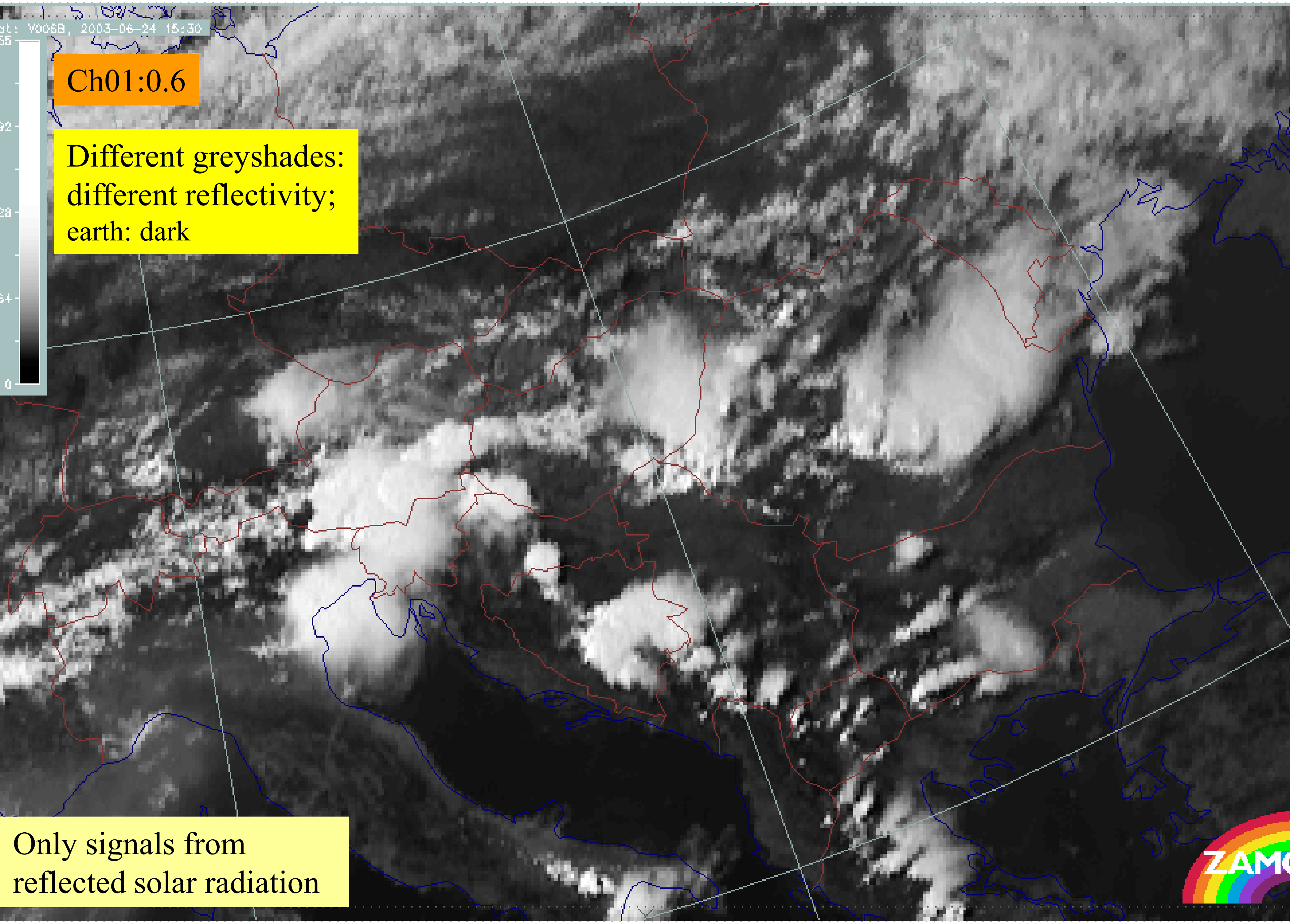
GOES-R spectral improvements help to see icing in clouds.

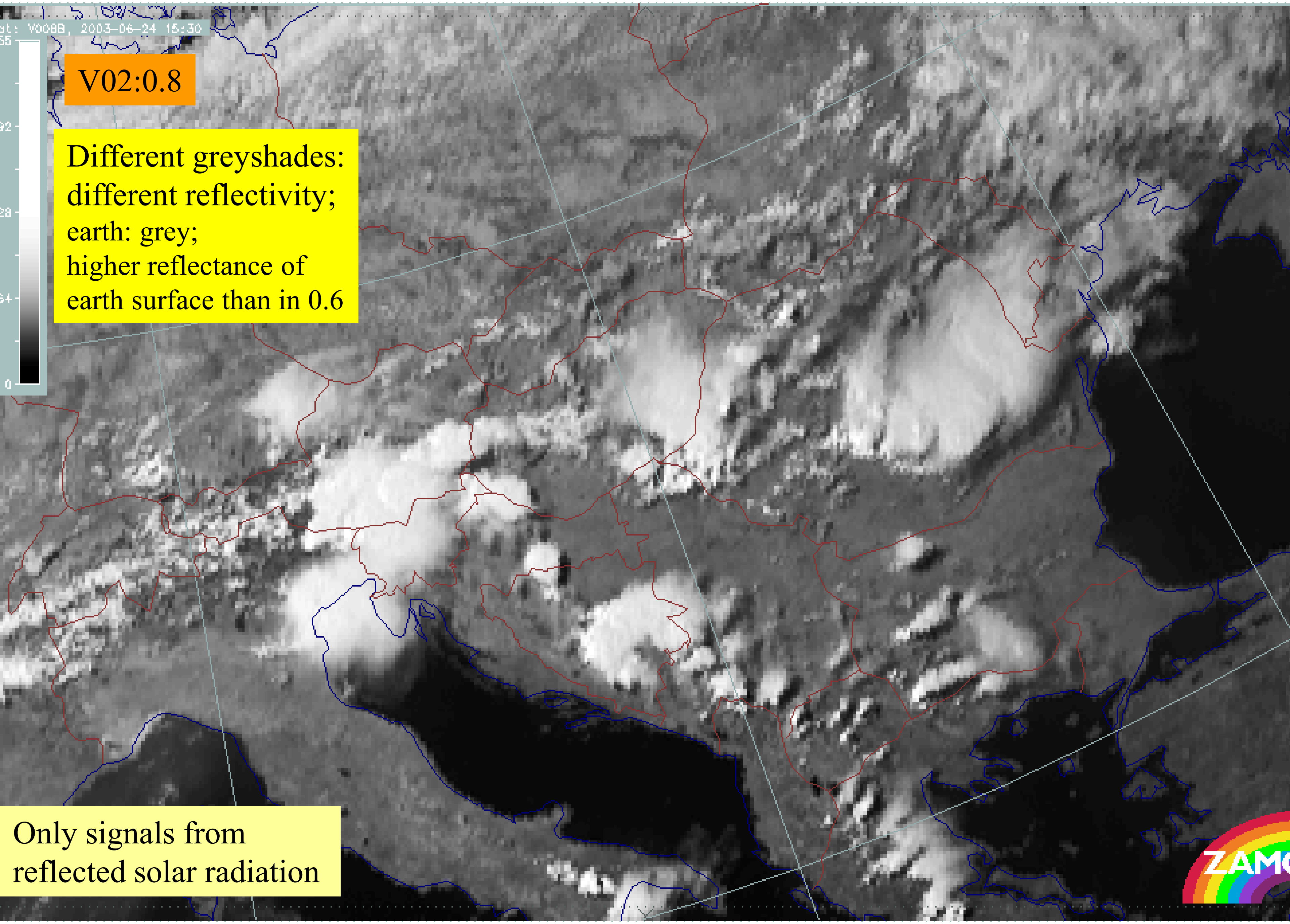


Some characteristics: IR 3.9

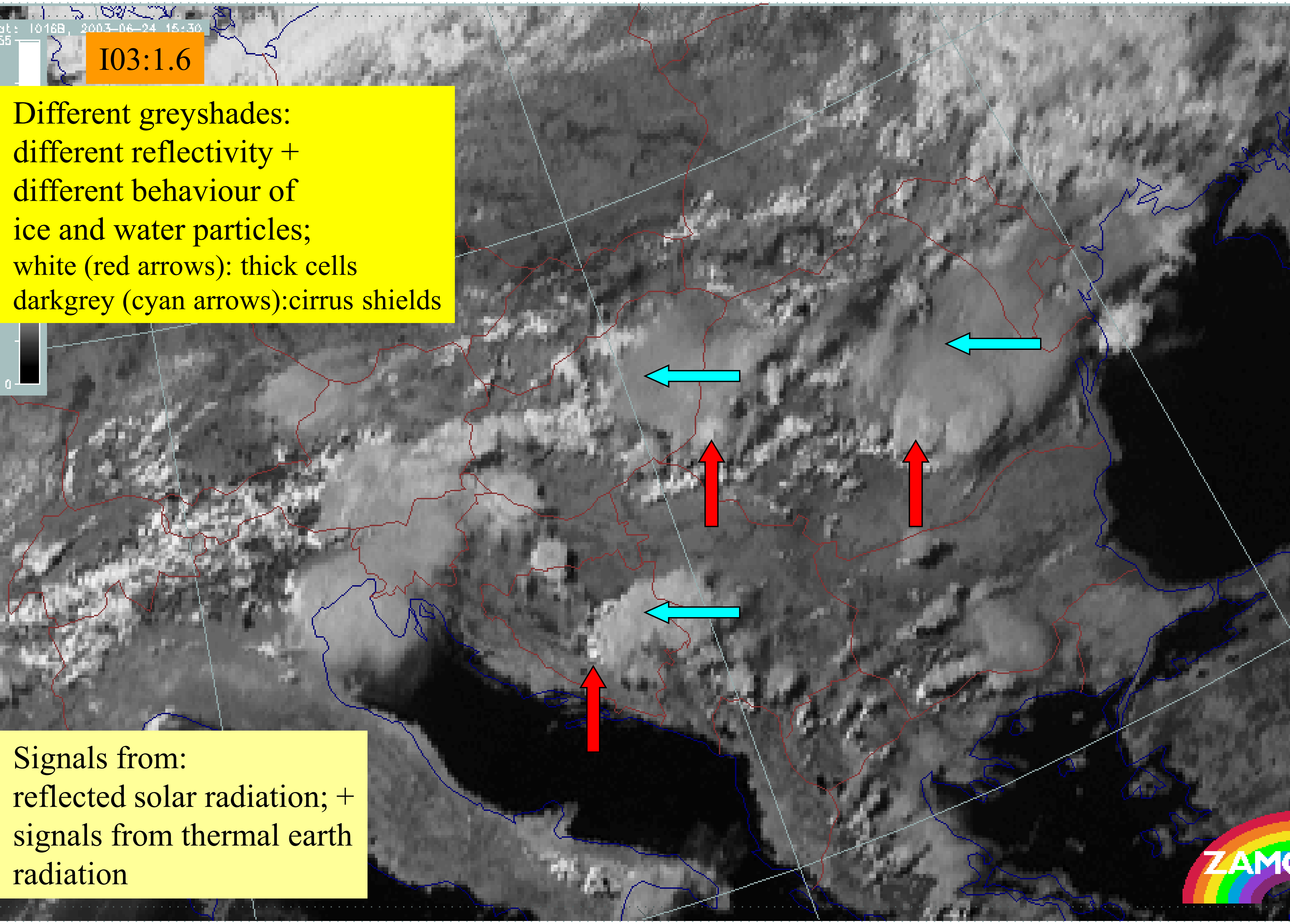
- Different radiation sources during day and night:
  - night: only IR
  - day: IR + VIS
- Optically different to Meteosat VIS and IR images:
  - in 3.9 impression of black clouds (original visualisation of radiation)
  - in the usual IR channel signals are inverted for easier comparison of clou with Vis channels (black → white)
- Night:
  - different signals from warm clouds between 3.9 and 10.8
  - difference in Ch03 and Ch09 used for fog recognition

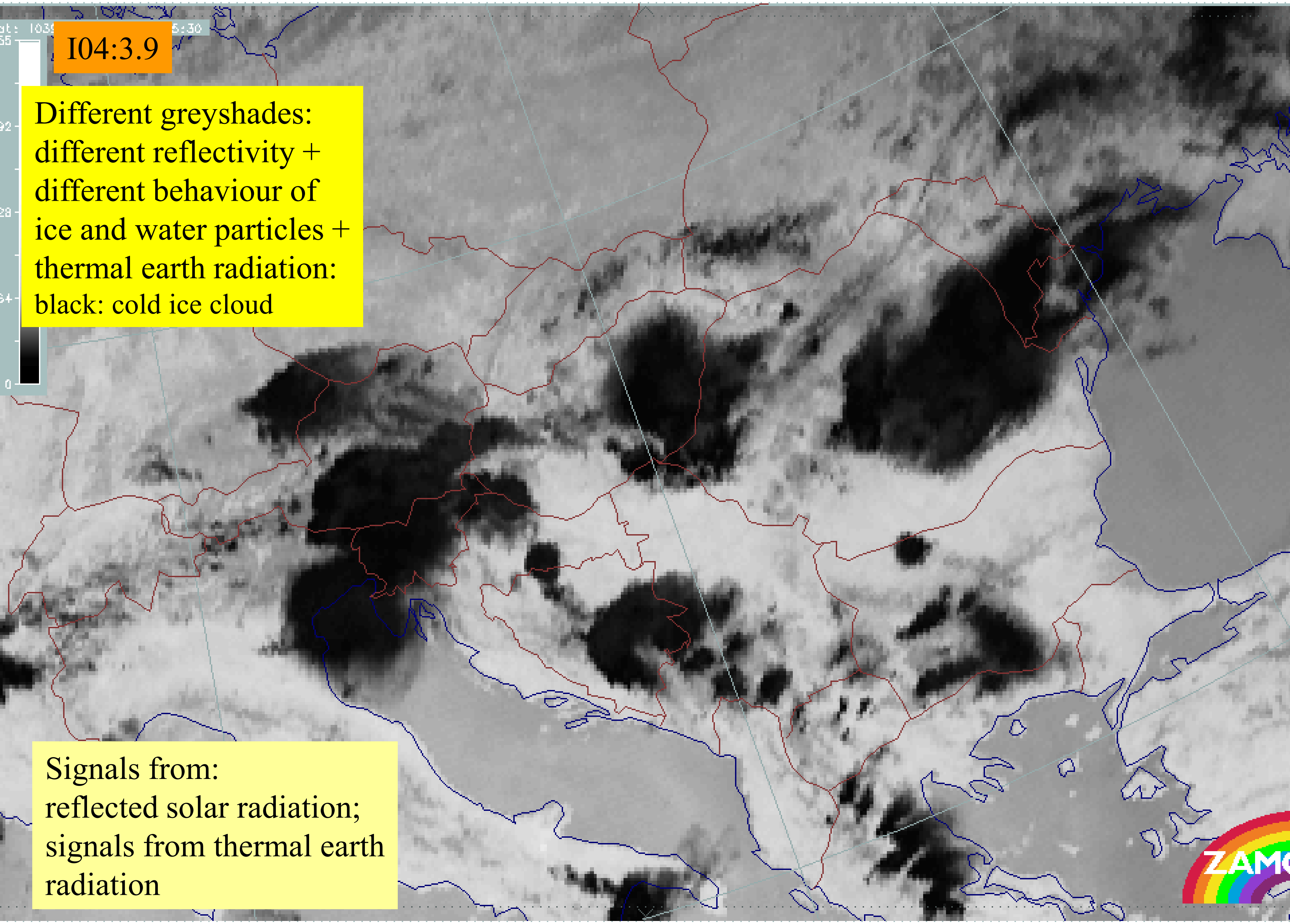


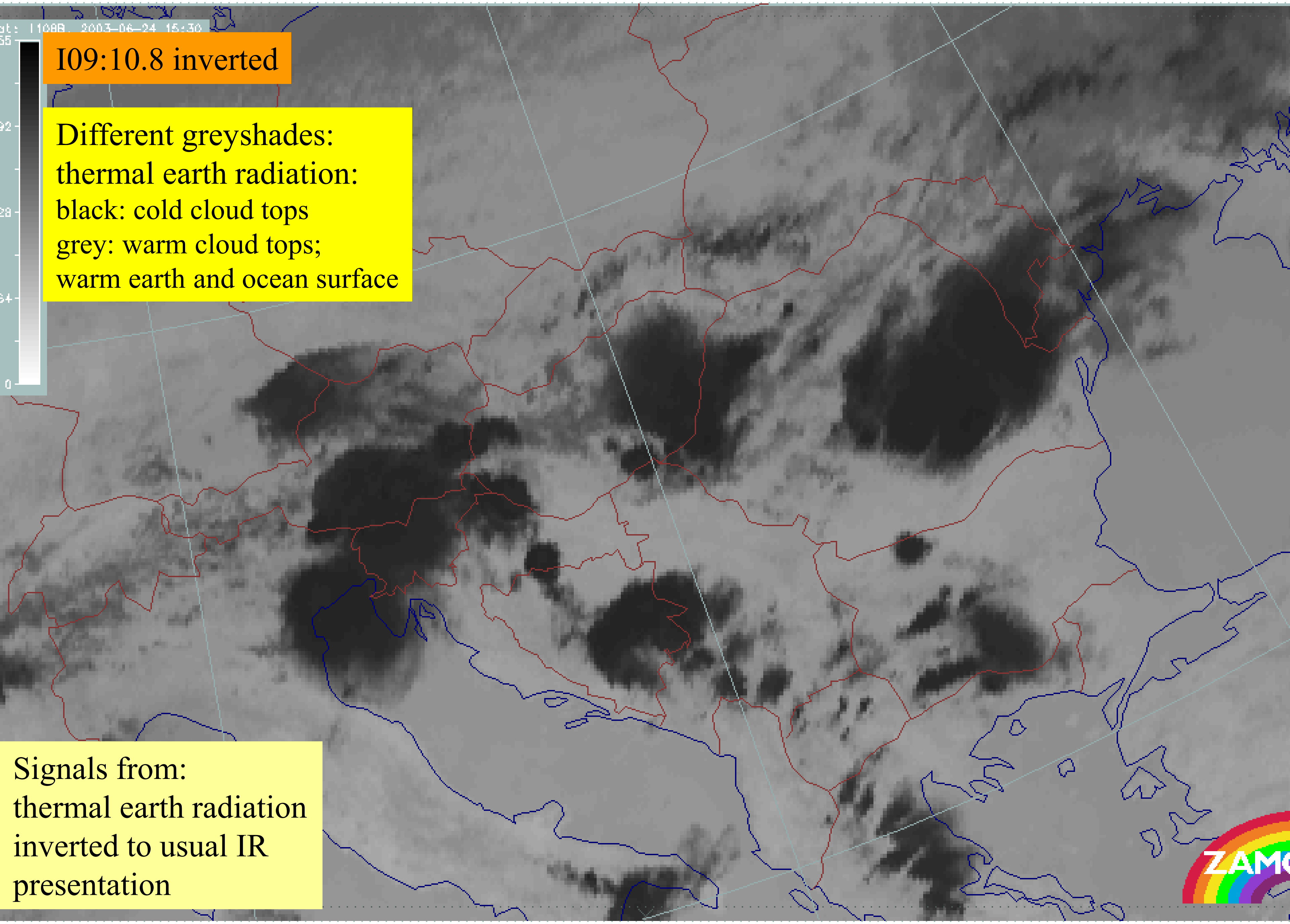

VOO6B, 2003-06-24 15:30
Ch01:0.6
Different greyshades:
different reflectivity;
earth: dark
Only signals from
reflected solar radiation

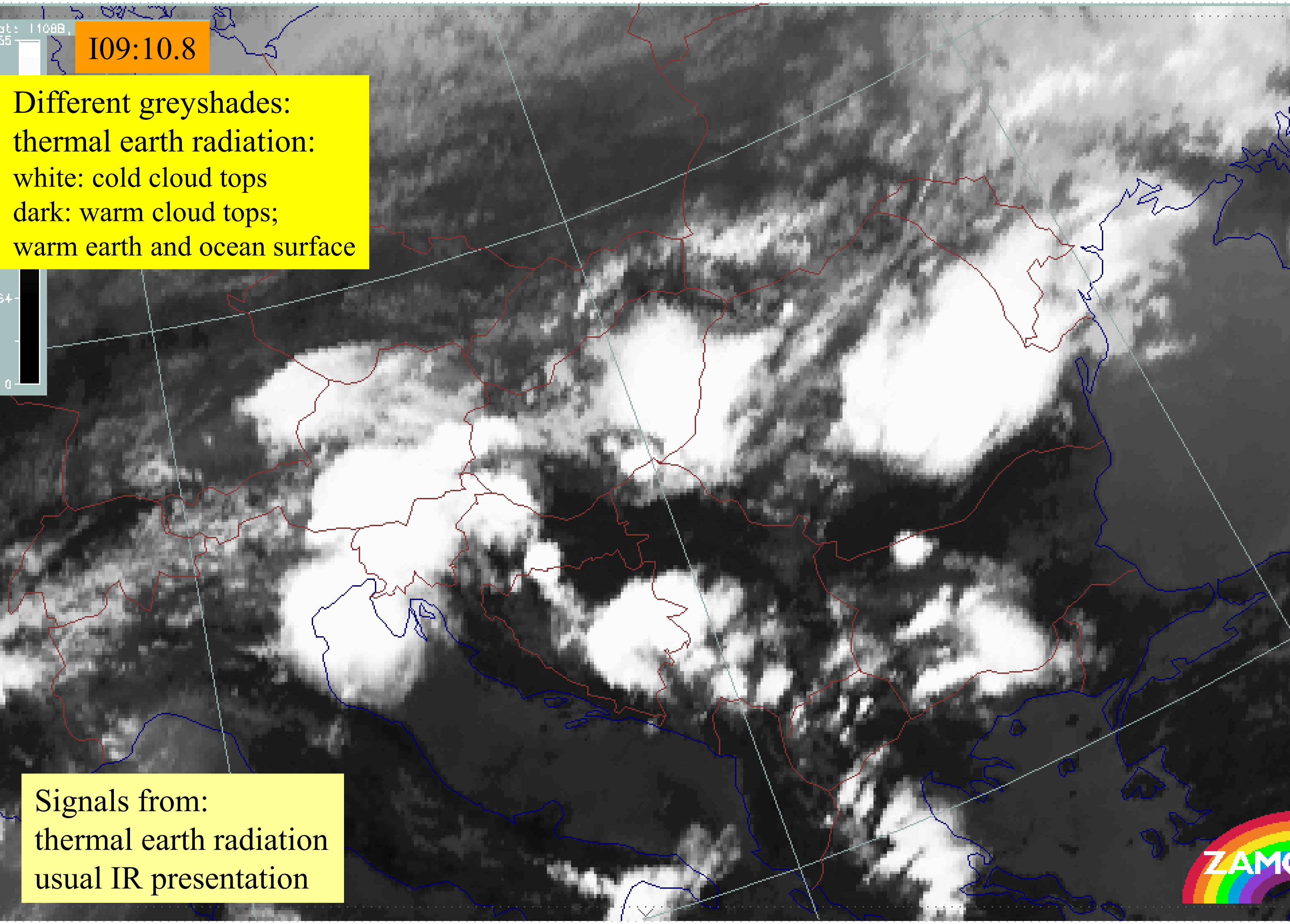


at: V008B, 2003-06-24 15:30
V02:0.8
Different greyshades:
different reflectivity;
earth: grey;
higher reflectance of
earth surface than in 0.6
Only signals from
reflected solar radiation

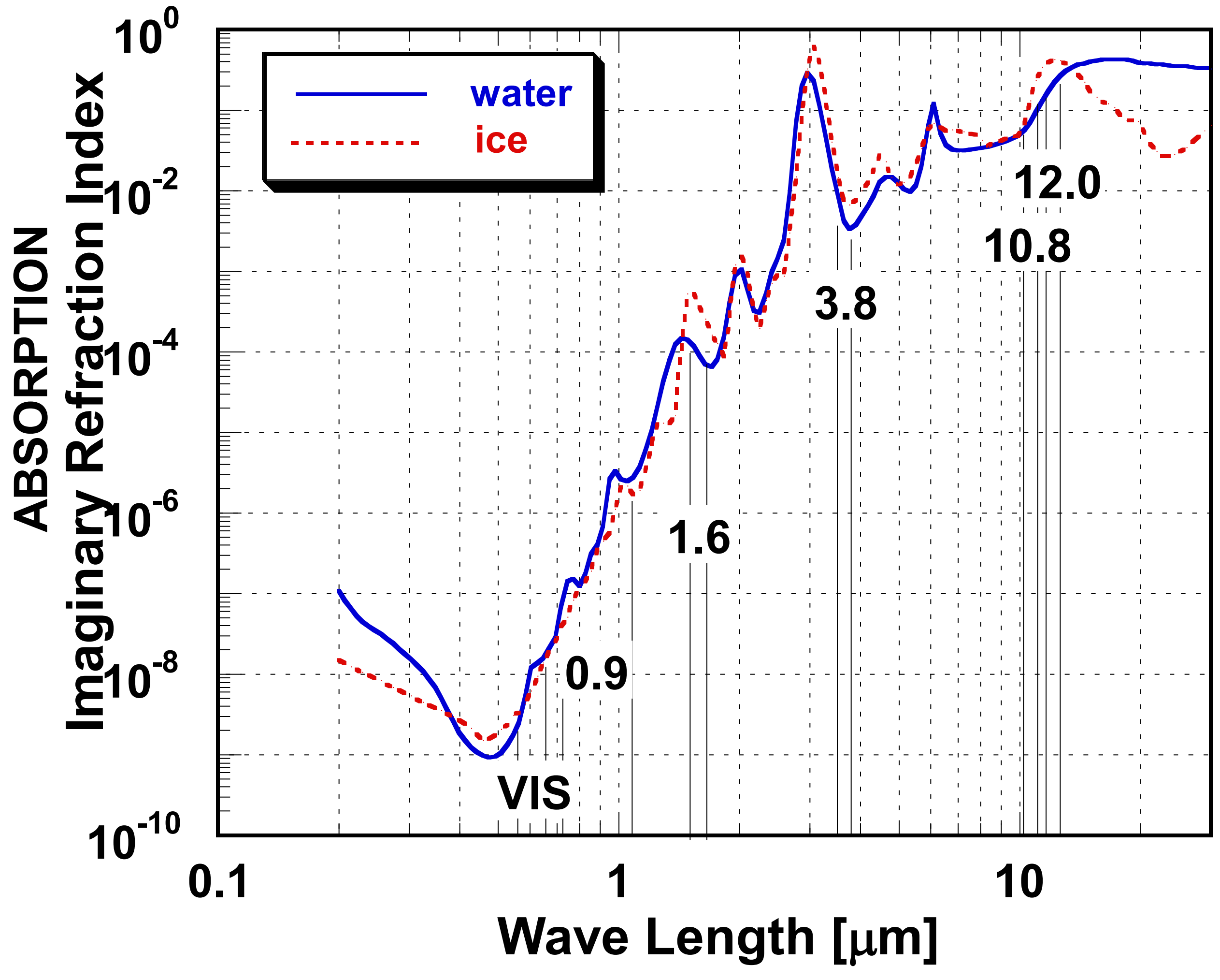

2003-06-24 15:30
I03:1.6
Different greyshades:
different reflectivity +
different behaviour of
ice and water particles;
white (red arrows): thick cells
darkgrey (cyan arrows):cirrus shields
Signals from:
reflected solar radiation; +
signals from thermal earth
radiation
ZAMG

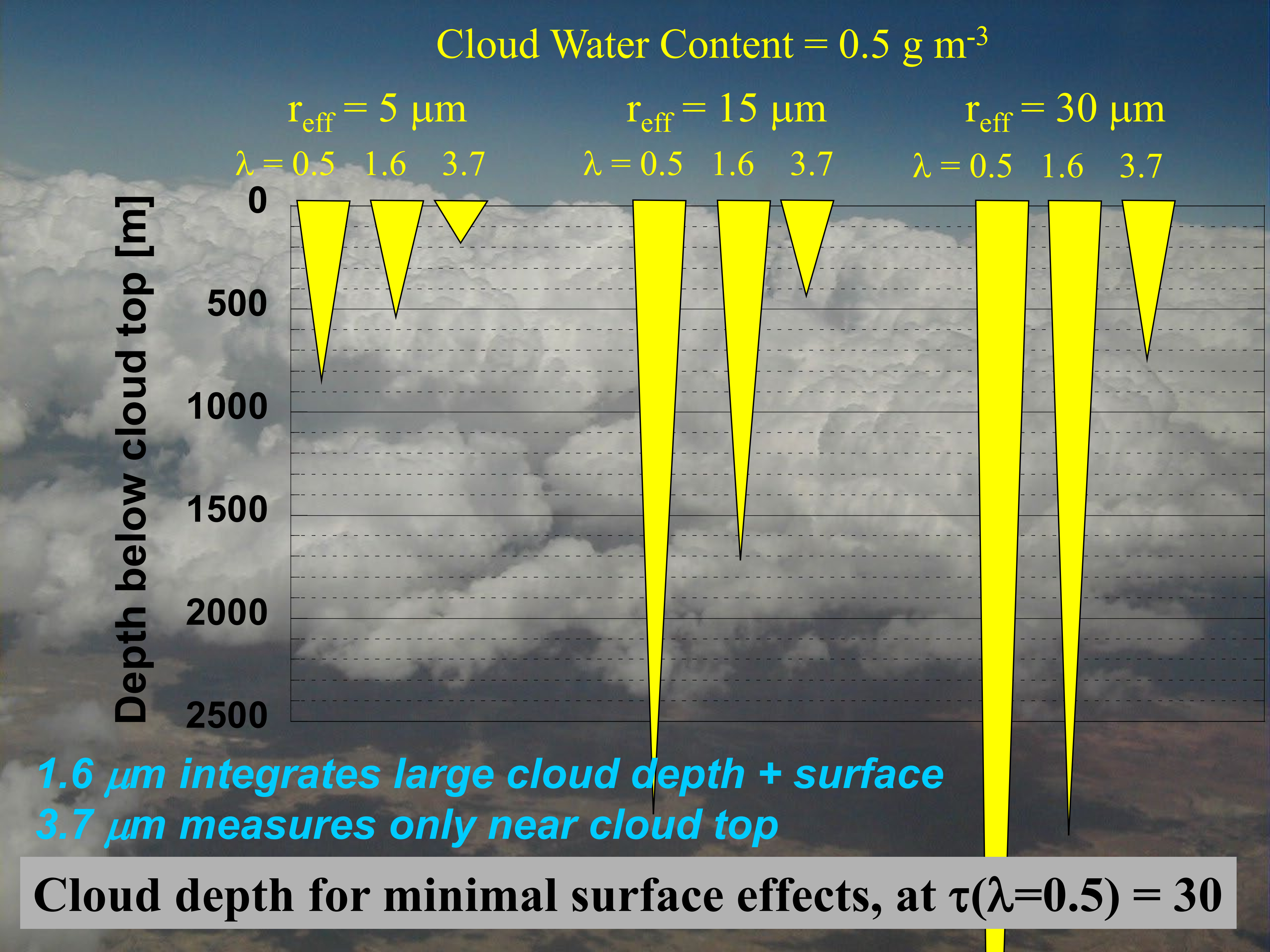

I04:3.9
Different greyshades:
different reflectivity +
different behaviour of
ice and water particles +
thermal earth radiation:
black: cold ice cloud
Signals from:
reflected solar radiation;
signals from thermal earth
radiation


I09:10.8 inverted
Different greyshades:
thermal earth radiation:
black: cold cloud tops
grey: warm cloud tops;
warm earth and ocean surface
Signals from:
thermal earth radiation
inverted to usual IR
presentation


I09:10.8
Different greyshades:
thermal earth radiation:
white: cold cloud tops
dark: warm cloud tops;
warm earth and ocean surface
Signals from:
thermal earth radiation
usual IR presentation

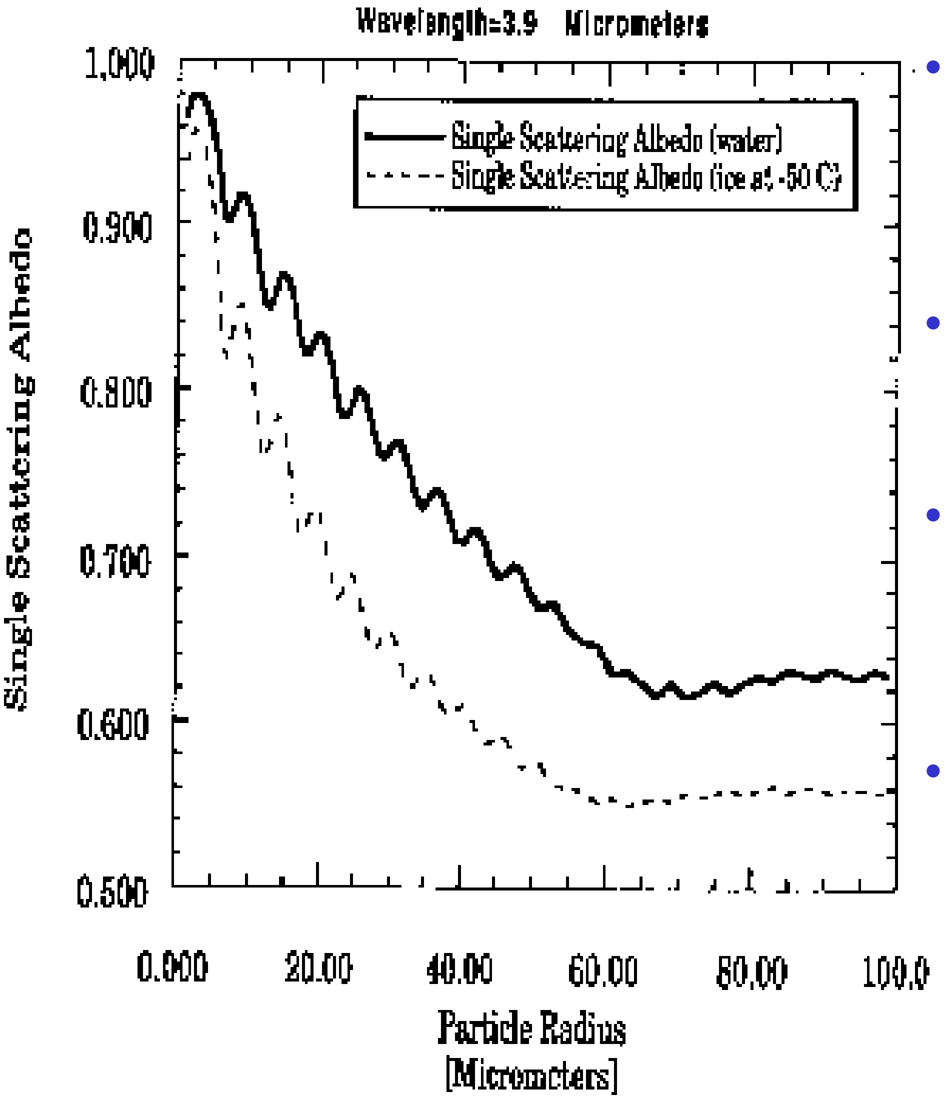
SEVIRI CHANNELS: IR3.9 μm





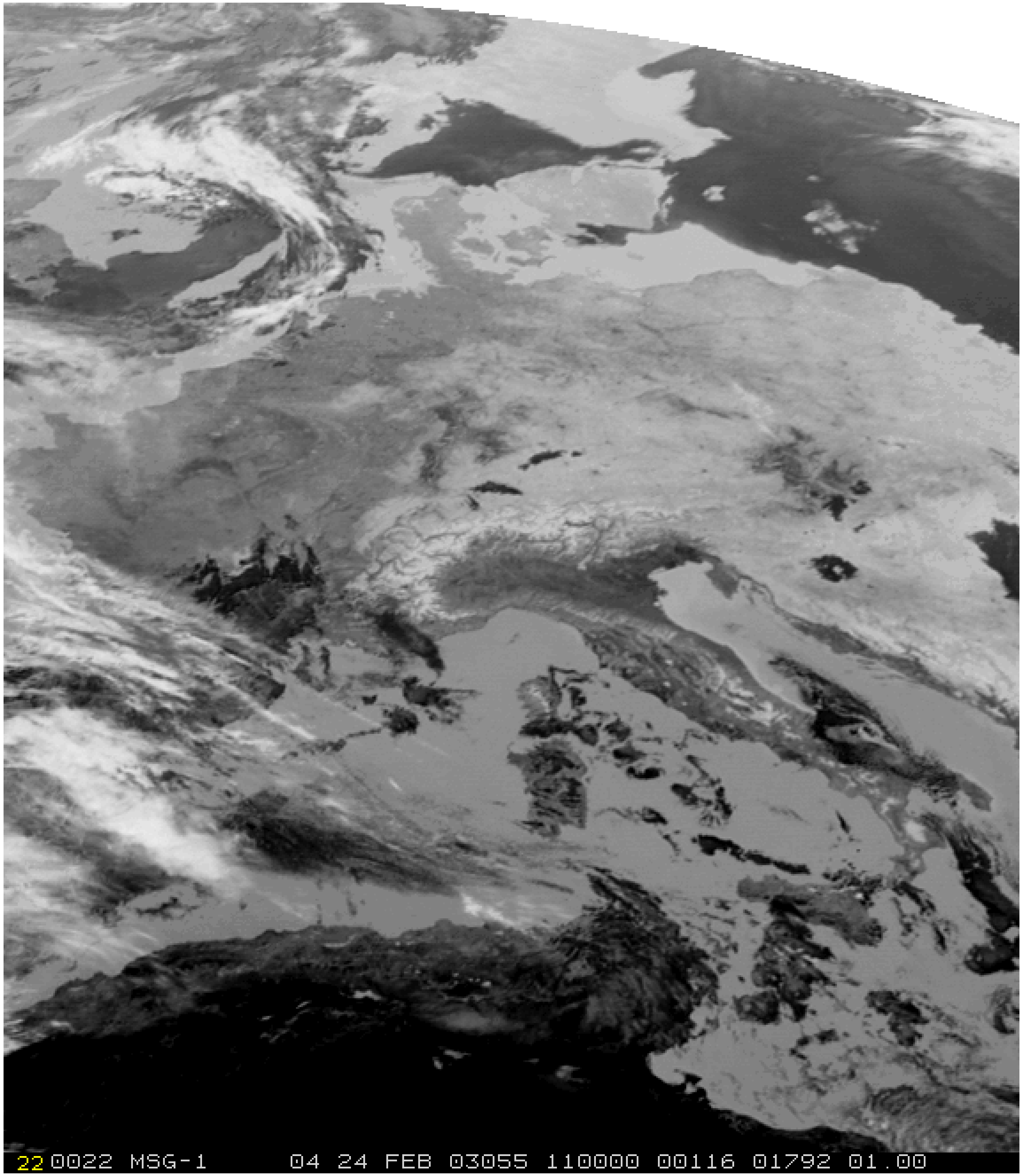
Cloud Water Content = 0.5 g m-3
reff = 5 µm
reff = 15 µm
reff = 30 µm
λ = 0.5 1.6 3.7
λ = 0.5 1.6 3.7
λ = 0.5 1.6 3.7
Depth below cloud top [m]
0
500
1000
1500
2000
2500
1.6 µm integrates large cloud depth + surface
3.7 µm measures only near cloud top
Cloud depth for minimal surface effects, at τ(λ=0.5) = 30

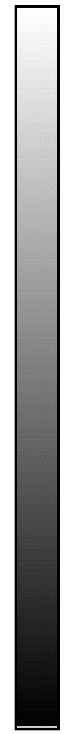
Reflection of Solar Radiation at IR3.9



- Reflection at IR3.9 is sensitive to cloud phase and very sensitive to particle size
- Higher reflection from water droplets than from ice particles
- During daytime, clouds with small water droplets (Ci, St, Sc) are much darker than ice clouds
- Marine Sc (large water droplets) is darker than Sc over land

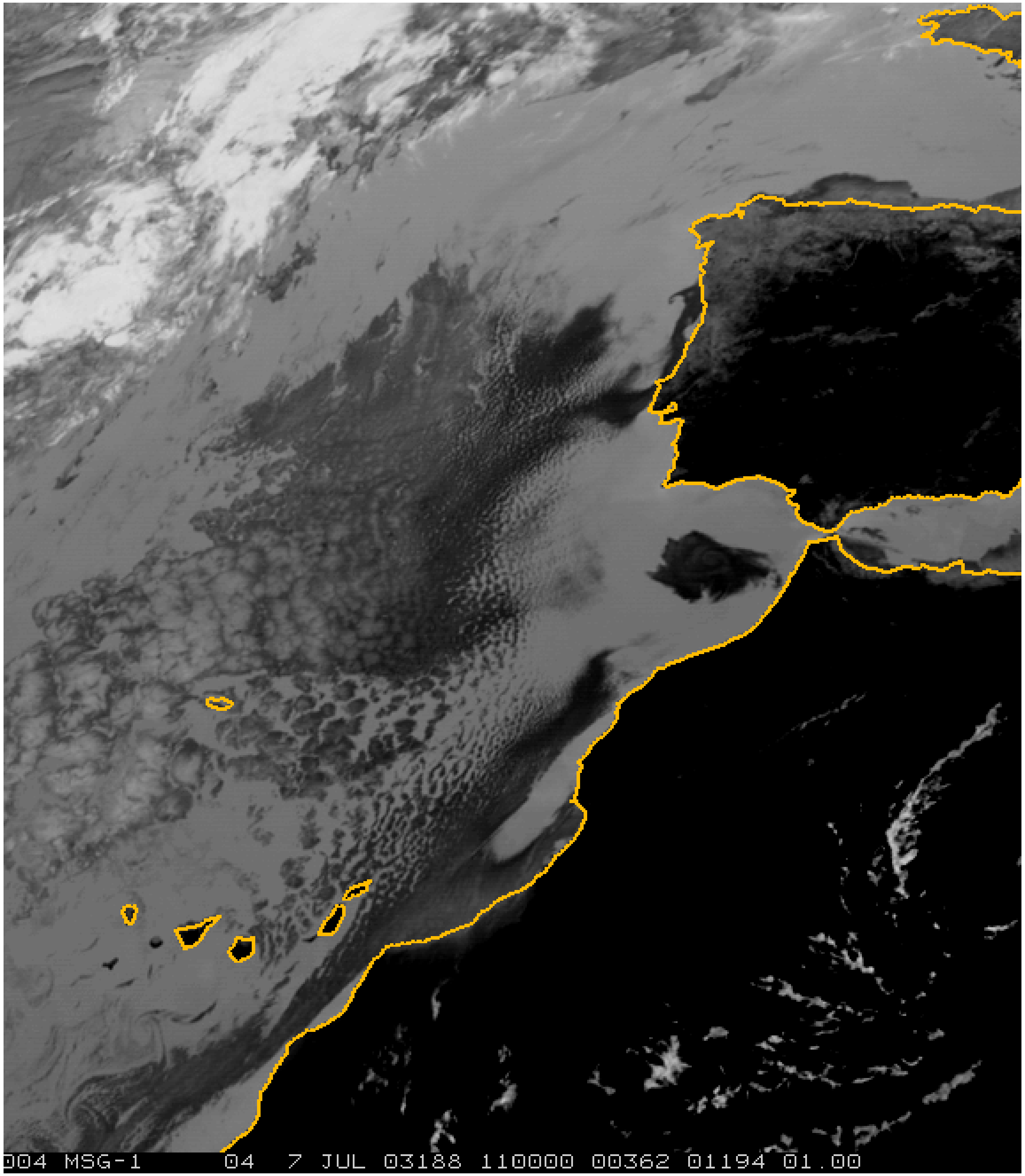
IR 3.9 µm Daytime

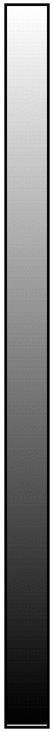




MSG-1
24 February 2003
11:00 UTC
Channel 04 (3.9 µm)

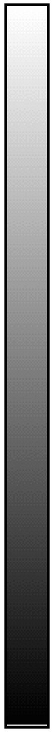
IR 3.9 µm Daytime





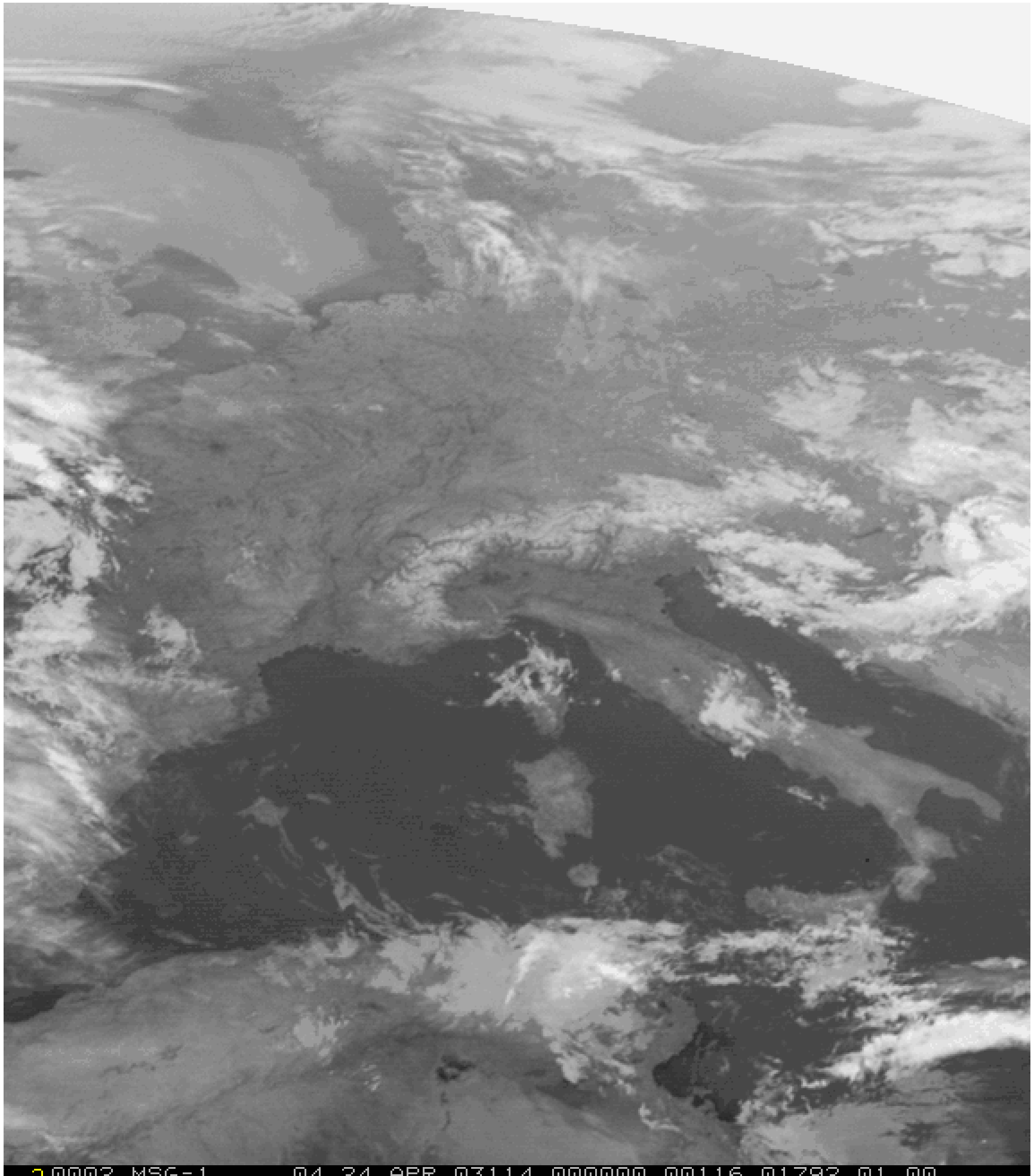
MSG-1
7 July 2003
11:00 UTC
Channel 04 (3.9 µm)

IR 3.9 µm Daytime



MSG-1
24 February 2003
12:45 UTC
Channel 04 (3.9 µm)

IR 3.9 µm Nighttime



Cold

high-level ice clouds

cold snow surfaces

mid-level clouds

low-level water clouds

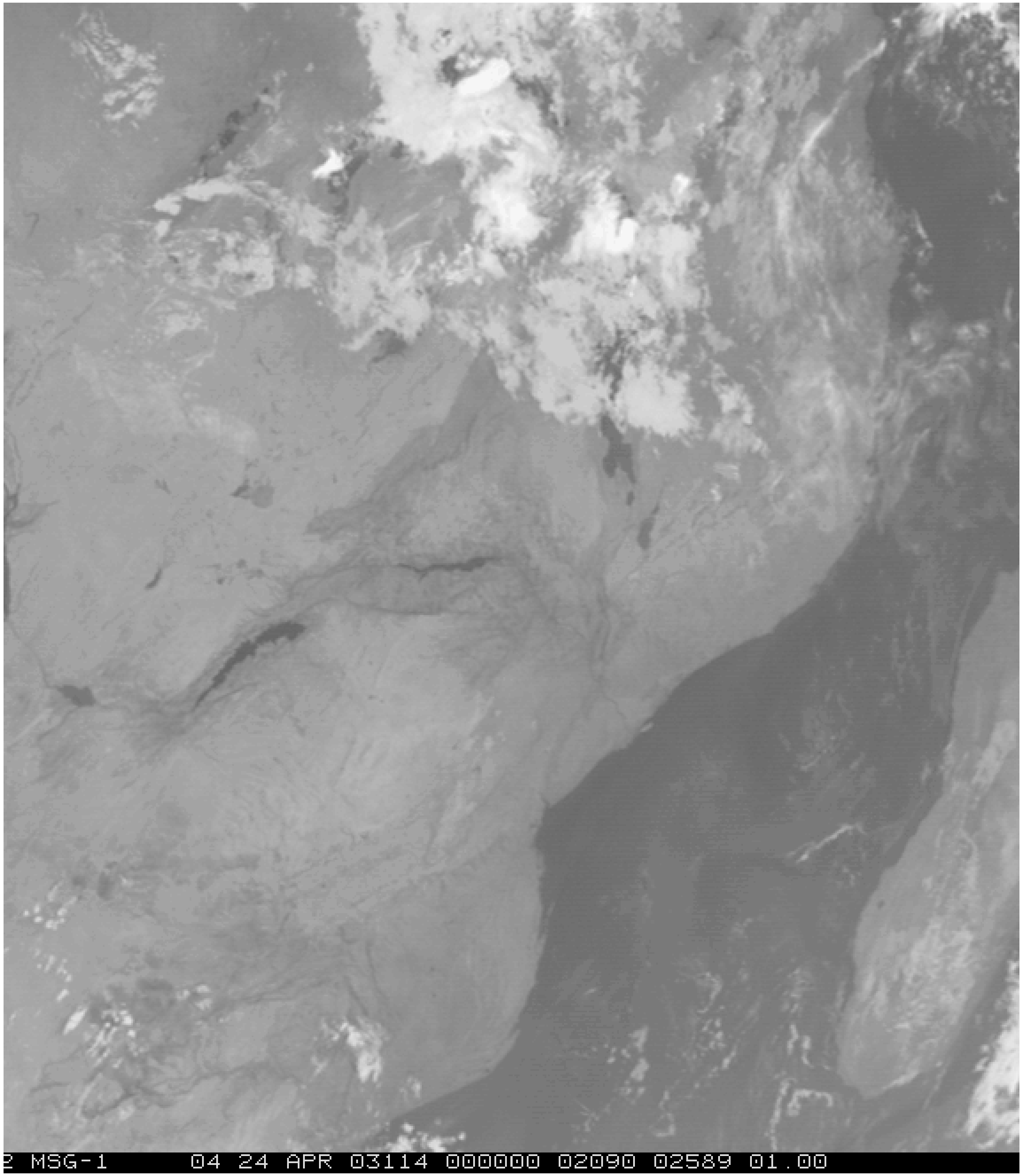
land surfaces

ocean, sea, lakes

Warm

MSG-1
24 April 2003
00:00 UTC
Channel 04 (3.9 µm)

IR 3.9 µm Nighttime



Cold

high-level ice clouds

mid-level clouds

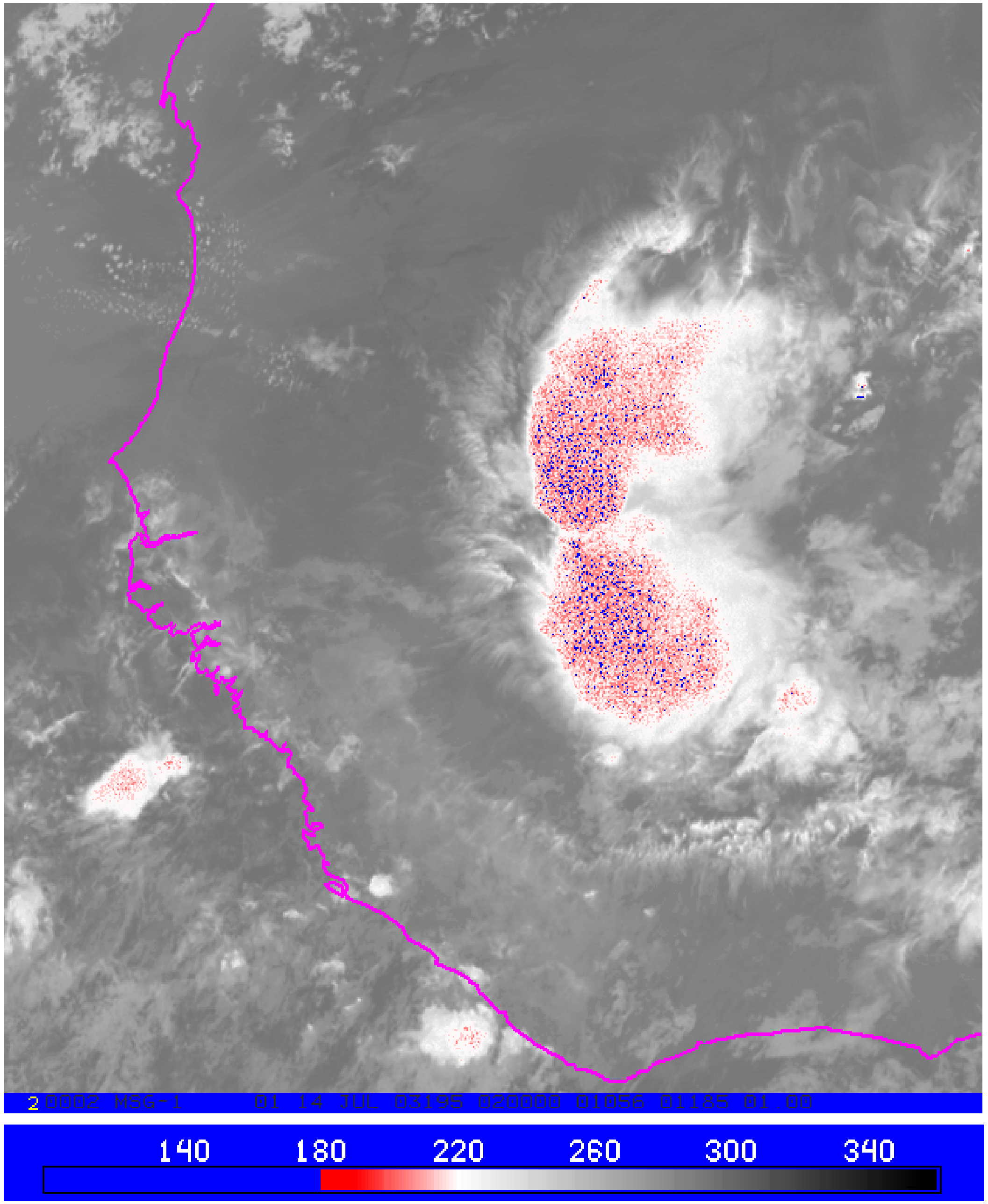
low-level water clouds

land surfaces

ocean, sea, lakes

Warm

MSG-1
24 April 2003
00:00 UTC
Channel 04 (3.9 µm)

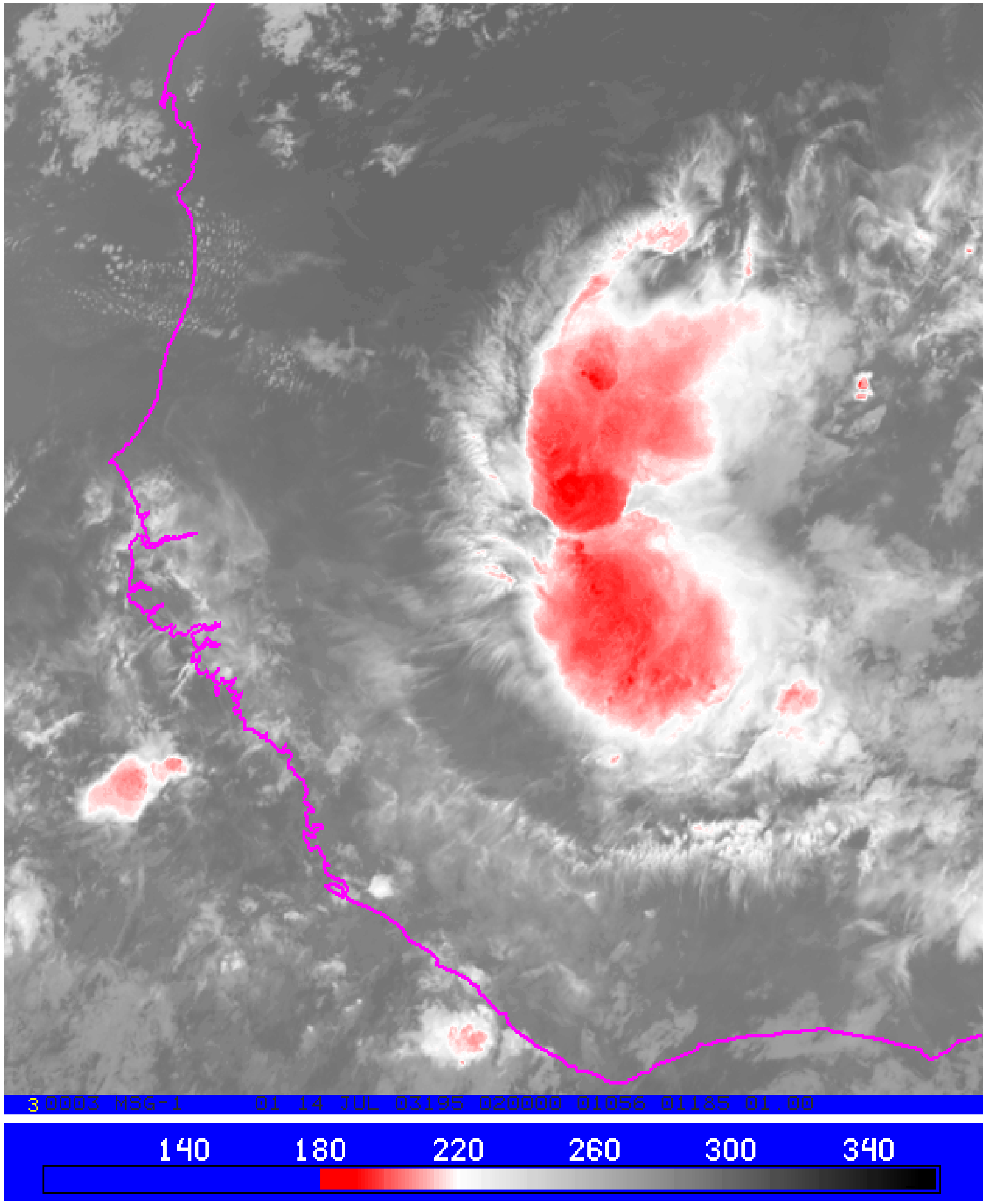


MSG-1
14 July 2003
02:00 UTC
BT IR3.9

During the night, the IR3.9 channel cannot be used for cold cloud tops.

Below BTs of 220 K the IR3.9 channel is very noisy (truncation error dominates).

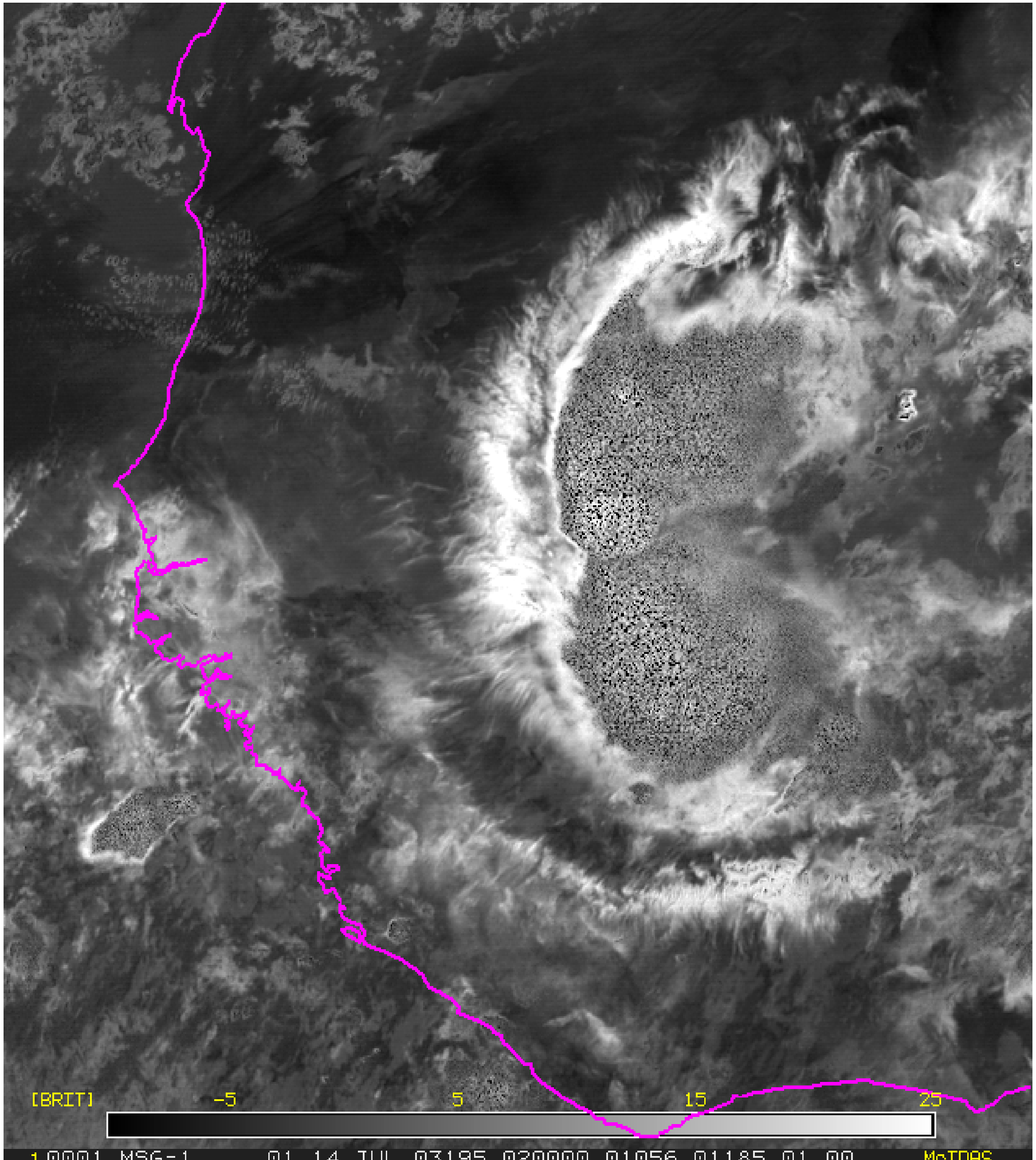
RAW [count]	RAD [mW/m^2]	TEMP [K]
54	0.01	218
53	0.01	213
52	0.00	205
51	0.00	131



Squall Line over Western Africa causing violent rainfall and sandstorms

MSG-1
14 July 2003
02:00 UTC
Channel 09 (IR10.8)

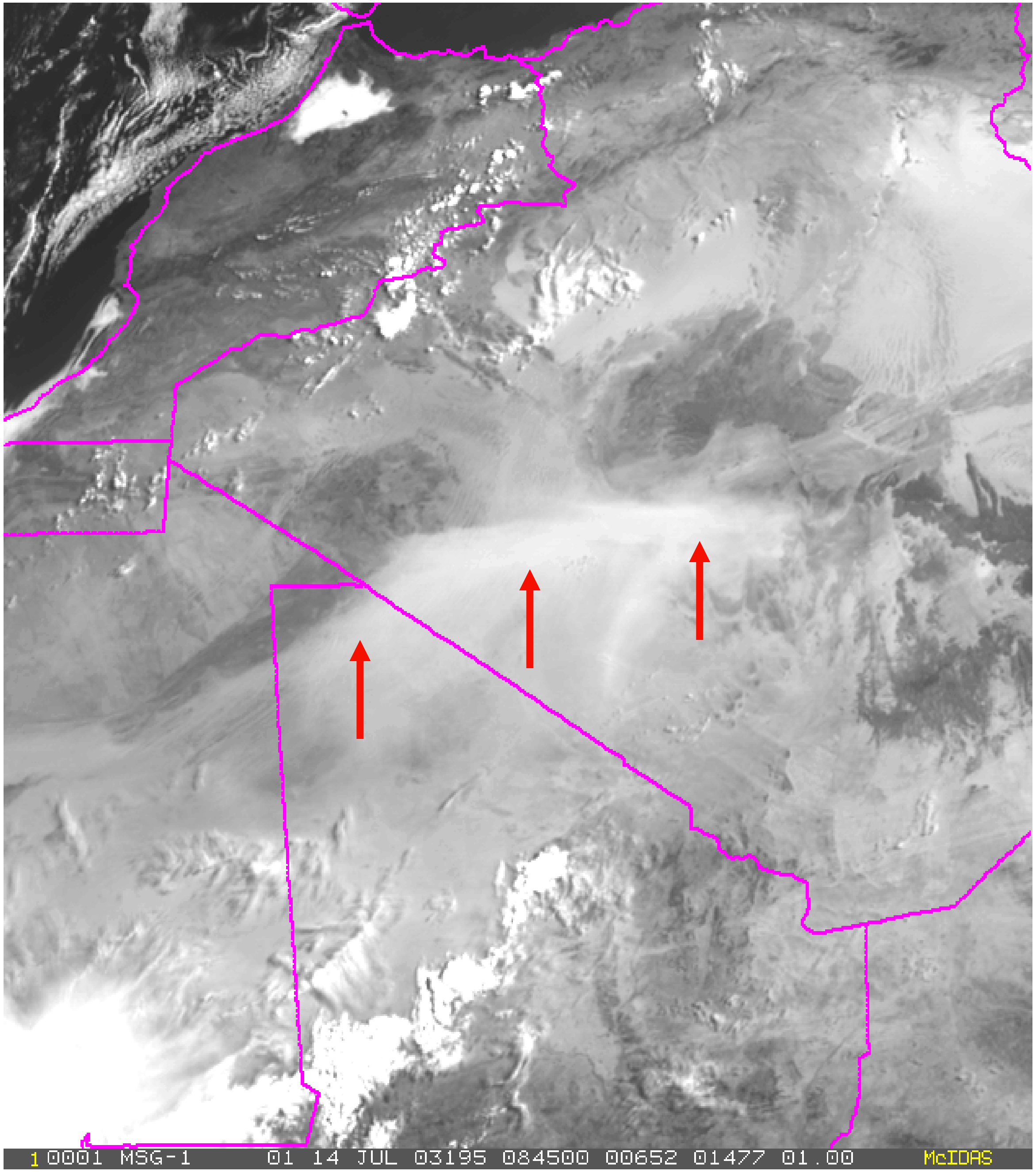
Squall Line over Western Africa causing violent rainfall and sandstorms



MSG-1
14 July 2003
02:00 UTC
Difference Image
Channels 3.9 - 10.8

Summary: Comparison IR3.9 vs IR10.8

- IR3.9 has solar contribution [daytime]
- IR3.9 is not a pure window channel (CO_2 band) ➔ Limb cooling
- Emissivities in IR3.9 differ from IR10.8
- IR3.9 is very sensitive to sub-pixel temperature variations
- Noise in IR3.9 makes it useless for $T < 220$ K
- Strong sun glint in IR3.9

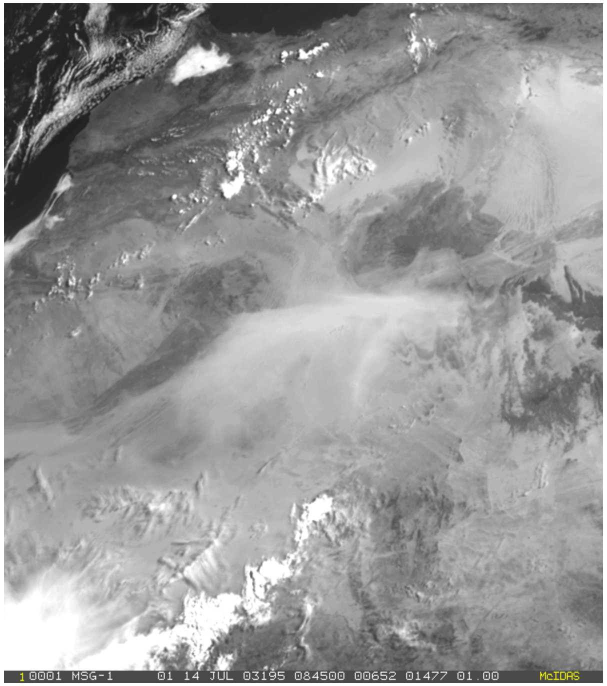


Dust and Aerosols

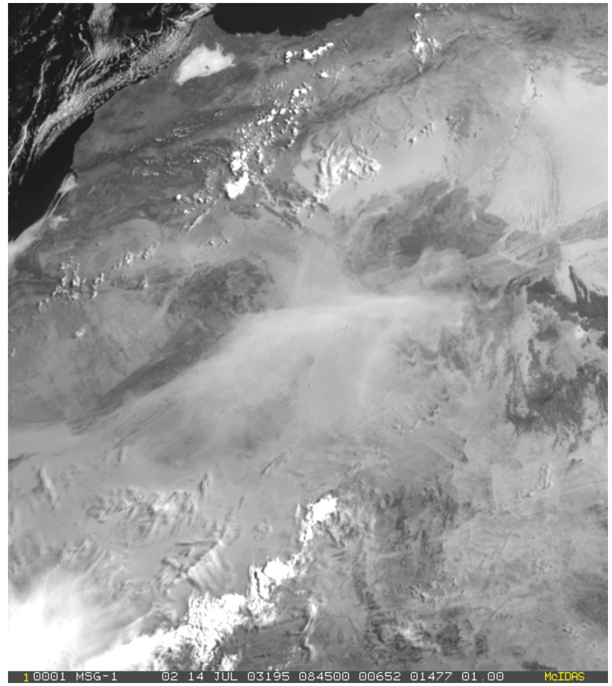
MSG imagery showing a **dust storm** over Algeria, which was triggered by a major convetive storm (squall line)

MSG-1
14 July 2003
08:45 UTC
Channel 01 (0.6 μm)

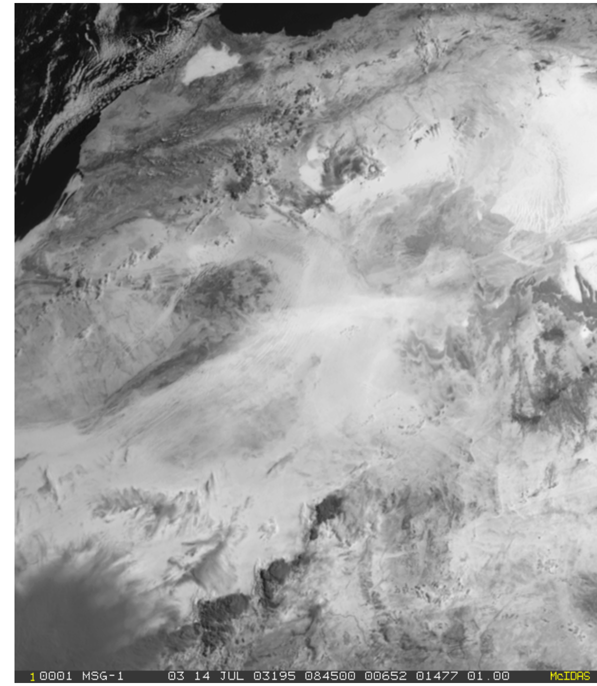
Dust and Aerosols



Channel 01 (0.6 μm)



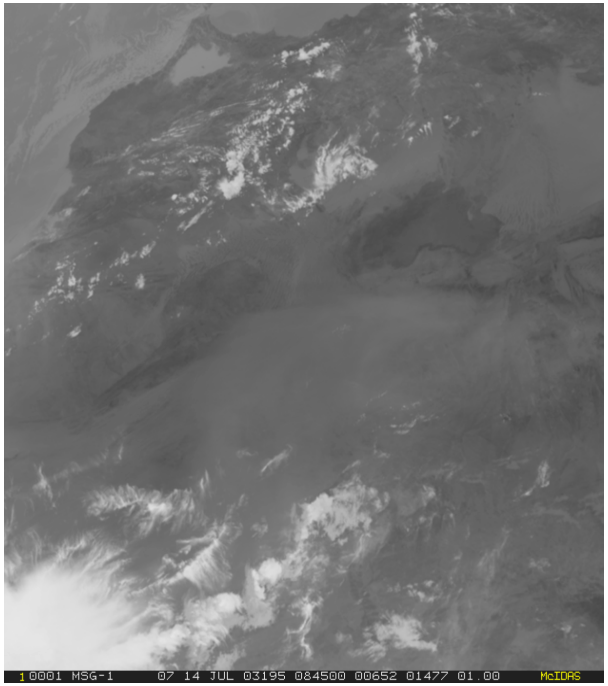
Channel 02 (0.8 μm)



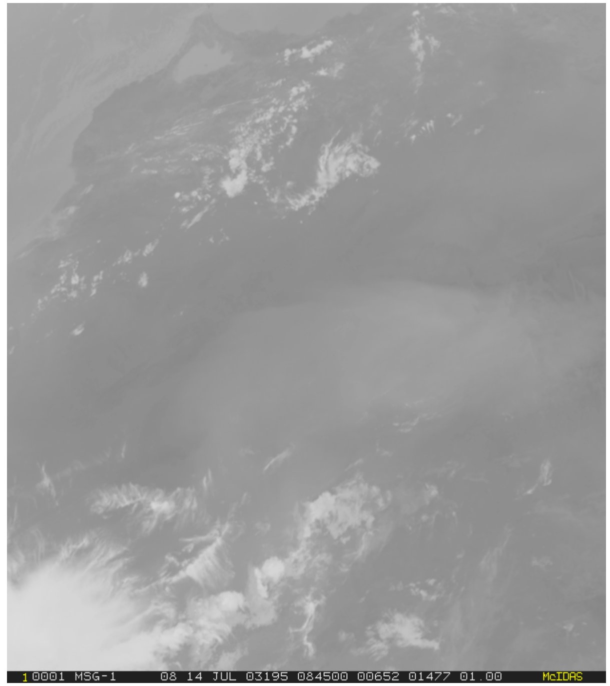
Channel 03 (1.6 μm)

MSG **VIS** imagery on 14 July 2003 at 08:45 UTC
showing a **dust storm** over Algeria

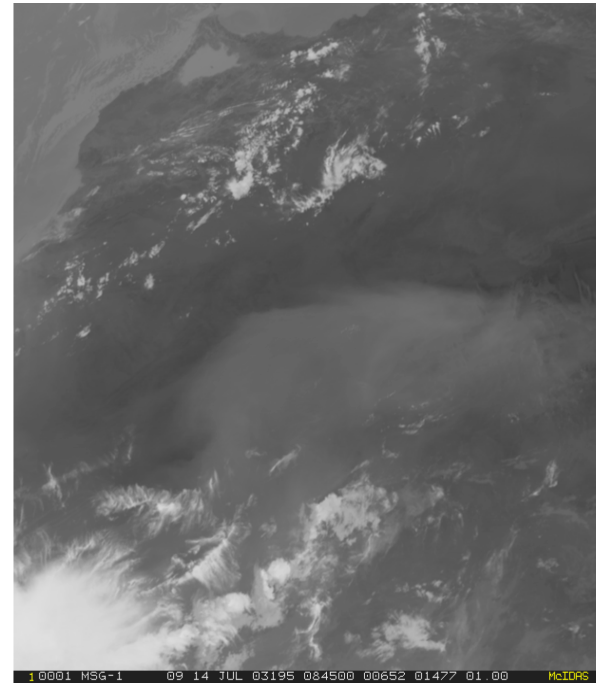
Dust and Aerosols



Channel 07 (8.7 μm)



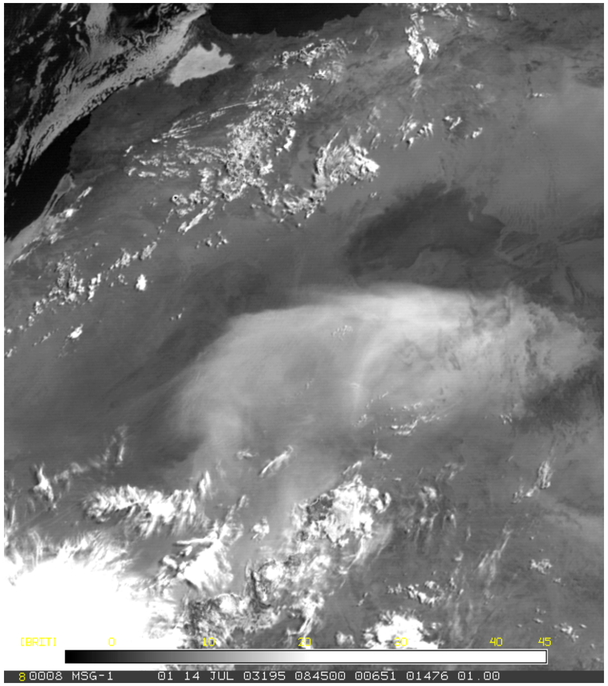
Channel 08 (9.7 μm)



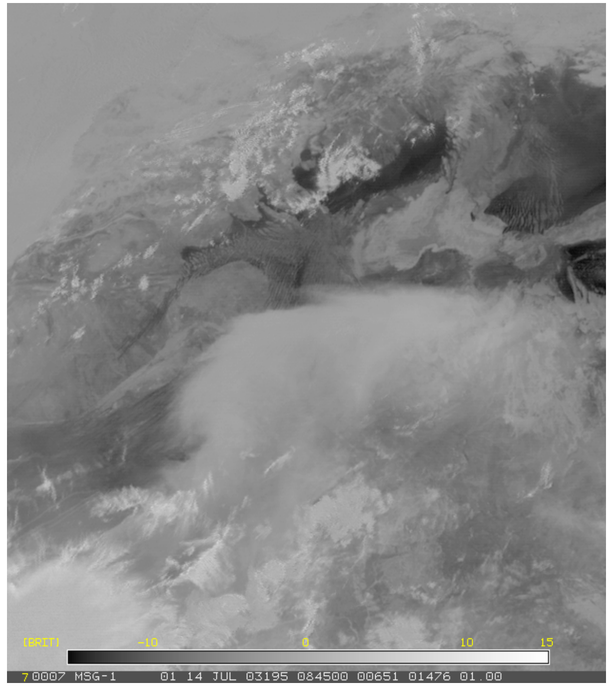
Channel 09 (10.8 μm)

MSG **IR** imagery on 14 July 2003 at 08:45 UTC
showing a **dust storm** over Algeria

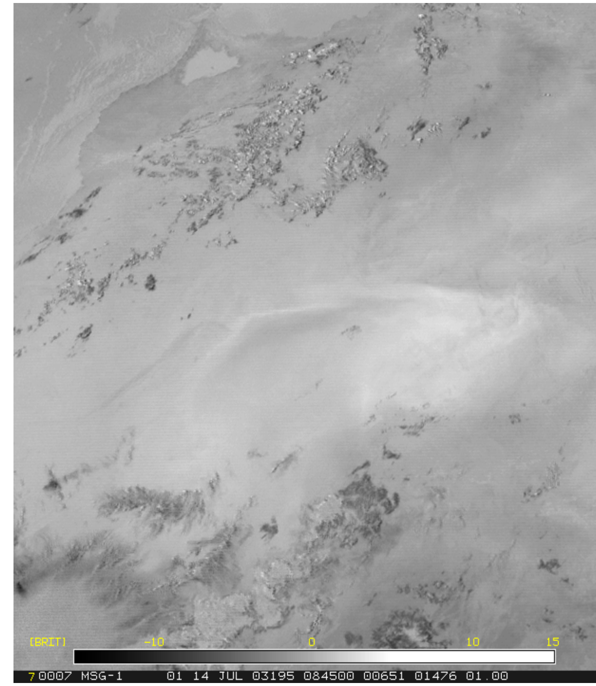
Dust and Aerosols



Diff. 3.9 µm - 10.8 µm



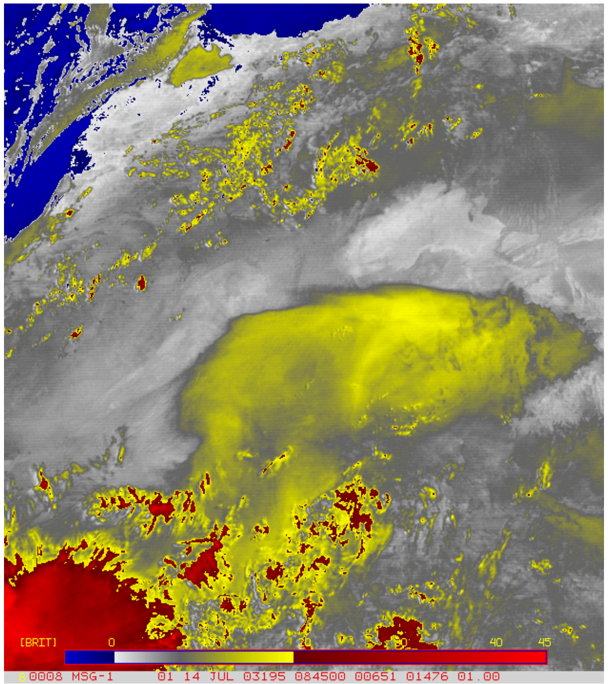
Diff. 8.7 µm - 10.8 µm



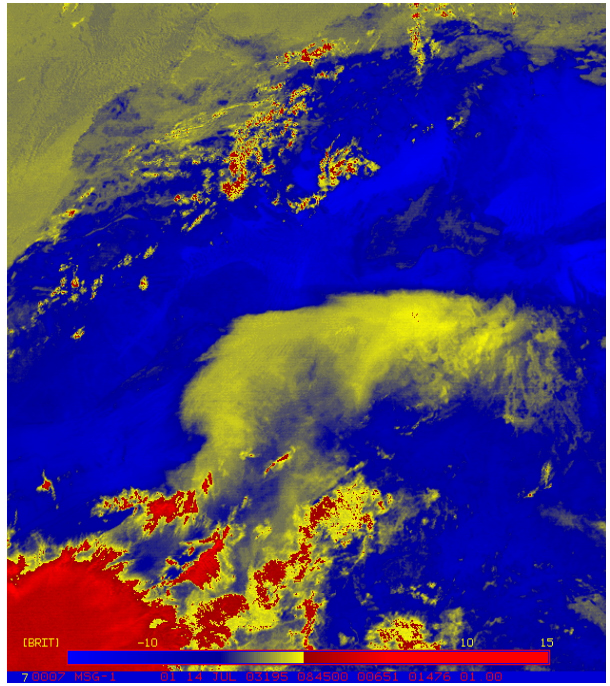
Diff. 12.0 µm - 10.8 µm

MSG imagery on 14 July 2003 at 08:45 UTC
showing a **dust storm** over Algeria

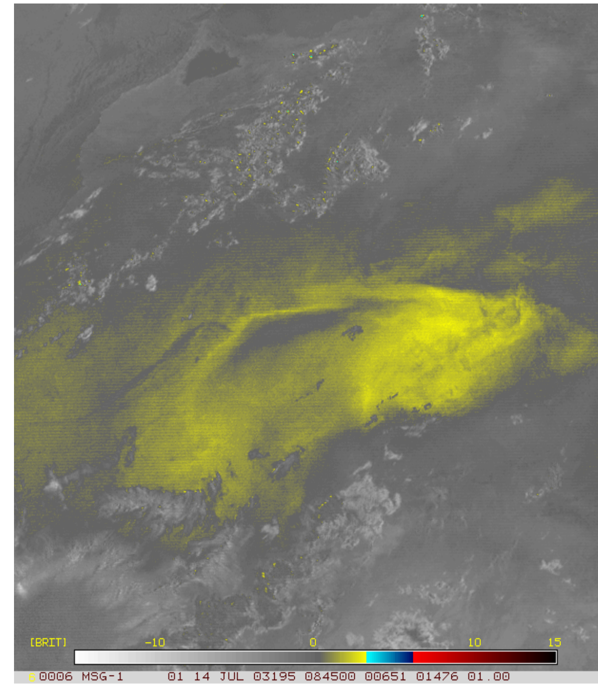
Dust and Aerosols



Diff. 3.9 μm - 10.8 μm



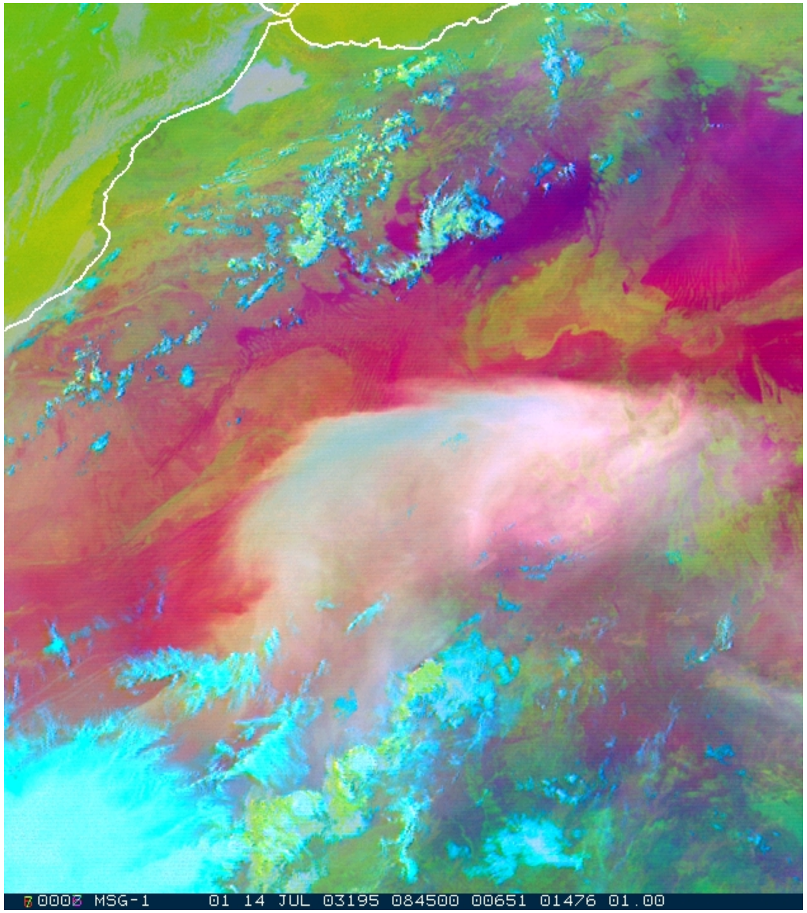
Diff. 8.7 μm - 10.8 μm

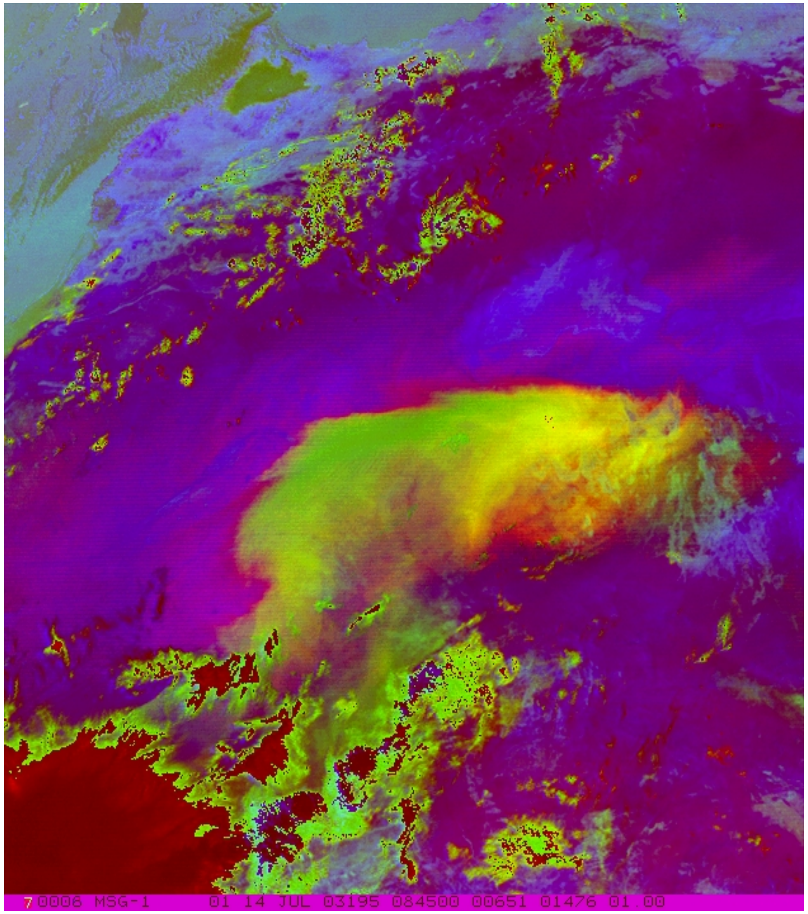


Diff. 12.0 μm - 10.8 μm

MSG enhanced imagery on 14 July 2003 at 08:45 UTC
showing a **dust storm** over Algeria

Dust and Aerosols

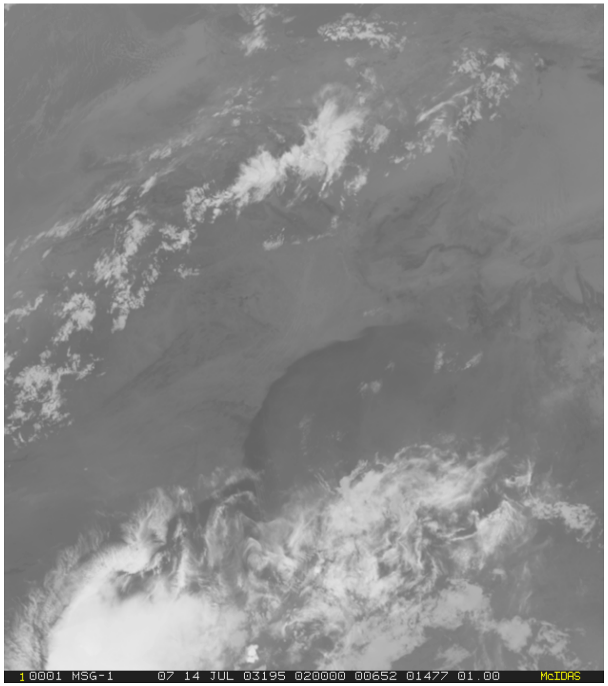




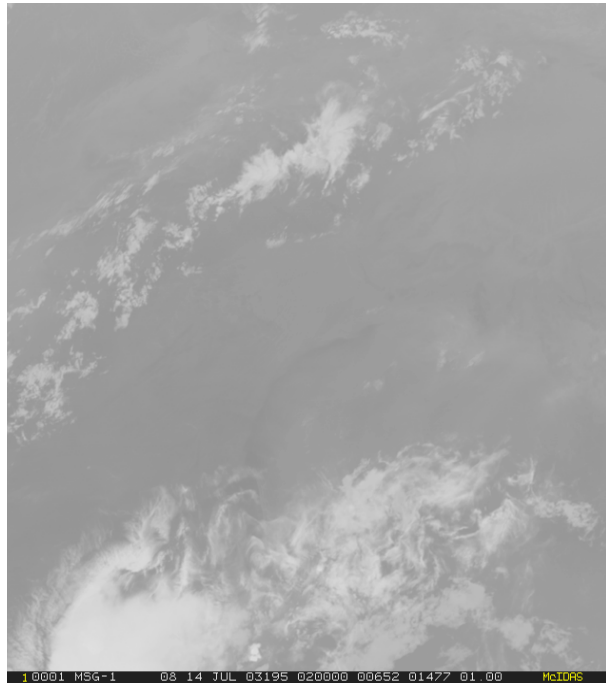
RGB 12.0-10.8 / 8.7-10.8 / 3.9-10.8

MSG RGB imagery on 14 July 2003 at 08:45 UTC
showing a **dust storm** over Algeria

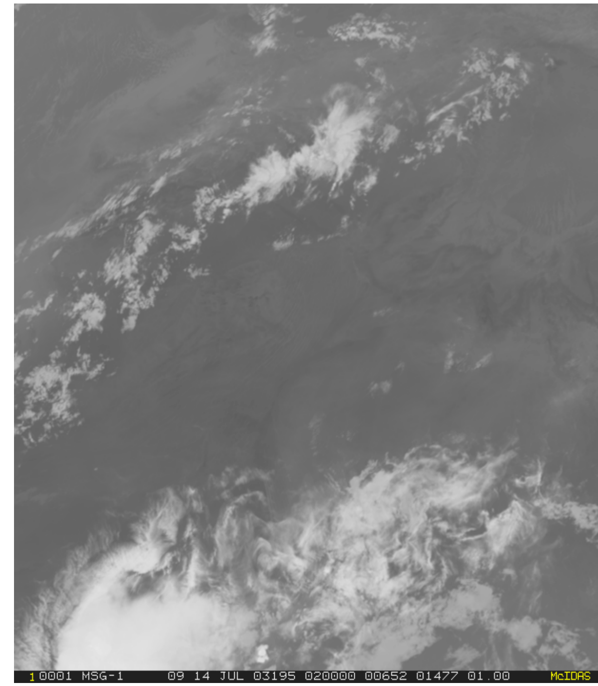
Dust and Aerosols



Channel 07 (8.7 µm)



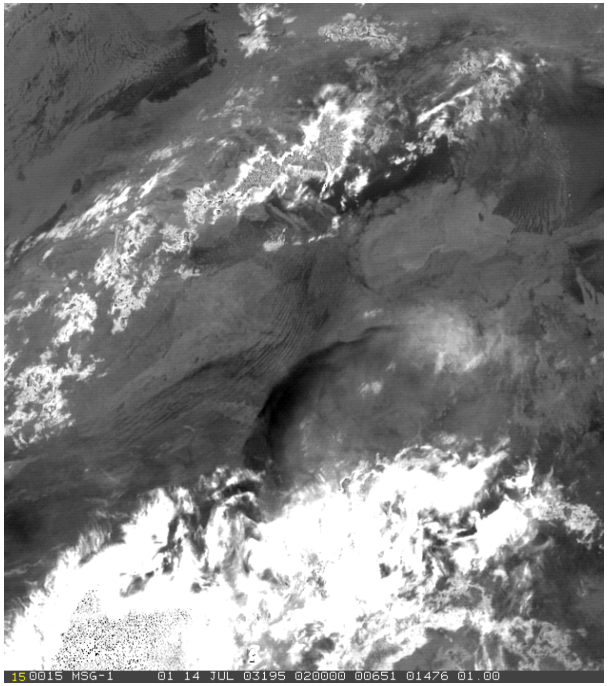
Channel 08 (9.7 µm)



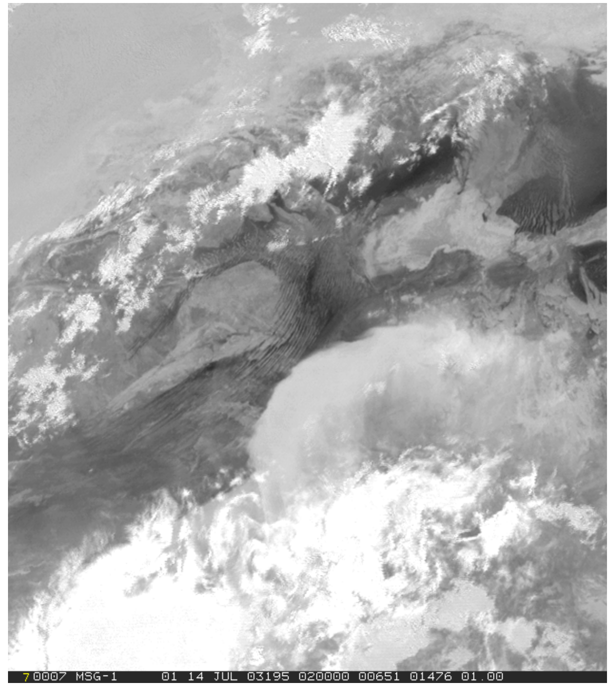
Channel 09 (10.8 µm)

MSG **IR** imagery on 14 July 2003 at 02:00 UTC
showing a **dust storm** over Algeria

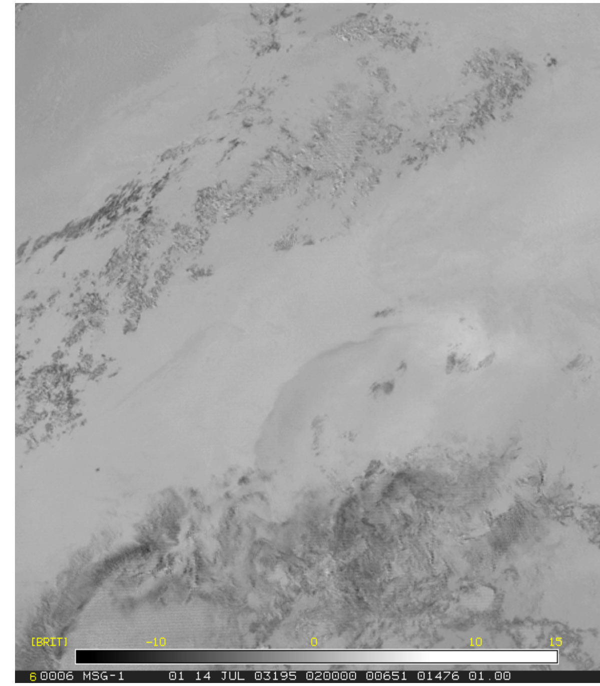
Dust and Aerosols



Diff. 3.9 μm - 10.8 μm



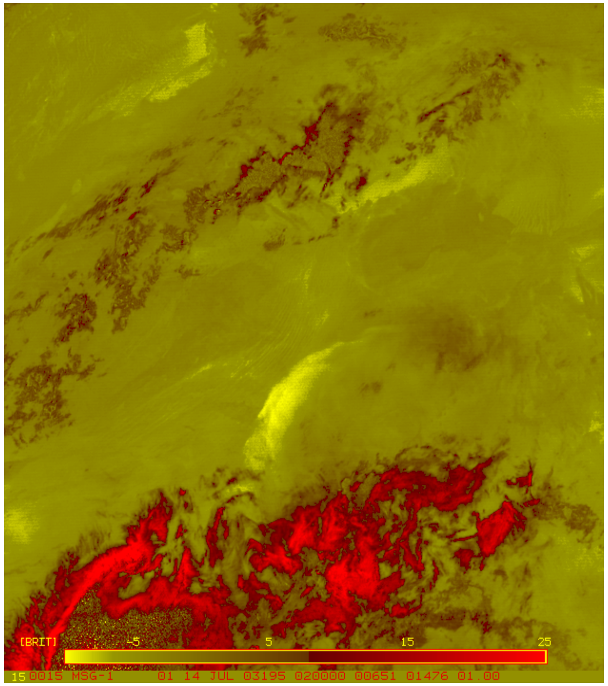
Diff. 8.7 μm - 10.8 μm



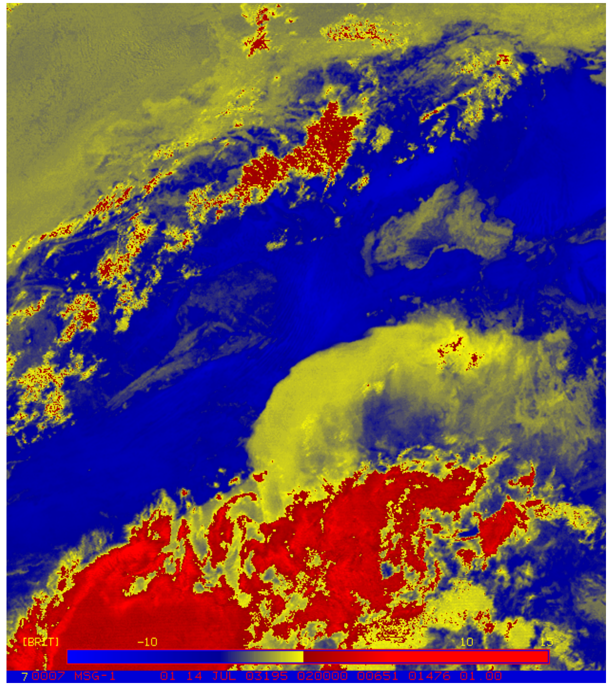
Diff. 12.0 μm - 10.8 μm

MSG imagery on 14 July 2003 at 02:00 UTC
showing a **duststorm** over Algeria

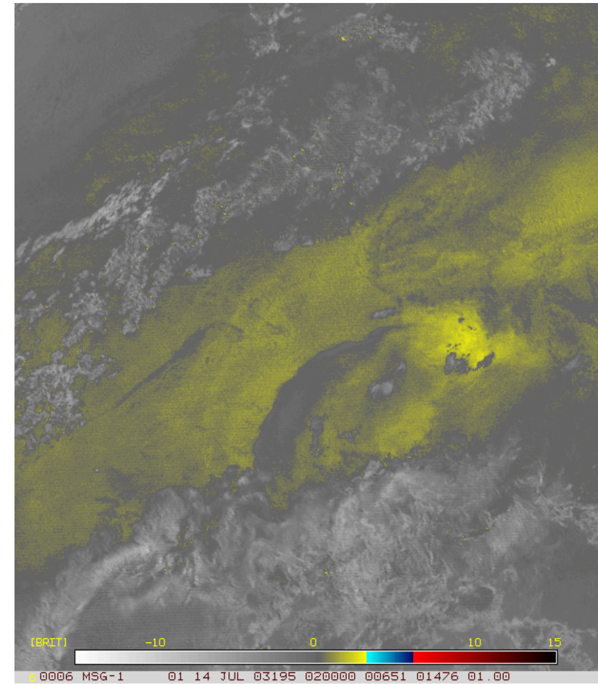
Dust and Aerosols



Diff. 3.9 µm - 10.8 µm

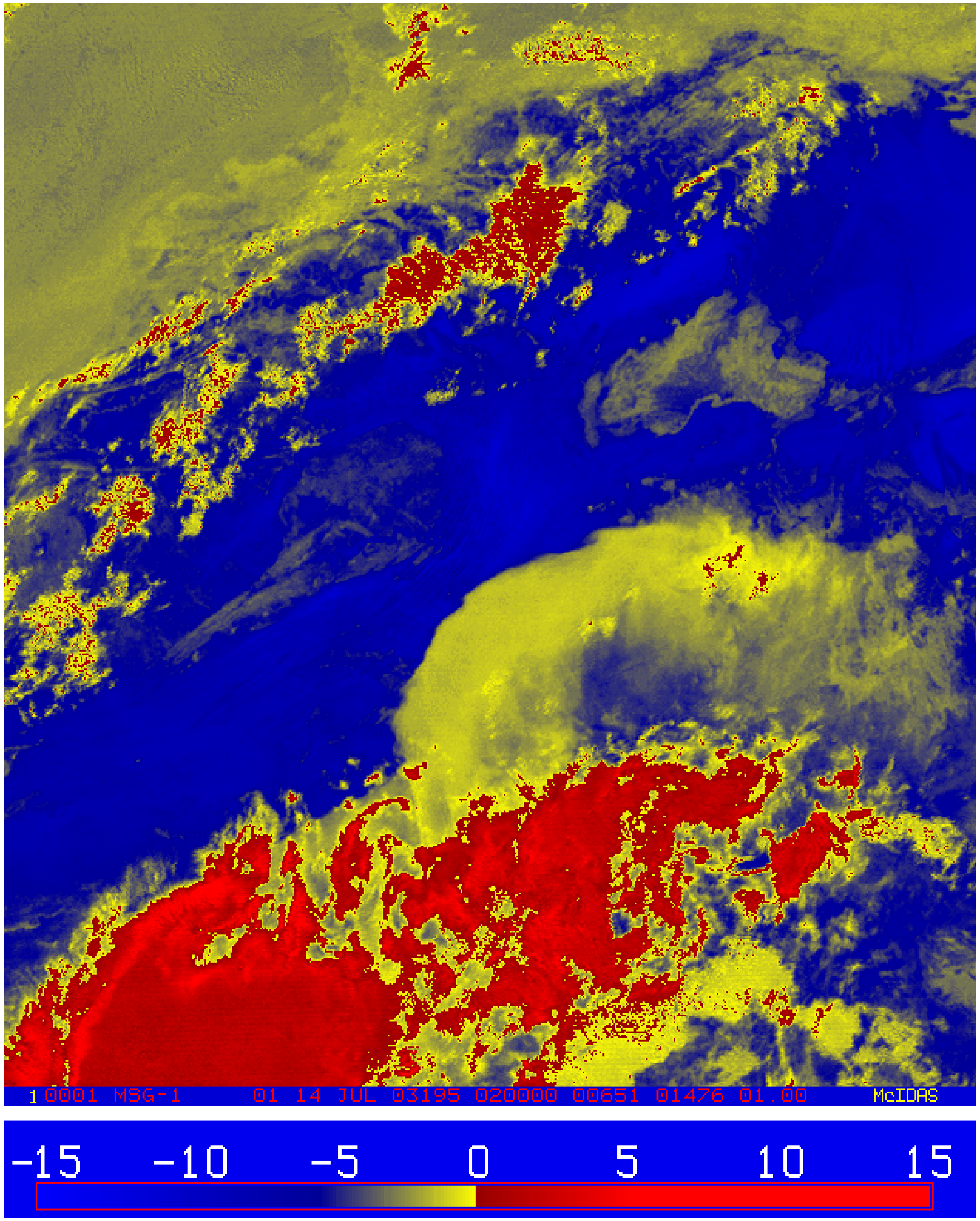


Diff. 8.7 µm - 10.8 µm



Diff. 12.0 µm - 10.8 µm

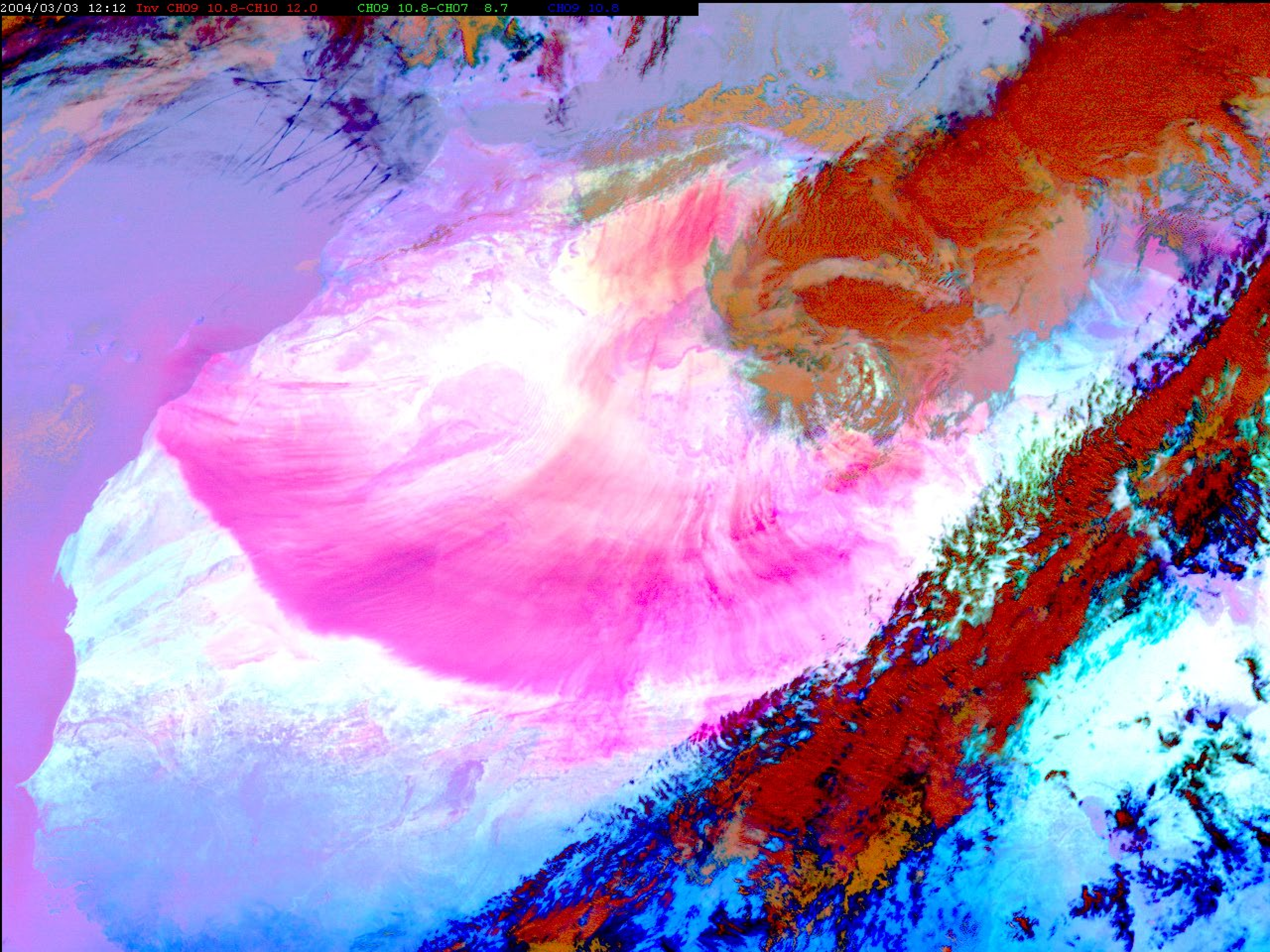
MSG enhanced imagery on 14 July 2003 at 02:00 UTC
showing a **duststorm** over Algeria



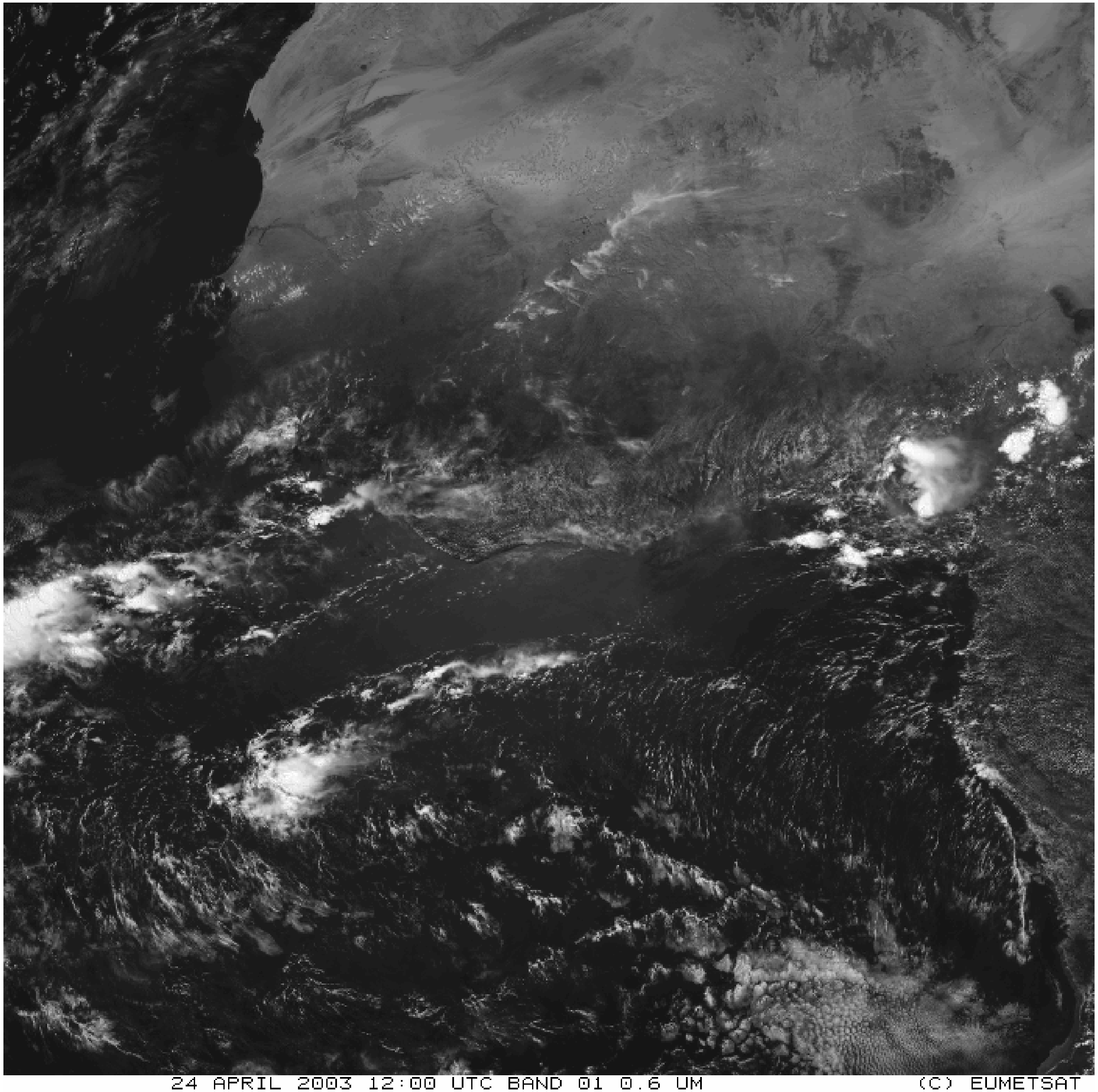
Dust and Aerosols

MSG-1
14 July 2003
02:00-08:30 UTC
Animation of
Difference Images
Channels 8.7 - 10.8

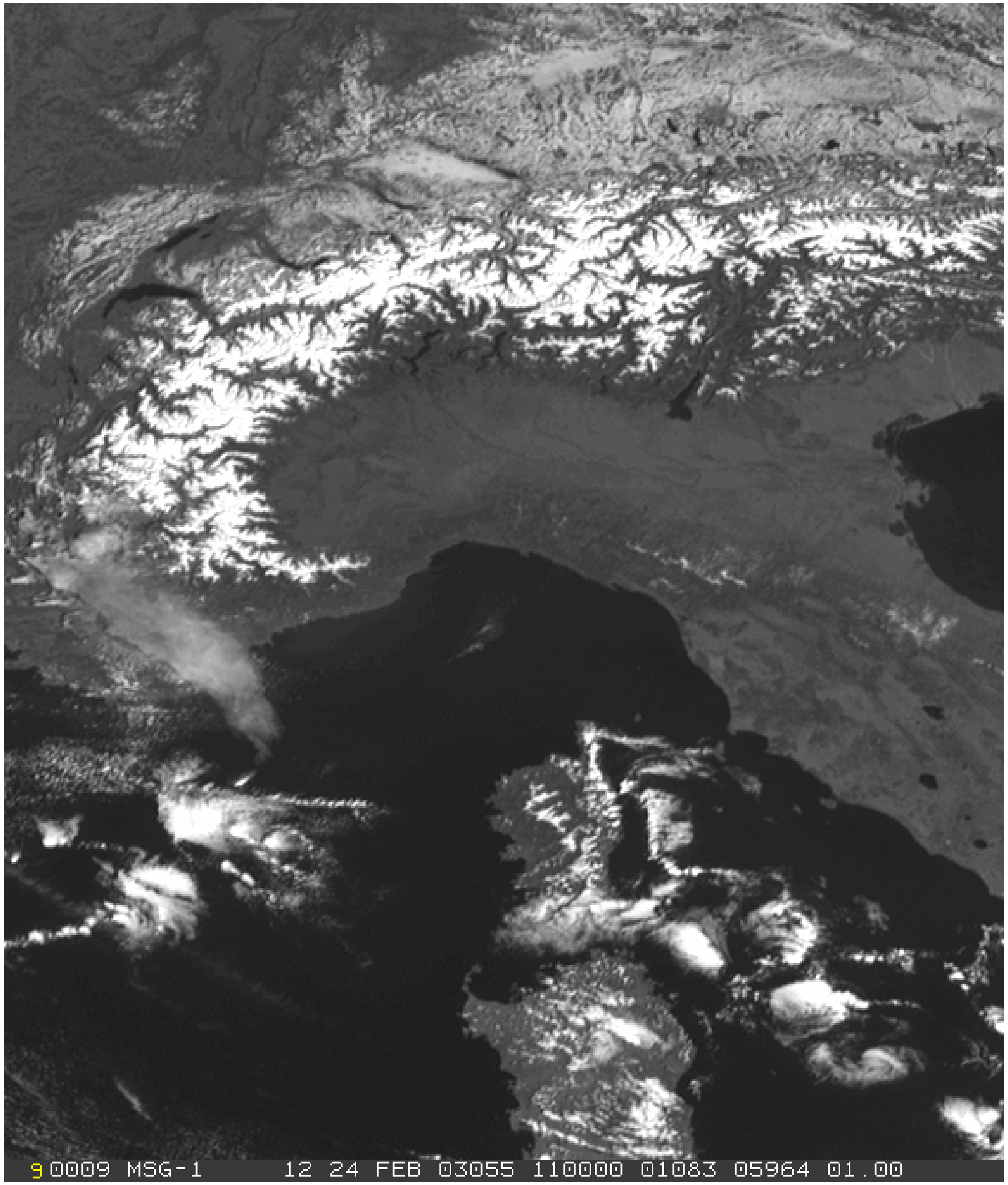
Monitoring of thin Cirrus clouds, but also very useful for detecting dust storms over deserts.


2004/03/03 12:12 Inv CH09 10.8-CH10 12.0 CH09 10.8-CH07 8.7 CH09 10.8

Some more example loops



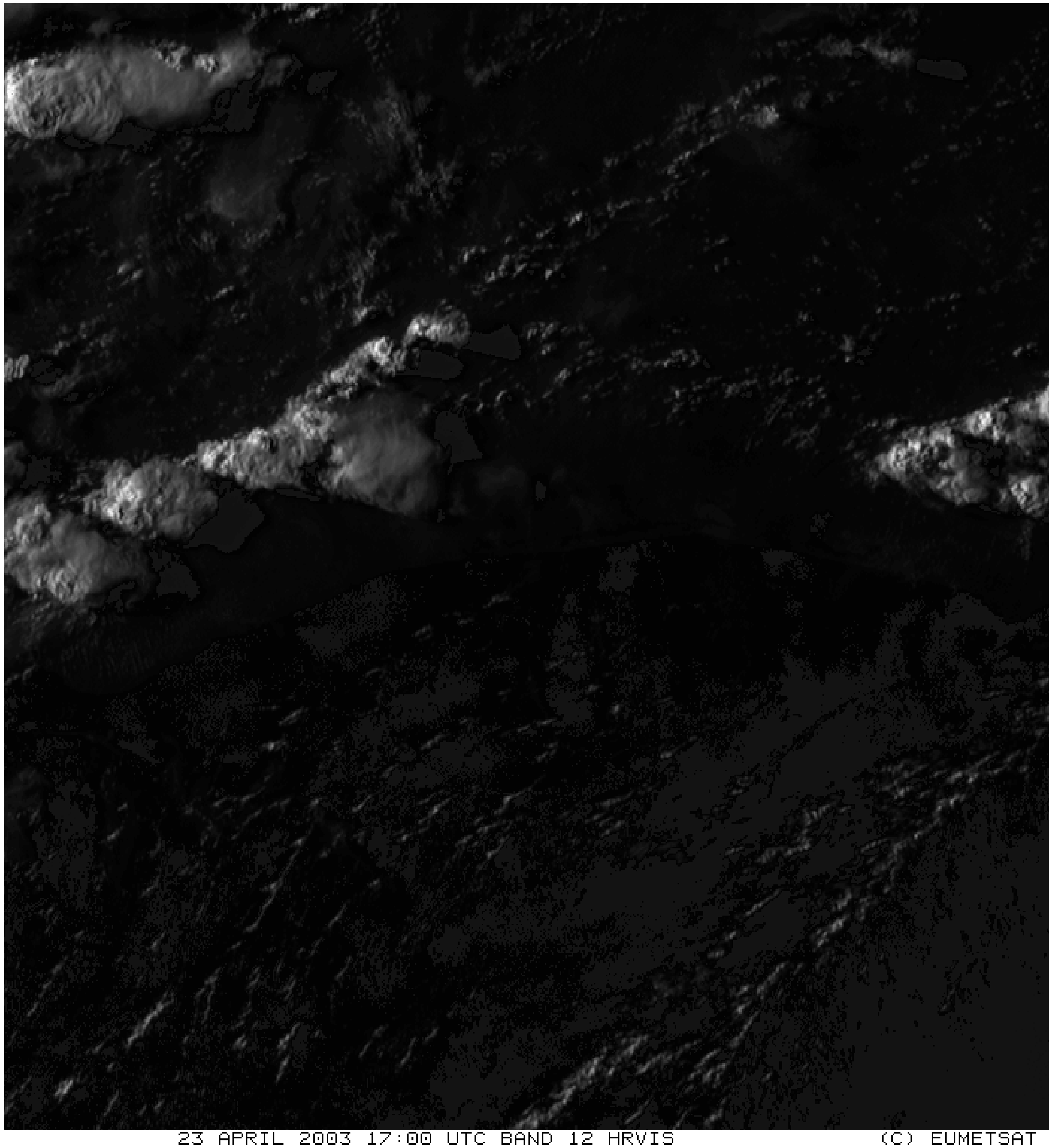
SEVIRI Channels 1 - 11 on MSG-1 24 Apr 03



HRV sequence over the Alps

12 Feb 2002

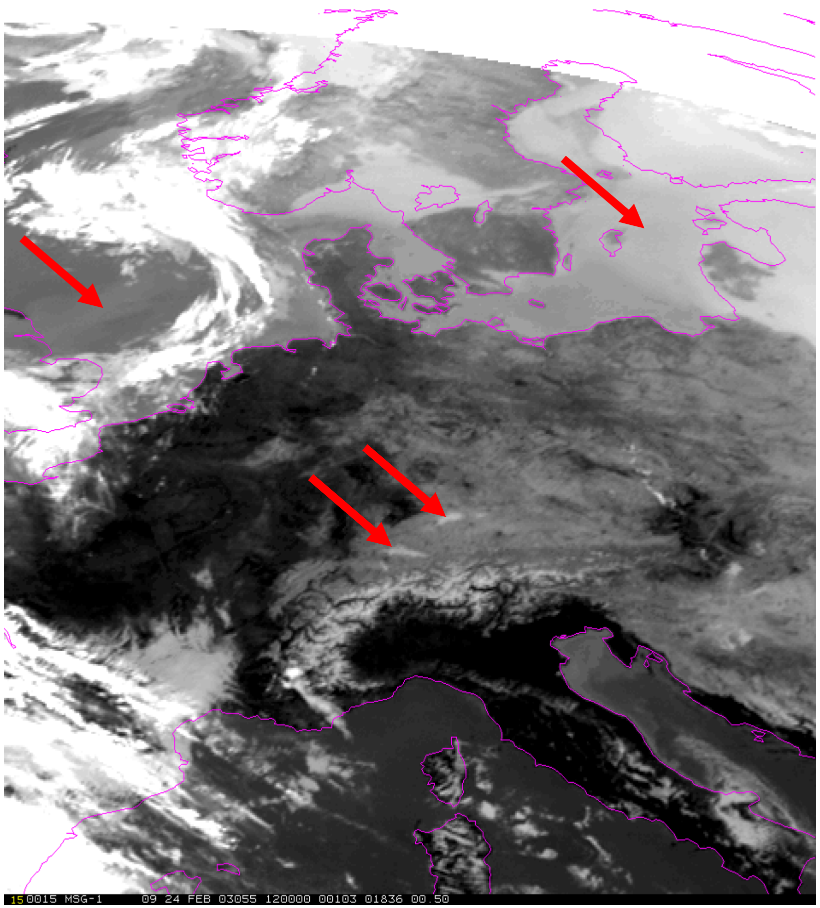
from 11:00 to 12:45 UTC



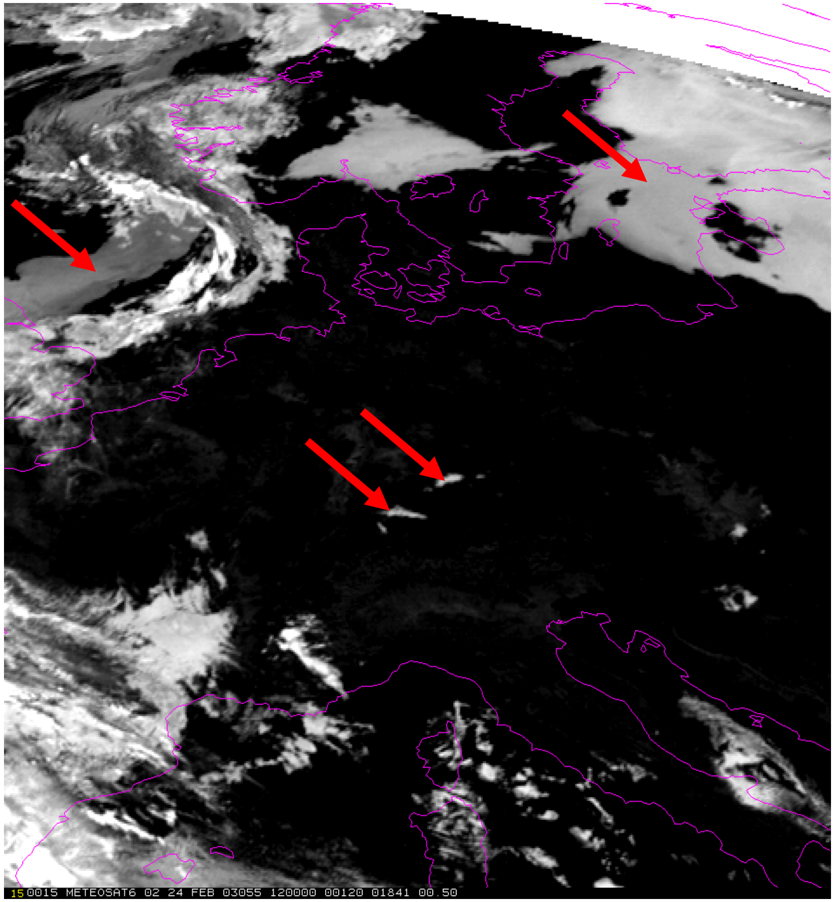
24 hours of MSG HRV over the tropics

Sea Breeze

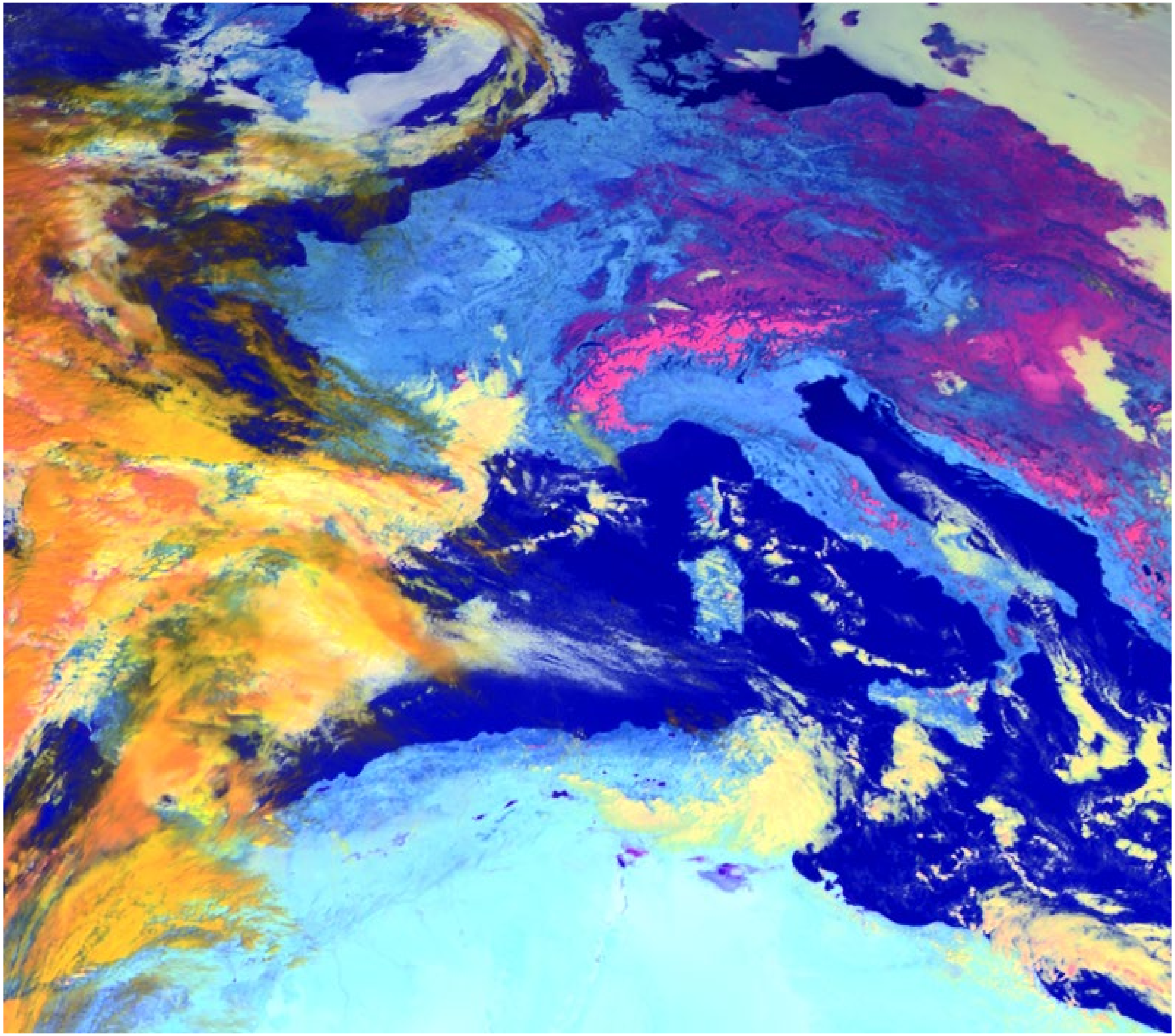
Example of fog detection



MSG 10.8 µm channel only

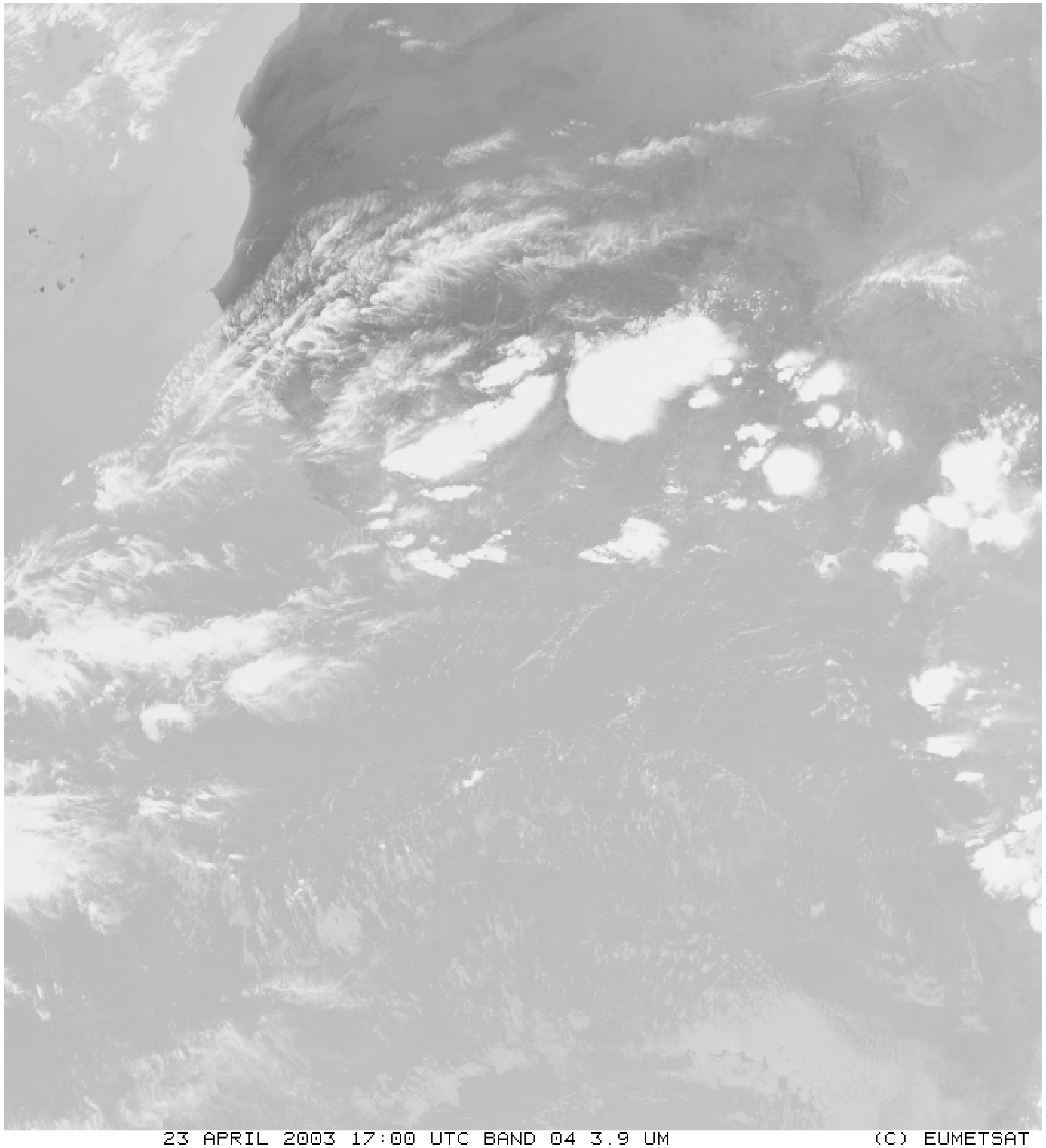


3.9 minus 10.8 µm channel



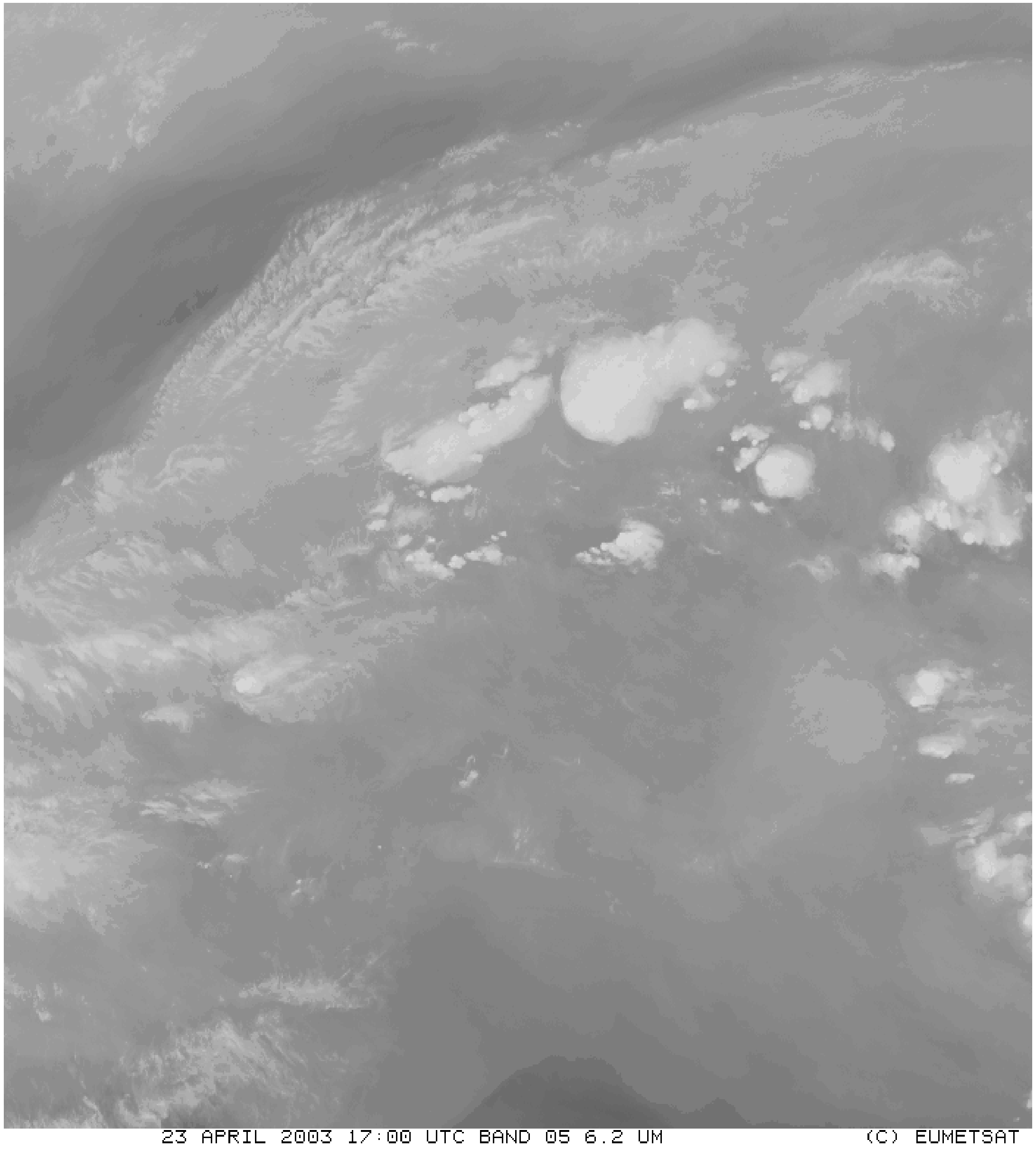
MSG
24 Feb 03

red = 0.6 µm
green = 1.6 µm
blue = 10.8 µm



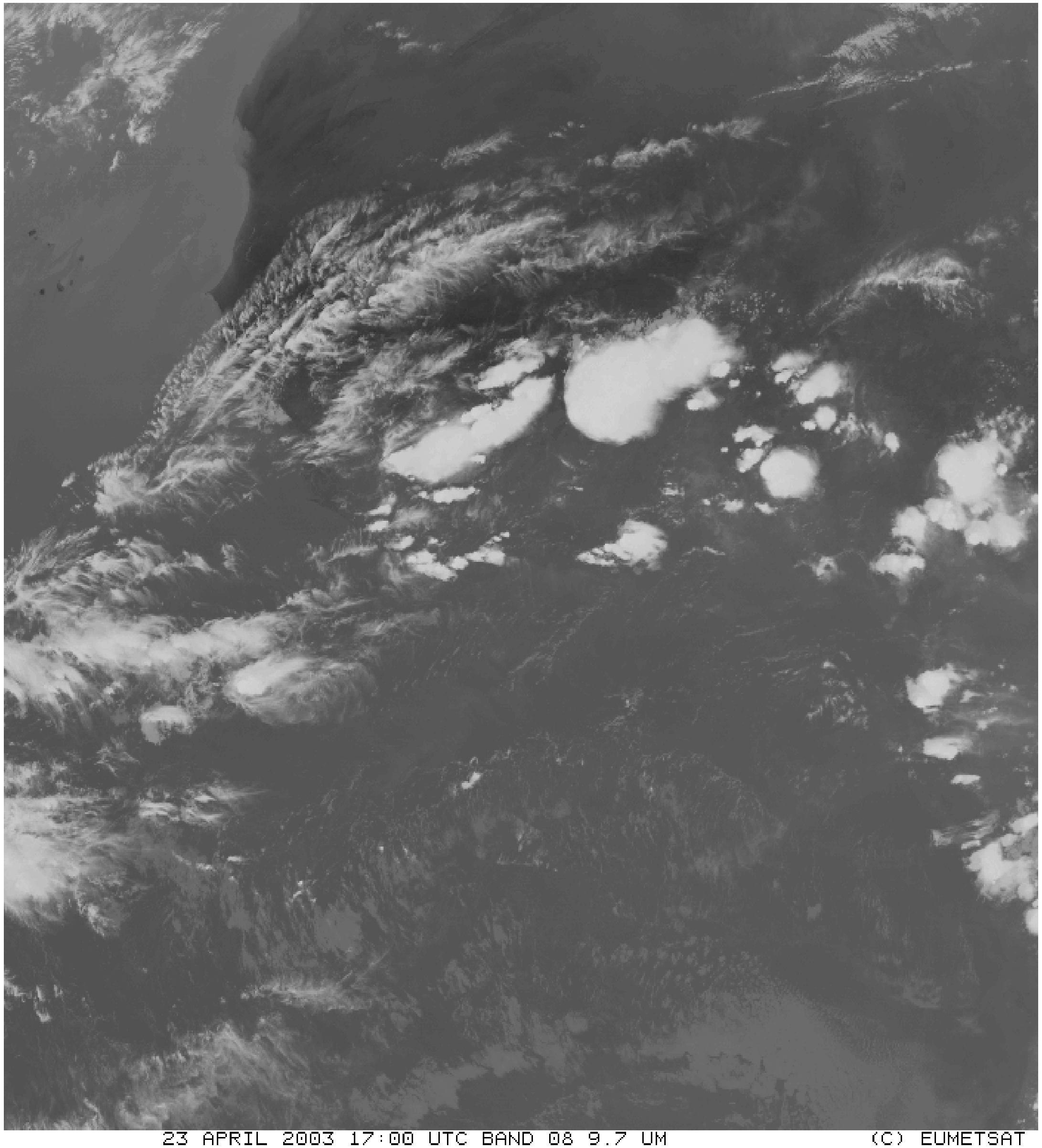
24 hr sequence of MSG 3.9 µm over the tropics

Sun-glint;
Diurnal cycle of the low cloud top temps show the reflected solar contribution

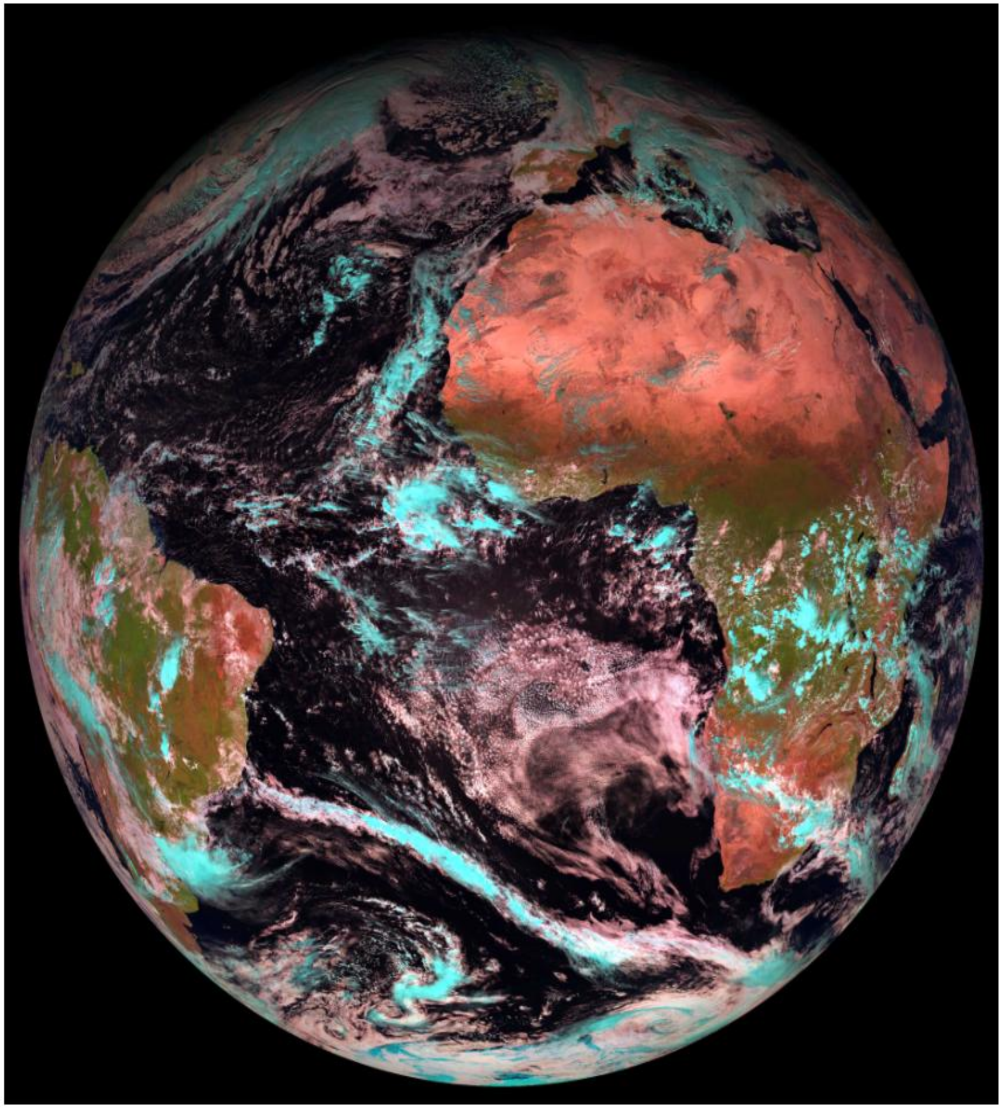


24 hr sequence of MSG 6.2 µm over the tropics

Build up of convection

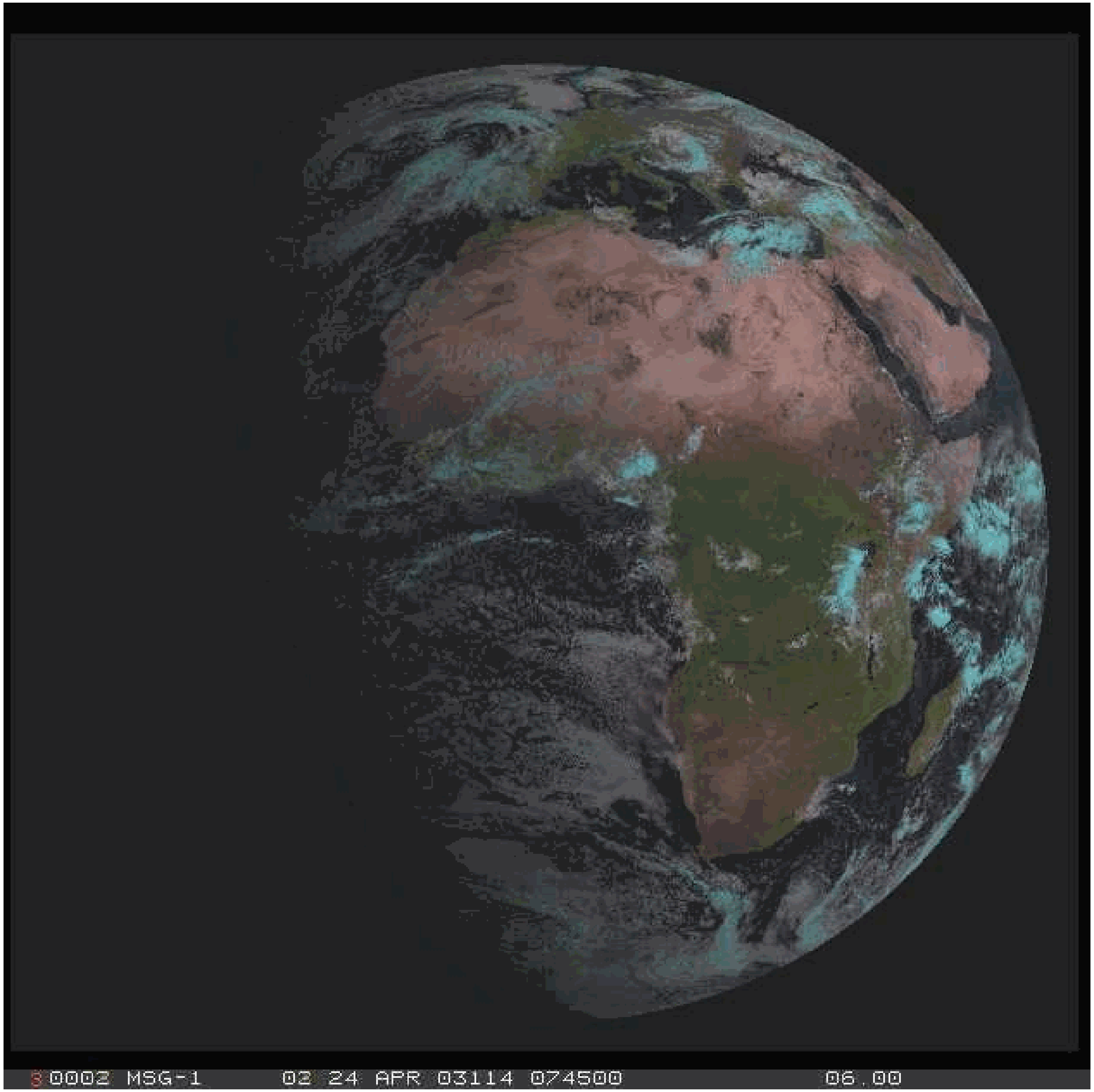


24 hr sequence of MSG 9.7 µm over the tropics



MSG-1 SEVIRI RGB Image:

0.6 µm => blue
0.8 µm => green
1.6 µm => red



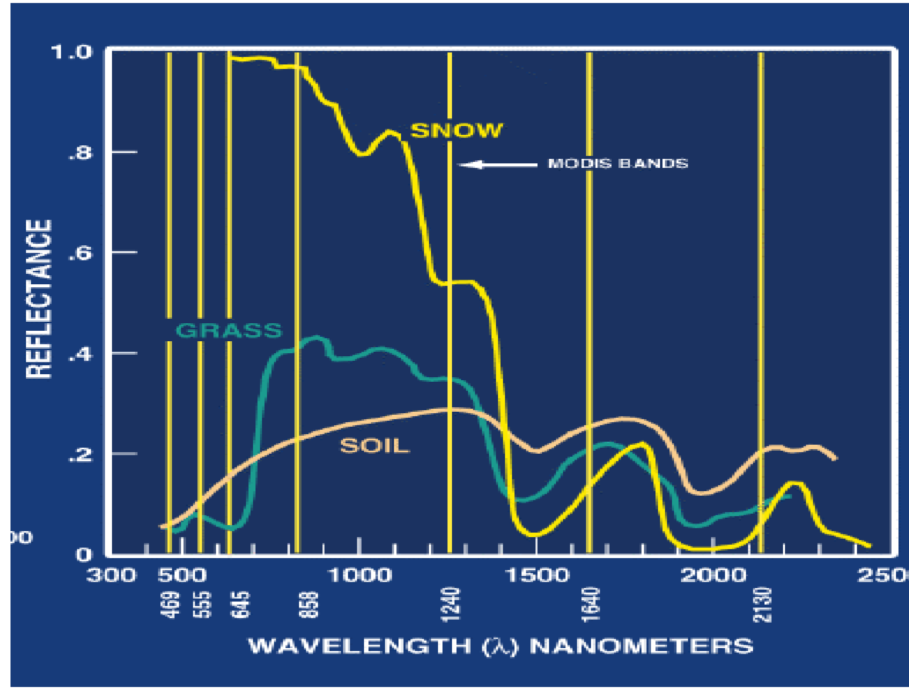
24 hr sequence MSG RGB over the tropics

Red
Green
Blue

Products from the Central Processing at EUMETSAT

MPEF = Meteorological Product Extraction Facility

- Atmospheric Motion Vectors (AMV)
- Calibration Monitoring (CAL-MON)
- Clear Sky Radiance (CSR)
- Climate Data Set (CDS)
- Cloud Analysis (CLA)
- Cloud Top Height (CTH)
- Global Instability (GI)
- ISCCP Data Set (IDS)
- GPCP Precipitation Index (PI)
- Total Ozone (TOZ)
- Tropospheric Humidity (TH)



Detecting Clouds (vis)

Reflectance Threshold Test

r3.9 > 6% considered to be cloudy and < 3% considered to be snow/ice

problems in bright deserts

Reflectance Ratio Test

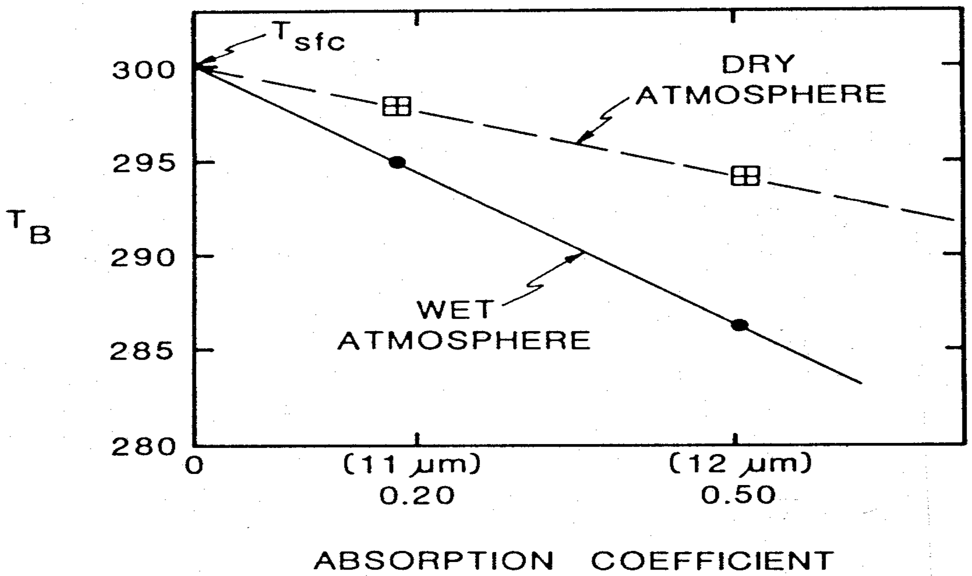
r.84/r.63 between 0.9 and 1.1 for cloudy regions

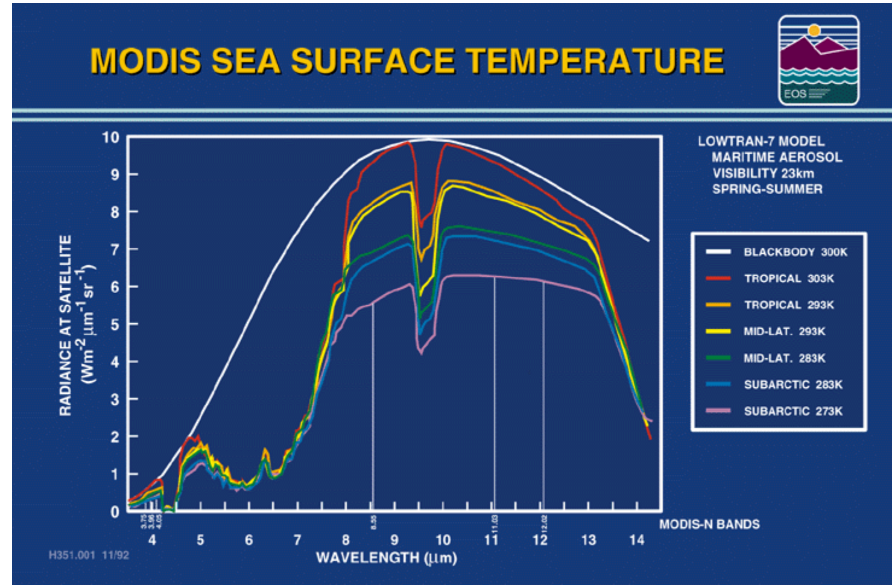
must be ecosystem specific

Snow Test

NDSI = [r.63-r1.6]/ [r.63+r1.6] > 0.4 and r.84 > 0.1 then snow

Temporal and Spatial Gradient Tests in VIS





Detecting Clouds (IR)

IR Window Brightness Temperature Threshold and Difference Tests

IR tests sensitive to sfc emissivity and atm PW, dust, and aerosols

BT11 < 270

BT11 + aPW * (BT11 - BT12) < SST

BT11 + bPW * (BT11 - BT8.7) < SST

aPW and bPW determined from lookup table as a function of PW

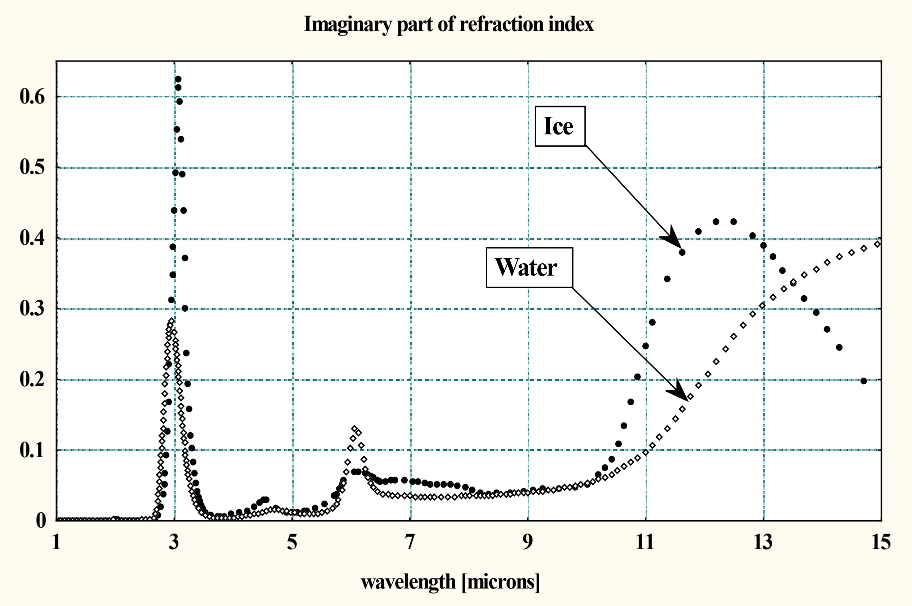
BT3.9 - BT11 > 3 indicates presence of partial or thin cloud cover

BT11 - BT6.3 large neg diff for clr sky over Antarctic Plateau winter

Temporal and Spatial Gradient Tests in IRW and WV

Estimating Cloud Properties

13.3/11 ratio reveals p_c cloud top pressure (since ε11~ε13)



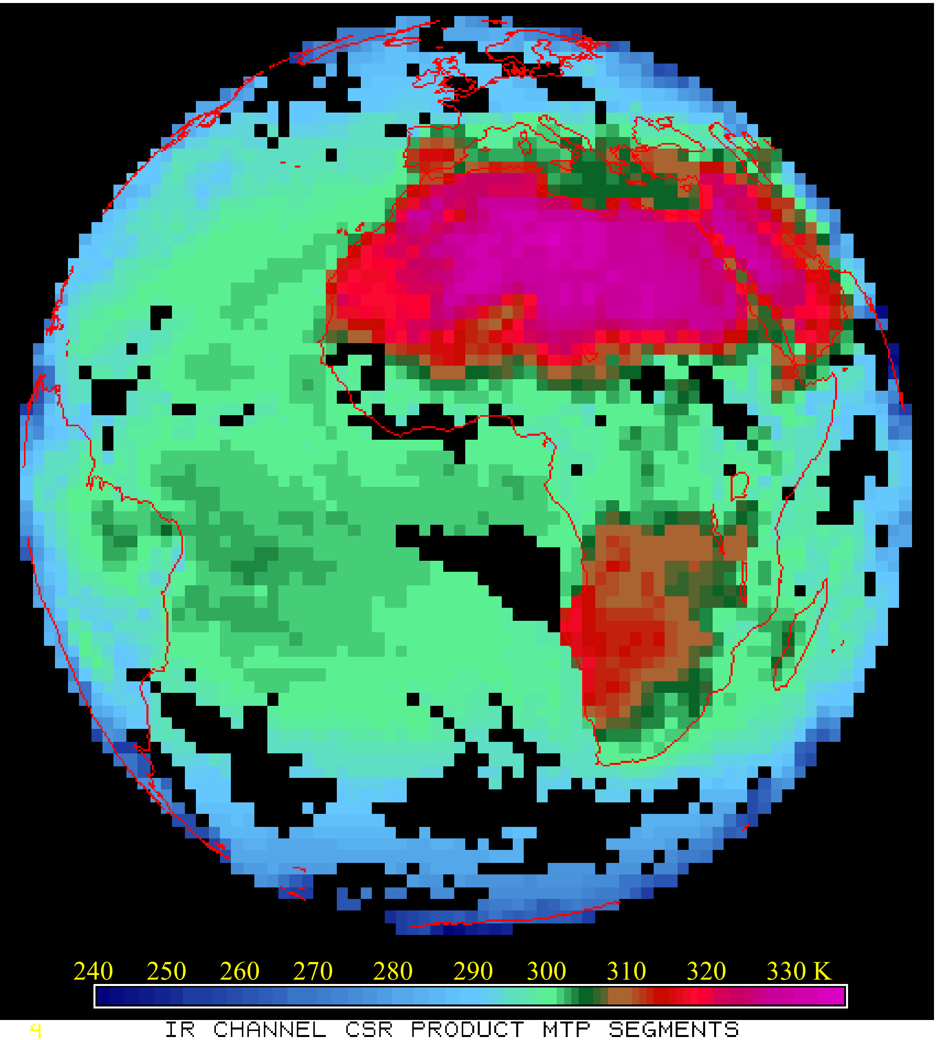
Meas = Calc

$$\frac{(I_{\lambda 1}-I_{\lambda 1}^{clr})}{(I_{\lambda 2}-I_{\lambda 2}^{clr})} = \frac{\eta\varepsilon_{\lambda 1}\int_{p_s}^{p_c}\tau_{\lambda 1}\, dB_{\lambda 1}}{\eta\varepsilon_{\lambda 2}\int_{p_s}^{p_c}\tau_{\lambda 2}\, dB_{\lambda 2}}$$

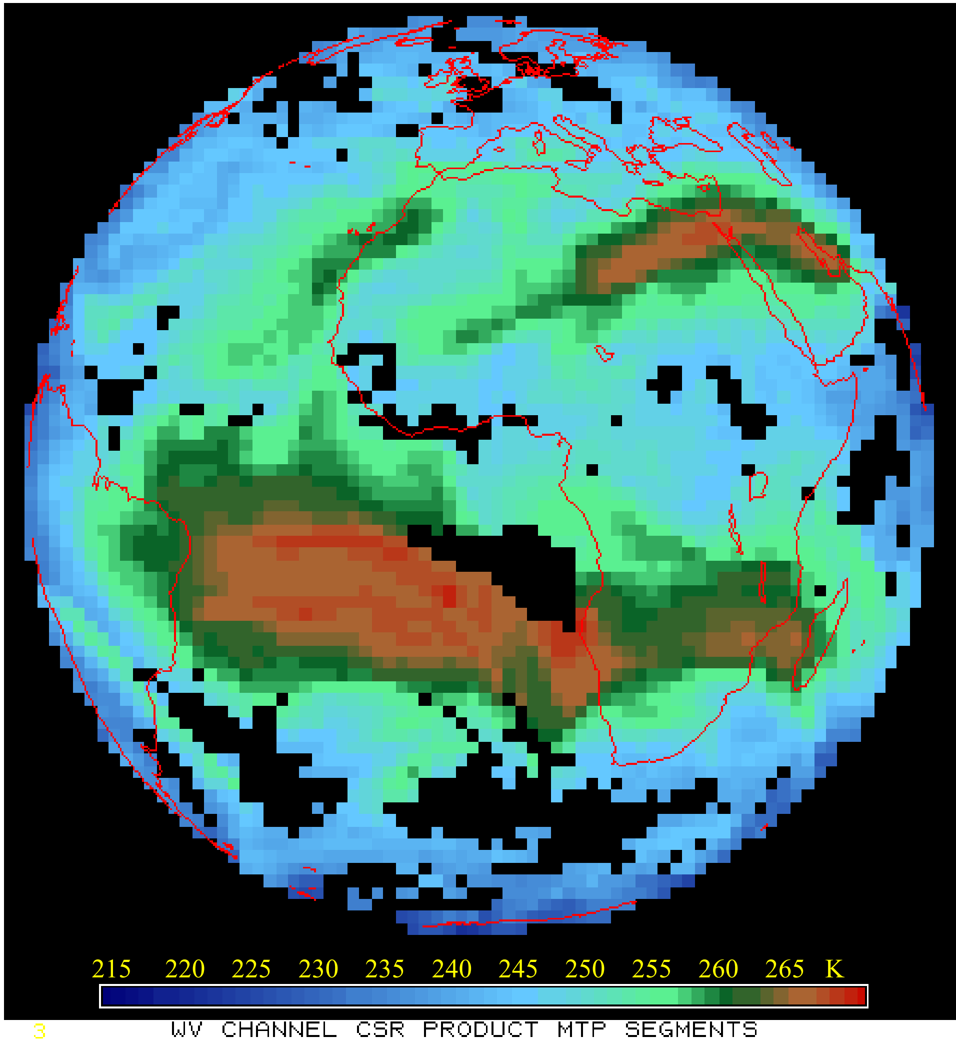
Given p_c an effective cloud amount(or effective emissivity) can be evaluated from 11 um (IRW)

$$N\varepsilon = \frac{I(w) - Iclr(w)}{B[w, T(Pc)] - Iclr(w)}$$

BT8.7 – BT11 identifies cloud phase; if >0 then ice; if <0 then water



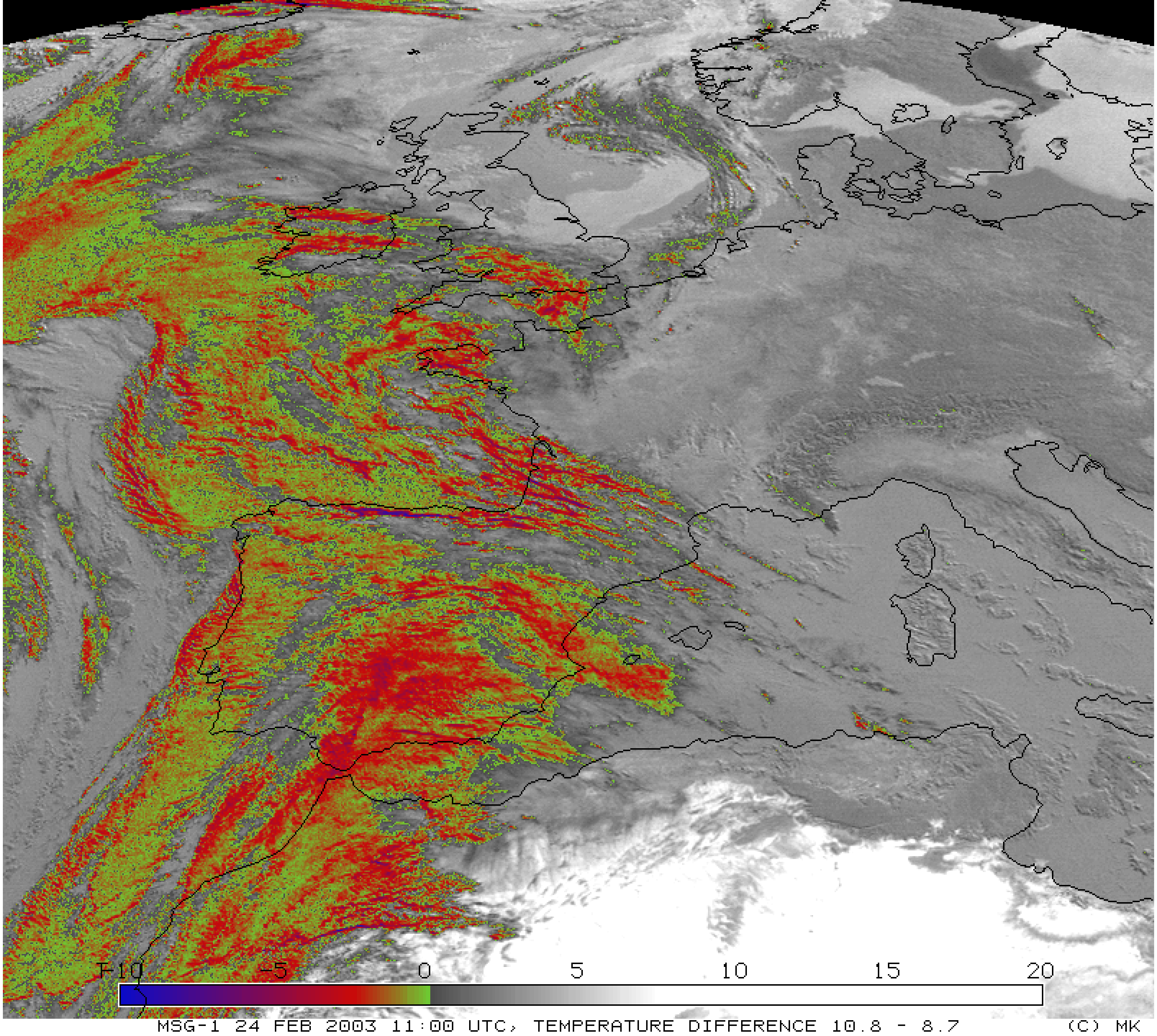
IR window

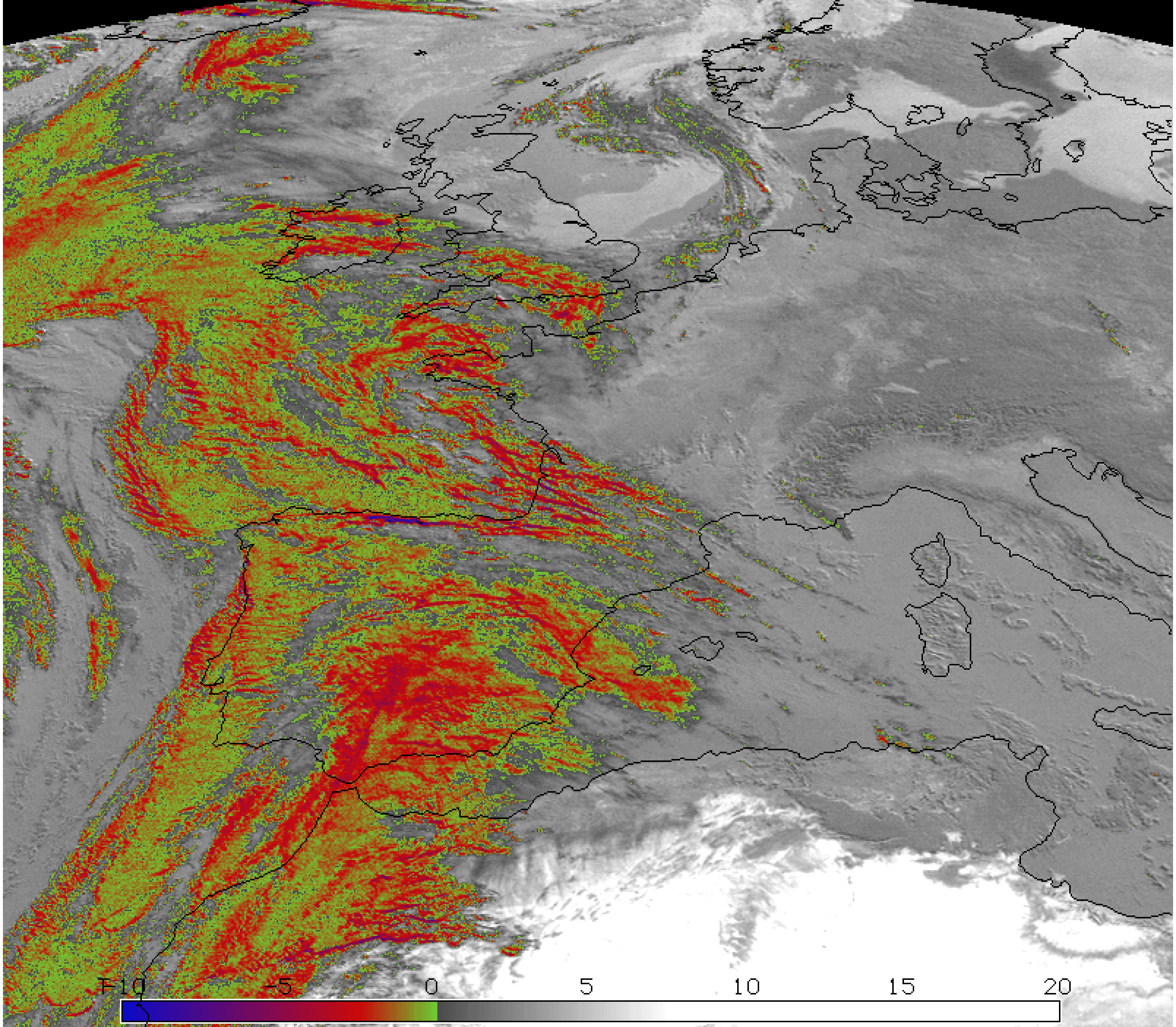


WV

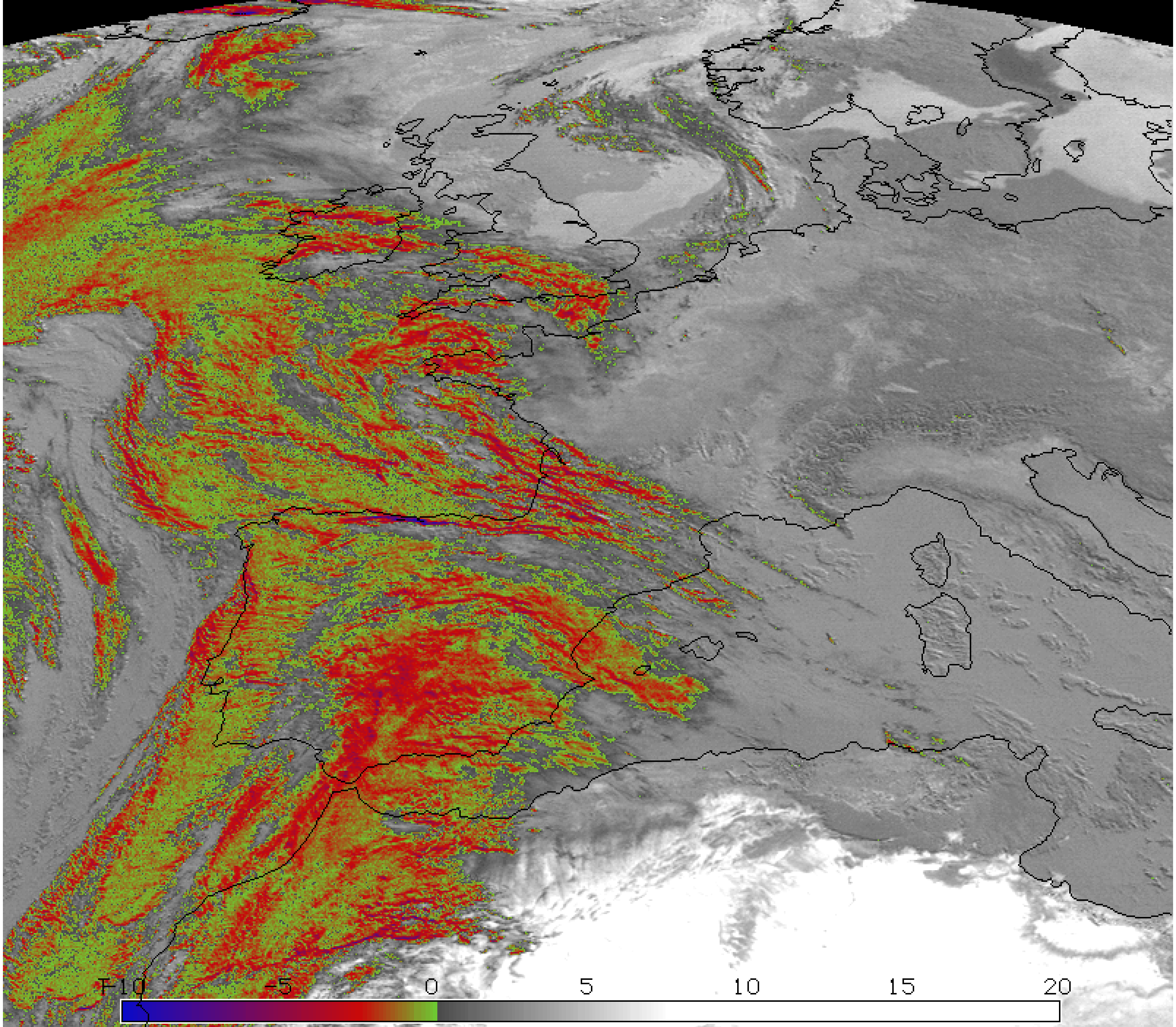
Clear sky radiances

for image segments

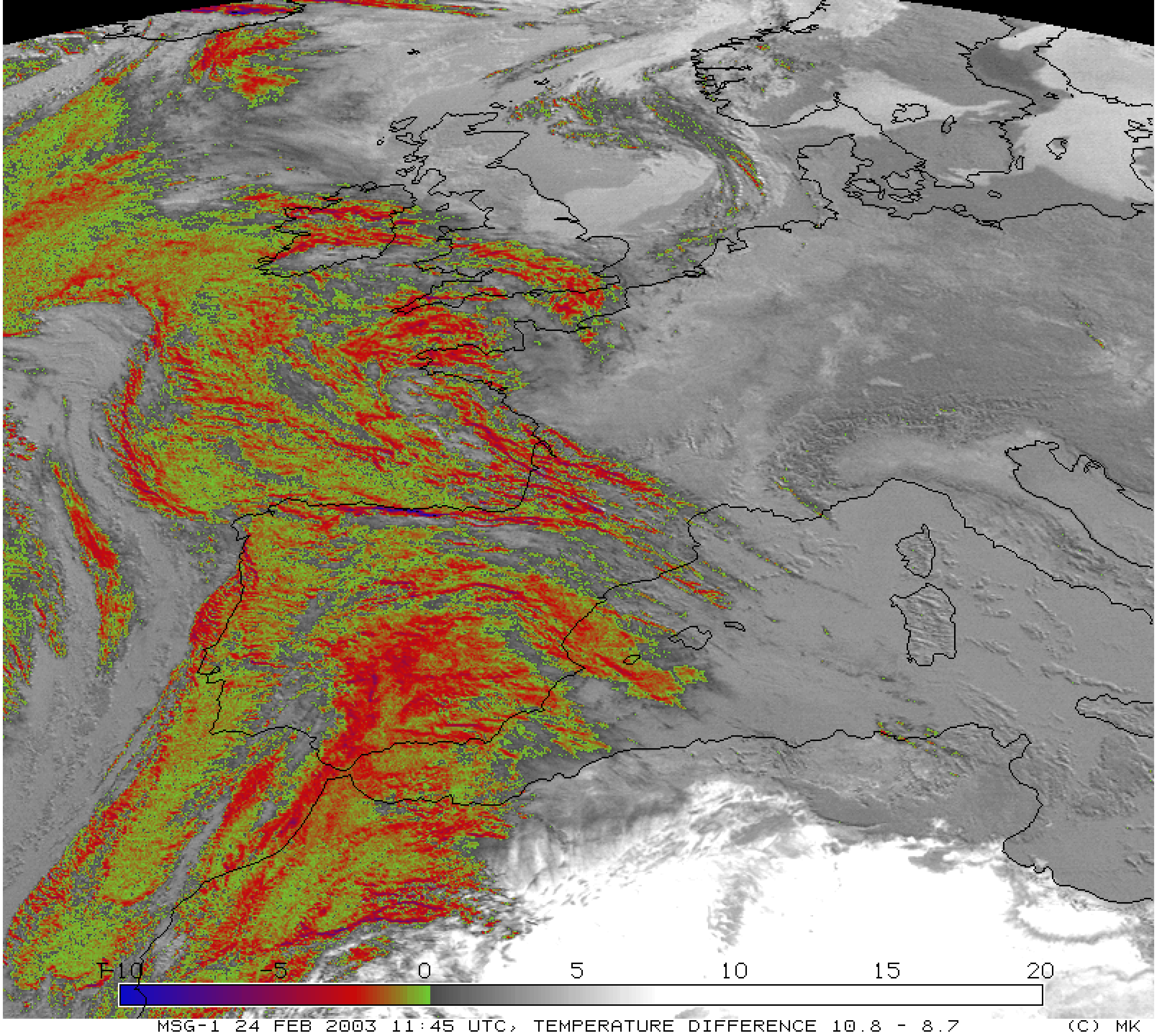

-10
-5
0
5
10
15
20
MSG-1 24 FEB 2003 11:00 UTC, TEMPERATURE DIFFERENCE 10.8 - 8.7
(C) MK

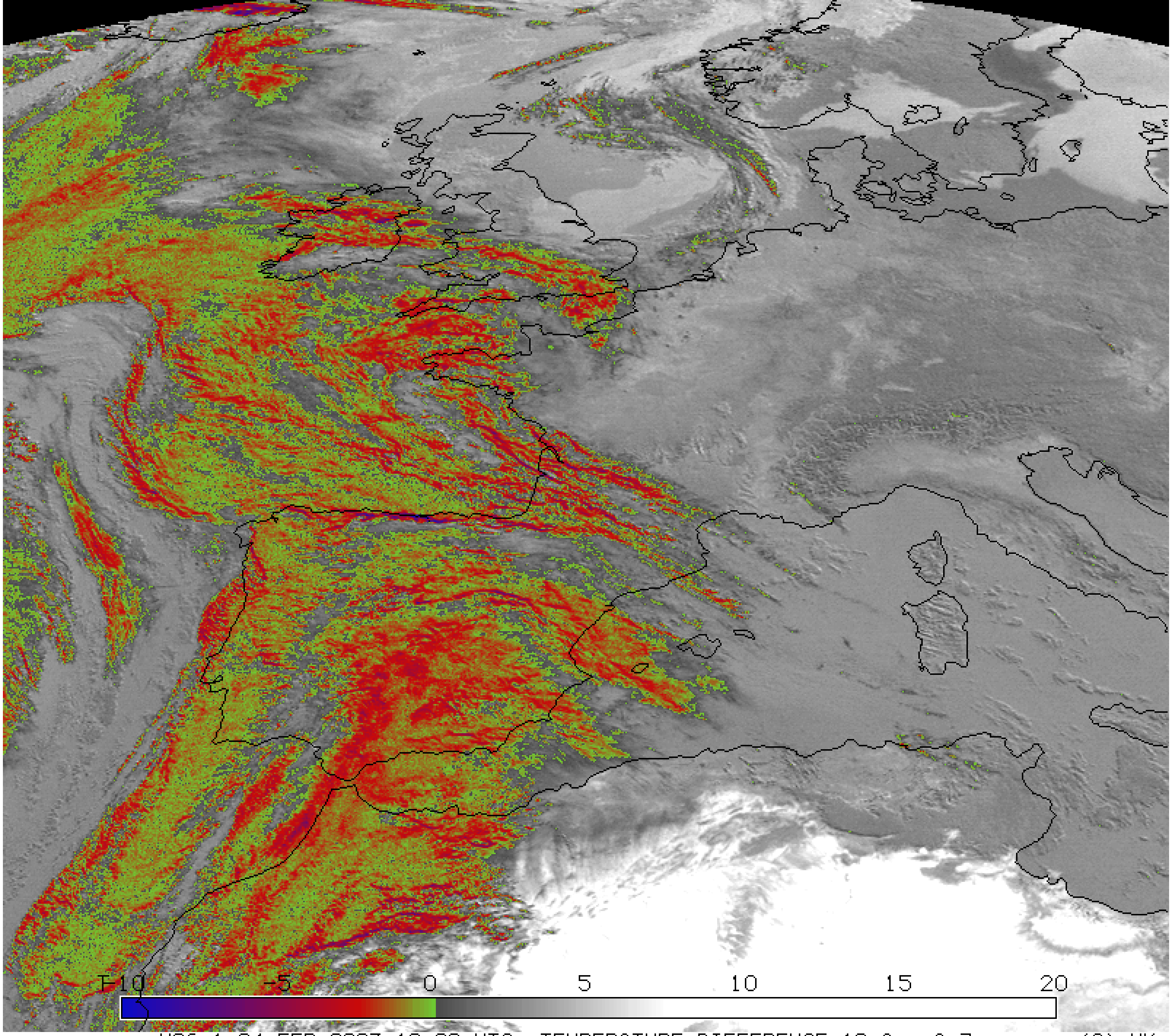


MSG-1 24 FEB 2003 11:15 UTC, TEMPERATURE DIFFERENCE 10.8 - 8.7 (C) MK

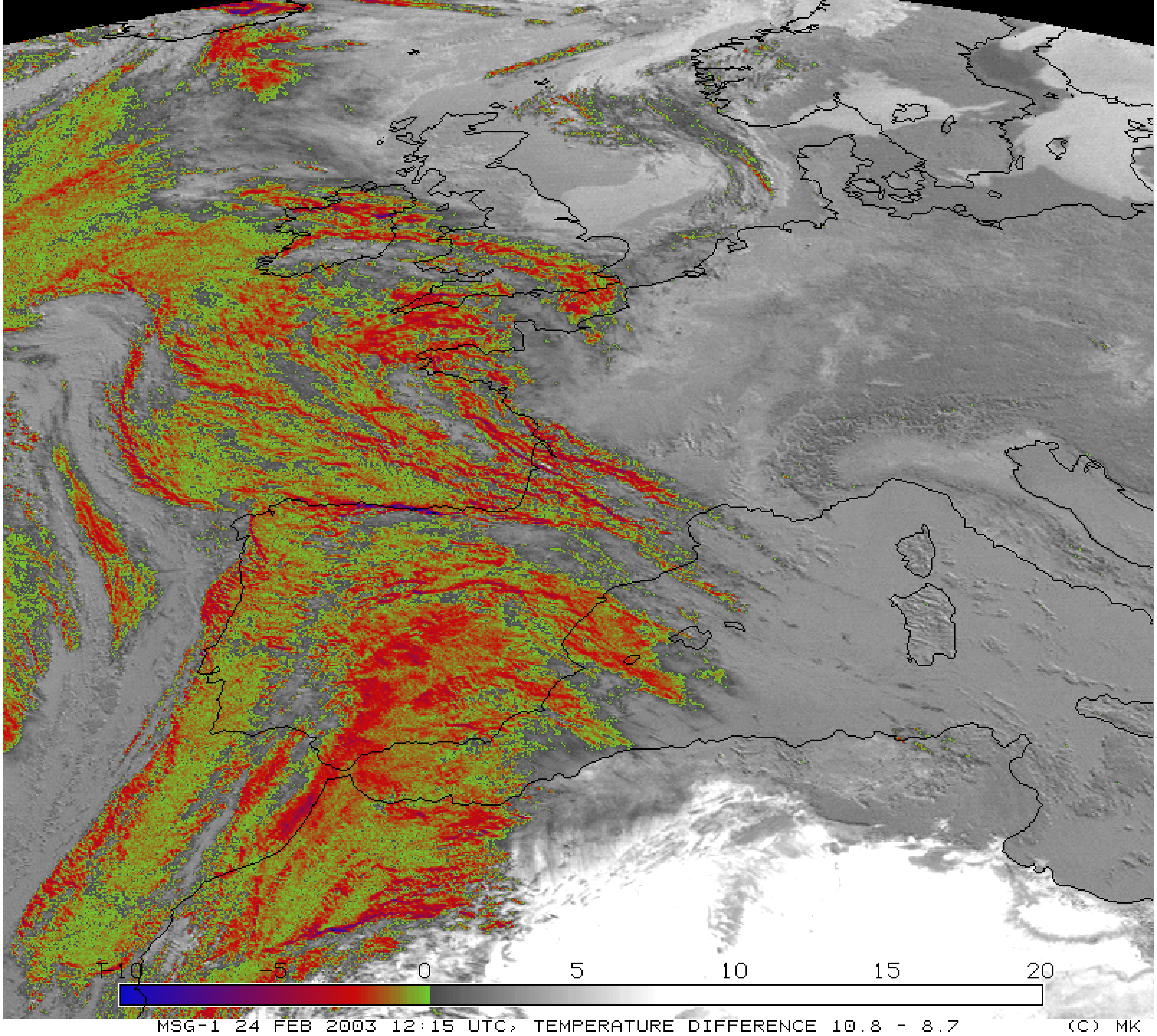


MSG-1 24 FEB 2003 11:30 UTC, TEMPERATURE DIFFERENCE 10.8 - 8.7 (C) MK

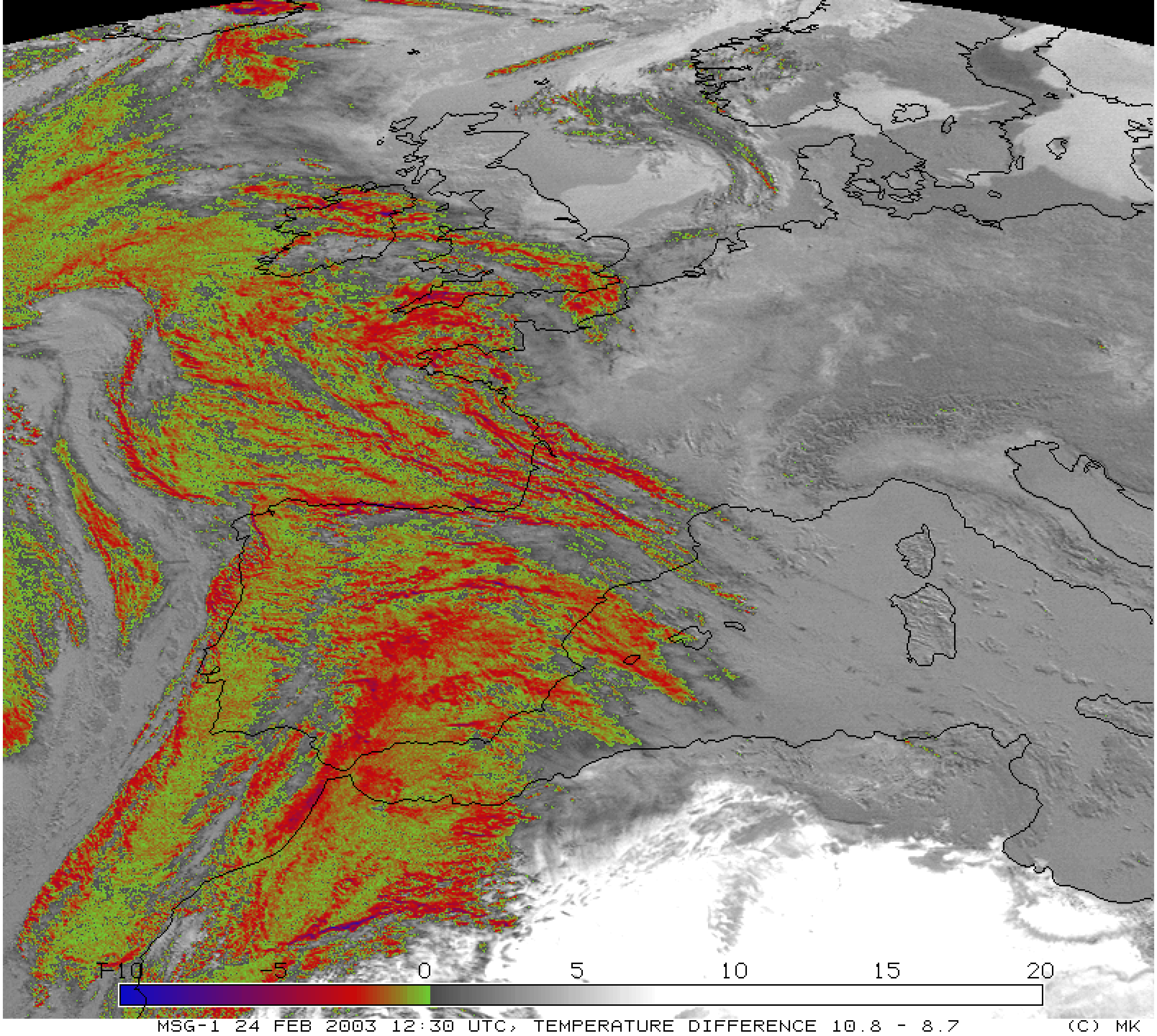

-10
-5
0
5
10
15
20
MSG-1 24 FEB 2003 11:45 UTC, TEMPERATURE DIFFERENCE 10.8 - 8.7
(C) MK

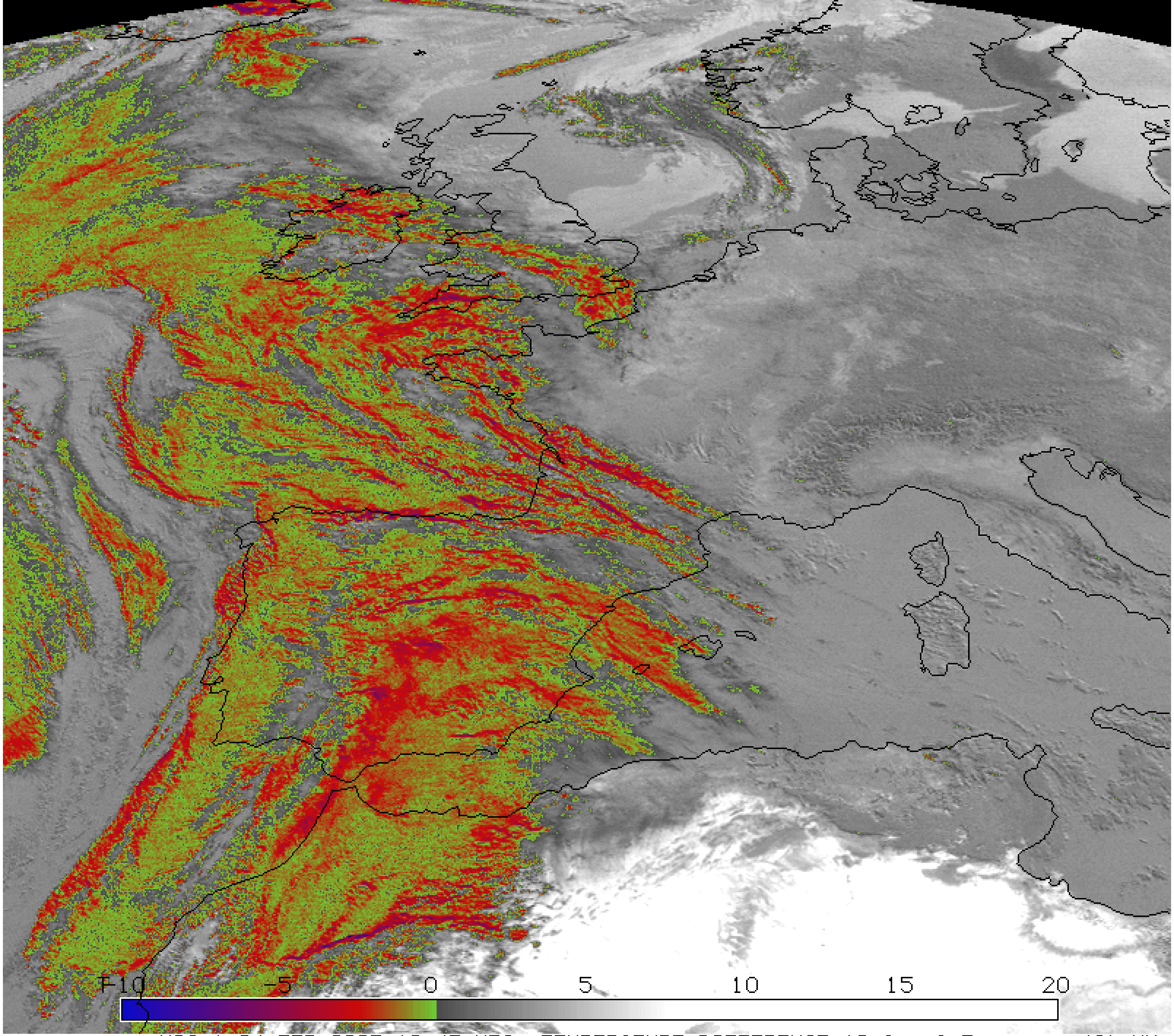


MSG-1 24 FEB 2003 12:00 UTC, TEMPERATURE DIFFERENCE 10.8 - 8.7 (C) MK

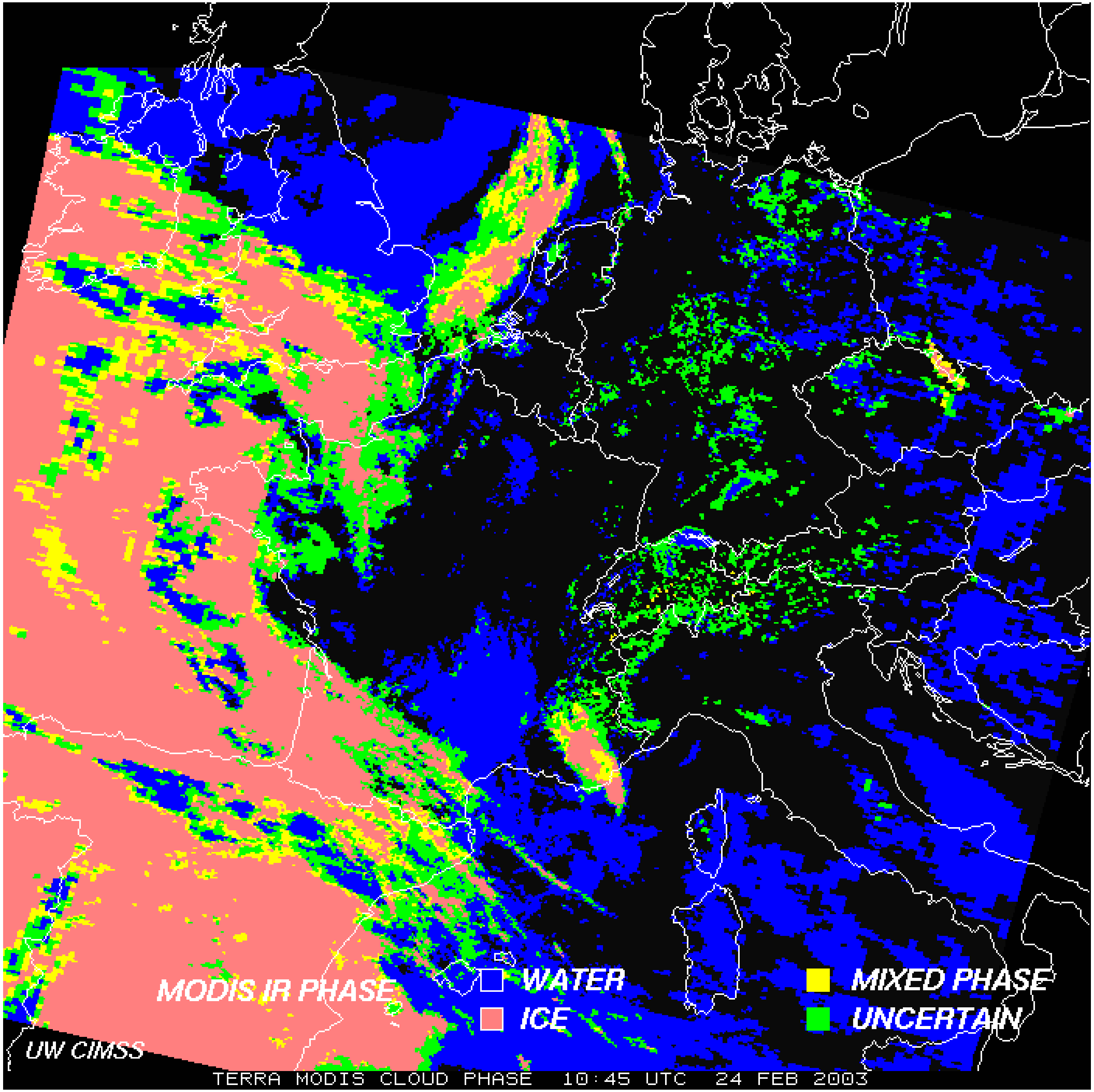


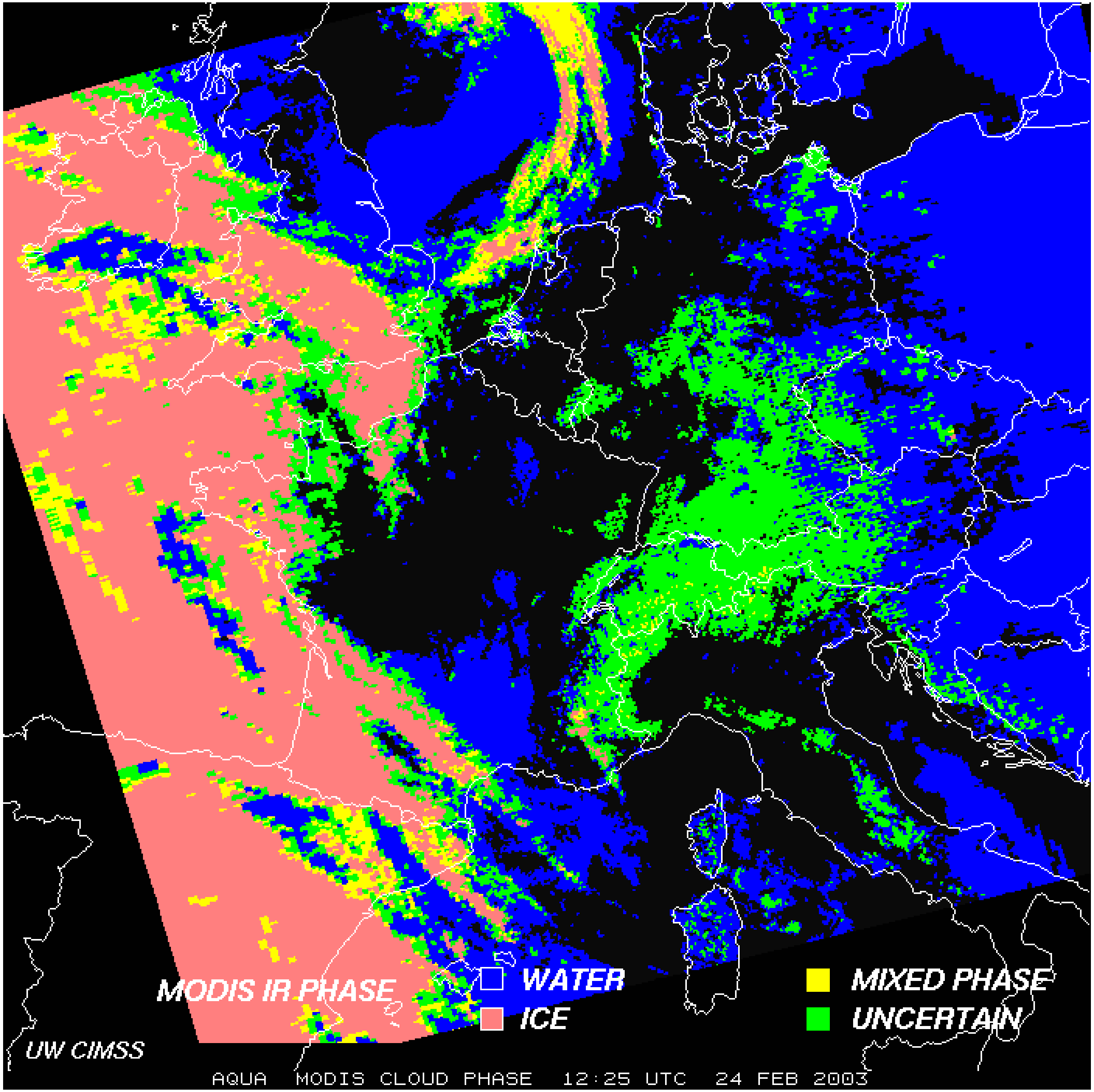
-10
-5
0
5
10
15
20
MSG-1 24 FEB 2003 12:15 UTC, TEMPERATURE DIFFERENCE 10.8 - 8.7
(C) MK


-10
-5
0
5
10
15
20
MSG-1 24 FEB 2003 12:30 UTC, TEMPERATURE DIFFERENCE 10.8 - 8.7
(C) MK

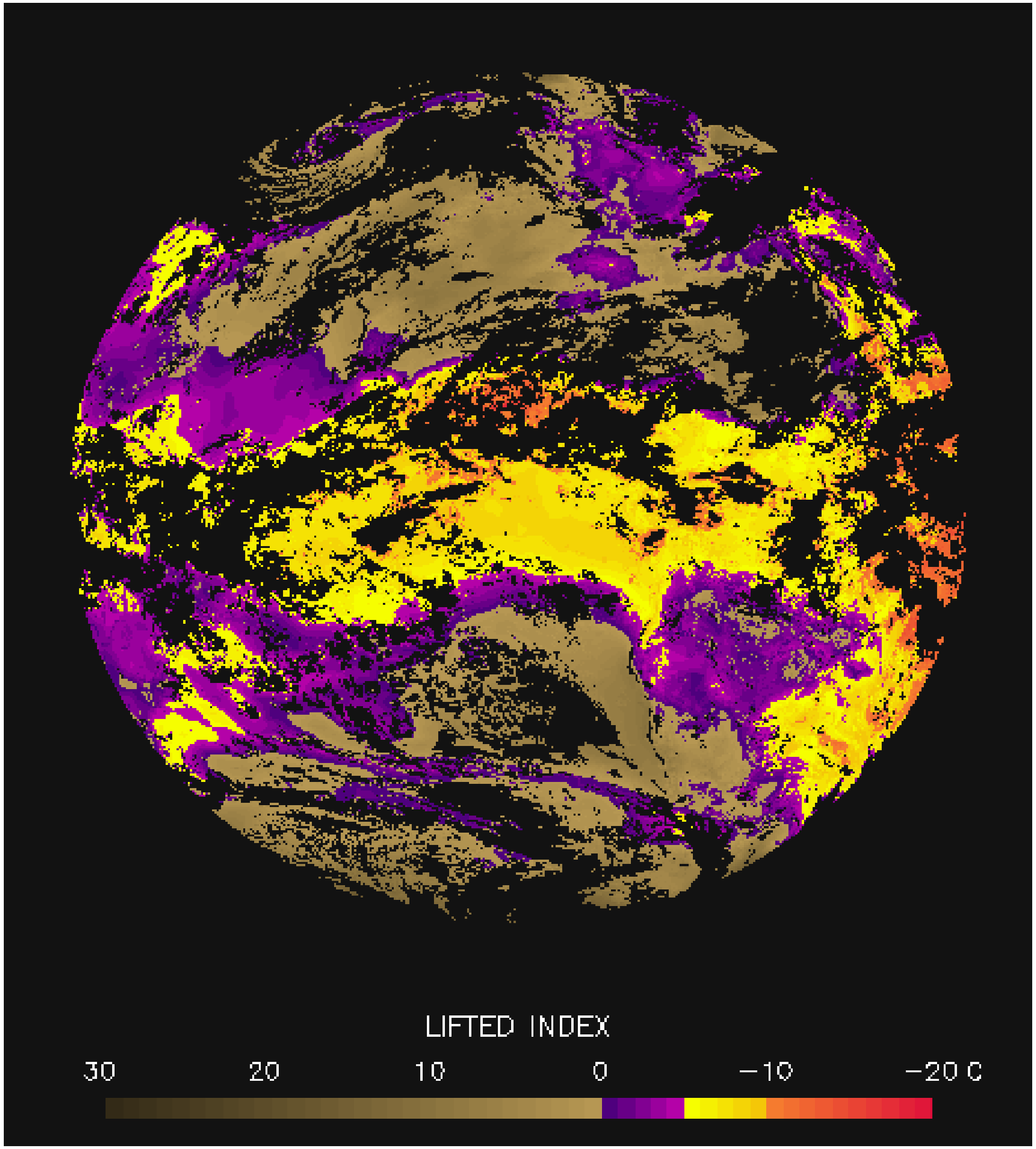


MSG-1 24 FEB 2003 12:45 UTC, TEMPERATURE DIFFERENCE 10.8 - 8.7 (C) MK

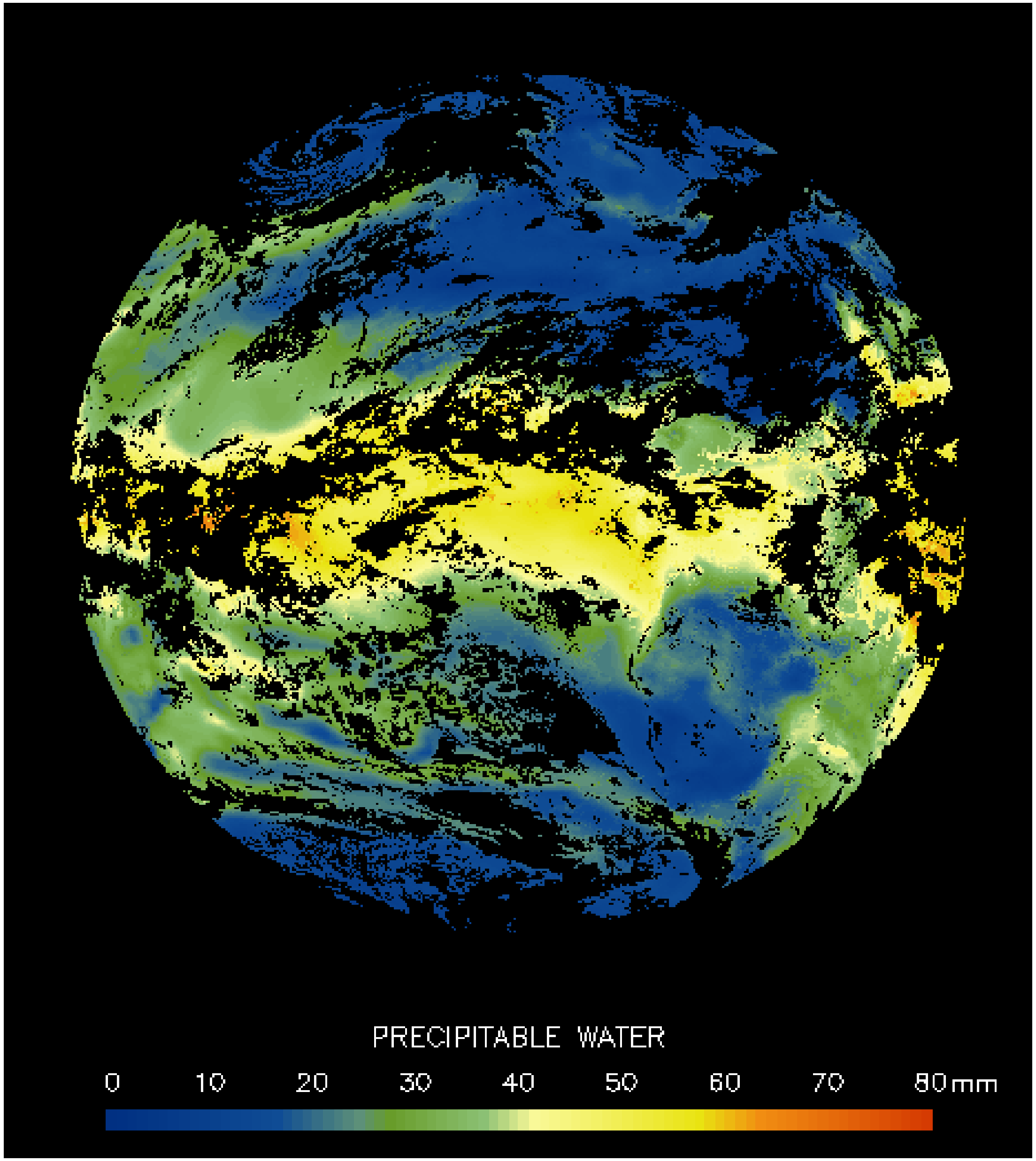

MODIS IR PHASE
WATER
ICE
MIXED PHASE
UNCERTAIN
UW CIMSS
TERRA MODIS CLOUD PHASE 10:45 UTC 24 FEB 2003


MODIS IR PHASE
WATER
ICE
MIXED PHASE
UNCERTAIN
UW CIMSS
AQUA MODIS CLOUD PHASE 12:25 UTC 24 FEB 2003

MSG Lifted Index

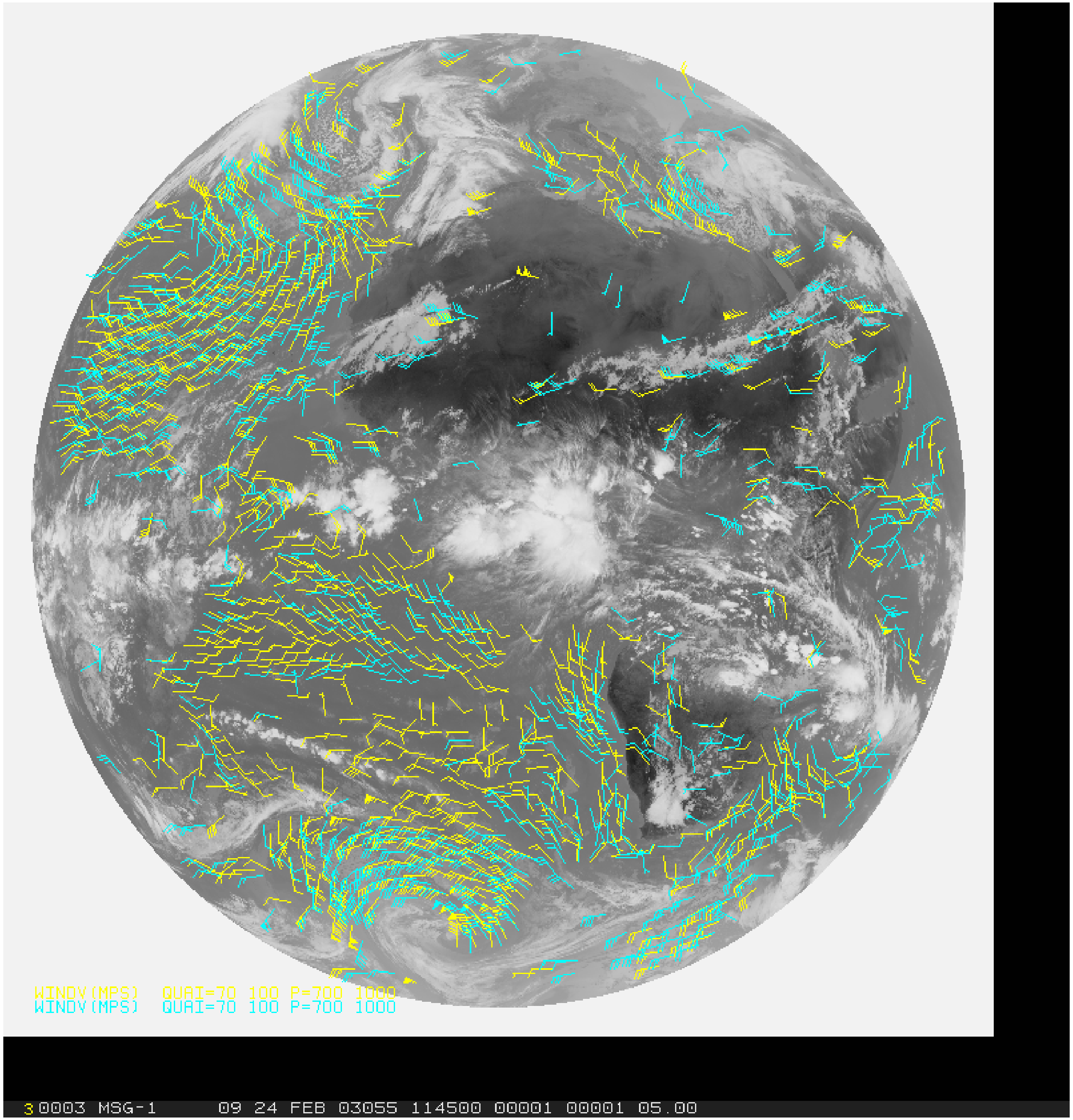


MSG Precipitable Water



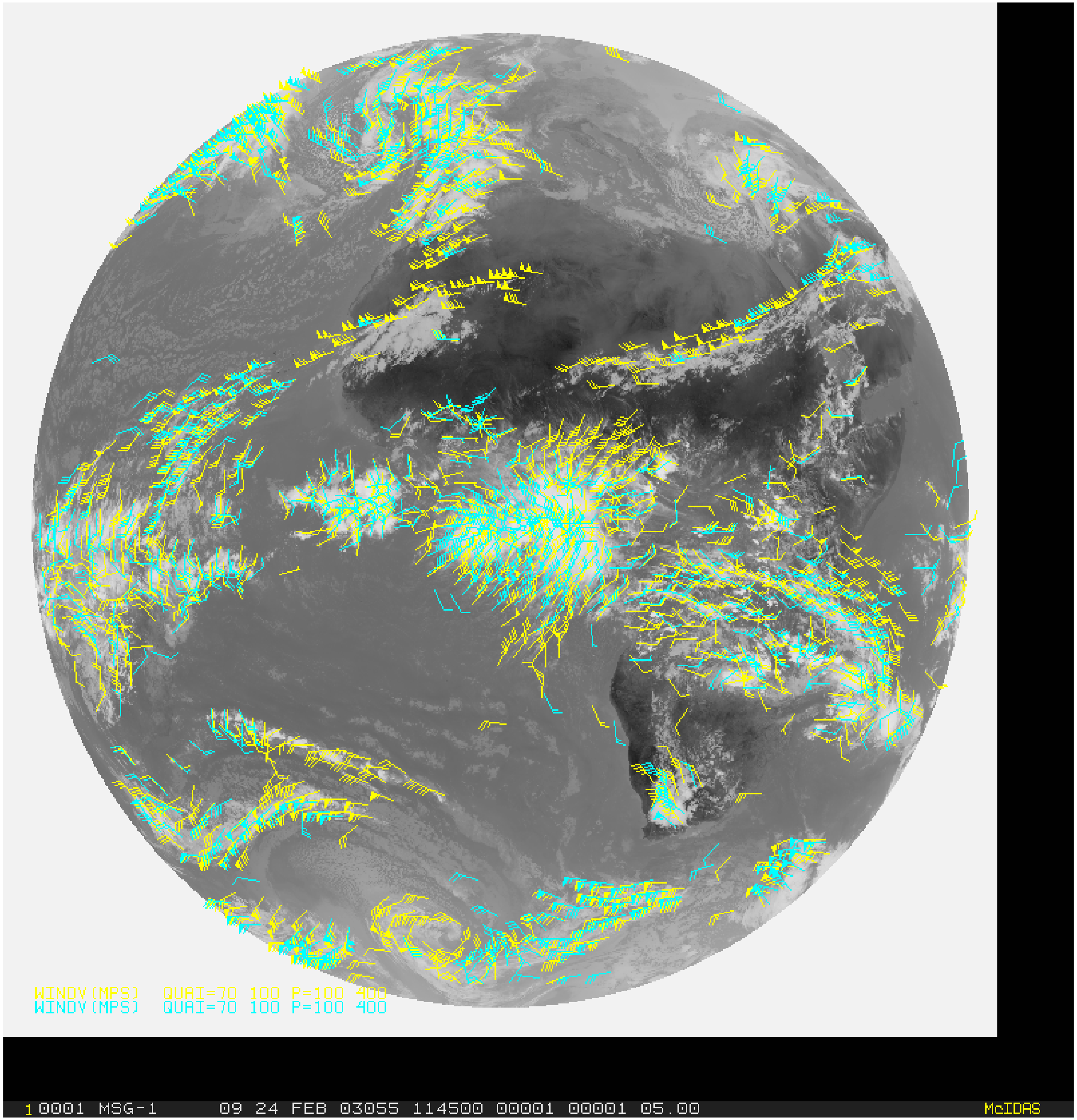
Atmospheric Motion Vectors from MSG

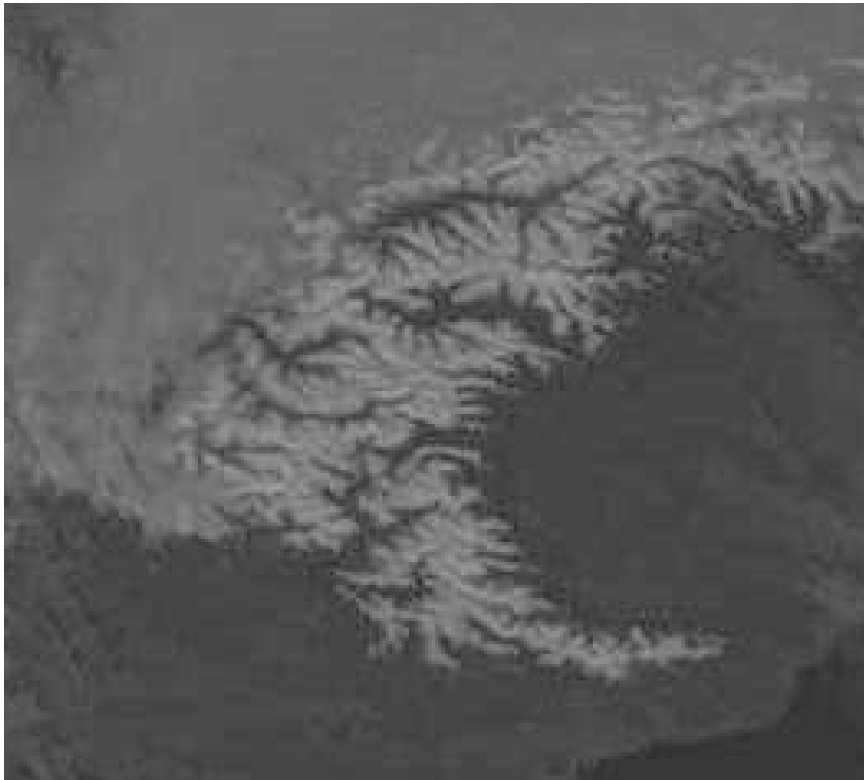
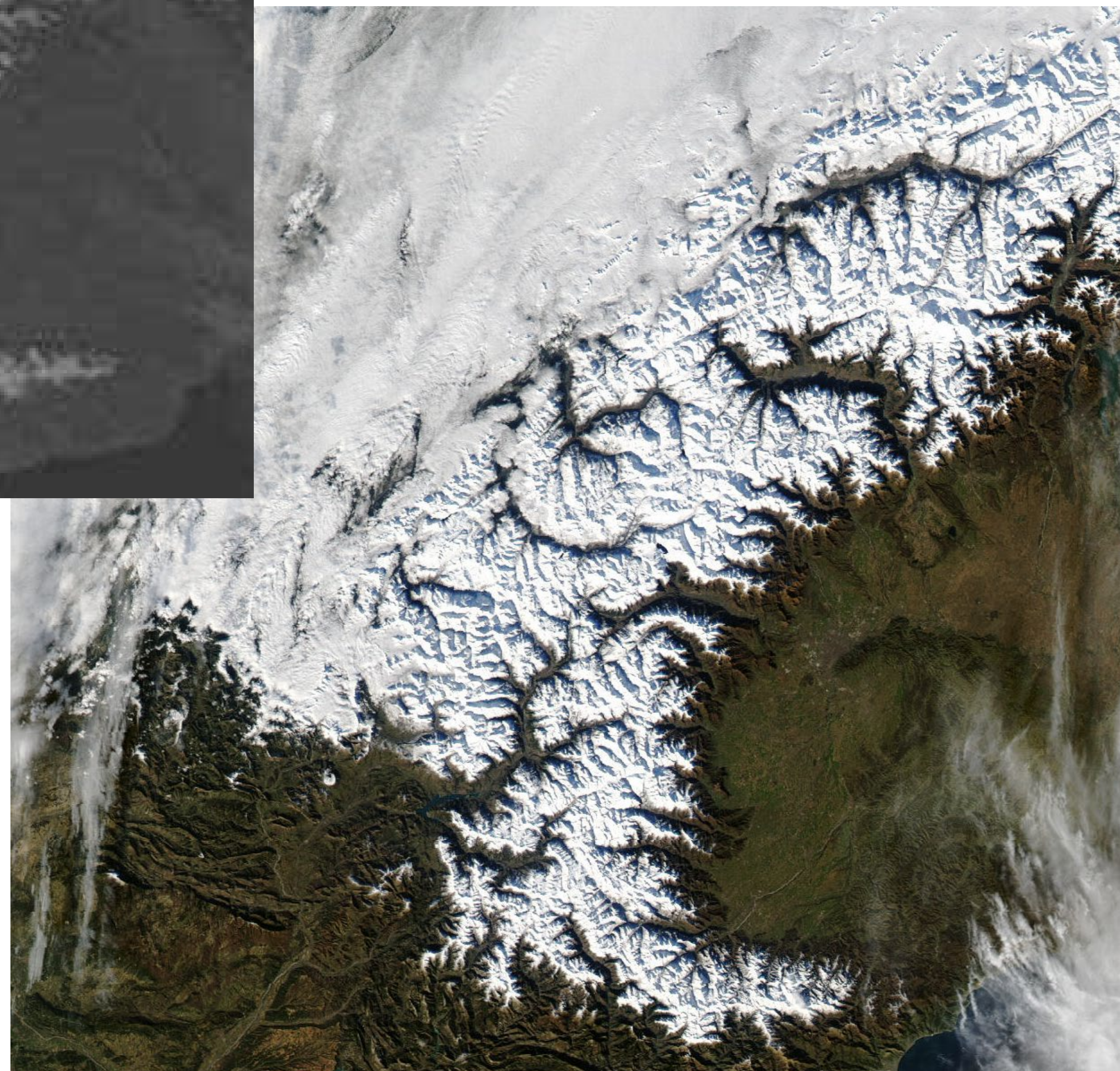
- **Tracking channels**
  - IR10.8, WV6.2, WV7.3, VIS0.6, VIS0.8
  - OZ9.7, IR3.9, HRVIS
- **Resolution**
  - 100 (50) km, every 15 min., final product every hour
- **Height Assignment**
  - IR EBBT
  - IR/WV semi-transparency correction
  - CO_2-ratioing



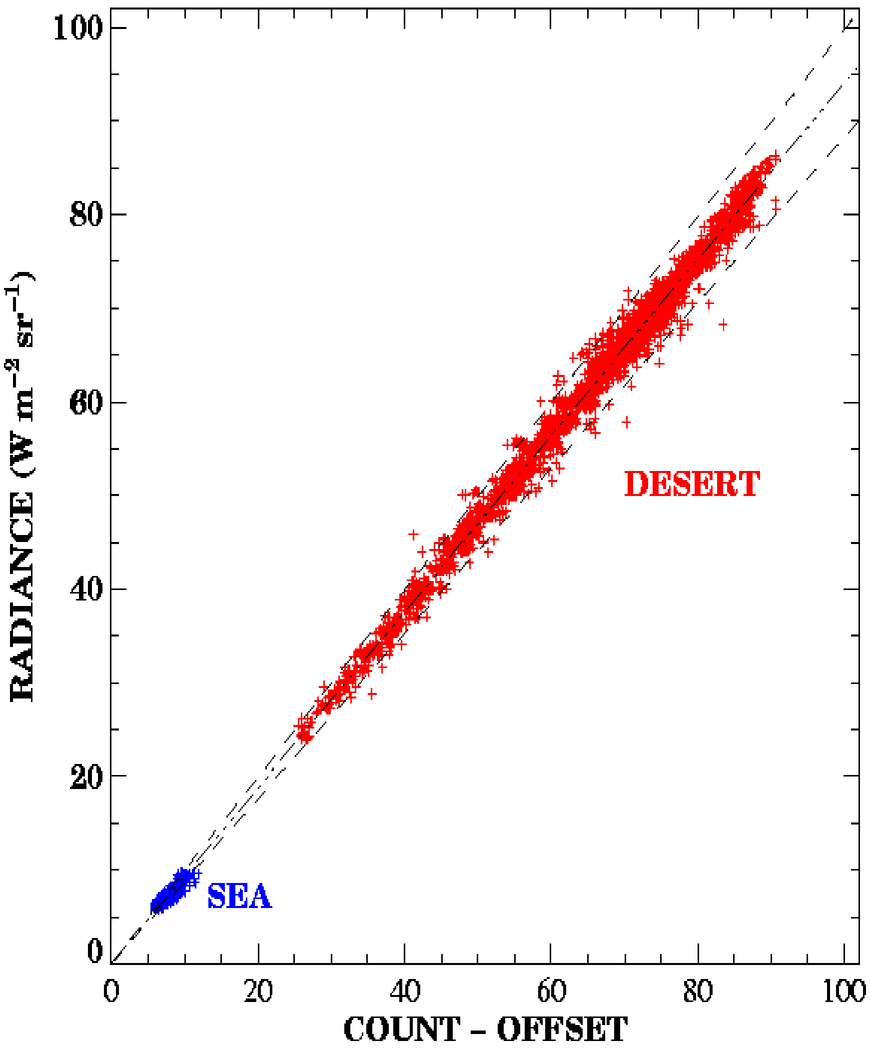
Low-level winds from MSG:
yellow: 10.8 µm
blue: 3.9 µm

High-level winds from MSG: yellow: 10.8 µm blue: 3.9 µm



- **Thermal IR channels use on-board calibration: Accuracy: about 1K**
- **Solar channels use vicarious calibration Accuracy: toward 5%**



GERB (Geostationary Earth Radiation Budget) Science Objectives

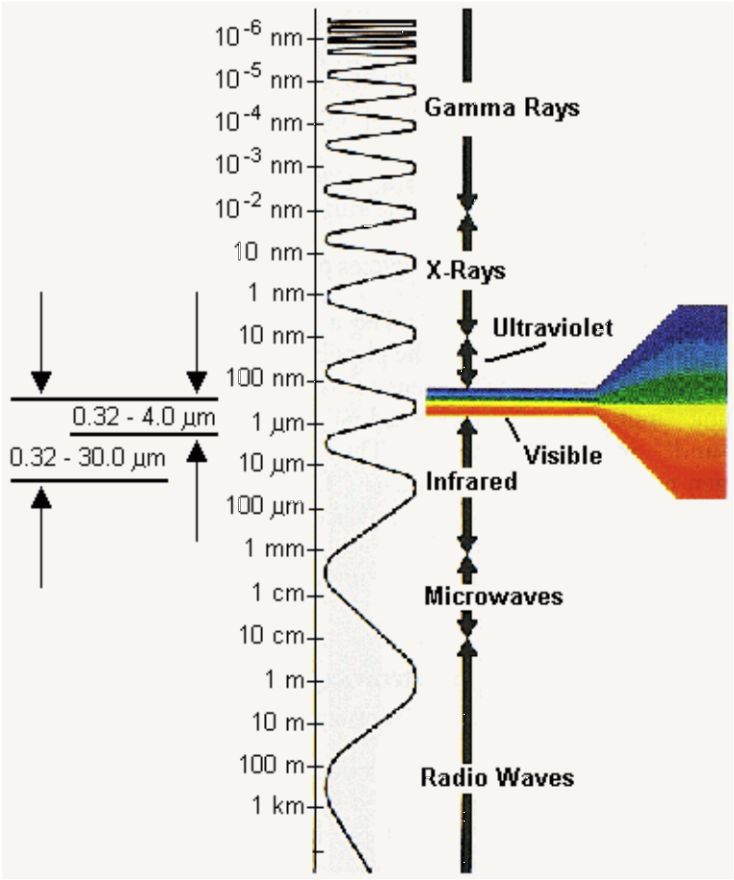
- Measure Total and short wave (SW) radiances
- Derive SW and LW fluxes
  - Validation of climate models
  - Observational studies of:
    - Tropical convection and marine stratocumulus, and their diurnal and synoptic variability.
    - The role of clouds in the ERB
    - The role of water vapour - radiative feedback
  - Validation of the TOA ERB in NWP models

GERB Imaging Principle - Frequency Bands

GERB measures in two frequency bands :

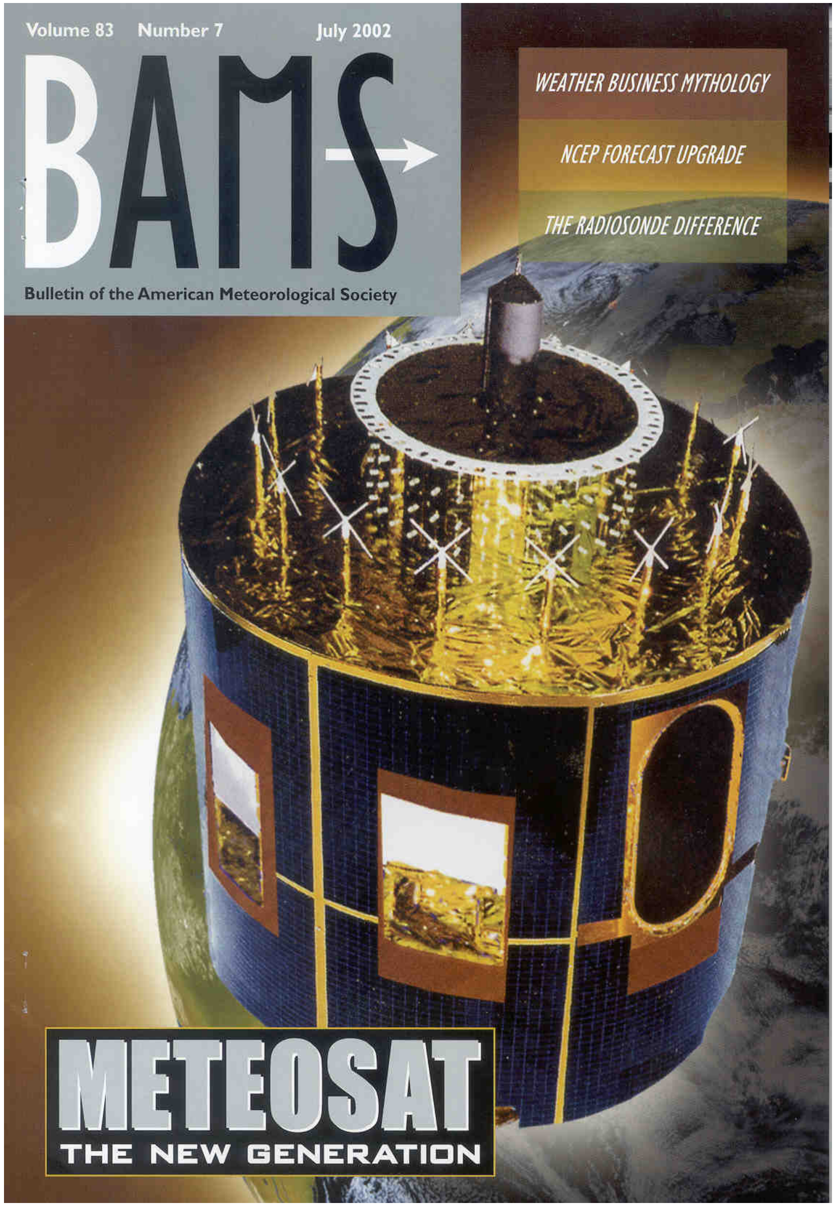
- a short wave (SW) band: 0.32 - 4.0 µm
- a TOTAL wave band: 0.32 - 30.0 µm
- the long wave (LW) band (4.0 - 30.0 µm) is obtained by subtraction of the SW from the Total)

The short wave band is achieved by the use of a quartz filter to block the lower frequency components.



Total channel

Short wavelength channel



July 2002

AN INTRODUCTION TO METEOSAT SECOND GENERATION (MSG)

BY JOHANNES SCHMETZ, PAOLO PILI, STEPHEN TJEMKES, DIETER JUST, JOCHEN KERKMANN, SERGIO ROTA, AND ALAIN RATIER

Meteosat Second Generation (MSG), the new generation of European geostationary meteorological satellites, has greatly enhanced capabilities, especially for observing rapidly changing weather phenomena and for the derivation of quantitative products.

The meteorological community has benefited for more than two decades from the services of the current generation of the European geostationary meteorological Meteosat satellites, the first of which was launched in 1977. Since then it was followed by six successful launches of Meteosat satellites and *Meteosat-7* is currently the operational satellite at the nominal position at 0° longitude. The Meteosat series will be replaced by a new generation called Meteosat Second Generation (MSG). MSG provides the user community with continuity of services from the current Meteosat system, but will also significantly enhance services and products. As is the current Meteosat series, MSG satellites are spin stabilized (Fig. 1). However, MSG gives significantly increased information due to an imaging-repeat cycle of 15 min

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http://dx.doi.org/110.1175/BAMS-83-7-Schmetz-1 and
http://dx.doi.org/110.1175/BAMS-83-7-Schmetz-2.
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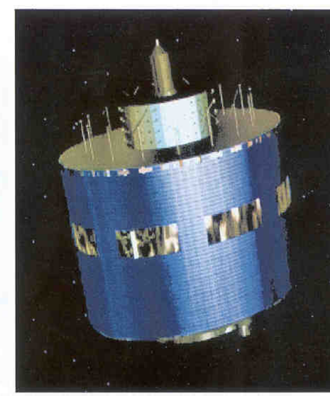

FIG. 1. **MSG spacecraft; as with the current Meteosat series, MSG satellites are spin stabilized.**