Use of SEVIRI and AVHRR channels for remote fire/smoke detection

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EUMETSAT

Motivation

The Devastation of fire

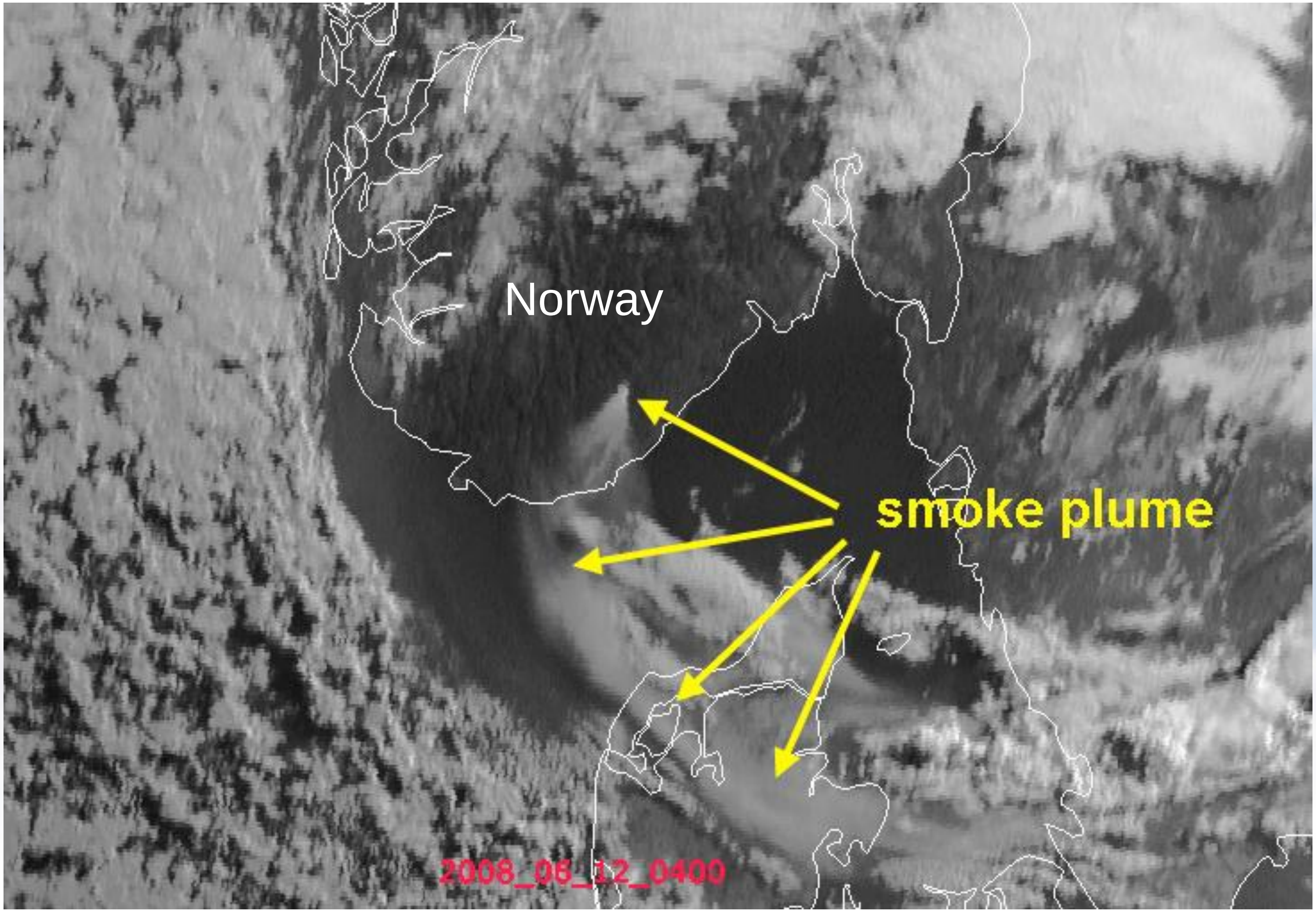
The Dangers of Smoke

Neighbouring impacts of Smoke

Modis
VIS image

Neighbouring impacts of Smoke

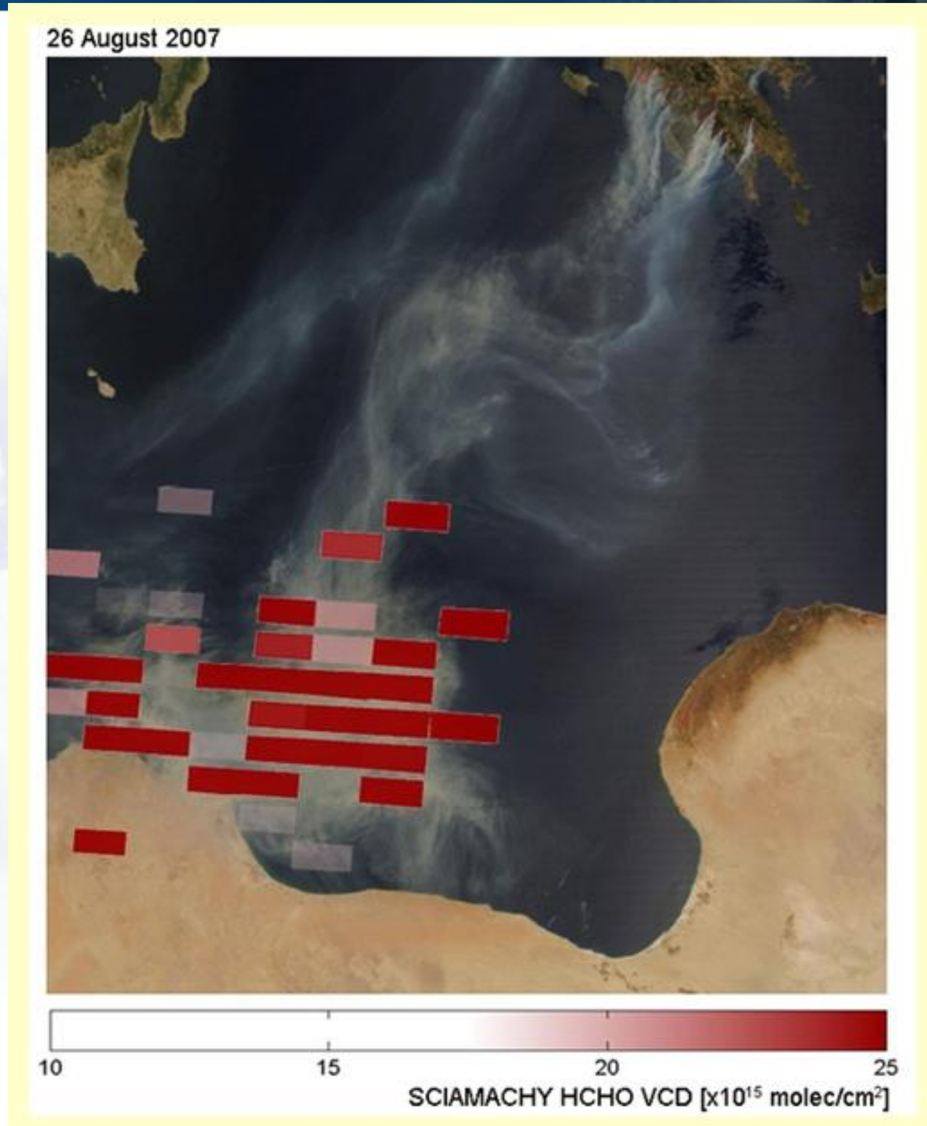
MSG
HRV image



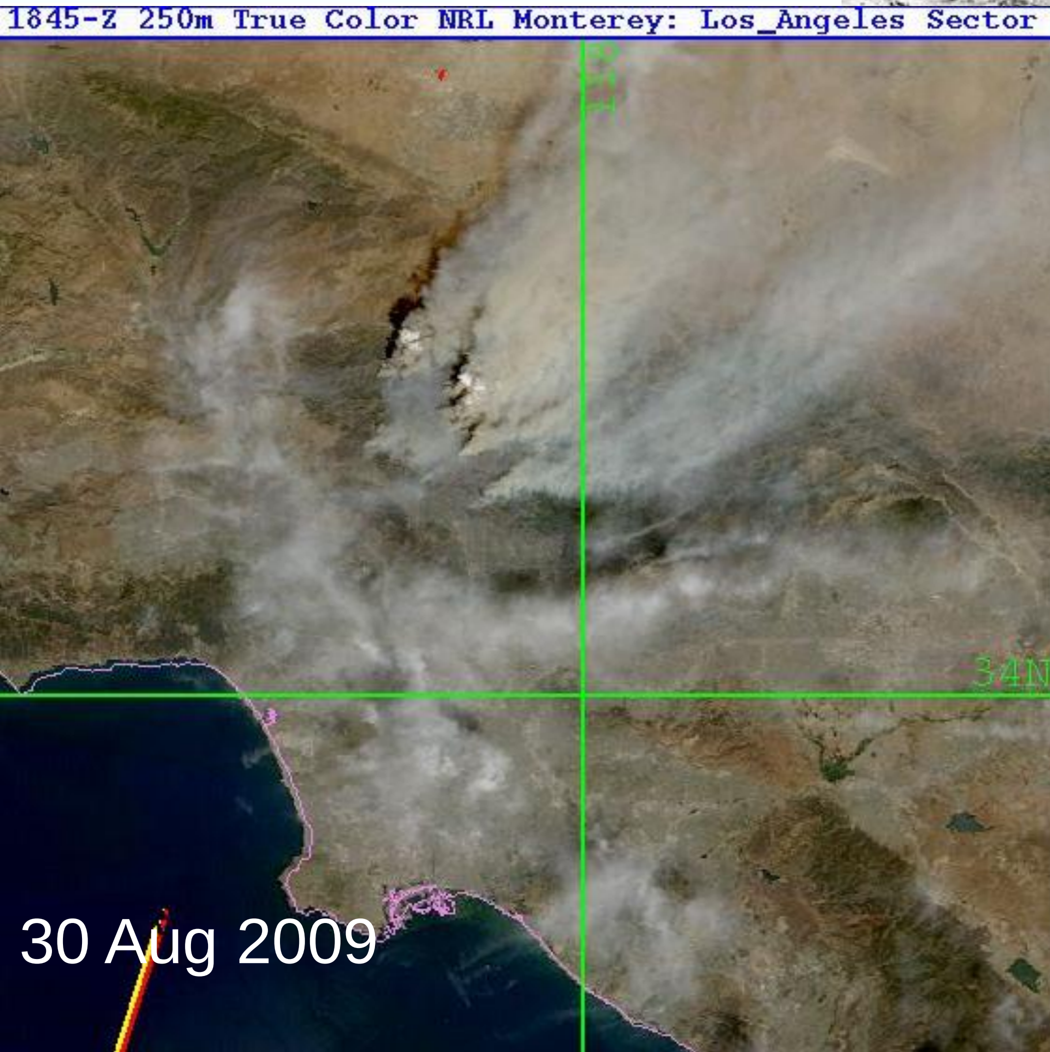
Neighbouring impacts of Smoke

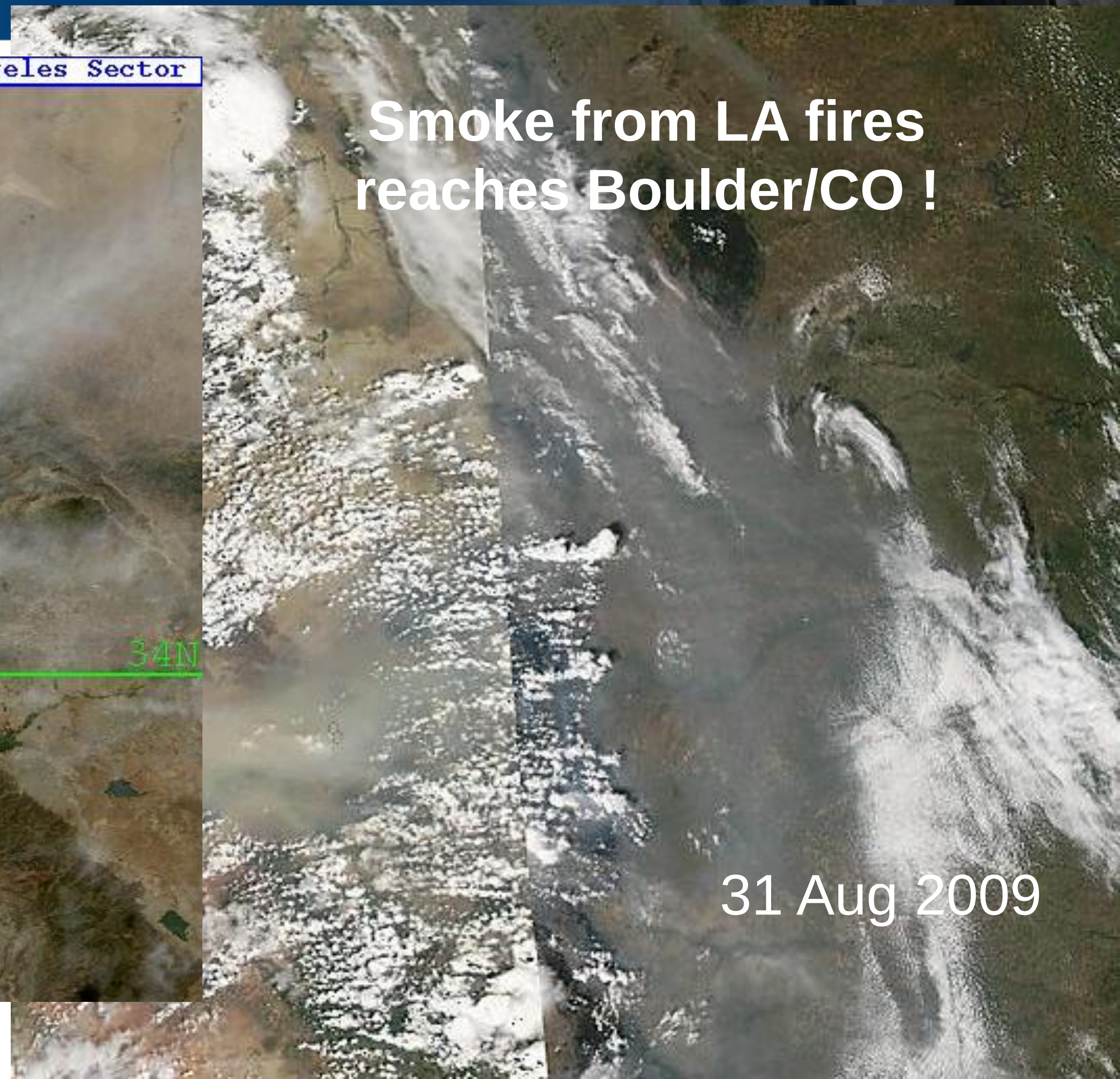
Formaldehyde concentration from SCIAMACHY:

Poisonous gas released by biomass burning in Greece reaches the coast of Libya.



Neighbouring impacts of Smoke





The impact on convection (pyroCb)

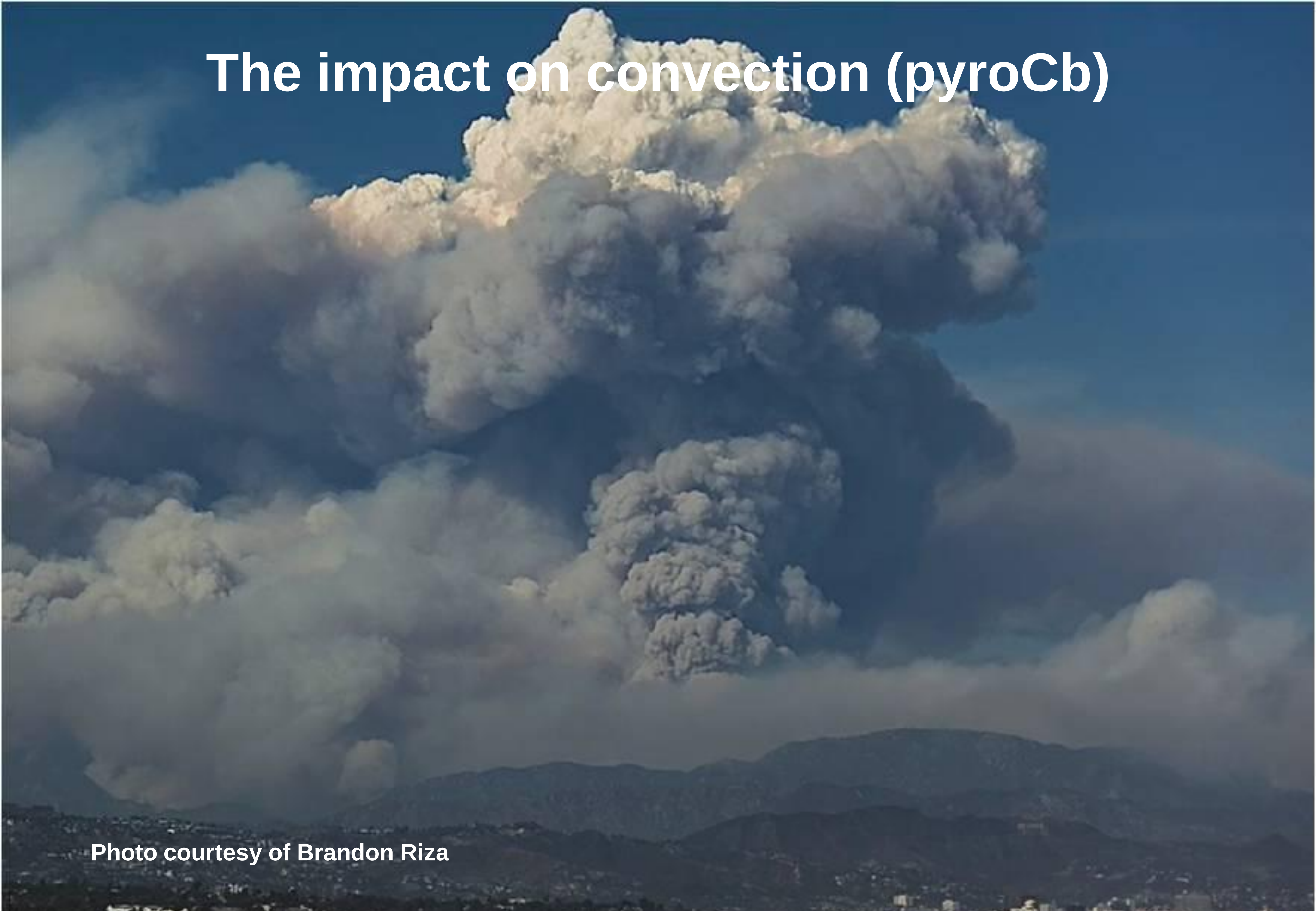


Photo courtesy of Brandon Riza

Pyro

Pyrocumulus (pyroCu)

- condensation but no lightning, no ice

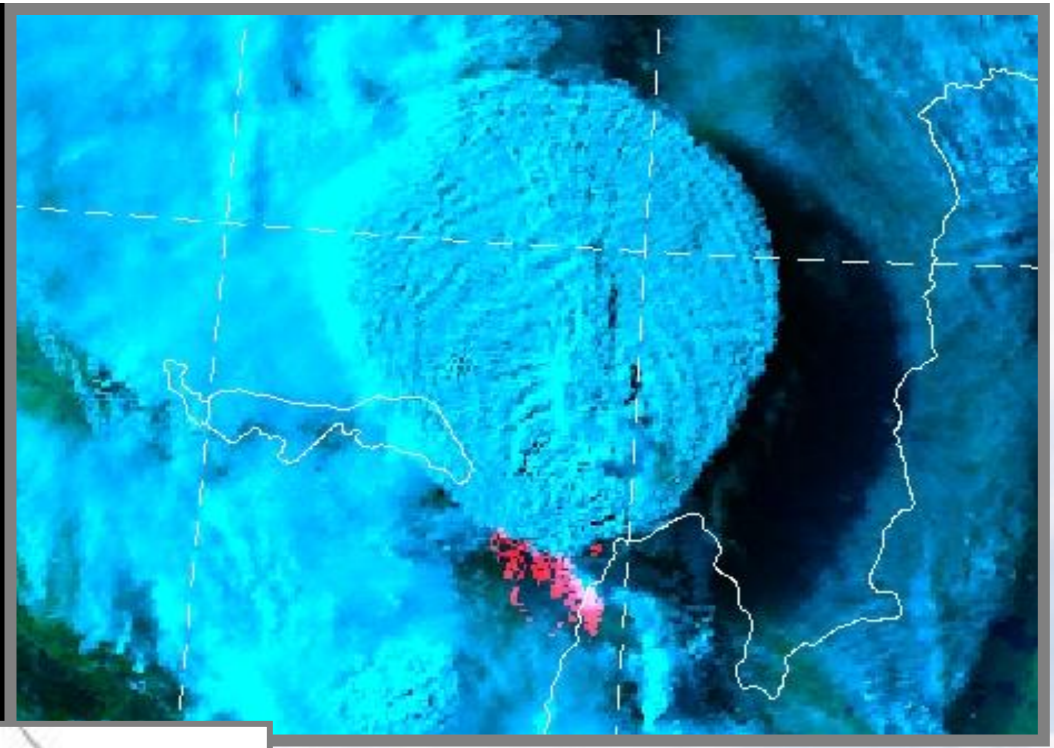
Pyrocumulonimbus (pyroCb)

- subset of pyroCu
- lightning, ice, rain, tornado
- can penetrate the tropopause

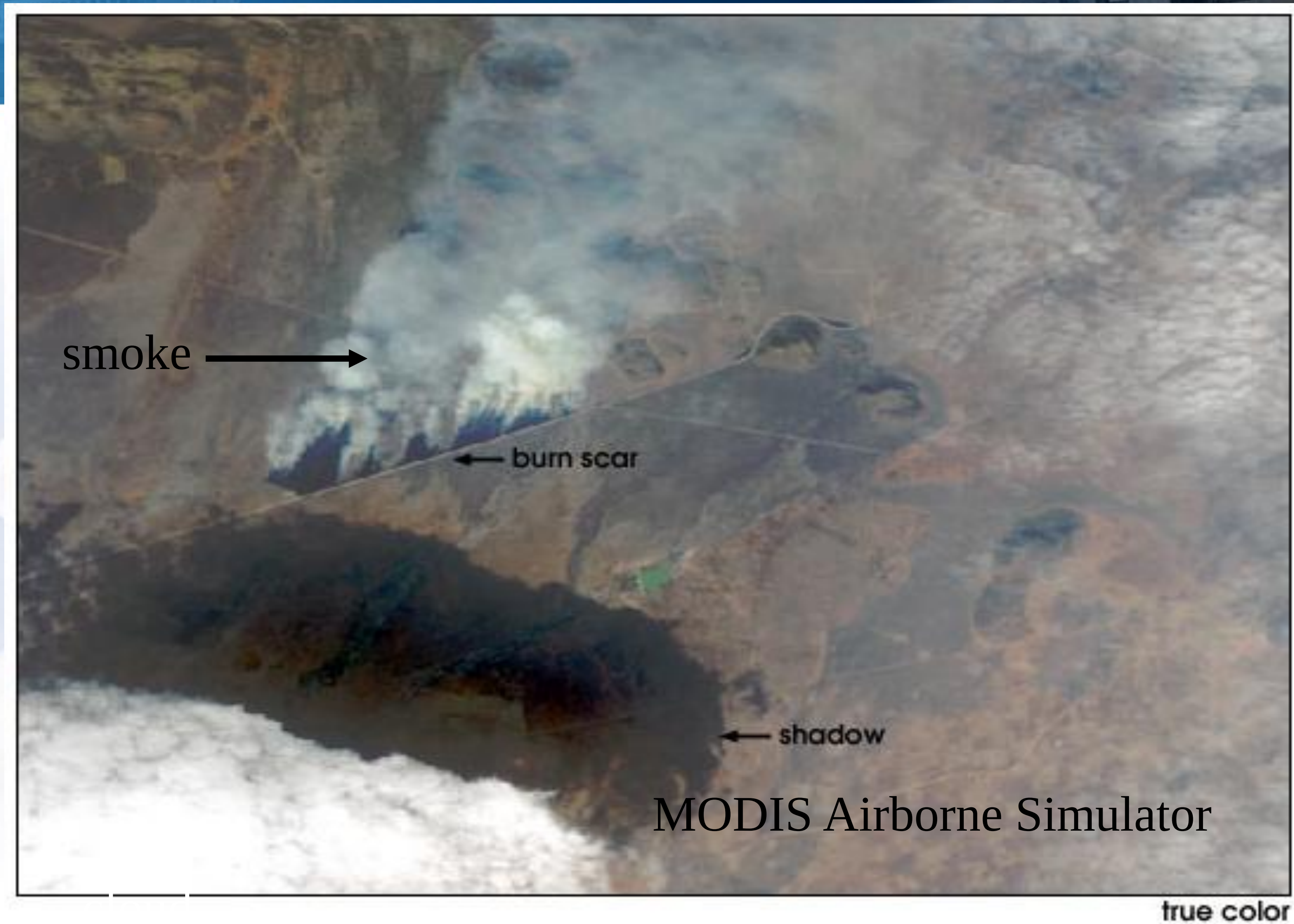
Courtesy of Mike Fromm

The Chisholm (Alberta) PyroCb - 28 May 2001

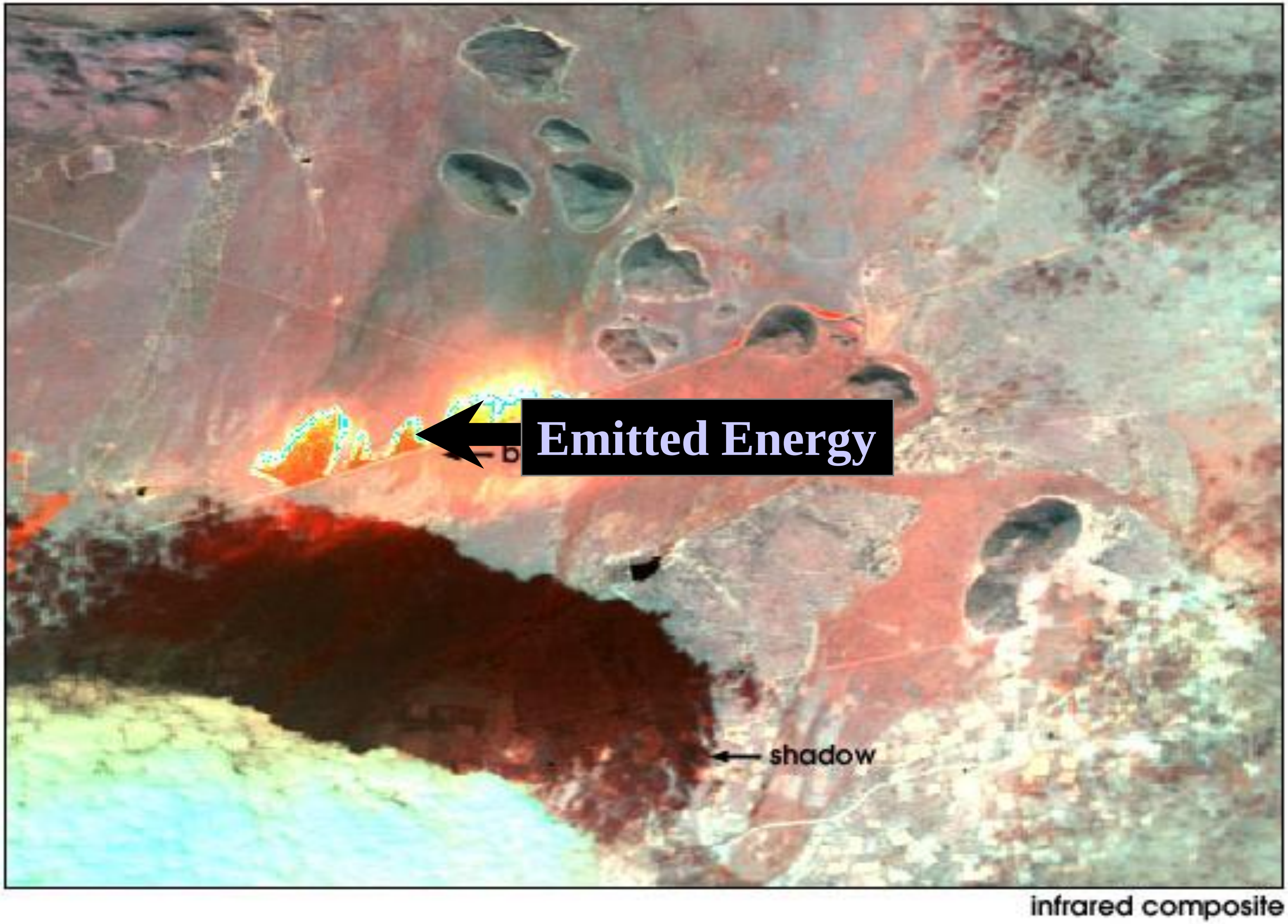
See Rosenfeld et al., (ACP, 2007)



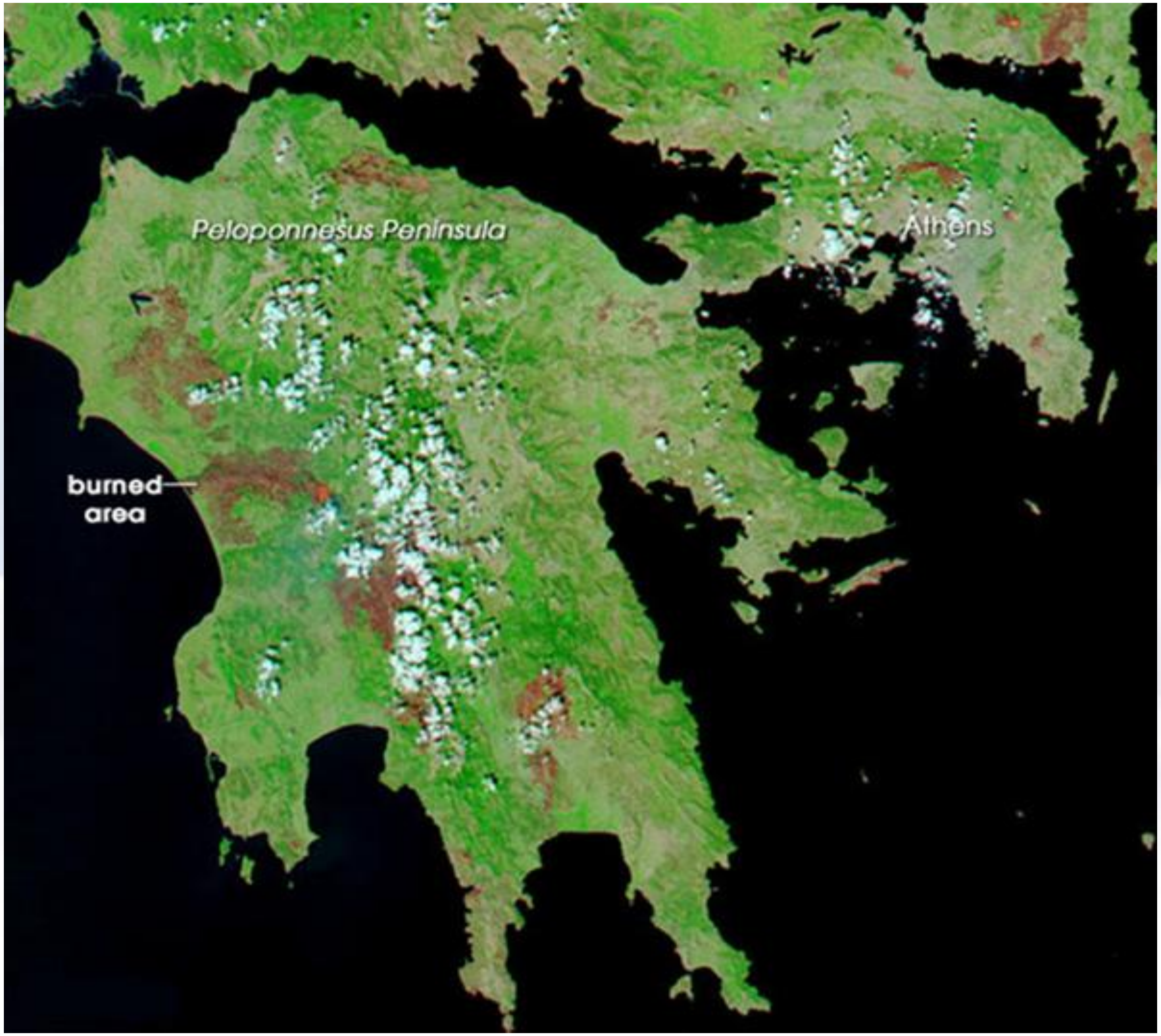
Fire Provides Multiple Signals in EO Data



Fire Provides Multiple Signals in EO Data



The Result of fire

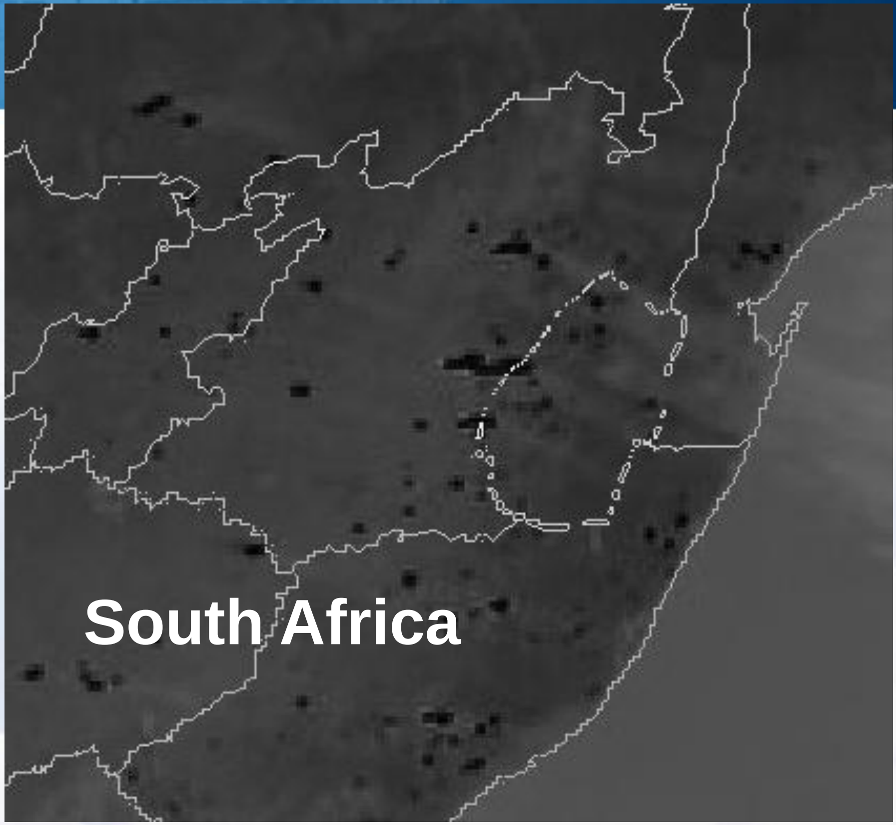


Satellite image showing burned areas of Greece as a result of several forest fires

MODIS 28 July 2003

VIS plus IR (0.6; 0.8; 2.1)

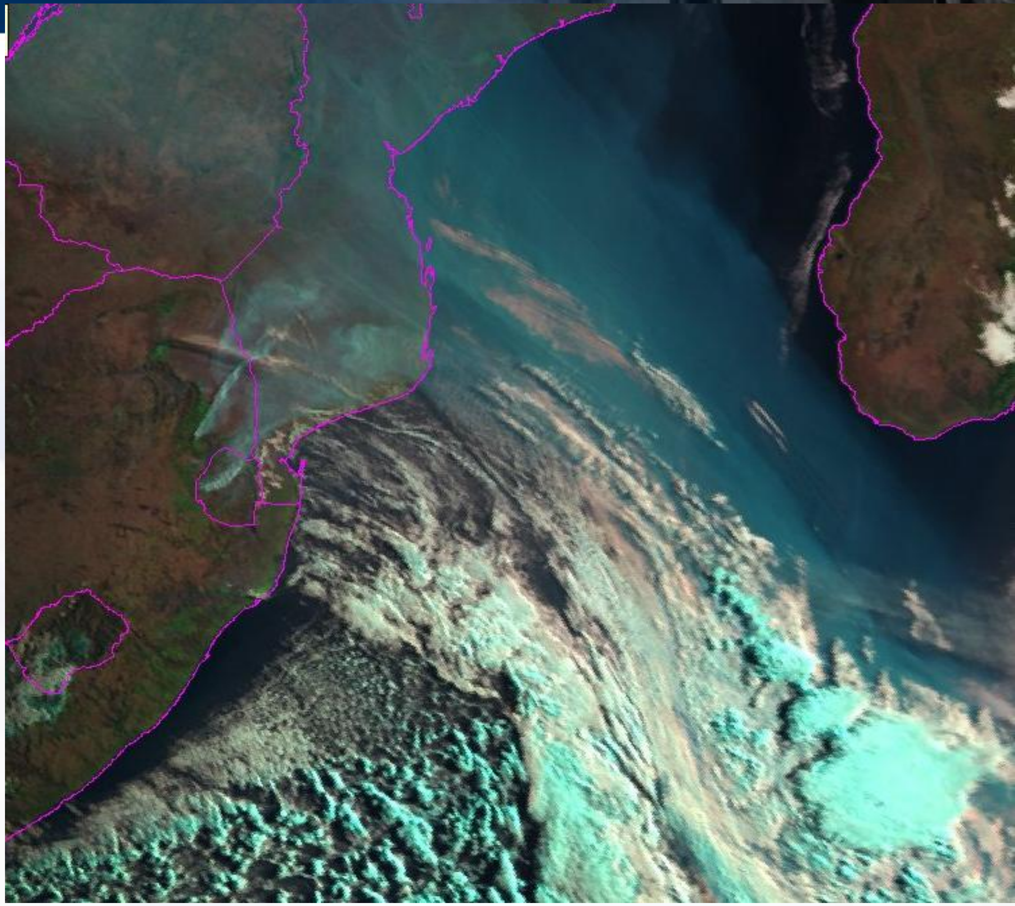
Fires/Smoke – MSG Example



Fire detection using ch. IR3.9

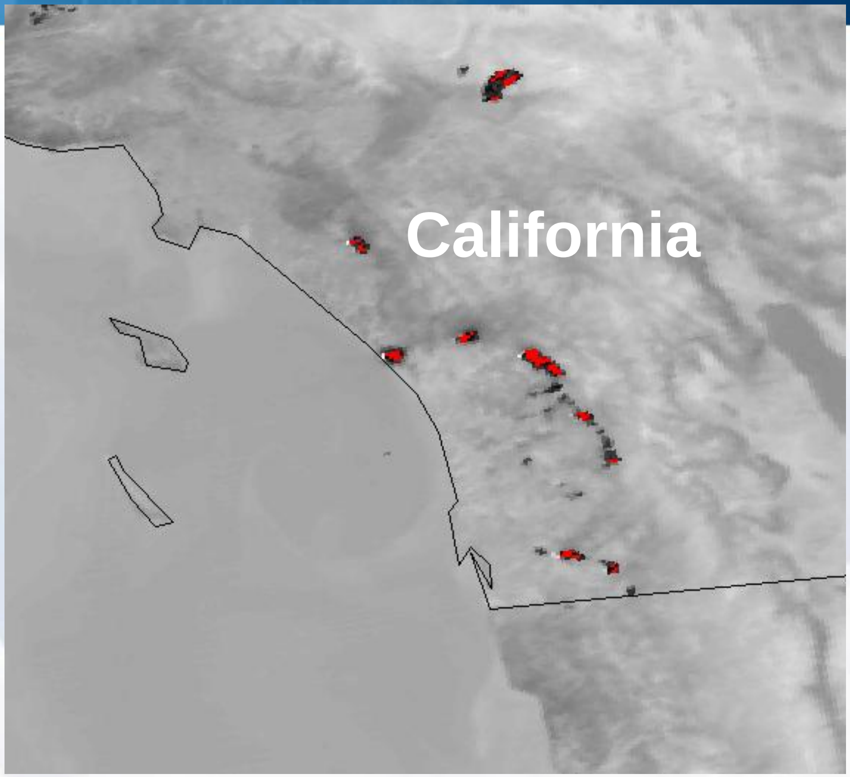
Met-9 imagery on
31 Aug / 1 Sep 2008

Click here to enter gallery



Visible imagery showing smoke

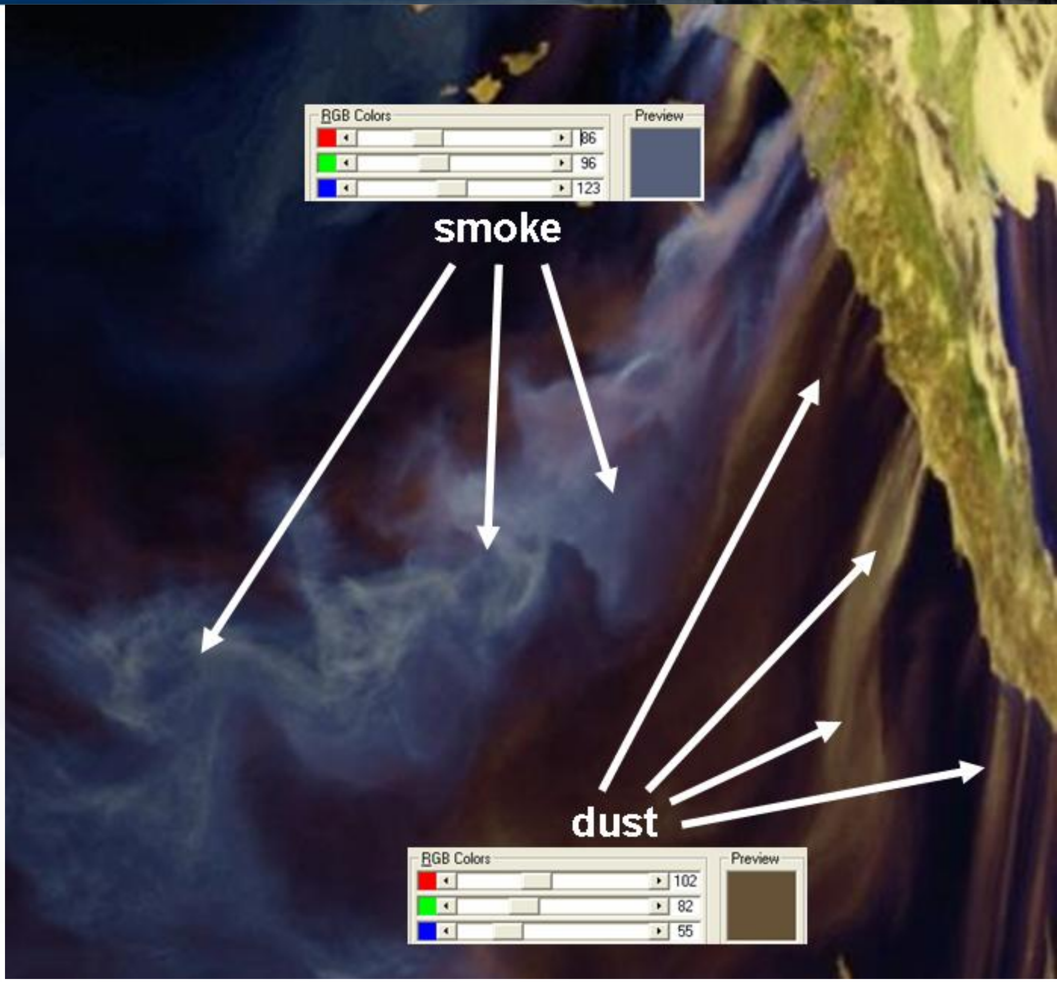
Fires/Smoke – Metop Example



Channel 3b (IR3.7)

AVHRR imagery
October 2007

Click here to enter gallery



Visible imagery showing smoke

Background Theory

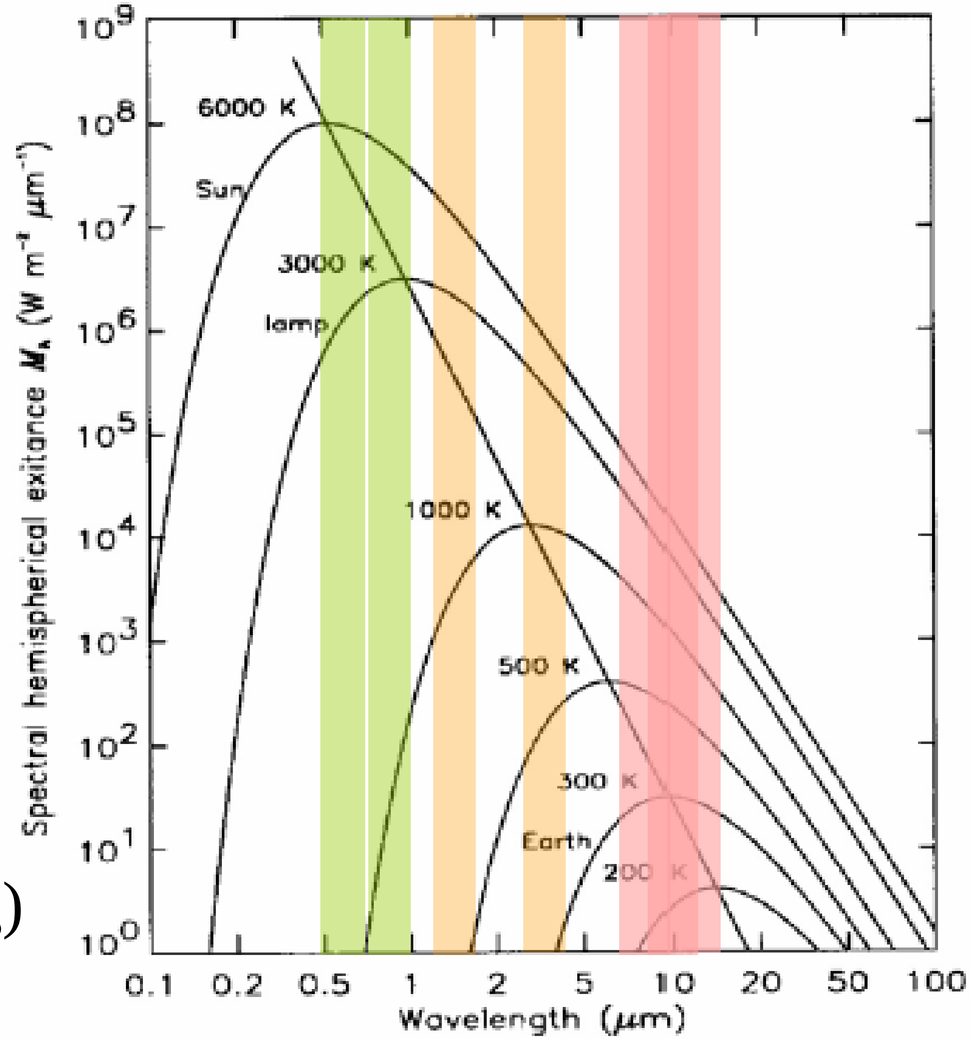
Planck's Radiation Law

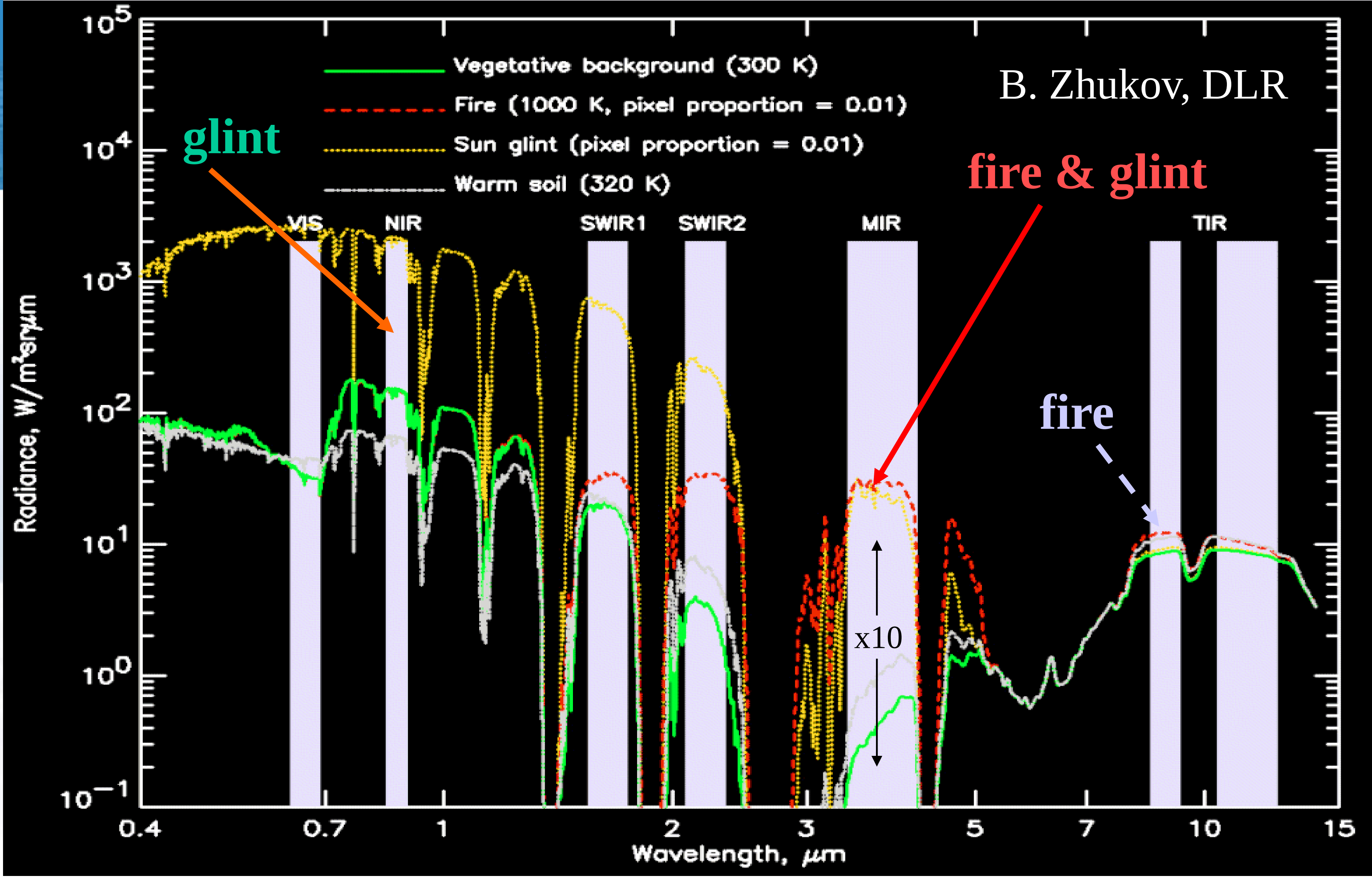
Planck's Radiation Law

$$L(\lambda, T) = \frac{C_1}{\lambda^5 (\exp(\frac{C_2}{\lambda T}) - 1)}$$

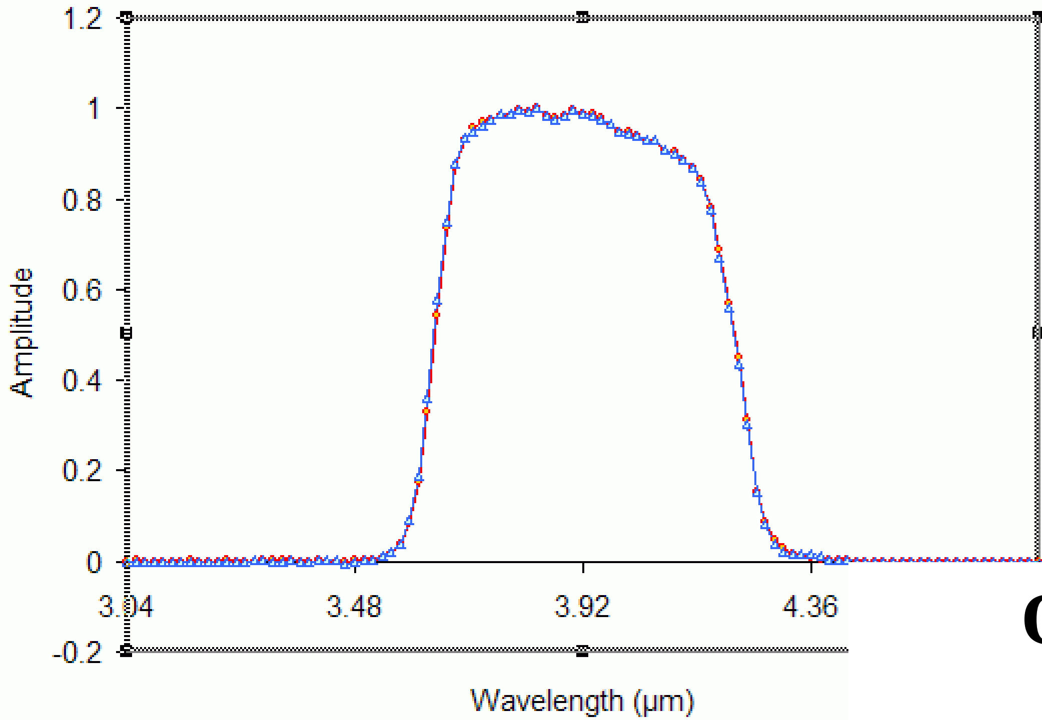
λ wavelength (m)
T temperature (K)
L spectral radiance ($Wm^{-2}\ sr^{-1}m^{-1}$)
$C_1 = 2\pi hc^2$ $W.m^2$
$C_2 = hc/k_B$ m.K

Fire temperatures range from a minimum of ~ 500 K (weak smoulding) to max ~ 1400 K (intense flaming). Emission peaks in the MIR region.



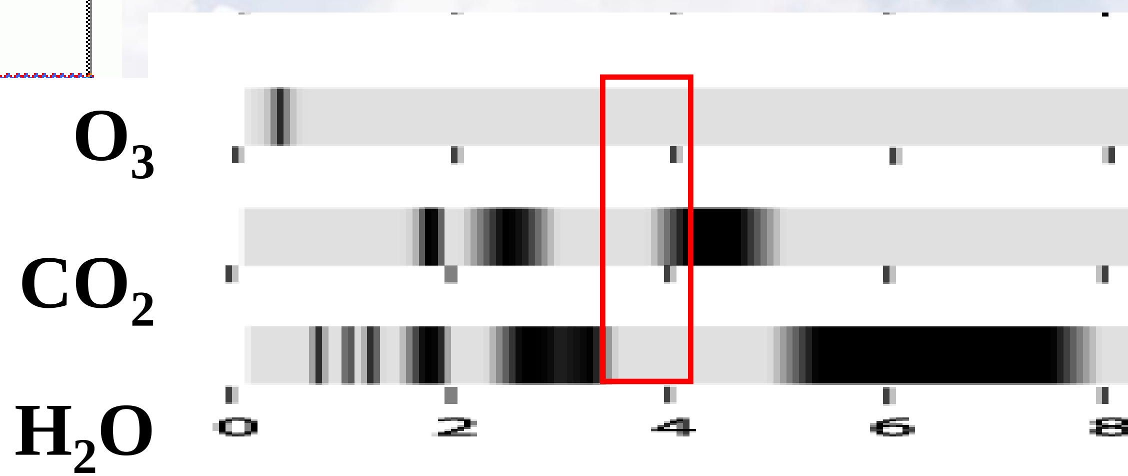

Vegetative background (300 K)
Fire (1000 K, pixel proportion = 0.01)
Sun glint (pixel proportion = 0.01)
Warm soil (320 K)
B. Zhukov, DLR
glint
fire & glint
fire
x10
VIS
NIR
SWIR1
SWIR2
MIR
TIR
Radiance, W/m²srμm
Wavelength, μm
0.4
0.7
1
2
3
5
7
10
15

SEVIRI 3.9 μm channel



FM Filter Function

Absorption Bands in MIR



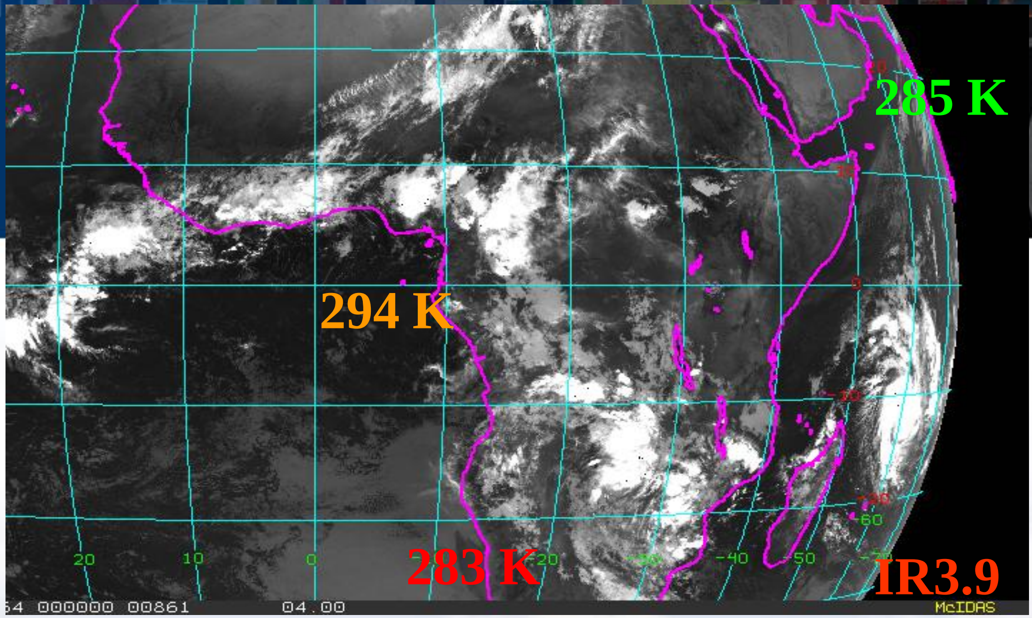
Wavelength (μm)

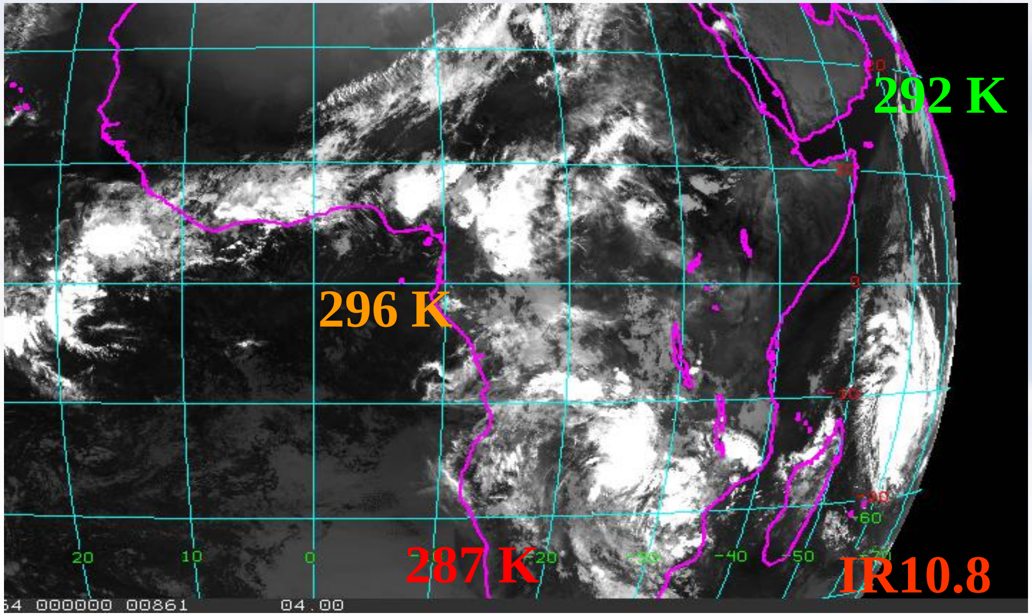
Brightness Temperatures Differences (BTD) for Cloud-free Ocean Targets

Tropical, moist atmosphere,
Small sat. viewing angle:
IR3.9 - IR10.8 = -2K

Sub-tropical, dry atmosphere,
Medium sat. viewing angle:
IR3.9 - IR10.8 = -4 K

Sub-tropical, dry atmosphere,
Large sat. viewing angle:
IR3.9 - IR10.8 = -7 K





Sunshine – Earthshine

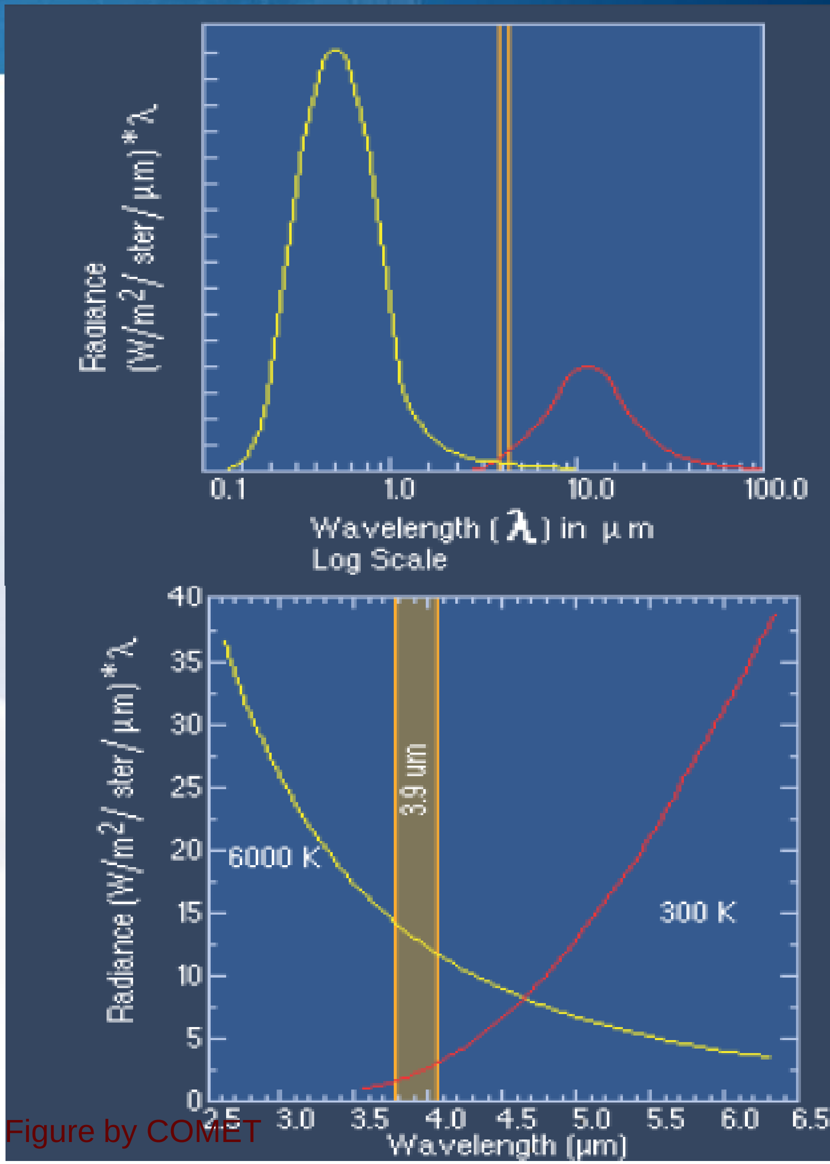


Figure by COMET

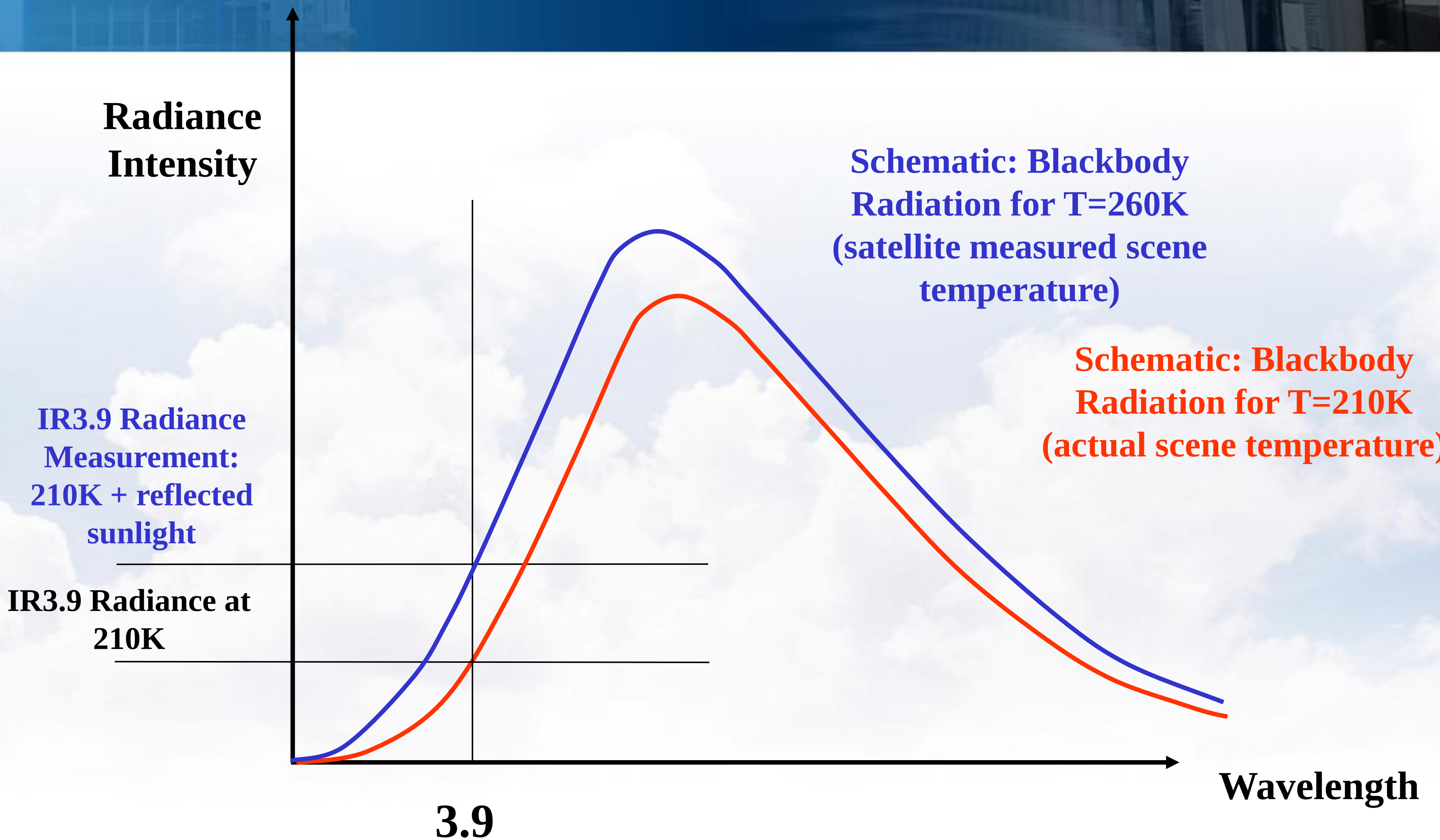
Signal in IR3.9 comes from reflected solar AND emitted thermal radiation!

Planck Blackbody Radiance — Reflectivity

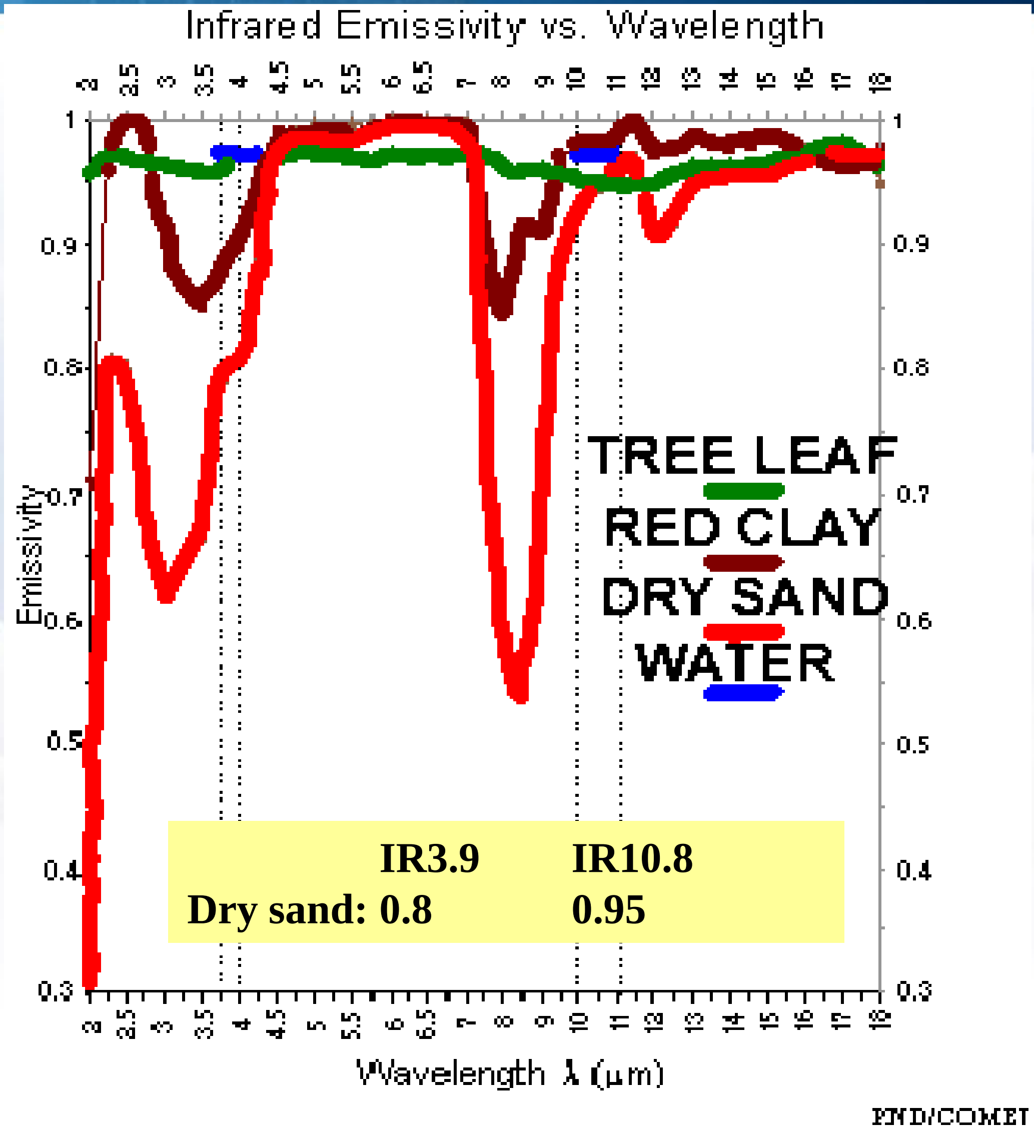
$$Radiance(3.9\mu m) = \varepsilon_{3.9} B_{3.9} + r_{3.9} S_{3.9}$$

Emissivity — Incoming Solar Radiation

IR3.9 Brightness Temperature



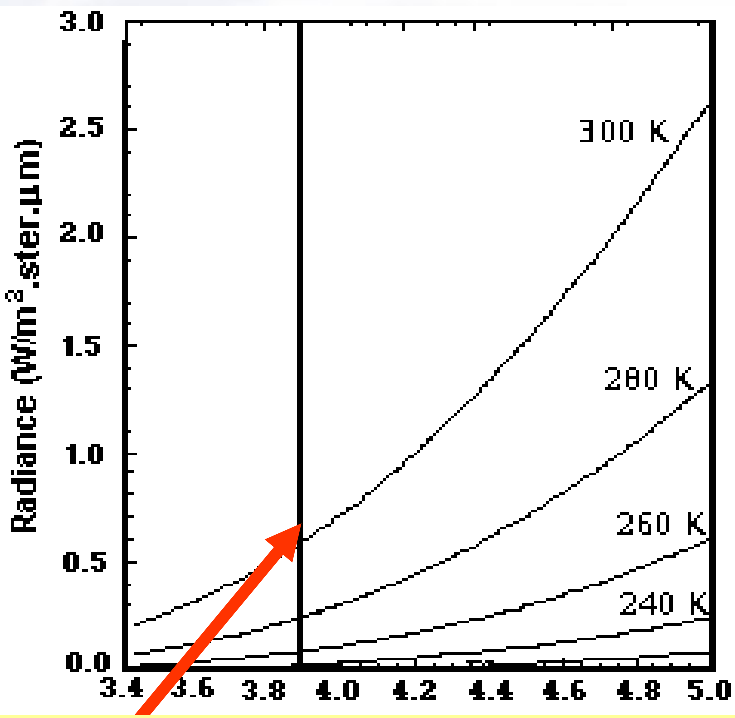
Surface Emissivity



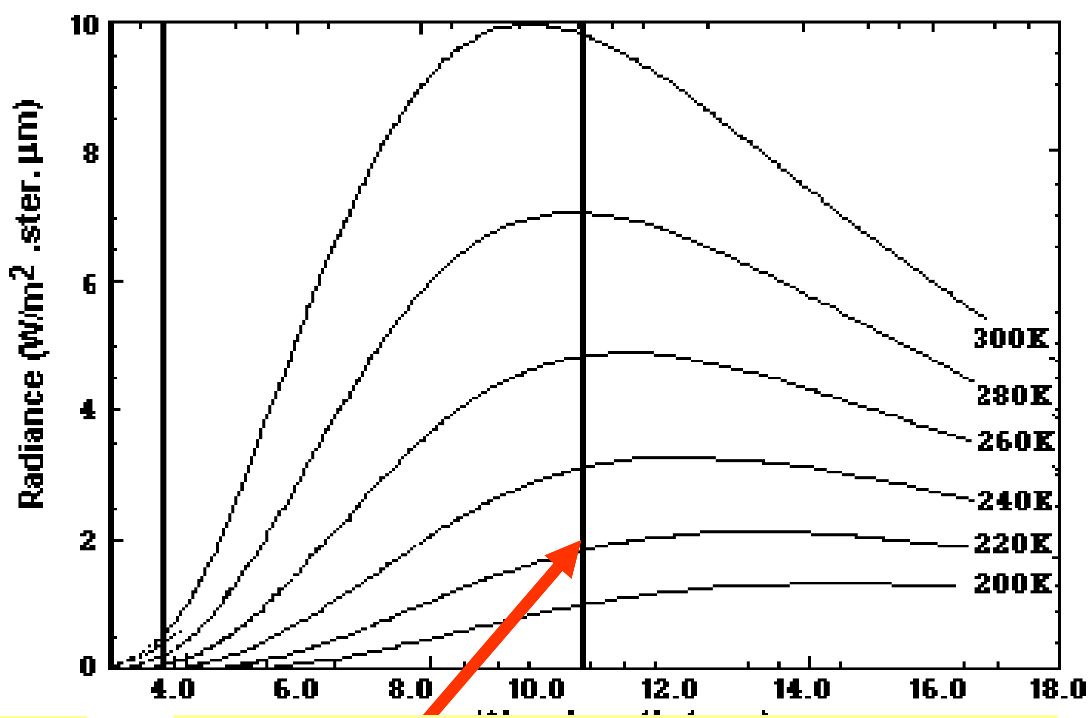
- Emissivity more variable near 3.9 μm
- Sandy areas appear 5-10 K cooler at IR3.9 than at IR10.8 (at night, dry atmosphere)

IR3.9 Channel: Sub-pixel response

- Radiance is not linear with temperature: $B = T^{\alpha/\lambda}$
- The response to changes in scene temperature is much larger at shorter wavelengths

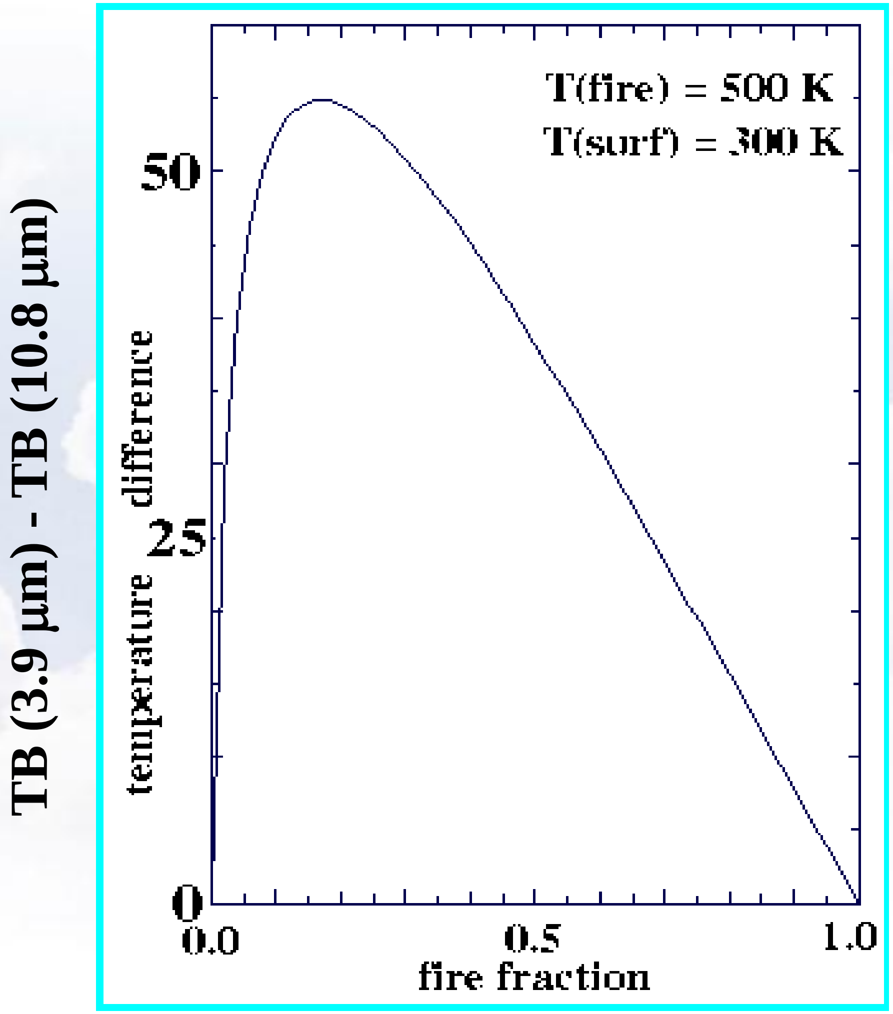


Strong non-linear increase of radiance with increasing temperature



More "linear" increase of radiance with increasing temperature

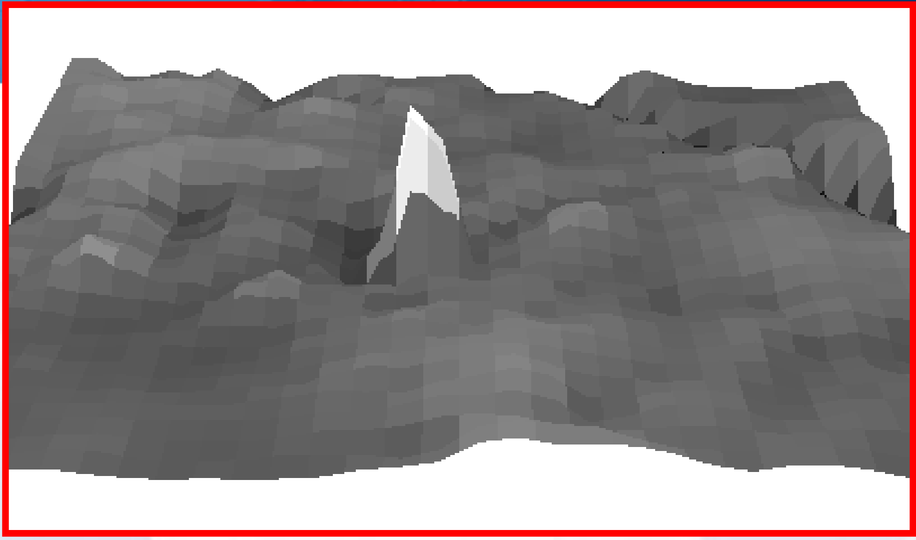
IR3.9 Channel: Sub-pixel response



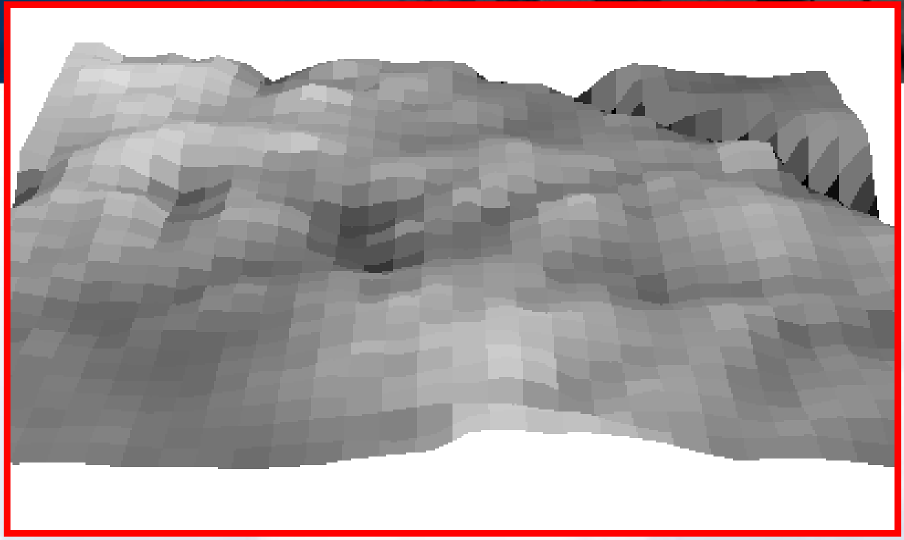
- Its strong sensitivity to sub-pixel "hot areas" makes the IR3.9 channel very useful in fire detection.
- If only 5% of the pixel is at 500 K, the IR3.9 channel measures 360 K, while the IR10.8 measures less than 320 K.

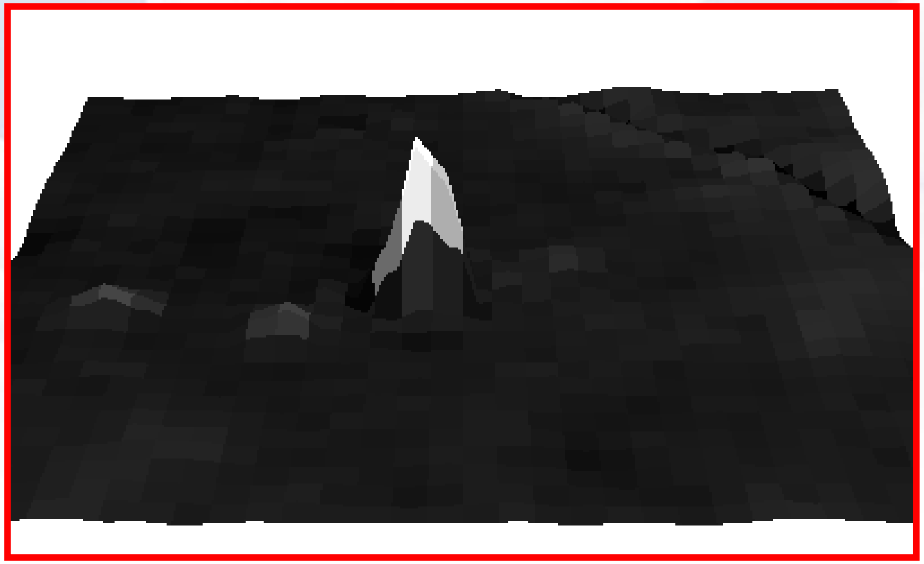
Brightness Temp. Characteristics of an Active Fire

3.9 µm



10.8µm



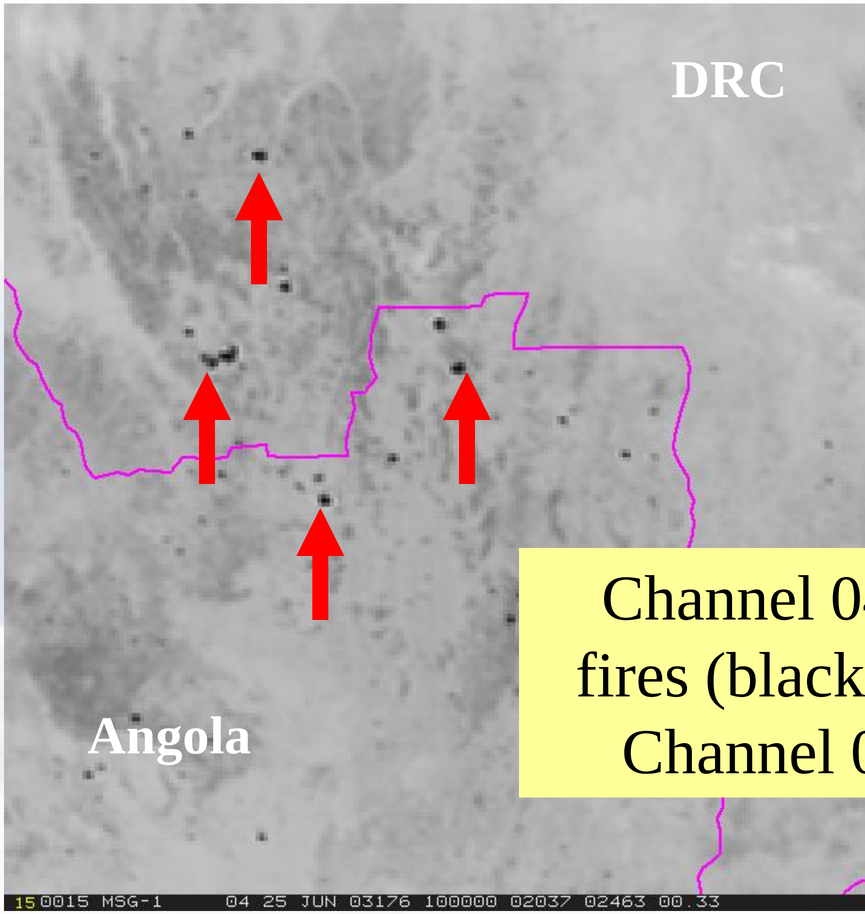


3.9µm - 10.8µm

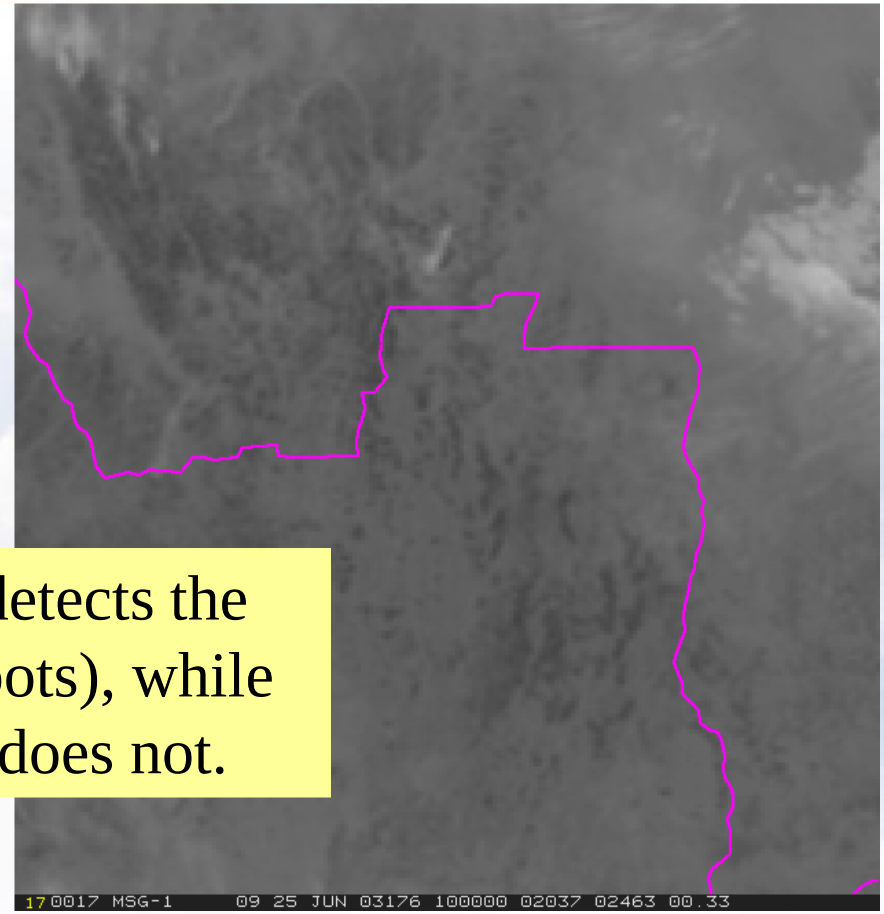
<u>Fire pixel detection should consider:</u>

- Spectral signals
- Spatial signals
- Temporal signals

First MSG Fire Examples



Channel 04 (3.9 µm)

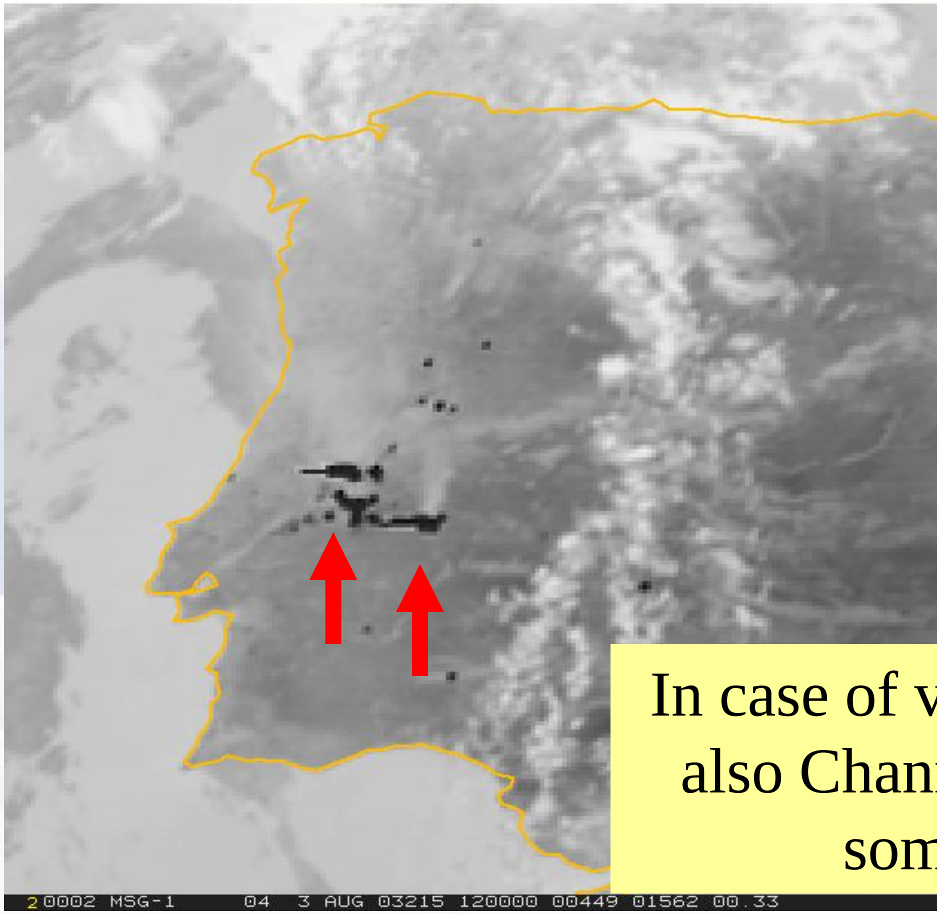


Channel 09 (10.8 µm)

Channel 04 detects the fires (black spots), while Channel 09 does not.

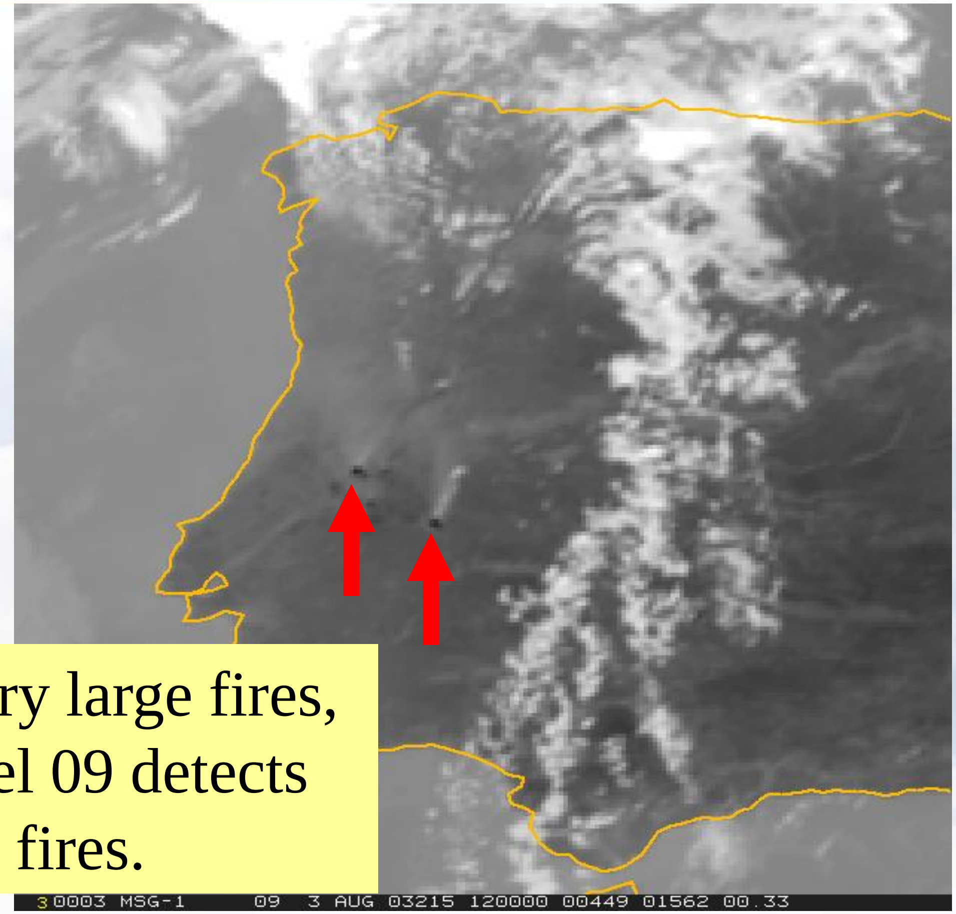
MSG imagery on 25 June 2003 at 10:00 UTC

First MSG Fire Examples



Channel 04 (3.9 μm)

In case of very large fires, also Channel 09 detects some fires.



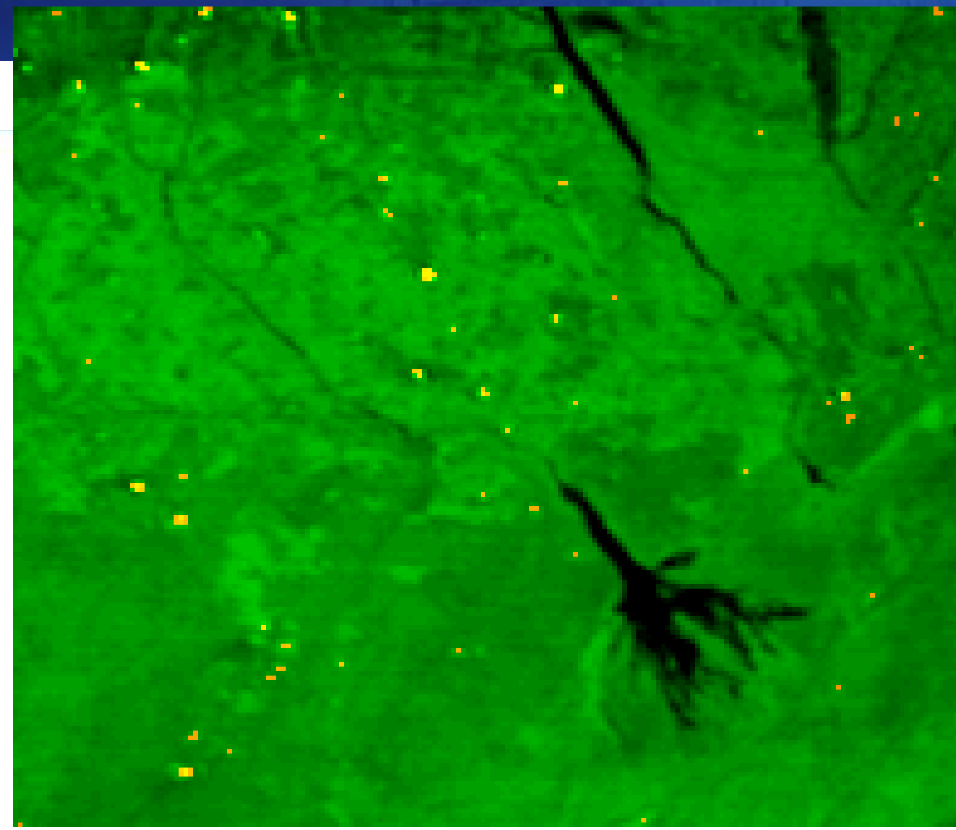
Channel 09 (10.8 μm)

MSG imagery on 3 August 2003 at 12:00 UTC

MODIS - SEVERI Comparison (1 Sep 2003)

MODIS (12:20 GMT)

SEVERI (12:57 GMT)

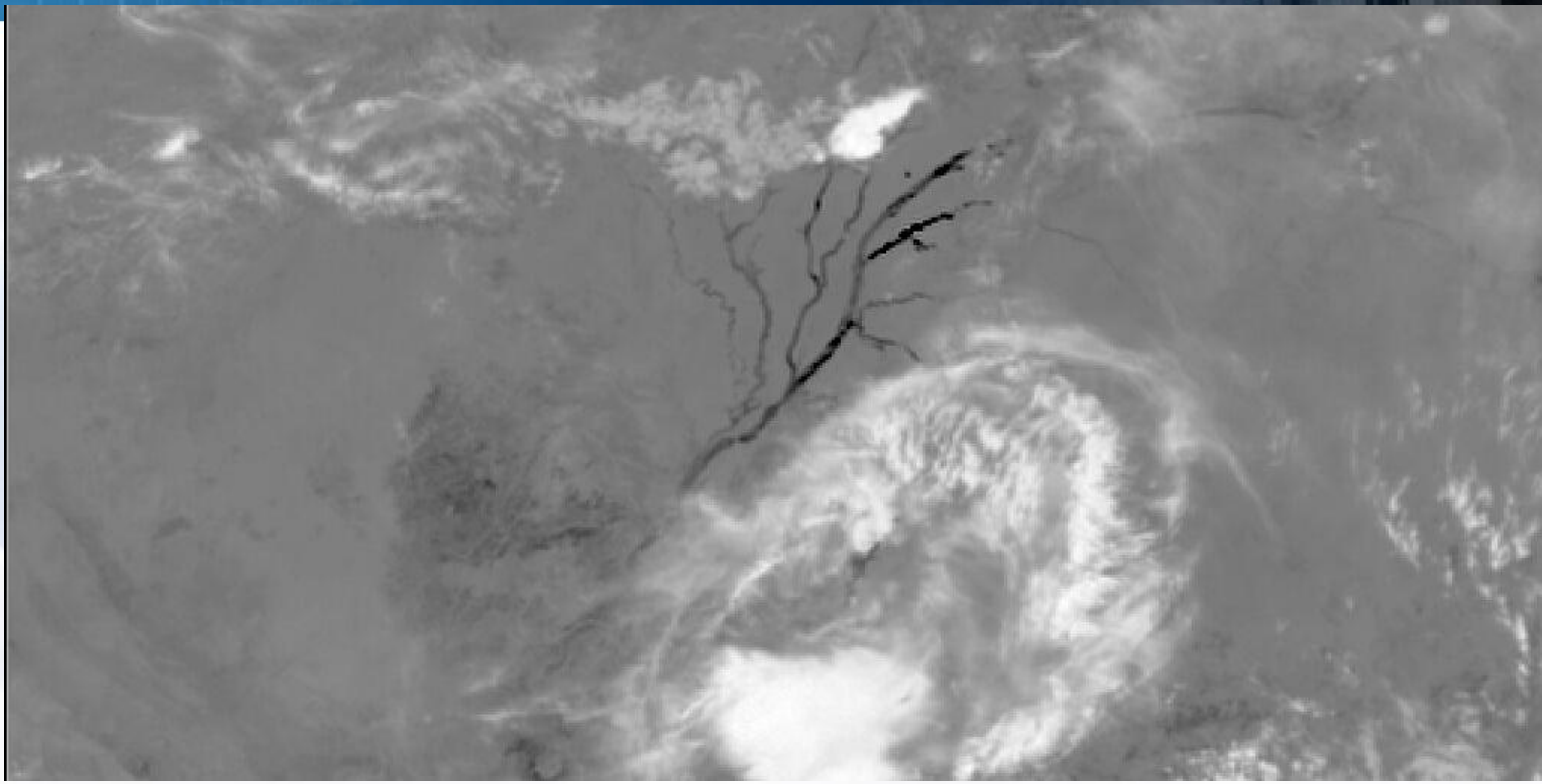


Green : IR3.9 channel radiance background

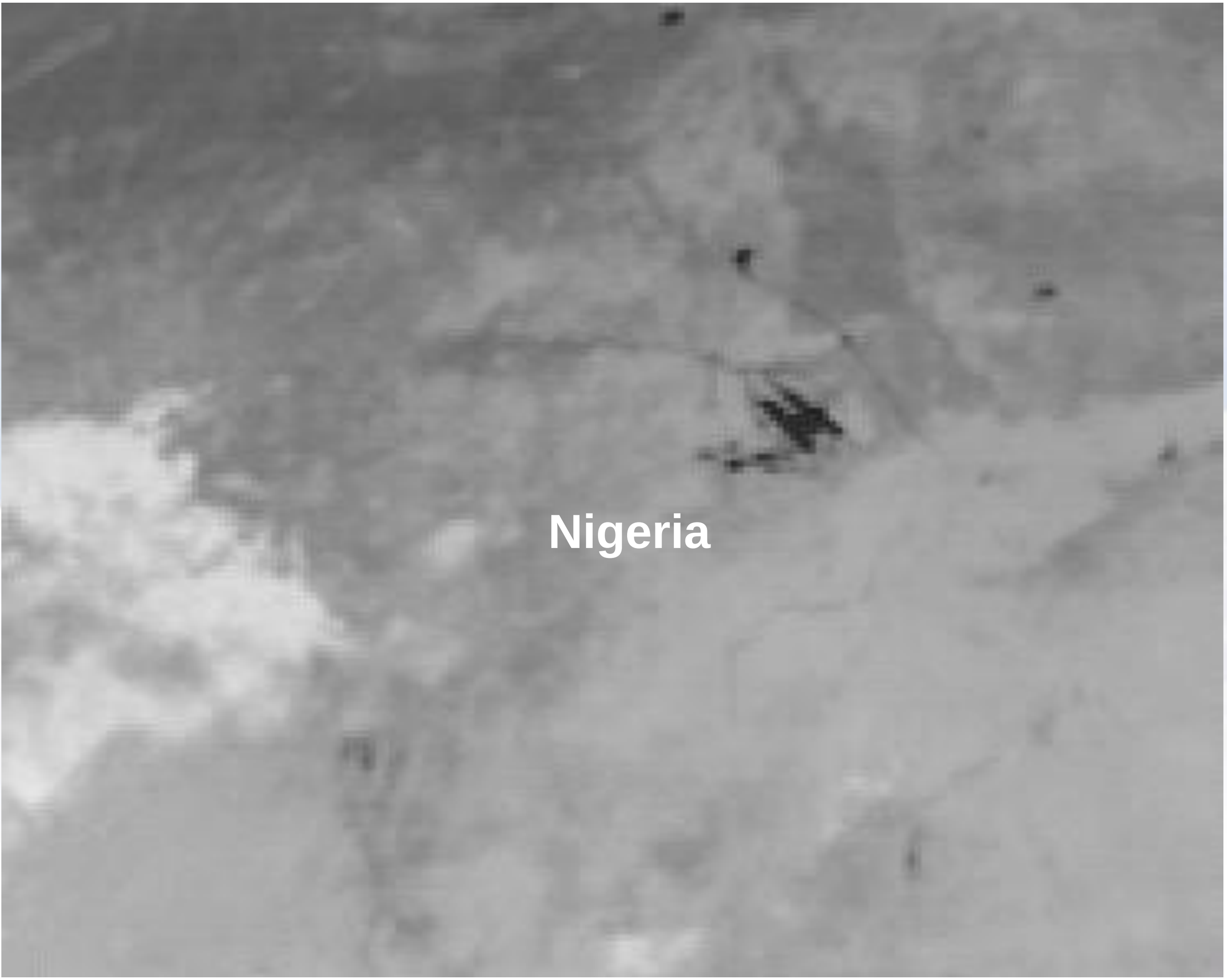
Yellow : Detected fire pixels using alg. based on Giglio *et al* (2004)

Impact of Sunglint

- There is very strong reflection of solar radiation at 3.9 μm (sunglint)
- Features such as rivers in sunglint are obvious, but “illuminated” lakes could take on the appearance of fires



Midday sun glint over the Congo river
MSG-1, 24 March 2004, 09:00 UTC, Channel 04 (3.9 µm)

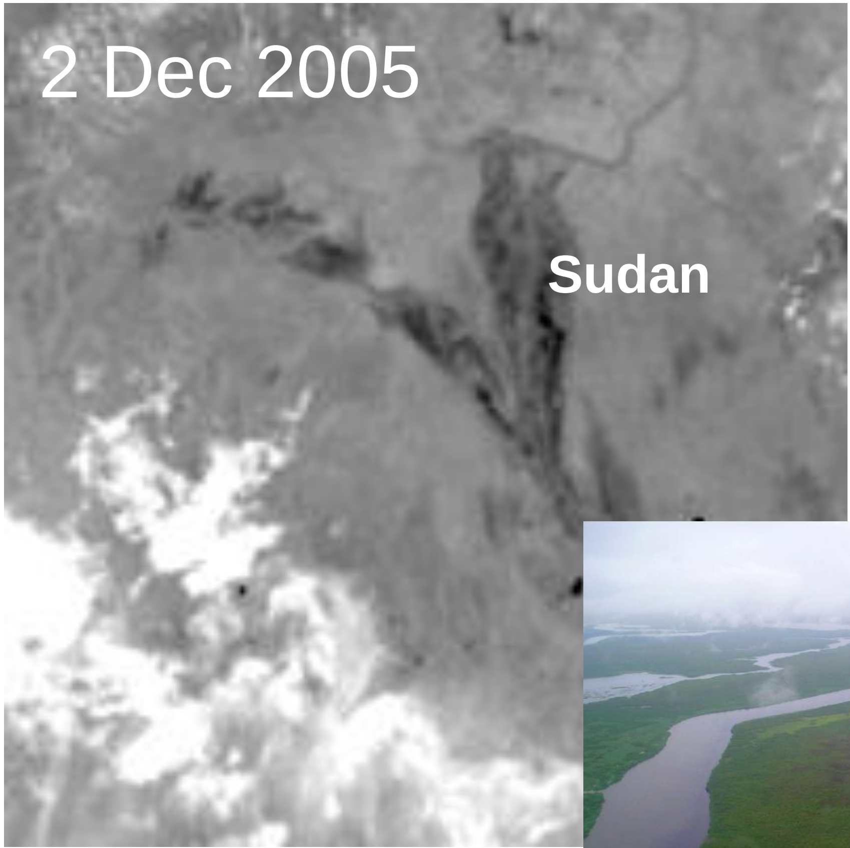


Sunglint in Channel 04 over the local rivers and lakes

MSG-1
5 June 2003
10:00 UTC
Channel 04
(IR3.9)

CLICK HERE

Warm water surfaces



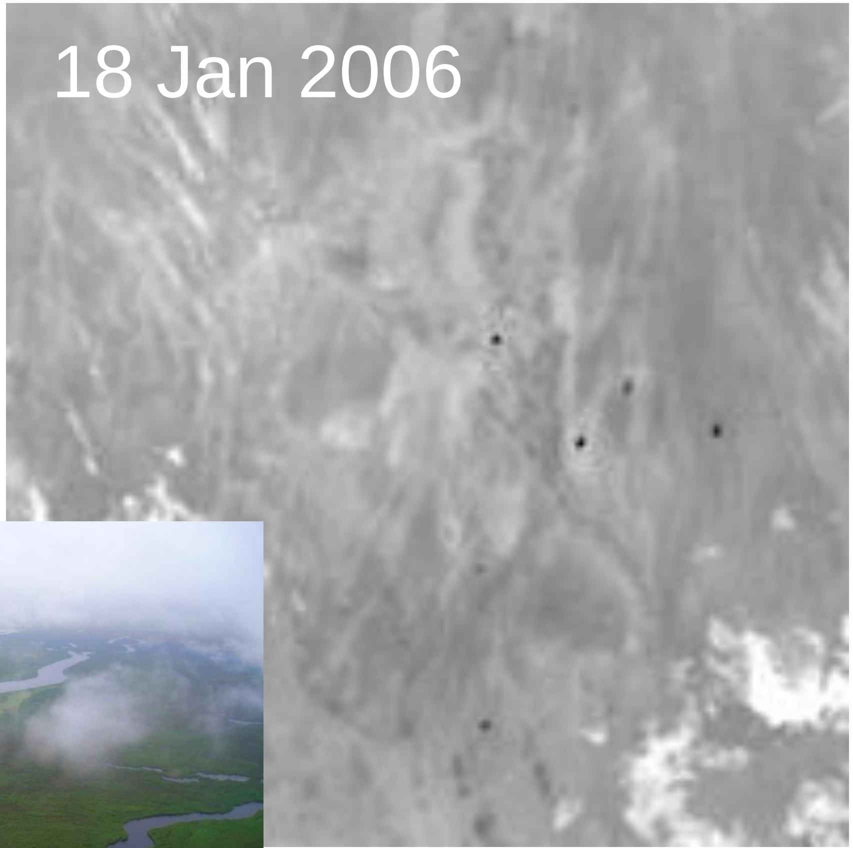
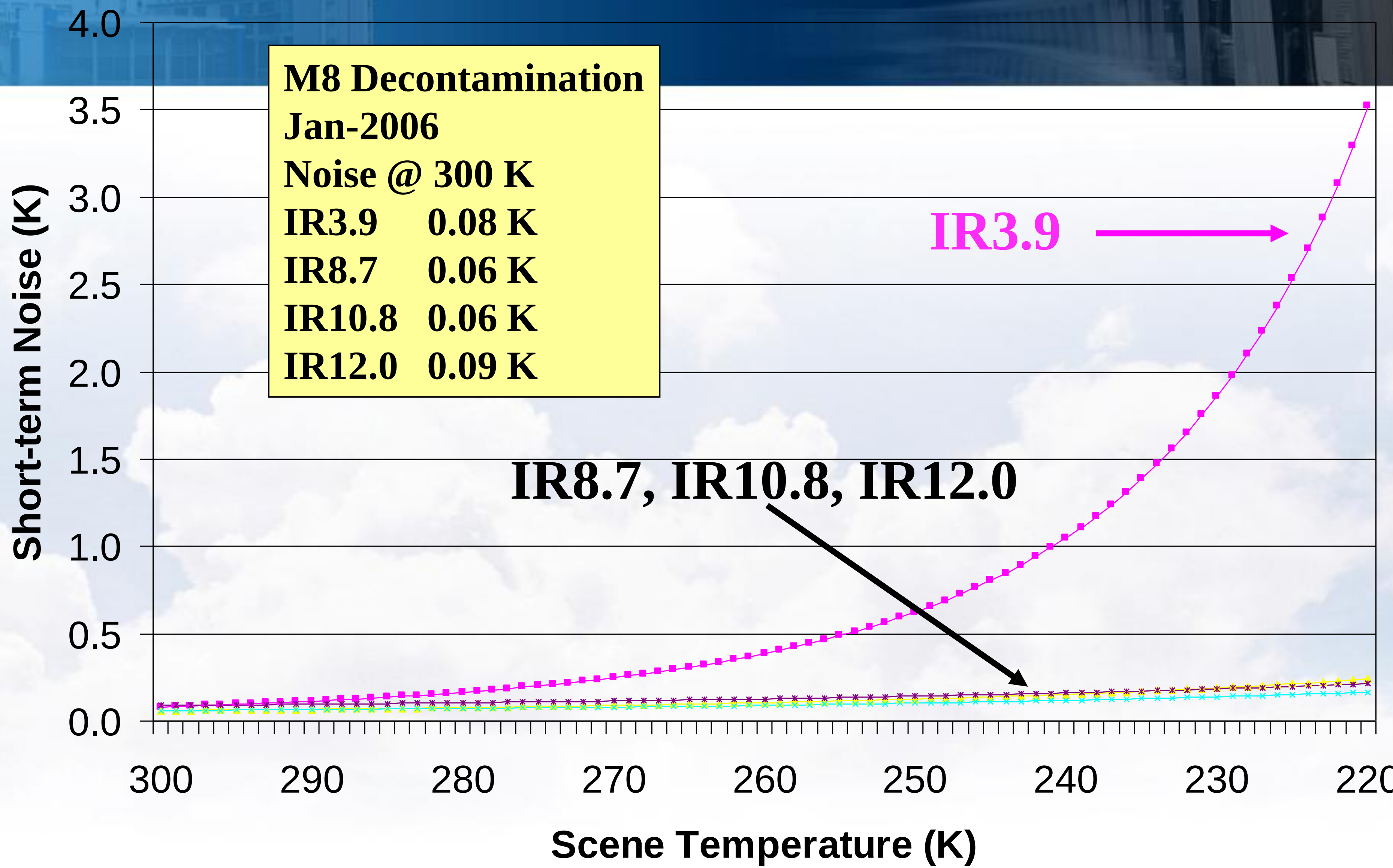
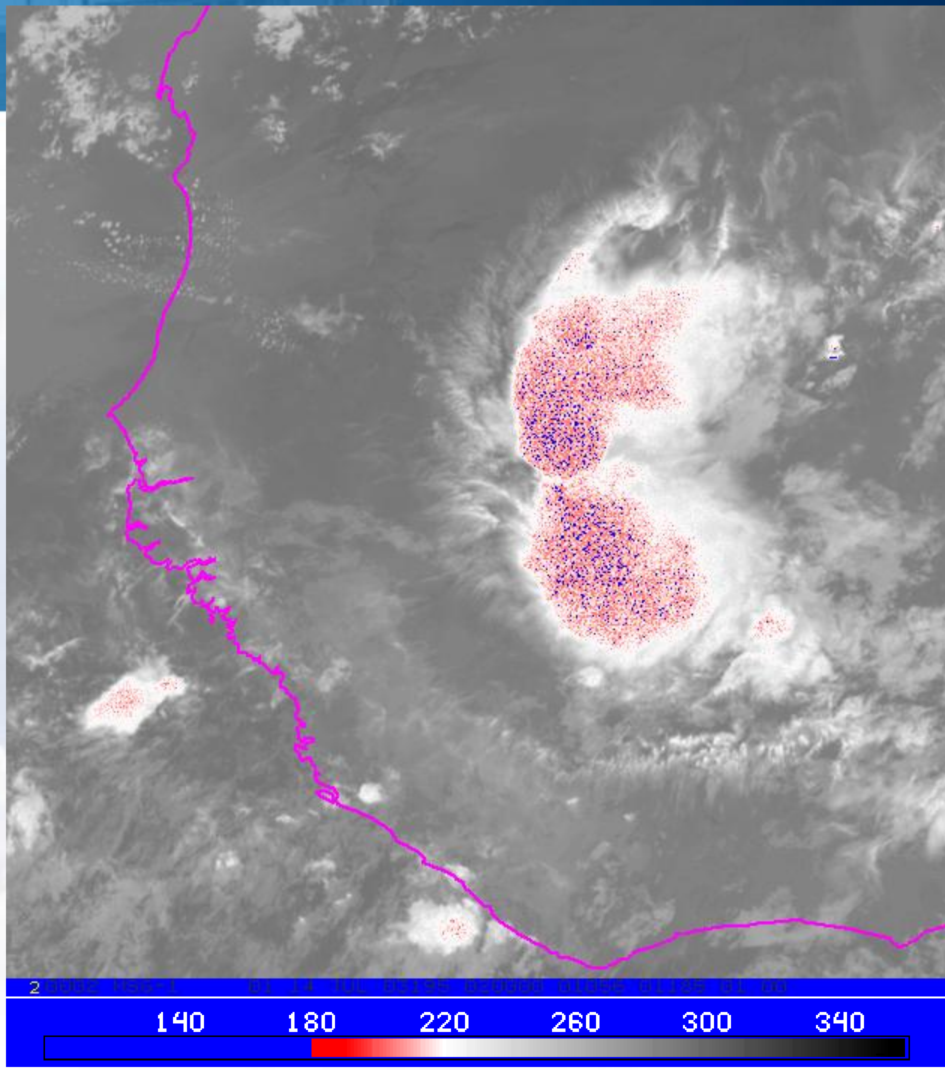


Photo by WFP Sudan VAM Unit

Short-term Noise of IR Channels



Noise in the IR3.9 Channel: Example



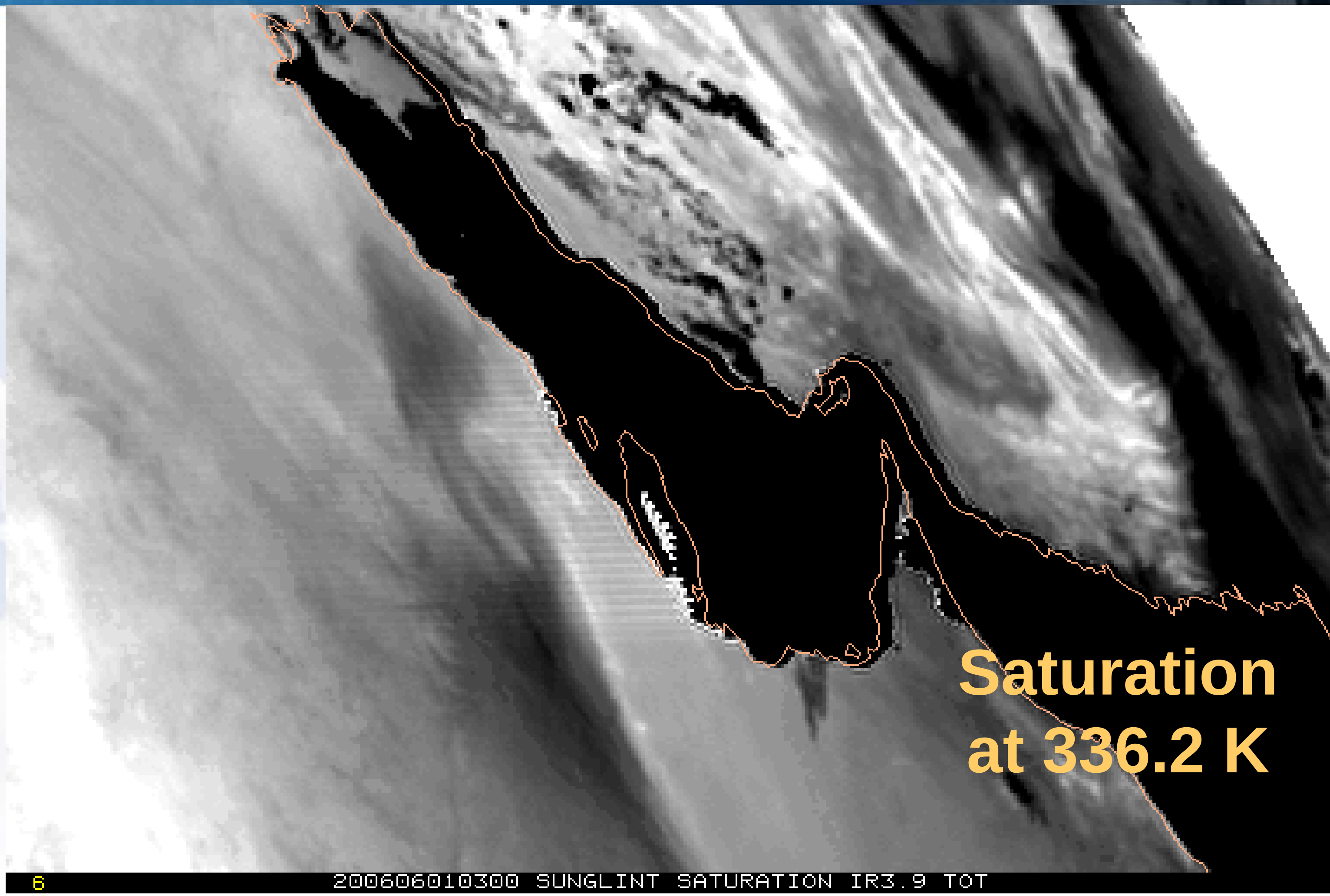
MSG-1, 14 July 2003, 02:00 UTC, IR3.9

Below BTs of 220 K the IR3.9 channel is very noisy (radiances close to zero).

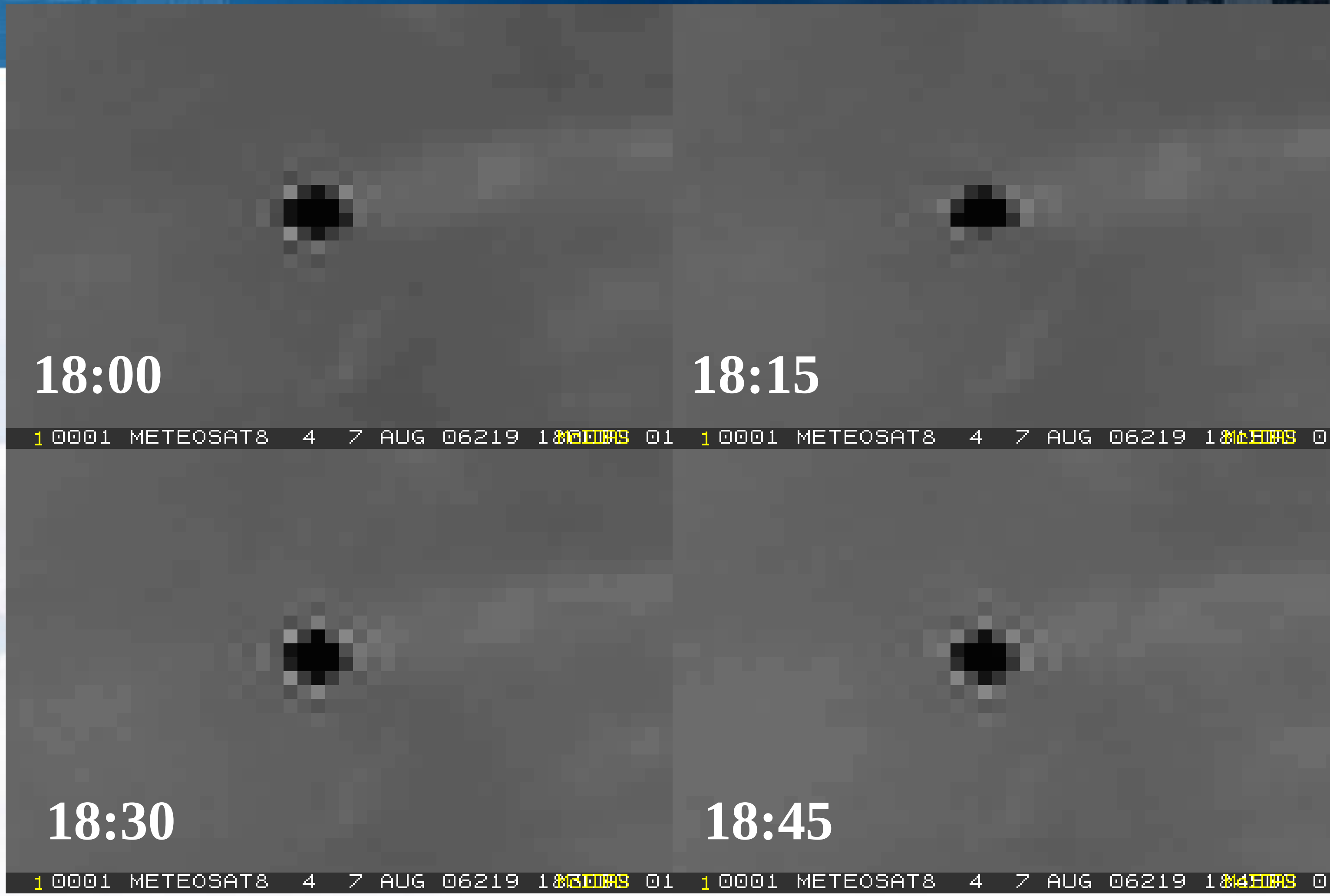
RAW [count]	RAD [mW/m^2]	TEMP [K]
54	0.01	218
53	0.01	213
52	0.00	205
51	0.00	131

Interpretation: IR3.9 imagery does a fine job for warm scene temperatures, but at night it is not useful for cold scenes like thunderstorm tops.

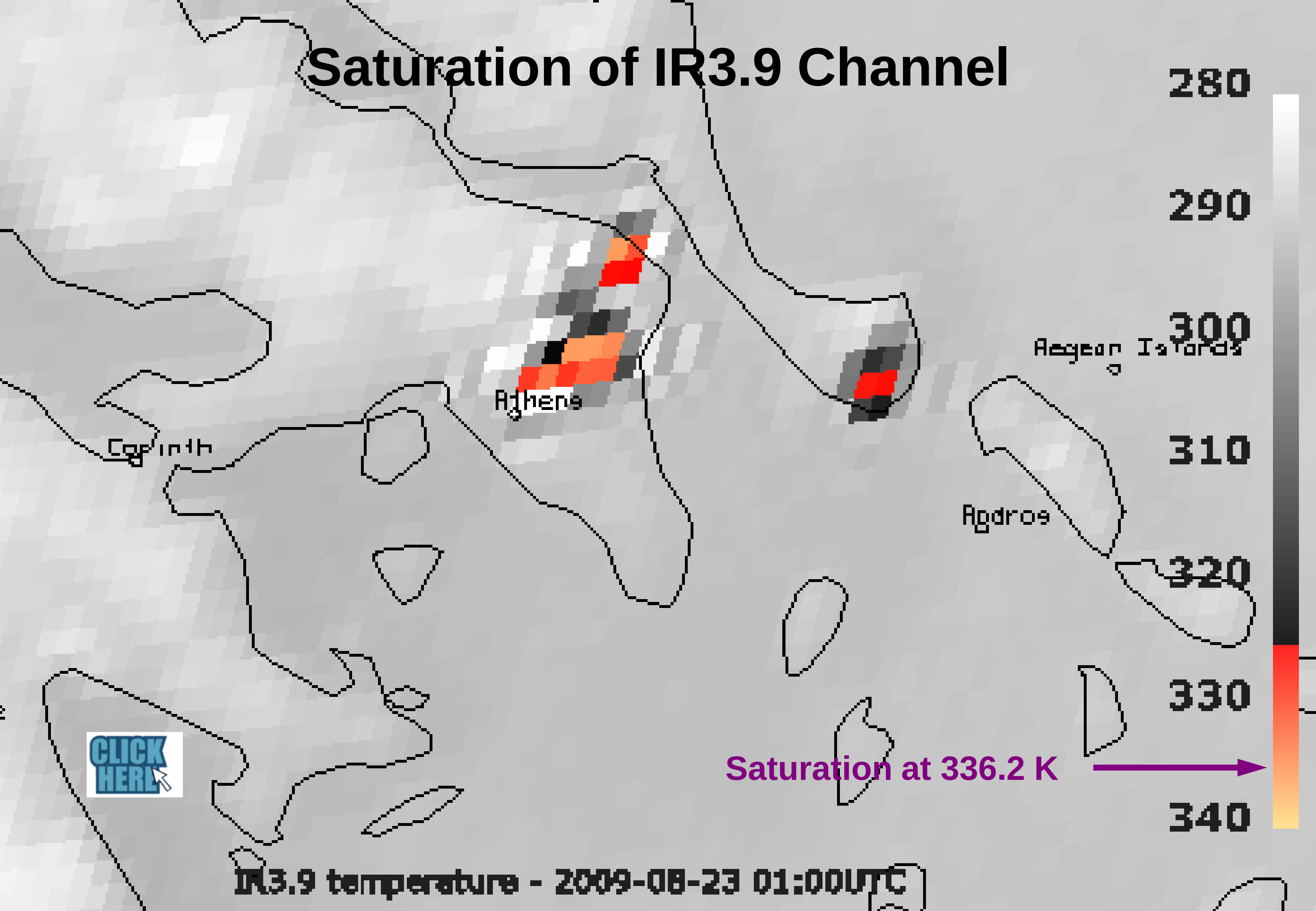
Saturation of IR3.9 Channel



Artefacts coming from Digital Filter

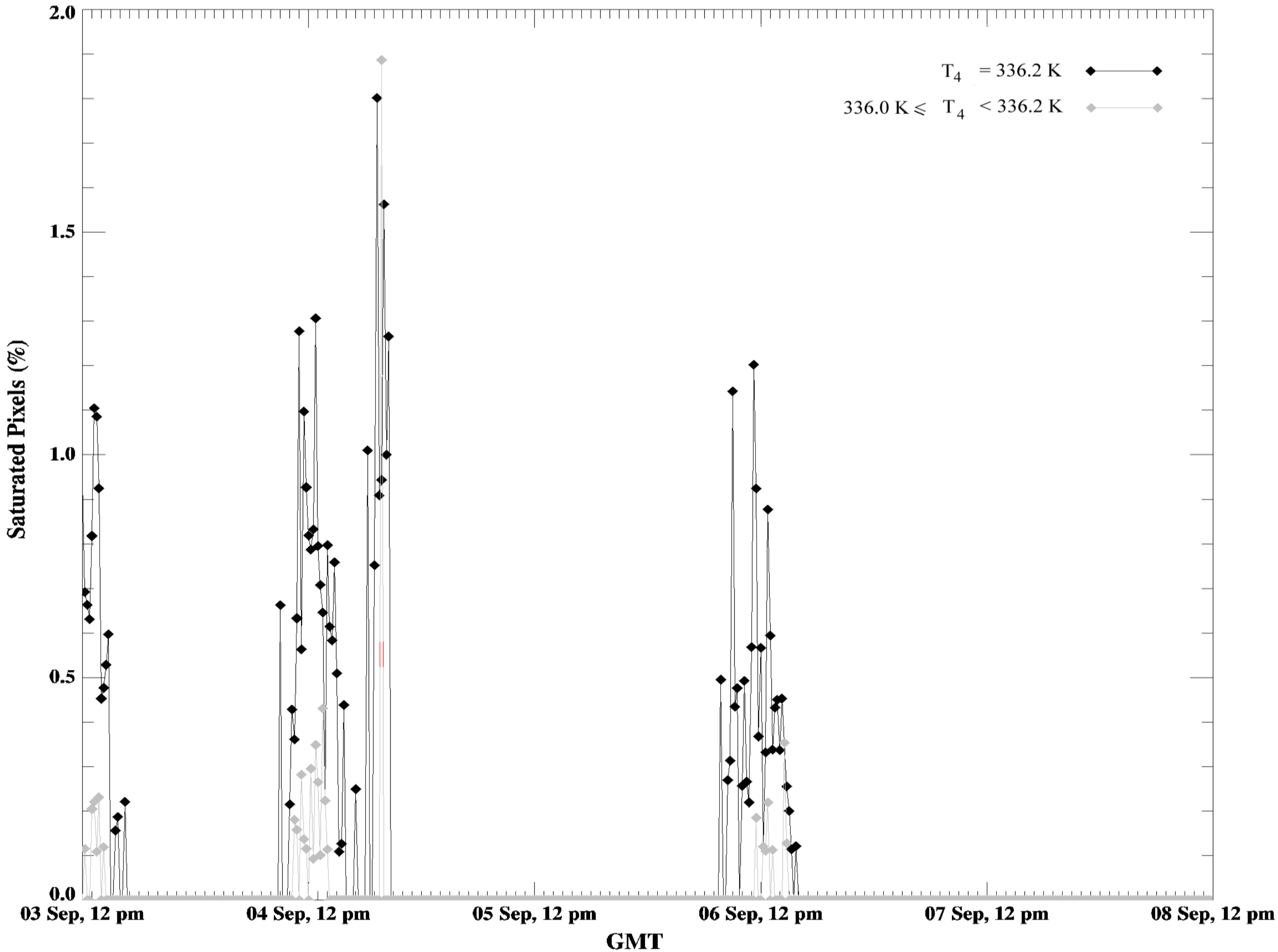


MSG-1, 7 August 2006, IR3.9 Channel (inverted)



Saturation of IR3.9 Channel
280
290
300
310
320
330
340
Aegean Islands
Athens
Corinth
Andros
CLICK HERE
Saturation at 336.2 K
IR3.9 temperature - 2009-08-23 01:00UTC

Frequency of Saturated IR3.9 Pixels




“Blinding” of IR3.9 Channel
Smoke plumes
Fires in Brazil, Feliz Natal
3 August 2007, 17:45 UTC, Met-9, HRV Channel
52_Band12_REFL - 2007_08_03_1745


"Blinding" of IR3.9 Channel
Blinding can occur for saturated, large fires
IR3.9 Channel
52_Band4_TEMP - 2007_08_03_1745
280
290
300
310
320
330
340

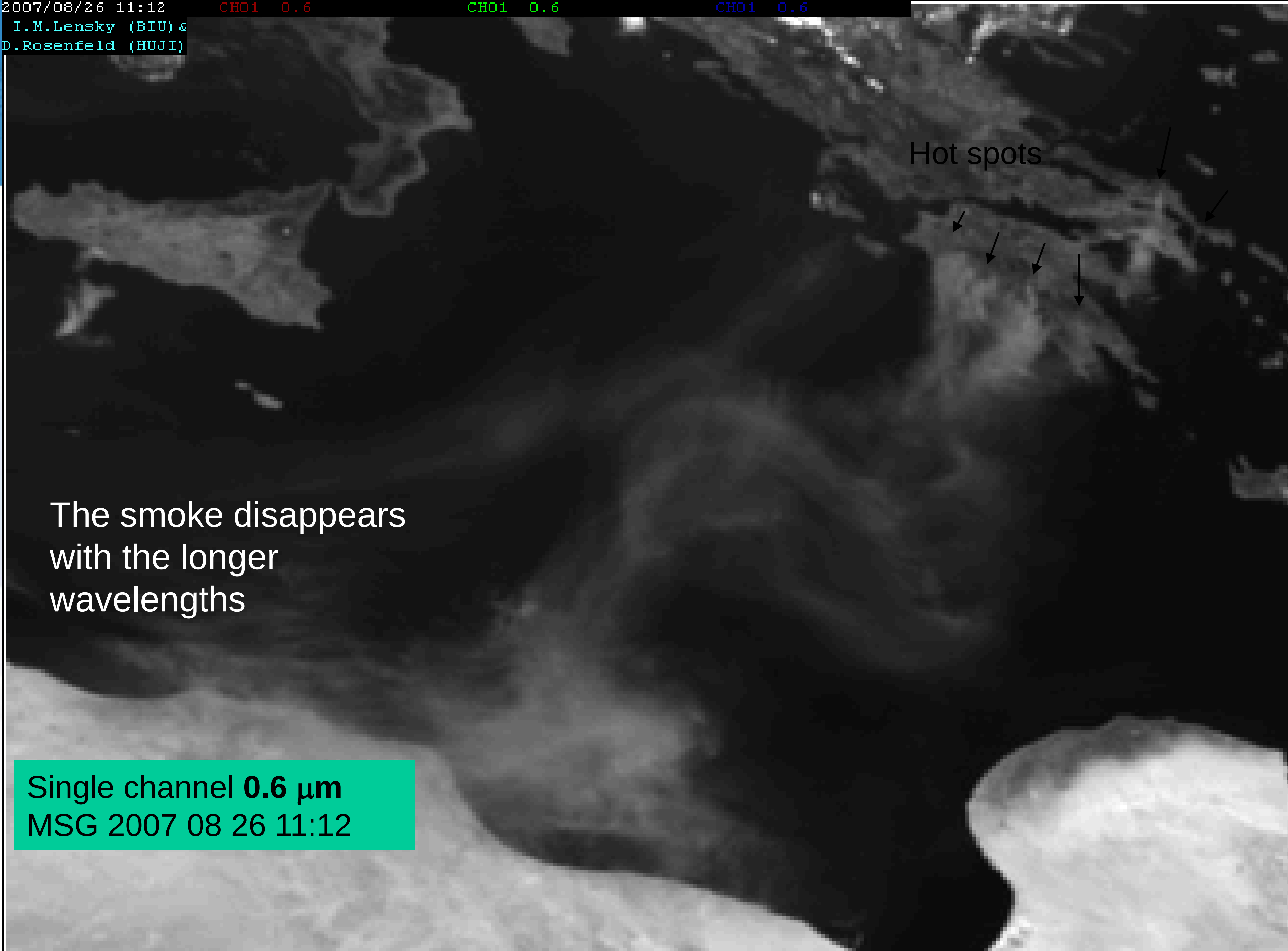

“Blinding” of IR3.9 Channel
IR10.8 confirms Blinding
IR10.8 Channel
52_Band9_TEMP - 2007_08_03_1745

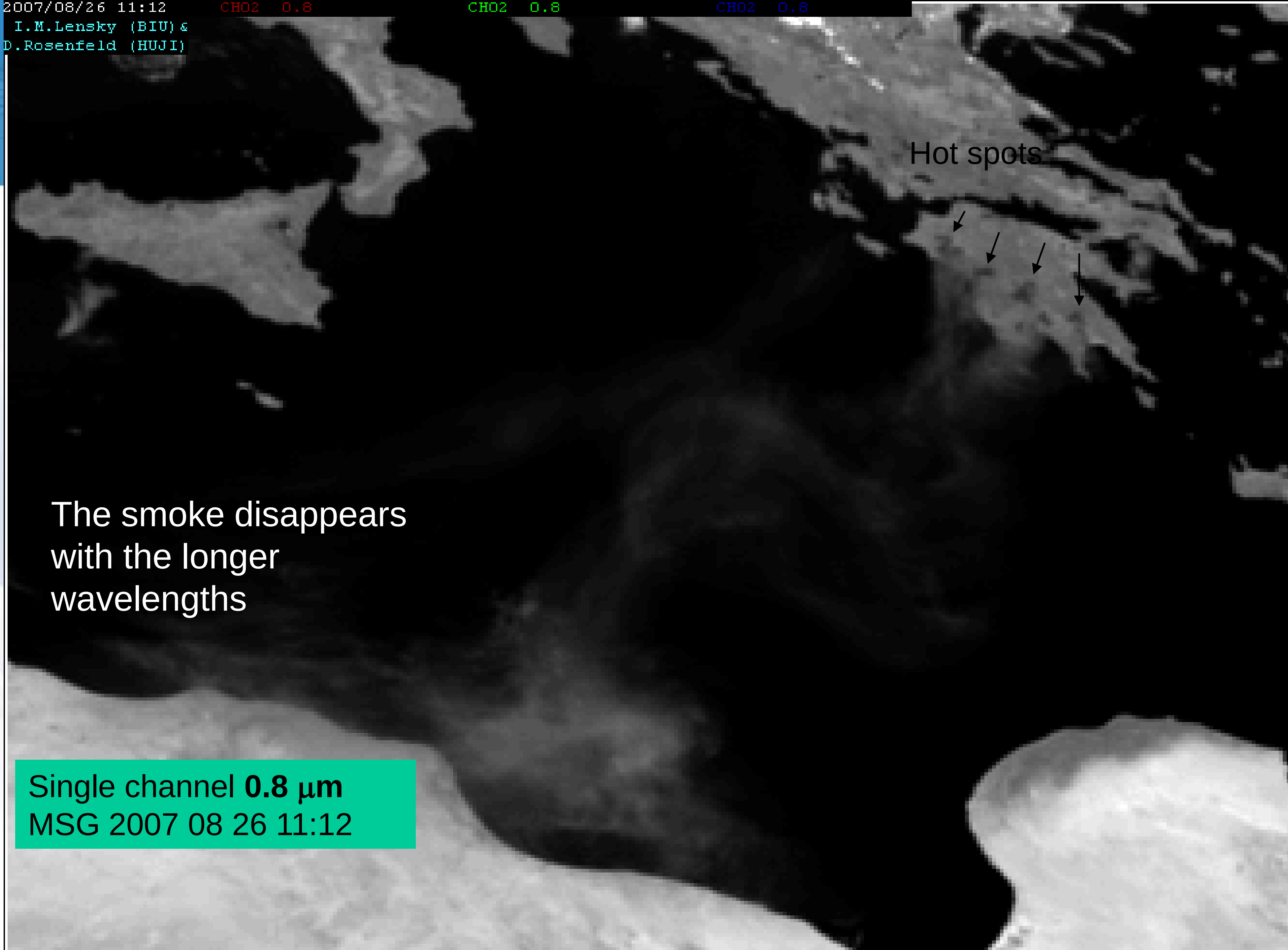
"Blinding" of IR3.9 Channel

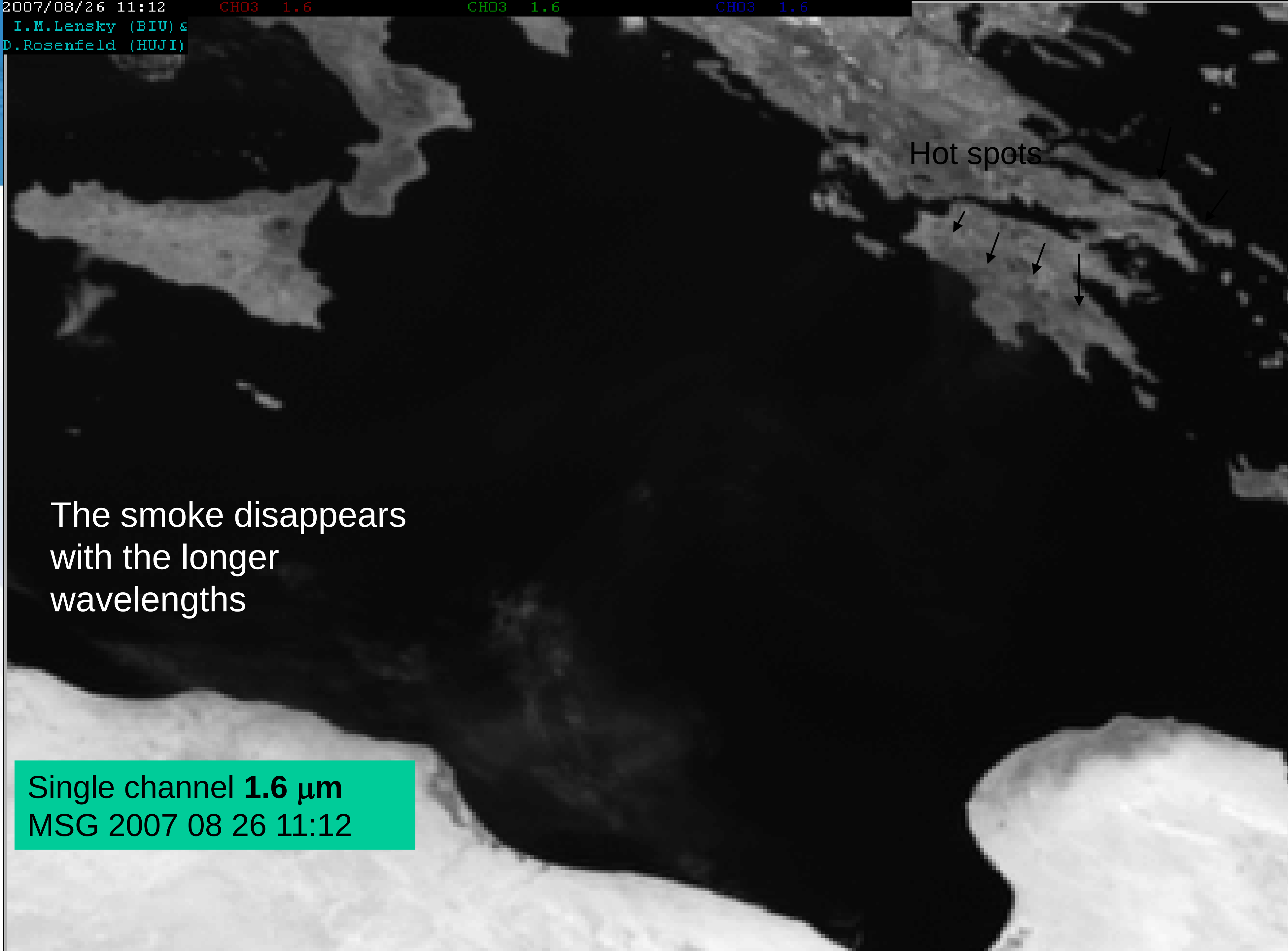
Mid-IR wavelength signal only weakly affected by smoke aerosols

0.67 µm

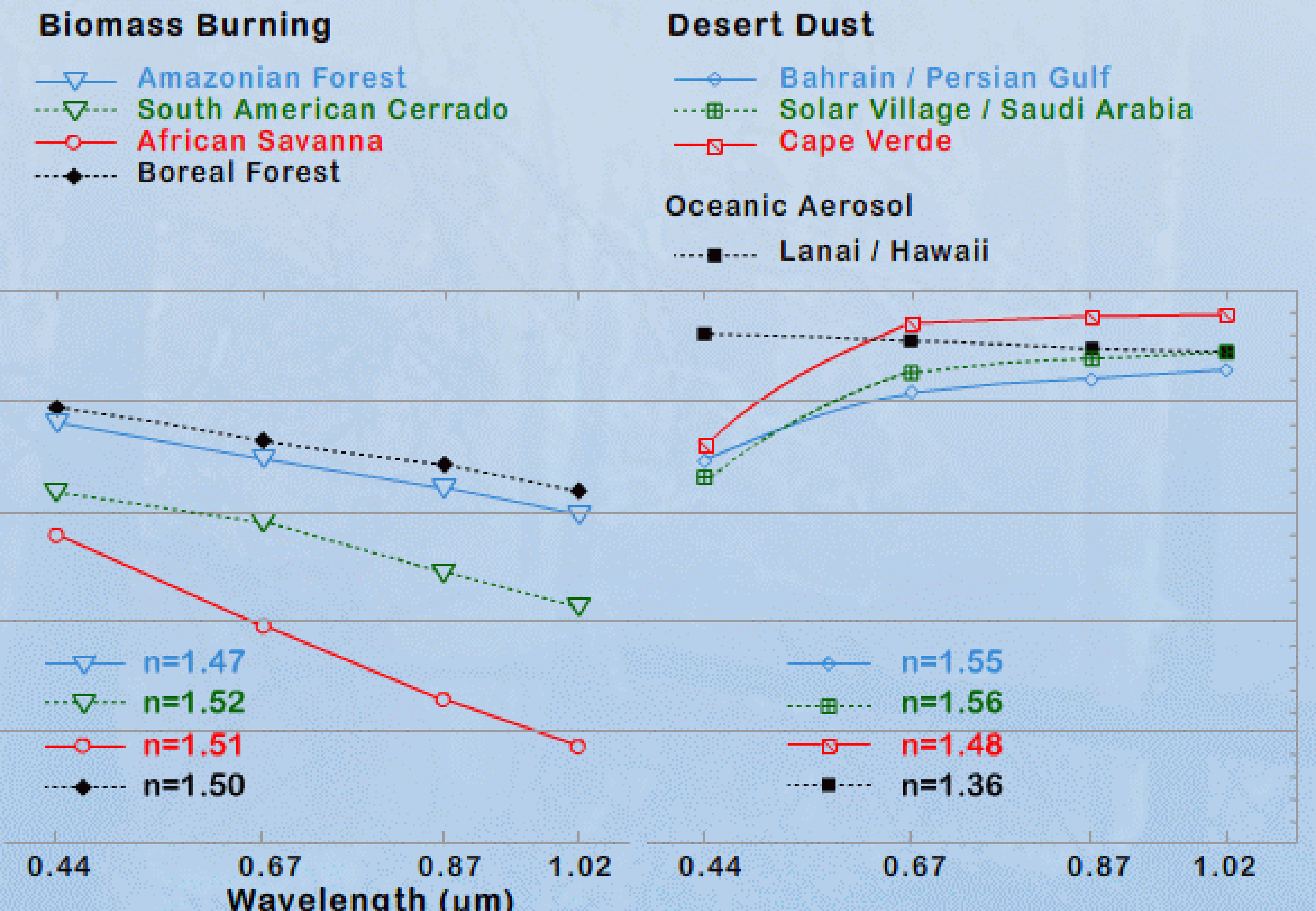
3.9 µm

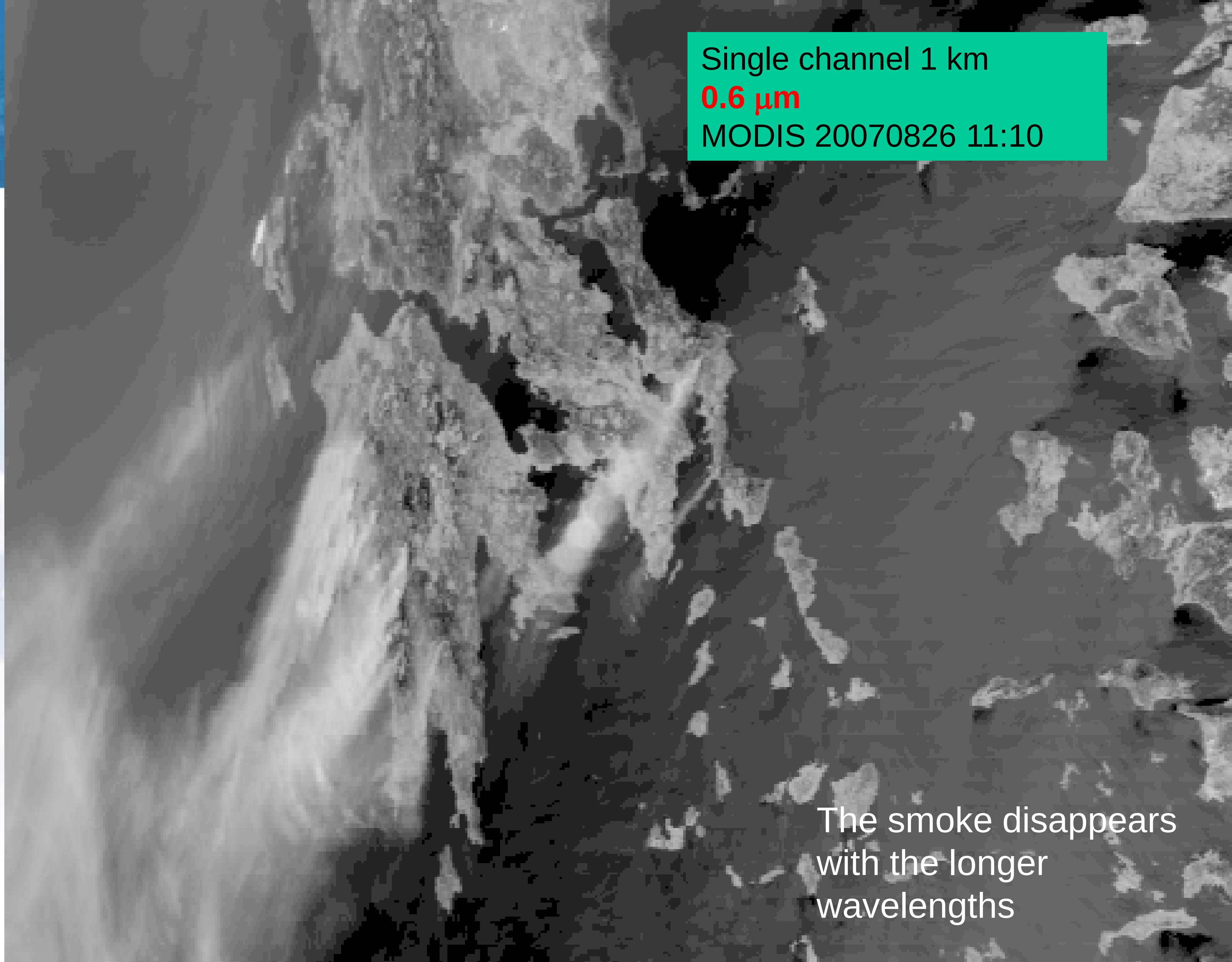

2007/08/26 11:12 CH01 0.6 CH01 0.6 CH01 0.6
I.M.Lensky (BIU) &
D.Rosenfeld (HUJI)
Hot spots
The smoke disappears with the longer wavelengths
Single channel **0.6 μm**
MSG 2007 08 26 11:12

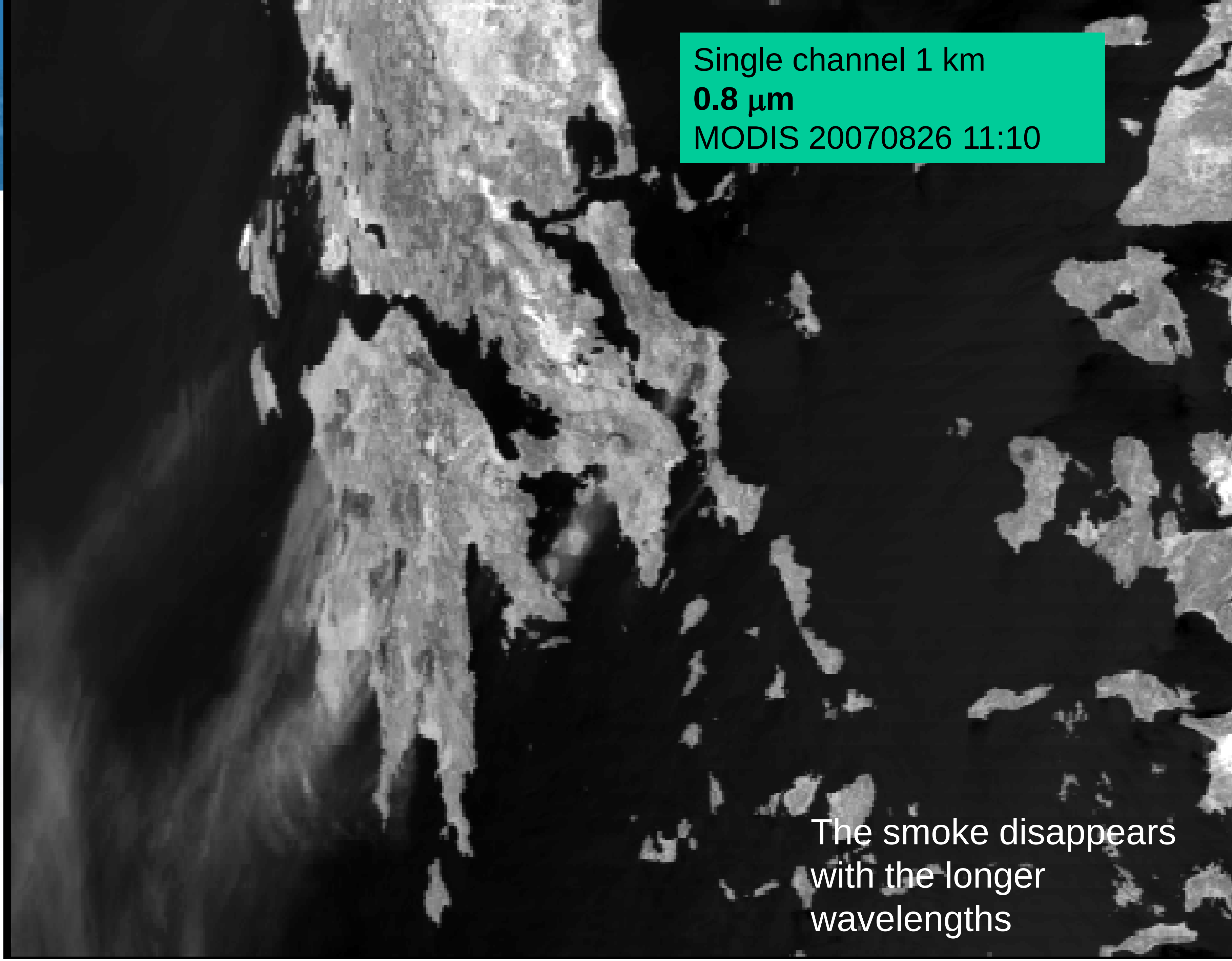

2007/08/26 11:12
CH02 0.8
CH02 0.8
CH02 0.8
I.M.Lensky (BIU) &
D.Rosenfeld (HUJI)
Hot spots
The smoke disappears with the longer wavelengths
Single channel **0.8 µm**
MSG 2007 08 26 11:12

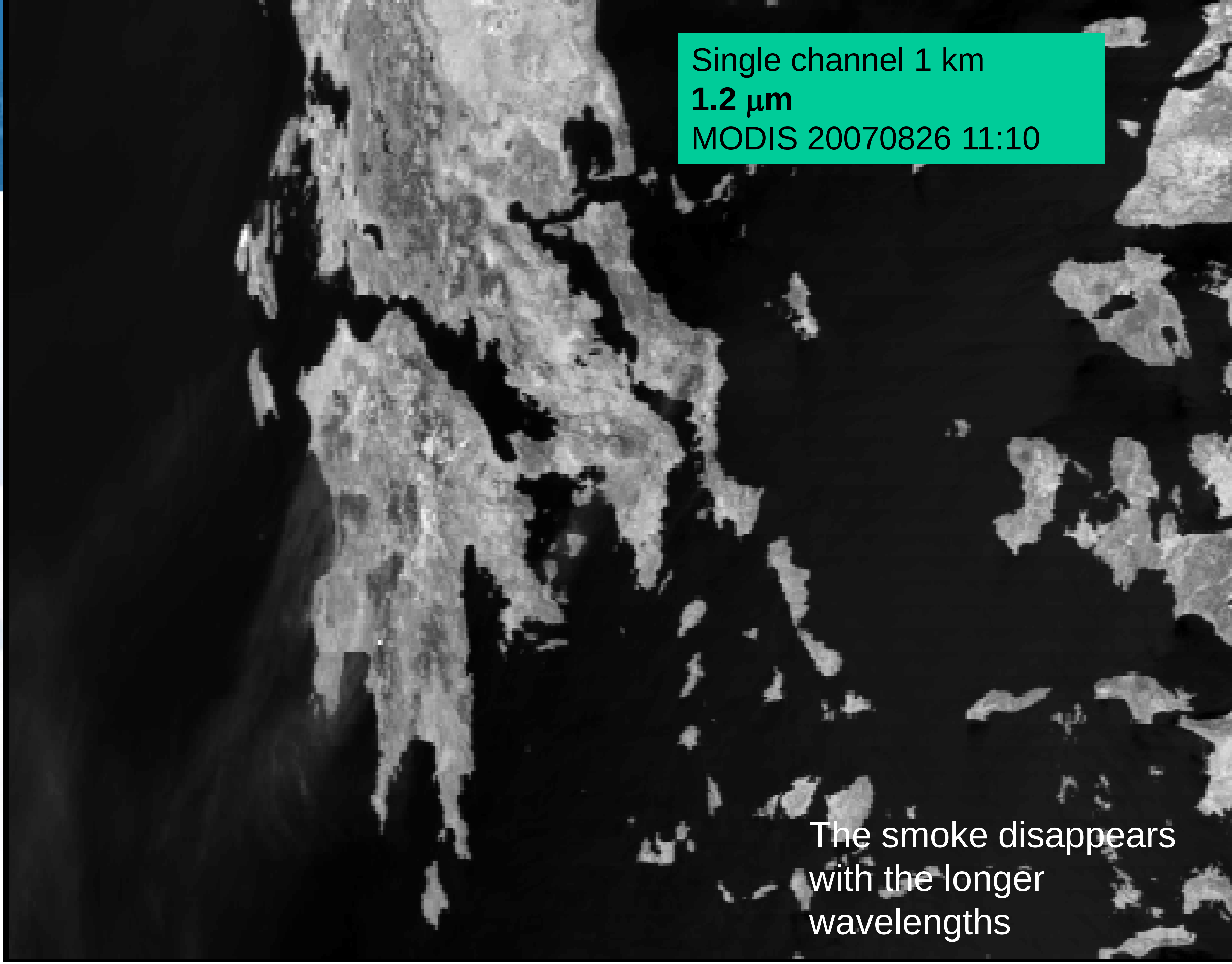


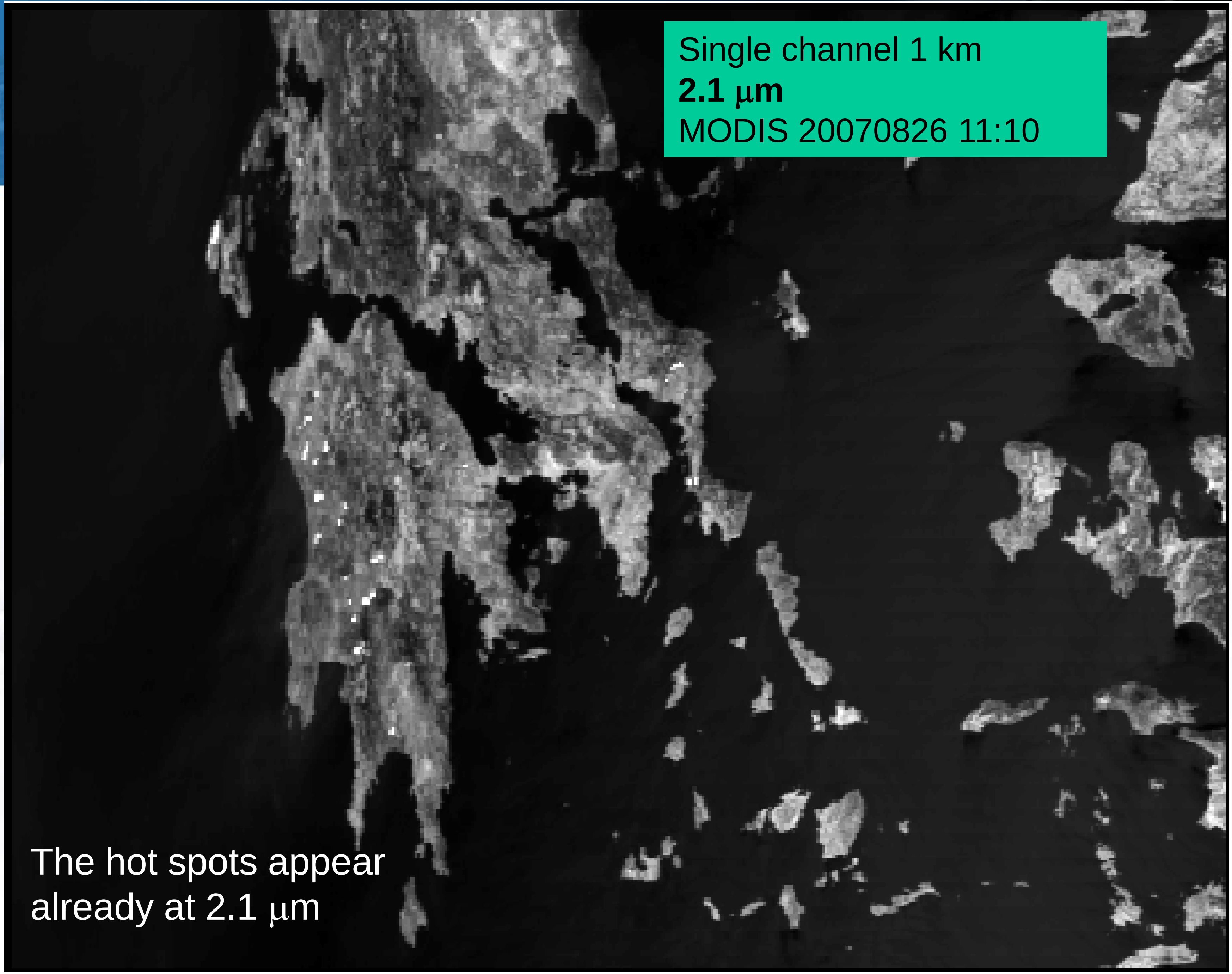
2007/08/26 11:12 CH03 1.6 CH03 1.6 CH03 1.6
I.M.Lensky (BIU)&
D.Rosenfeld (HUJI)
Hot spots
The smoke disappears with the longer wavelengths
Single channel **1.6 μm**
MSG 2007 08 26 11:12


Biomass Burning
Amazonian Forest
South American Cerrado
African Savanna
Boreal Forest
Desert Dust
Bahrain / Persian Gulf
Solar Village / Saudi Arabia
Cape Verde
Oceanic Aerosol
Lanai / Hawaii
n=1.47
n=1.52
n=1.51
n=1.50
n=1.55
n=1.56
n=1.48
n=1.36
0.44
0.67
0.87
1.02
0.44
0.67
0.87
1.02
Wavelength (μm)


Single channel 1 km
0.6 µm
MODIS 20070826 11:10
The smoke disappears
with the longer
wavelengths


Single channel 1 km
0.8 µm
MODIS 20070826 11:10
The smoke disappears
with the longer
wavelengths

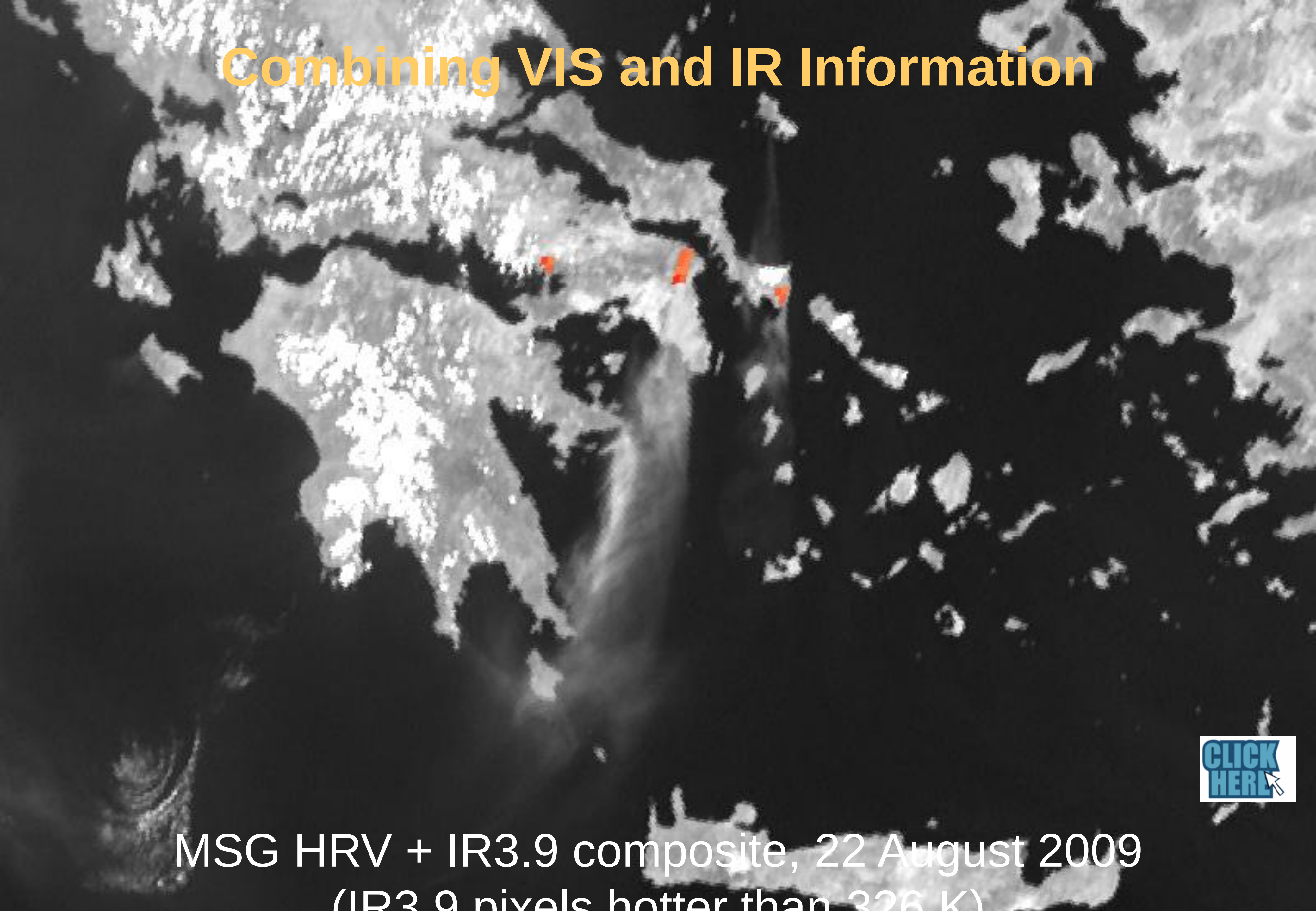

Single channel 1 km
1.2 µm
MODIS 20070826 11:10
The smoke disappears with the longer wavelengths


Single channel 1 km
2.1 μm
MODIS 20070826 11:10
The hot spots appear already at 2.1 μm

Combining VIS and IR Information

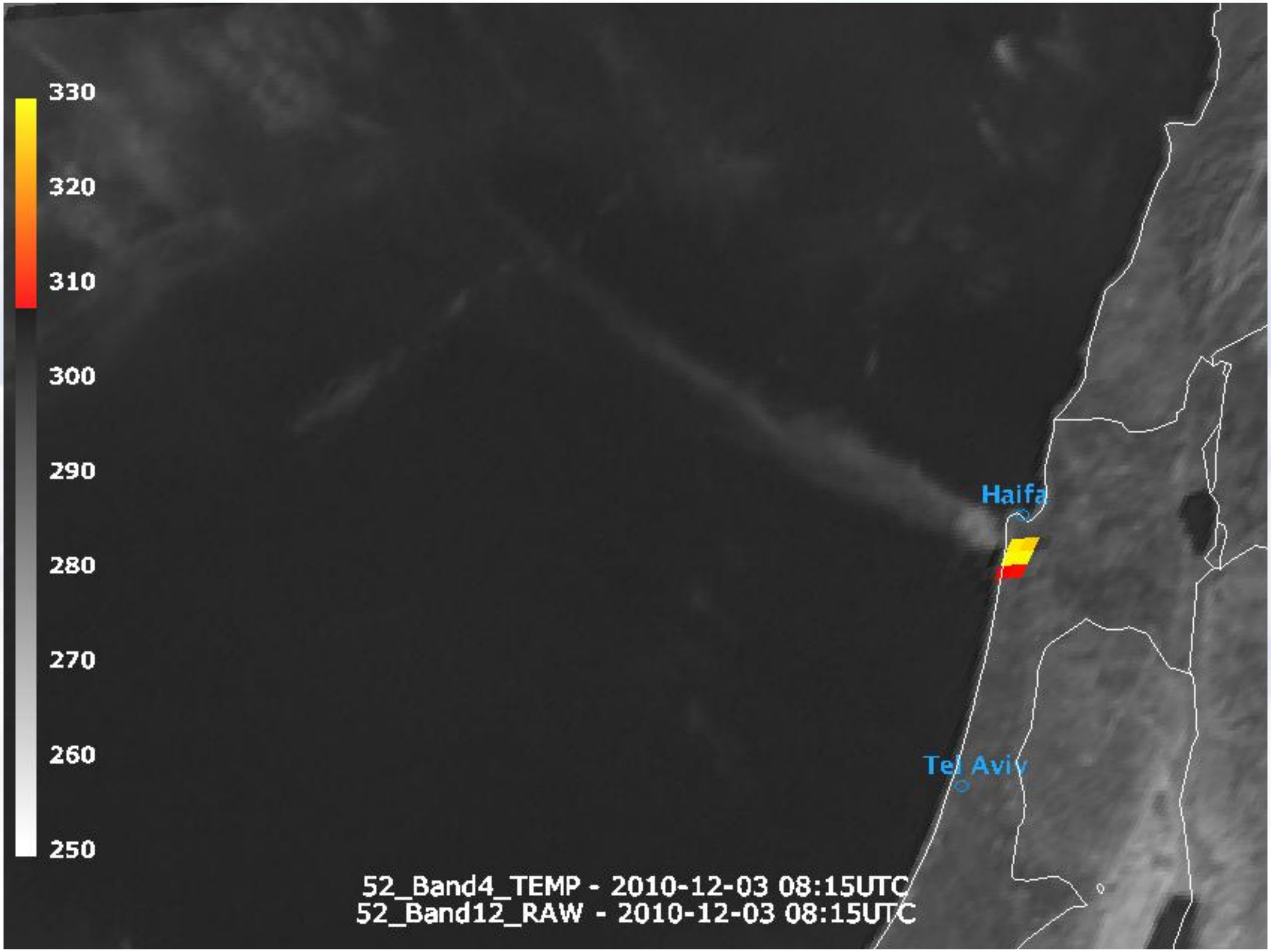
Aqua MODIS rapid fire product, 22 August 2009
True colour RGB + fire product

Combining VIS and IR Information



MSG HRV + IR3.9 composite, 22 August 2009
(IR3.9 pixels hotter than 326 K)

Large Forest Fire near Haifa, 3 Dec 2010



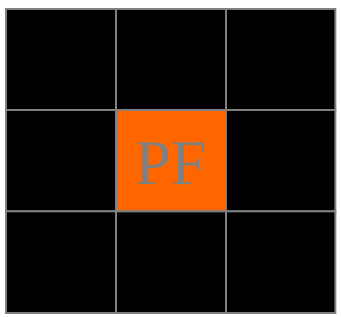
CLICK HERE

SIMPLE FIRE DETECTION ALGORITHM FOR SEVIRI
(Wooster and Roberts, KCL)

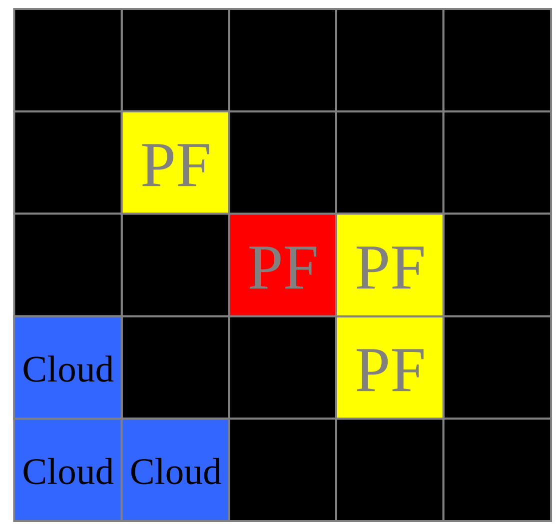
Simple Contextual Fire Pixel Detection Alg. For SEVIRI

Stage 1- Potential Fire (PF) Pixel Detection: based on 3.9 & 10.8 µm brightness temps. (T4 & T11 respectively) and their difference (T411)

Stage 2 - Background Characterisation of each PF pixel: based on window centred on each PF (only cloud-free/non-PF pixels included)



or

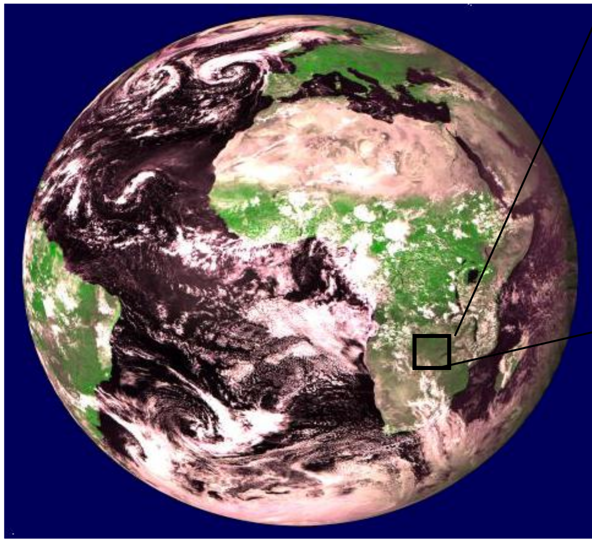


Stage 3 – Confirmation of each PF pixel as ‘True’ or ‘False’ fire pixel: Based on comparison between PF and background T4, T11 and T411

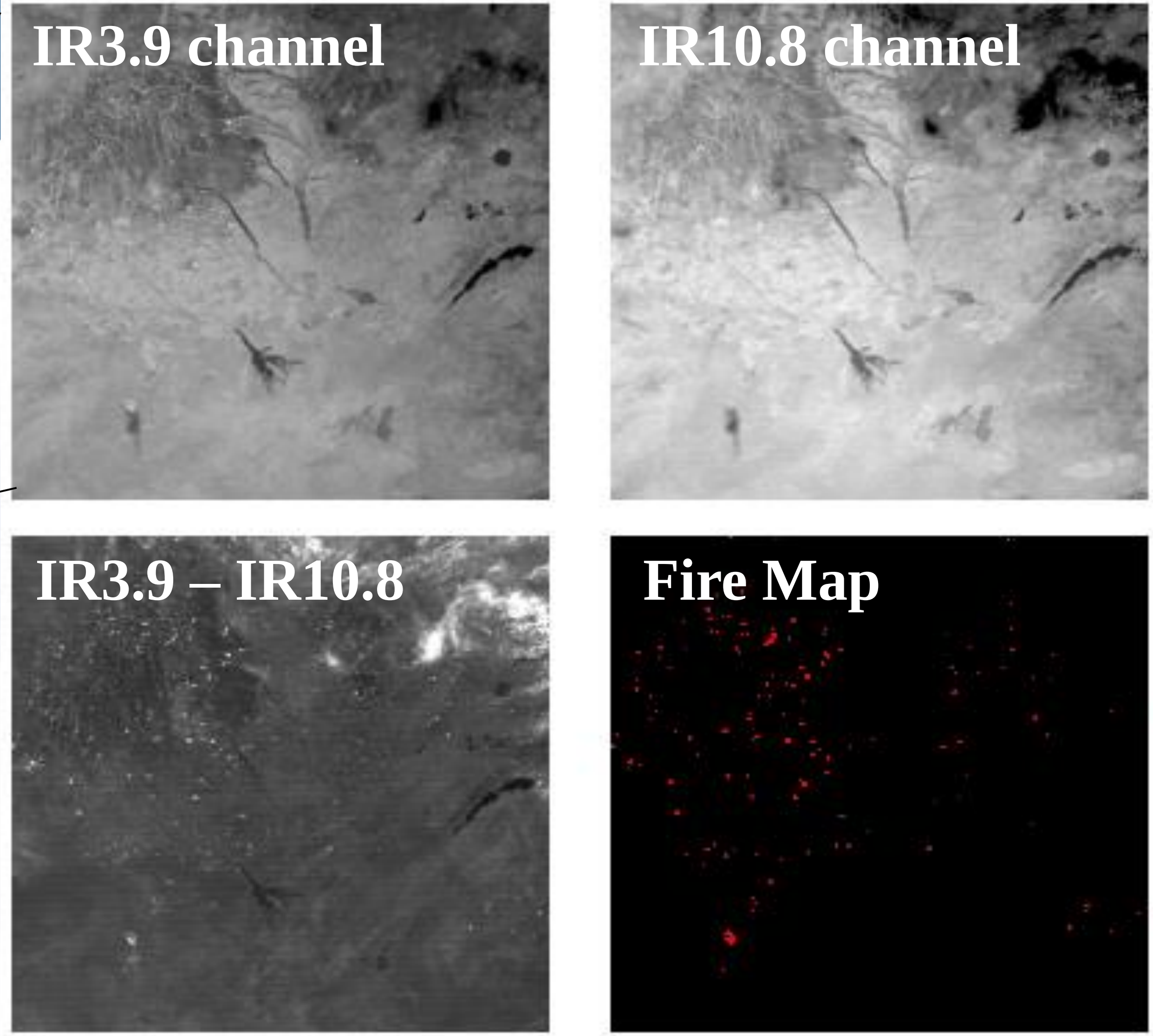
Simple Contextual Fire Pixel Detection Alg. For SEVIRI

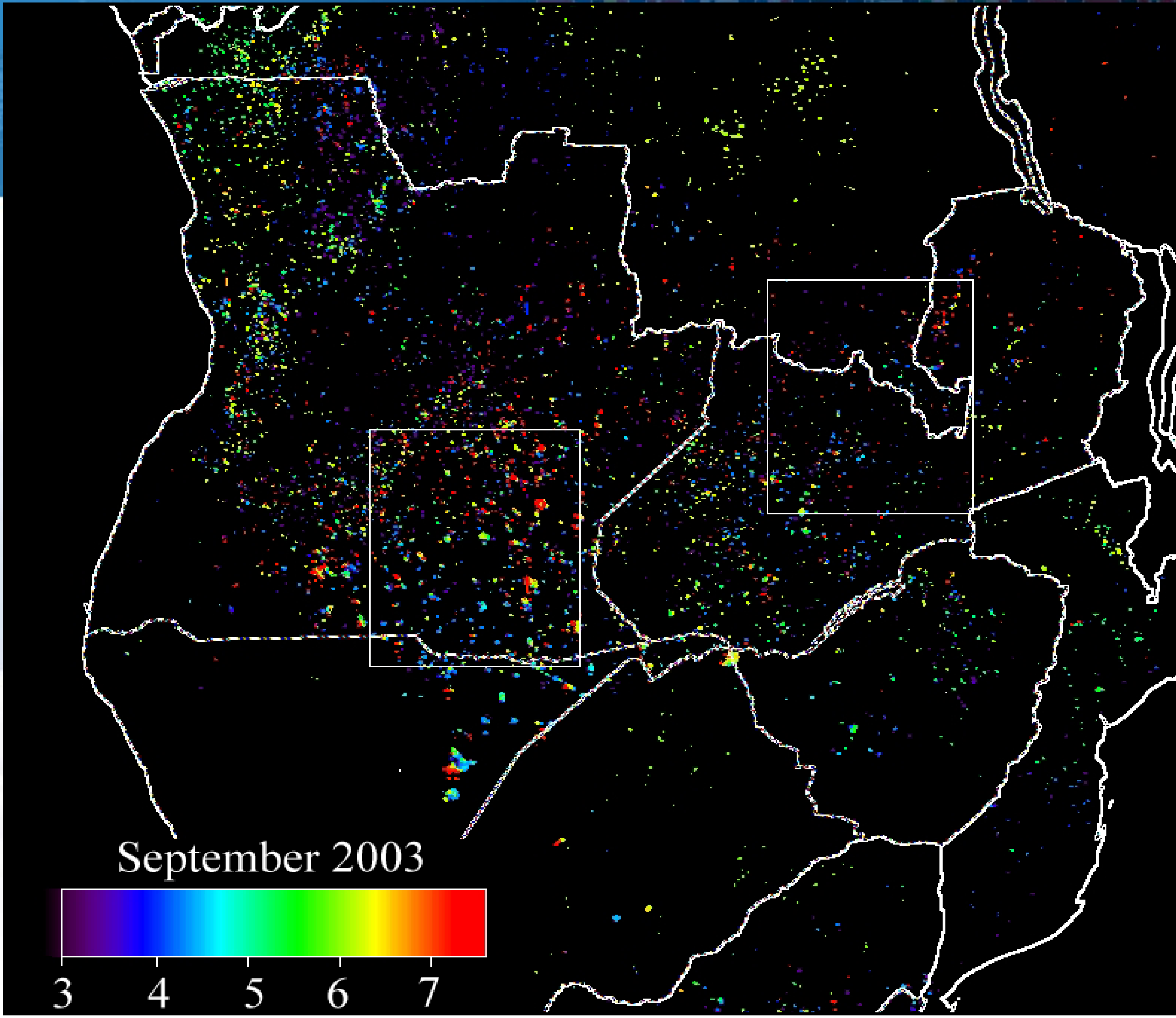
	Function	Time Period (UTC)	Tests and Thresholds
(1)	Potential Fire Pixel Detection	09:00 – 16:00	T4 > 320K, T11>285K, T411 > 15K
	Potential Fire Pixel Detection	16:01 – 08:59	T4 > 290K, T11>285K, T411 > 10K
(2)	Background Characterisation	09:00 – 16:00	Valid BG pixel:T4 < 315K, T411 < 15K Mean (BG4, BG11, BGT411) σ (BG4, BG11, BGT411)
	Background Characterisation	16:01 – 08:59	Valid BG pixel:T4 < 308K, T411 < 10K Mean (BG4, BG11, BG411) σ (BG4, BG11, BG411)
(3)	Confirmation as 'True' or 'False' Fire Pixel	09:00 – 16:00	T4 > (Mean BG4 + 2.3 x σBG4) T411>(MeanBGT411+2.3 x σBGT411) T411 > (σBGT411 + 6K)
	Confirmation as 'True' or 'False' Fire Pixel	16:01 – 08:59	T4 > (Mean BG4 + 2.0 x σBG4) T411>(MeanBGT411+2.0 x σBGT411) T411 > (σBGT411 + 4.5 K)

MSG SEVIRI

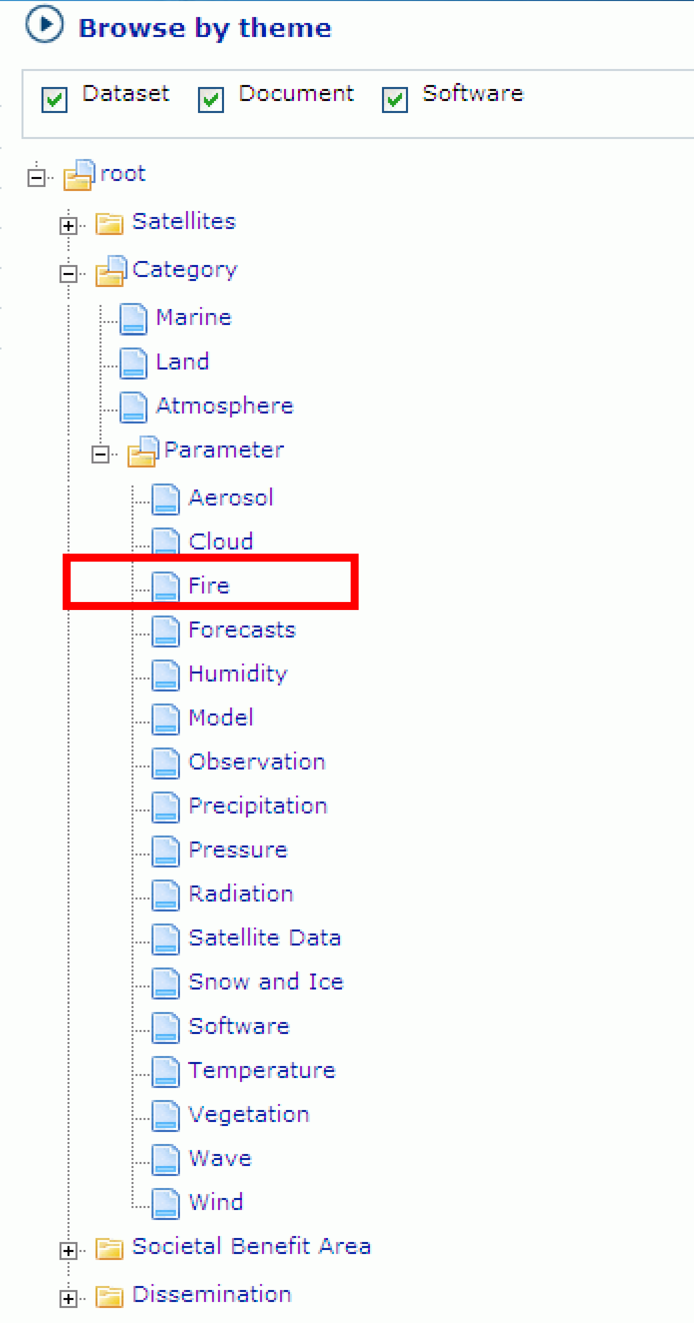


15 mins imaging frequency





SEVIRI 5-Day Active Fire Map



MSG SEVIRI
Fire Products
(Product Navigator)

Active Fire Monitoring (FIR)

Provider:	EUMETSAT
Satellite:	Met-10, Met-9 (rapid scan)
Status:	Operational
Area:	Disk (80 degrees)
Formats:	GRIB, ~~ASCII~~, CAP
Resolution:	Pixel, 15 Min (5 Min)
Dissemination:	EumetCast

ftp://ftp.eumetsat.int/pub/OPS/out/simon/FIRE/

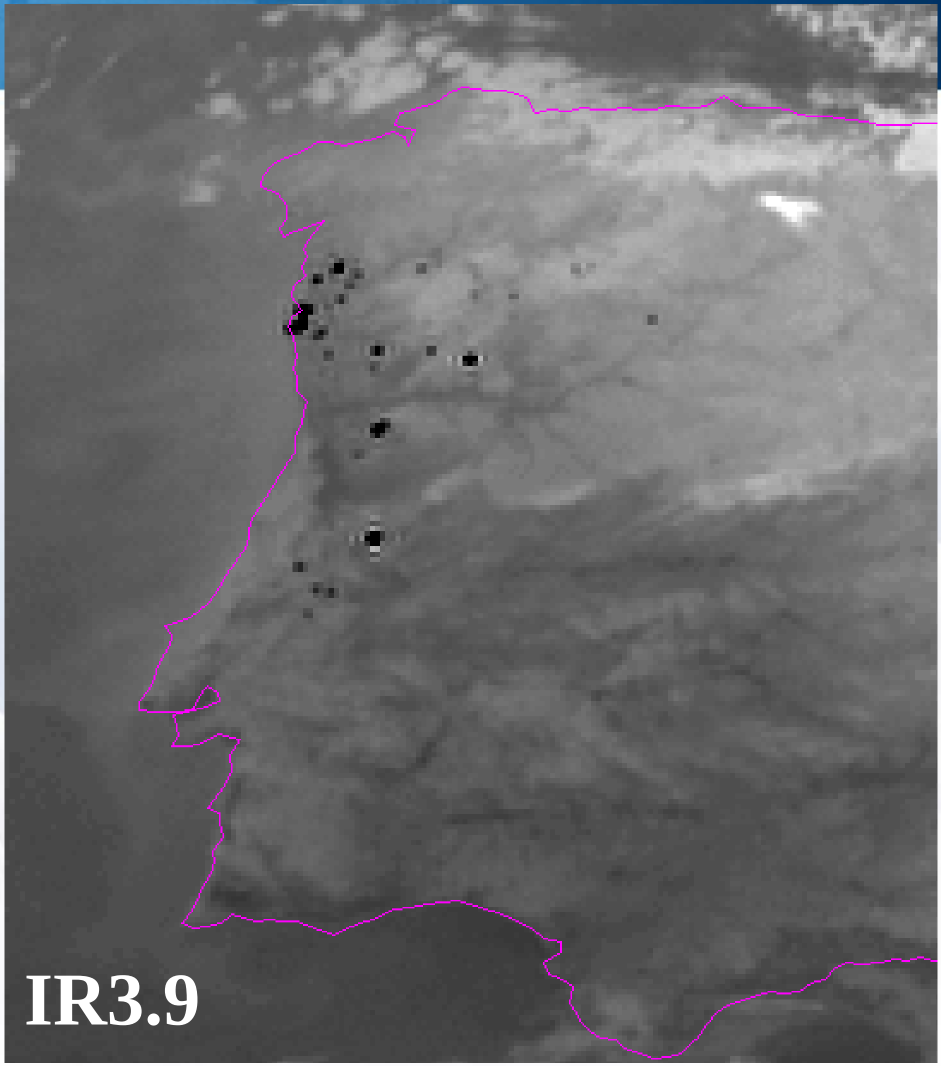
Internet:	Yes (Met-10)
Archive:	Yes

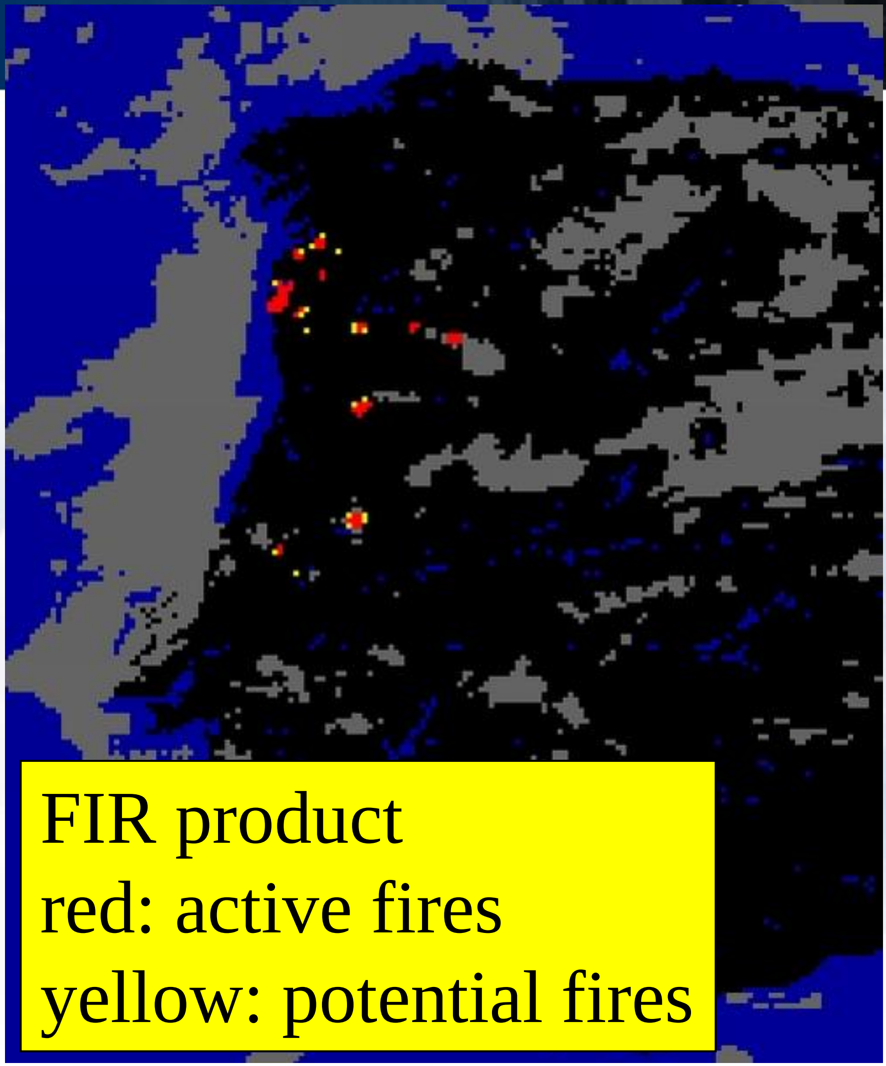
```
Data from EUMETSAT, Satellite: MET08, Date: 2007/01/31 12:00Z

Row:  883   Col: 1322   Lat:  -28.358 Lon:   17.066      Possible fire
Row:  905   Col: 1095   Lat:  -27.894 Lon:   24.805      Possible fire
Row: 1064   Col:  928   Lat:  -22.946 Lon:   29.439      Possible fire
Row: 1115   Col:  854   Lat:  -21.442 Lon:   31.749      Possible fire
Row: 1168   Col: 1083   Lat:  -19.547 Lon:   23.297      Possible fire
Row: 1183   Col: 1079   Lat:  -19.097 Lon:   23.349      Possible fire
Row: 1183   Col: 1109   Lat:  -19.072 Lon:   22.365      Possible fire
Row: 1199   Col: 1176   Lat:  -18.540 Lon:   20.135      Possible fire
Row: 1217                                                Possible fire
Row: 1219                                                Possible fire
Row: 1240                                                Possible fire
Row: 1246                                                Possible fire
Row: 1251   Col: 1385   Lat:  -16.887 Lon:   13.561      Possible fire
Row: 1253   Col: 1386   Lat:  -16.828 Lon:   13.526      Possible fire
Row: 1798   Col:  549   Lat:   -1.650 Lon:   40.046      Possible fire
Row: 1898   Col:  581   Lat:    1.191 Lon:   38.744      Possible fire
Row: 1915   Col:  626   Lat:    1.668 Lon:   36.999      Possible fire
Row: 1945   Col:  853   Lat:    2.479 Lon:   28.947      Possible fire
Row: 1945   Col:  854   Lat:    2.479 Lon:   28.913      Possible fire
Row: 1945   Col:  881   Lat:    2.475 Lon:   28.021      Possible fire
Row: 1946   Col:  881   Lat:    2.503 Lon:   28.021      Possible fire
Row: 1948   Col:  887   Lat:    2.558 Lon:   27.826  *** Probable fire ***
Row: 1948   Col:  888   Lat:    2.558 Lon:   27.793  *** Probable fire ***
Row: 1949   Col:  887   Lat:    2.586 Lon:   27.827      Possible fire
Row: 1949   Col:  888   Lat:    2.585 Lon:   27.794  *** Probable fire ***
Row: 1955   Col:  811   Lat:    2.764 Lon:   30.369      Possible fire
Row: 1955   Col:  907   Lat:    2.750 Lon:   27.179      Possible fire
Row: 1956   Col:  871   Lat:    2.783 Lon:   28.359  *** Probable fire ***
Row: 1956   Col:  872   Lat:    2.783 Lon:   28.326  *** Probable fire ***
```

Example FIR product in ASCII format
(from ftp server)

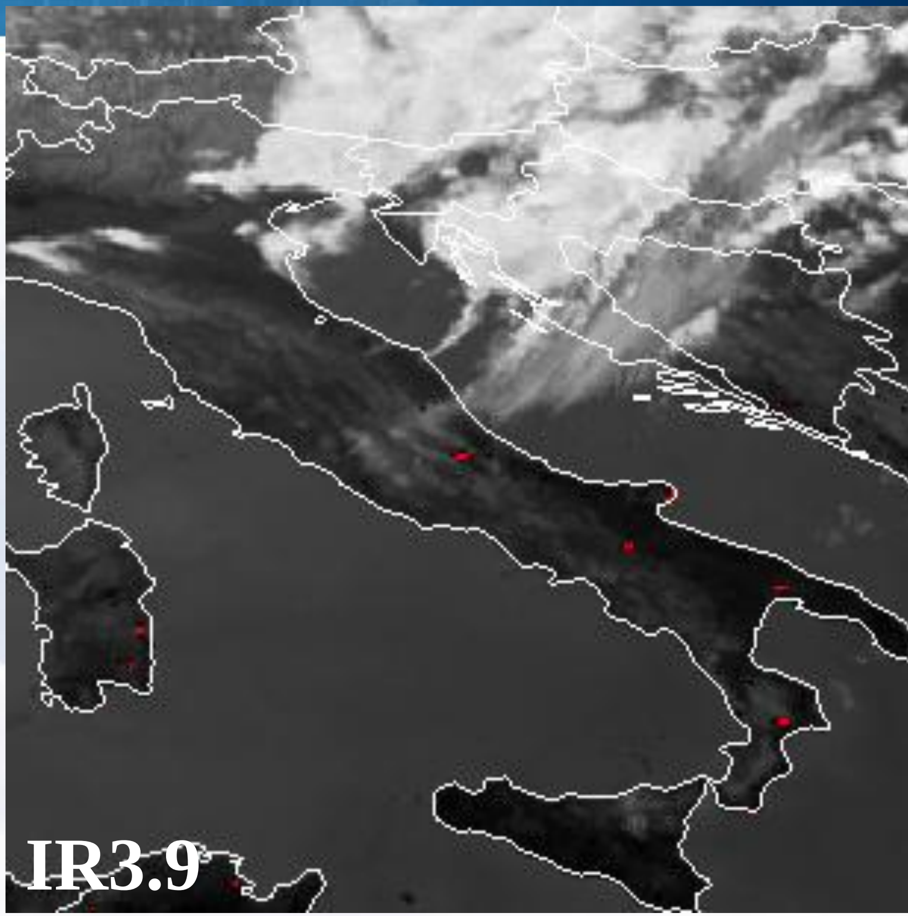
Result of Fire Detection over Europe





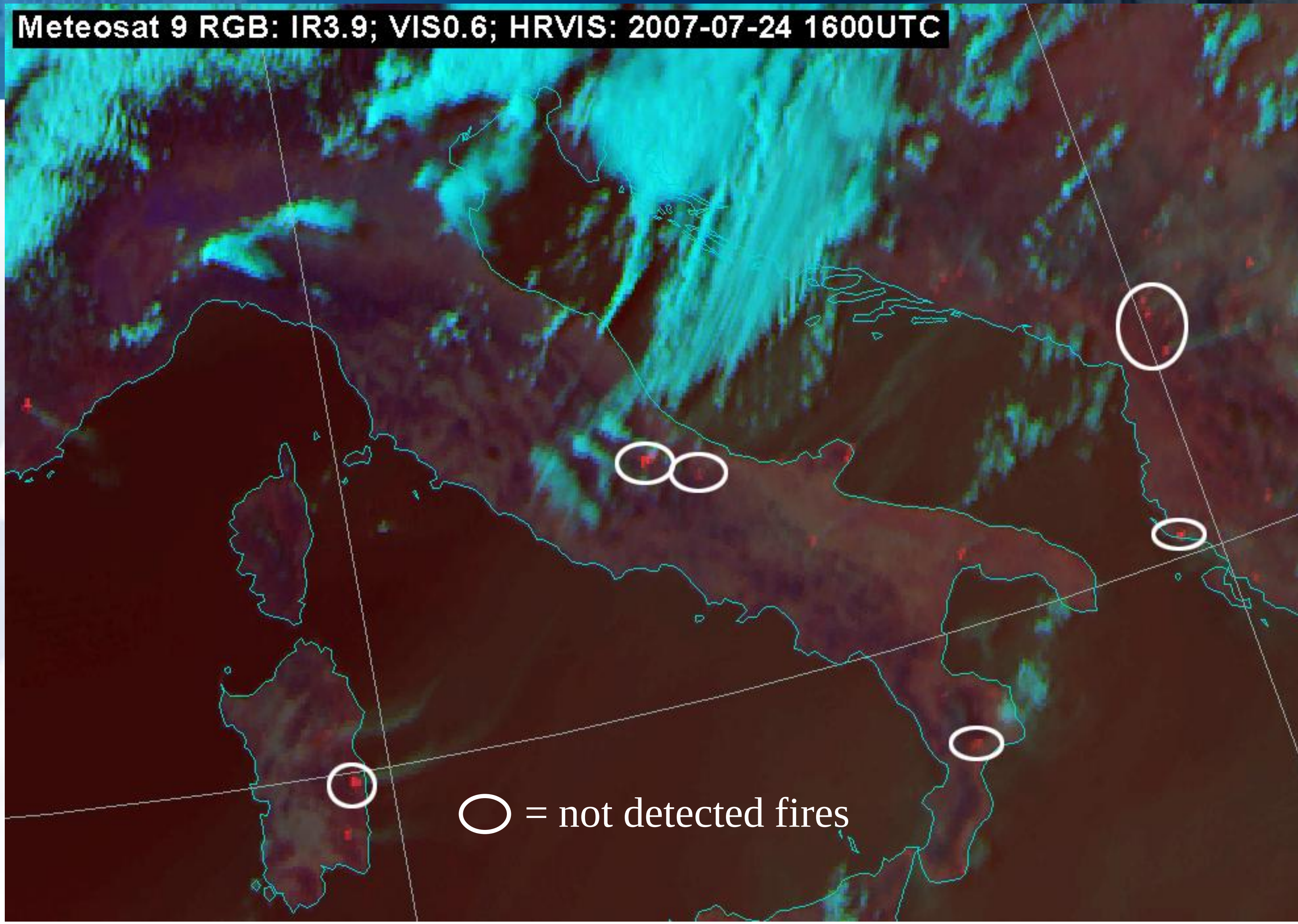
MSG-1, 21 Aug 2005, 02:00 UTC

Result of Fire Detection over Europe

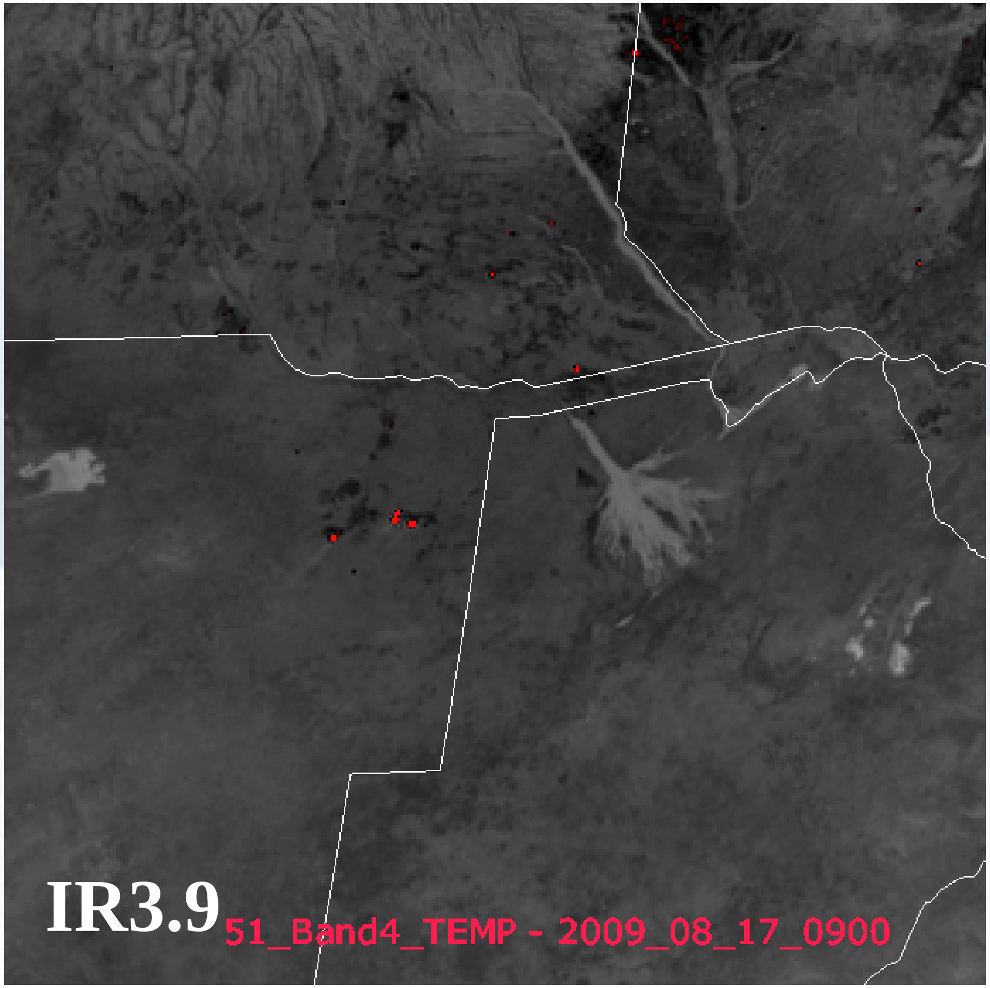


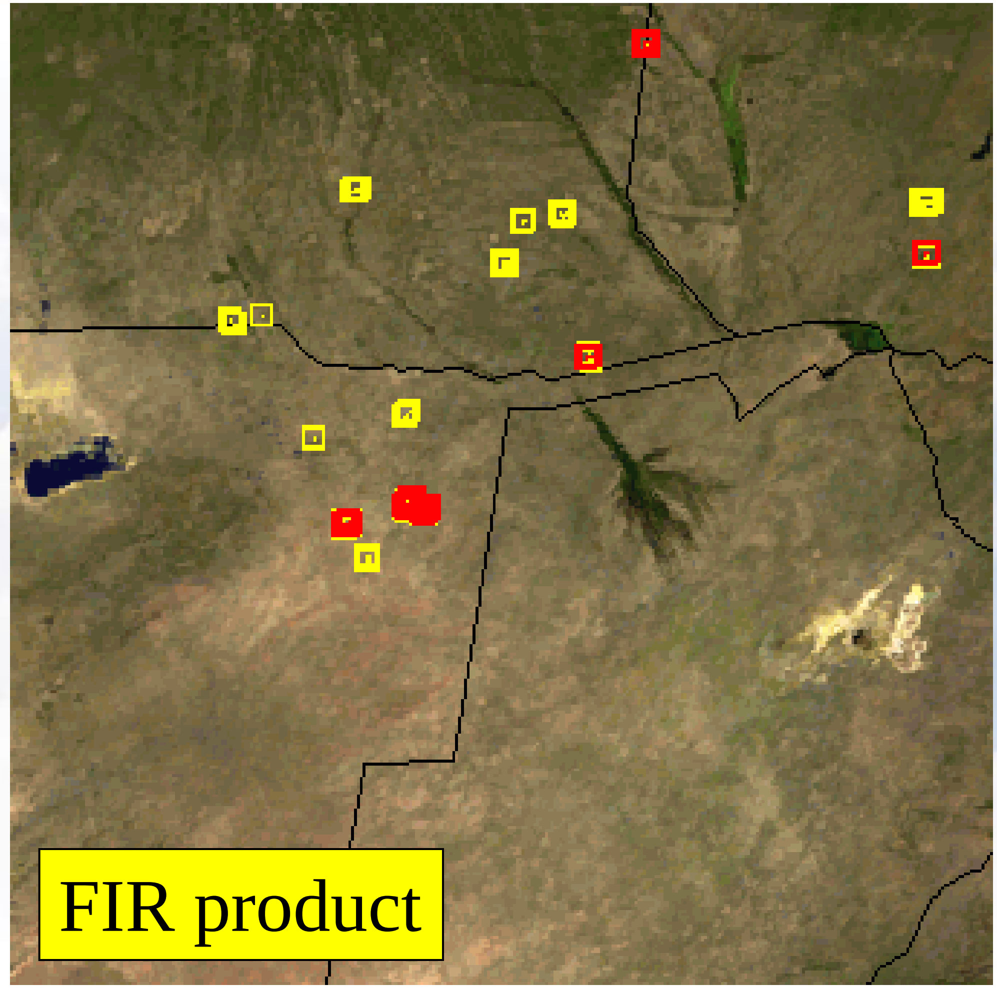
MSG-2, 24 July 2007, 16:00 UTC

Result of Fire Detection over Europe



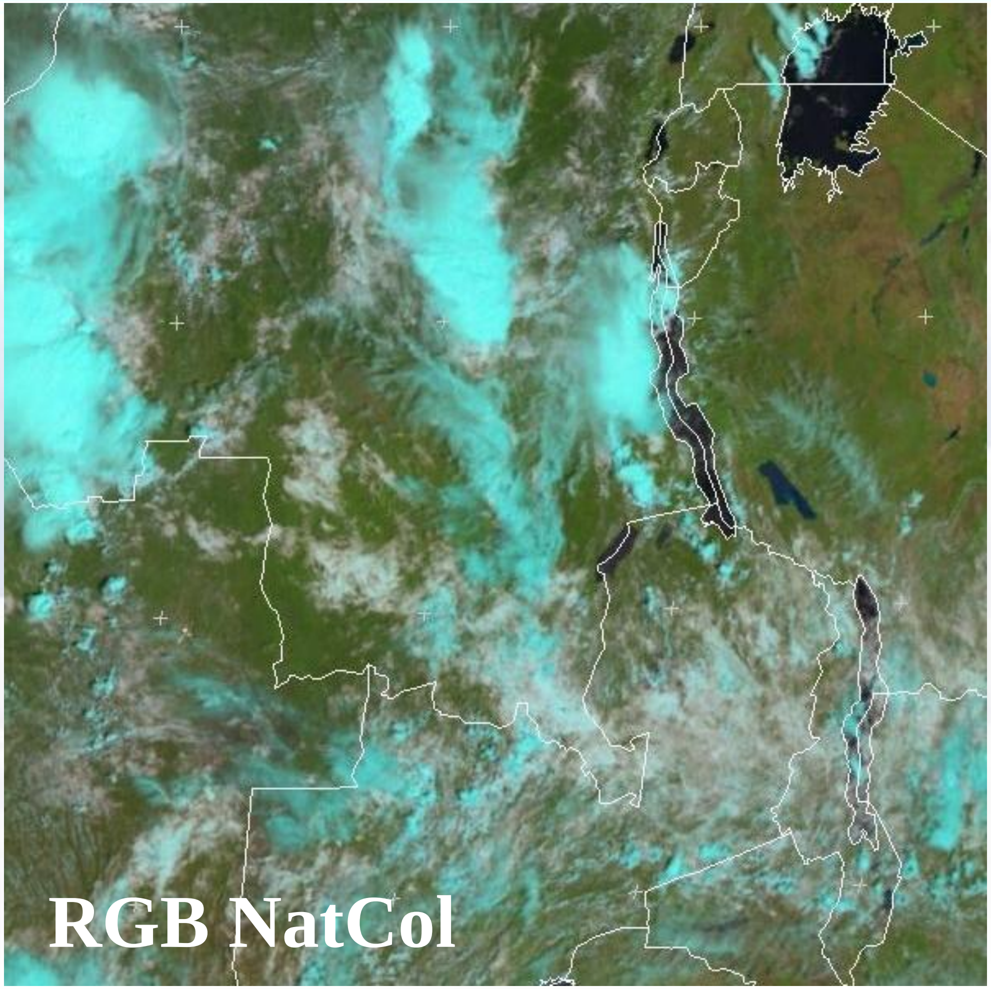
Result of Fire Detection over Africa

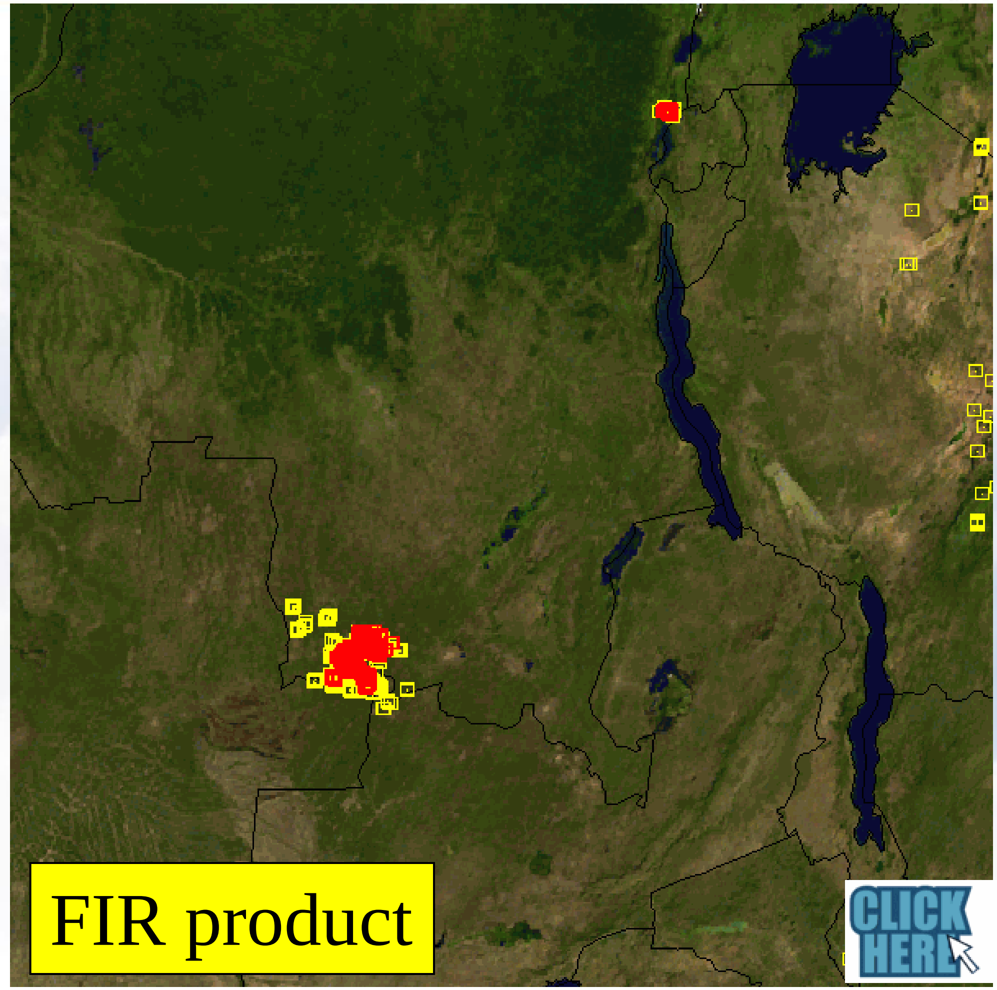




MSG-2, 17 Aug 2009, 09:00 UTC

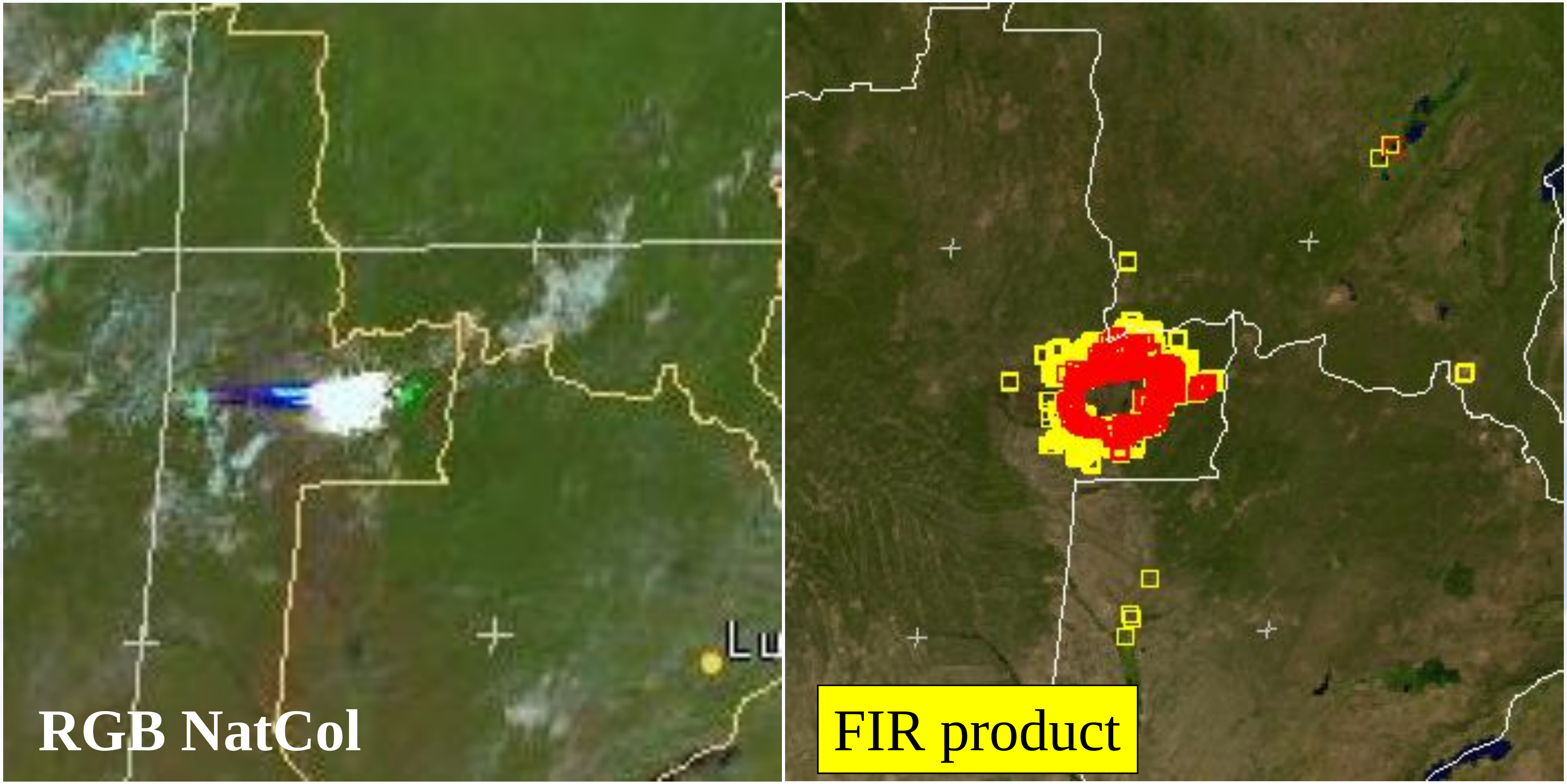
Result of Fire Detection over Africa





MSG-2, 18 Jan 2010, 08:30 UTC

The sun glint problem persists



MSG-2, 4 Jan 2011, 08:30 UTC

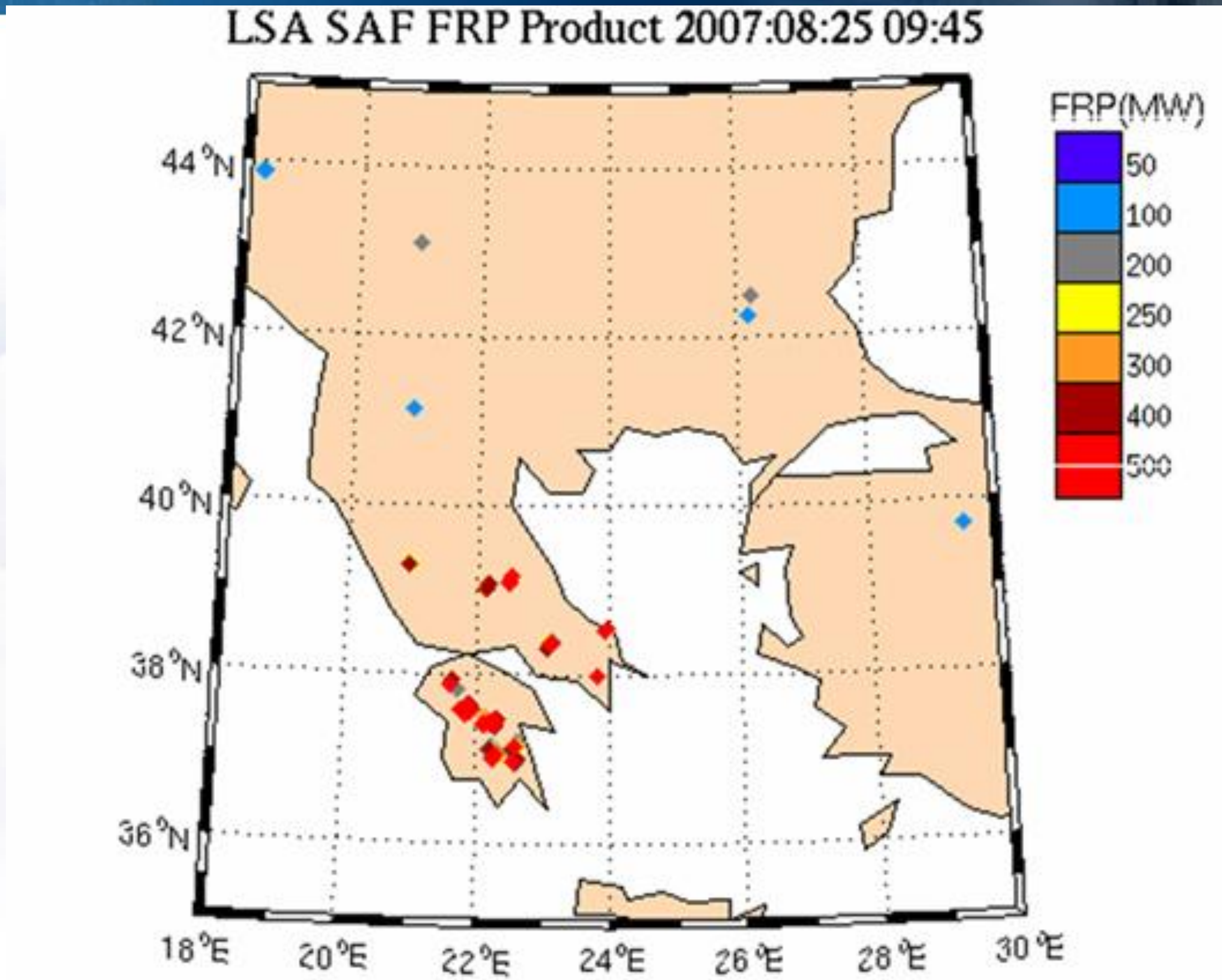
Result of Fire Detection over Europe

See IR3.9r loop

Fire Radiative Power (FRP)

Provider:	Land SAF
Satellite:	Met-9
Status:	Pre-Operational / Develop.
Area:	Disk
Formats:	HDF-5
Resolution:	Pixel, GRID (1 deg), 15 Min
Dissemination:	Eumetcast, ftp
Internet:	No
Archive:	Yes

Land SAF Fire Radiative Power Product



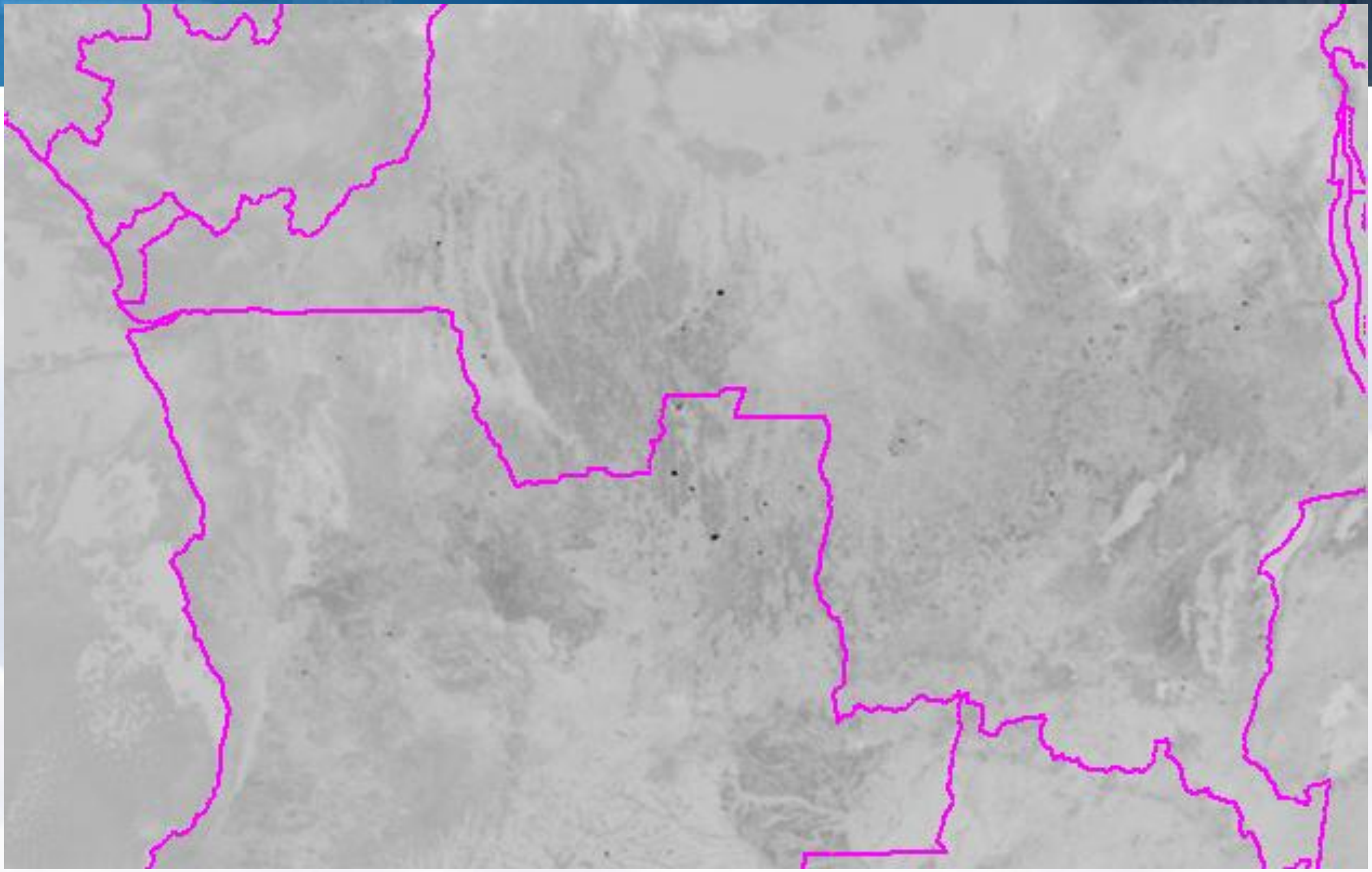
Confirmation using smoke !

Fire Risk Map (FRM)

Provider:	Land SAF
Satellite:	Met-9
Status:	Develop.
Area:	Disk (80 degrees)
Formats:	
Resolution:	
Dissemination:	
Internet:	
Archive:	

Now for some examples !

Diurnal Cycle of Fires

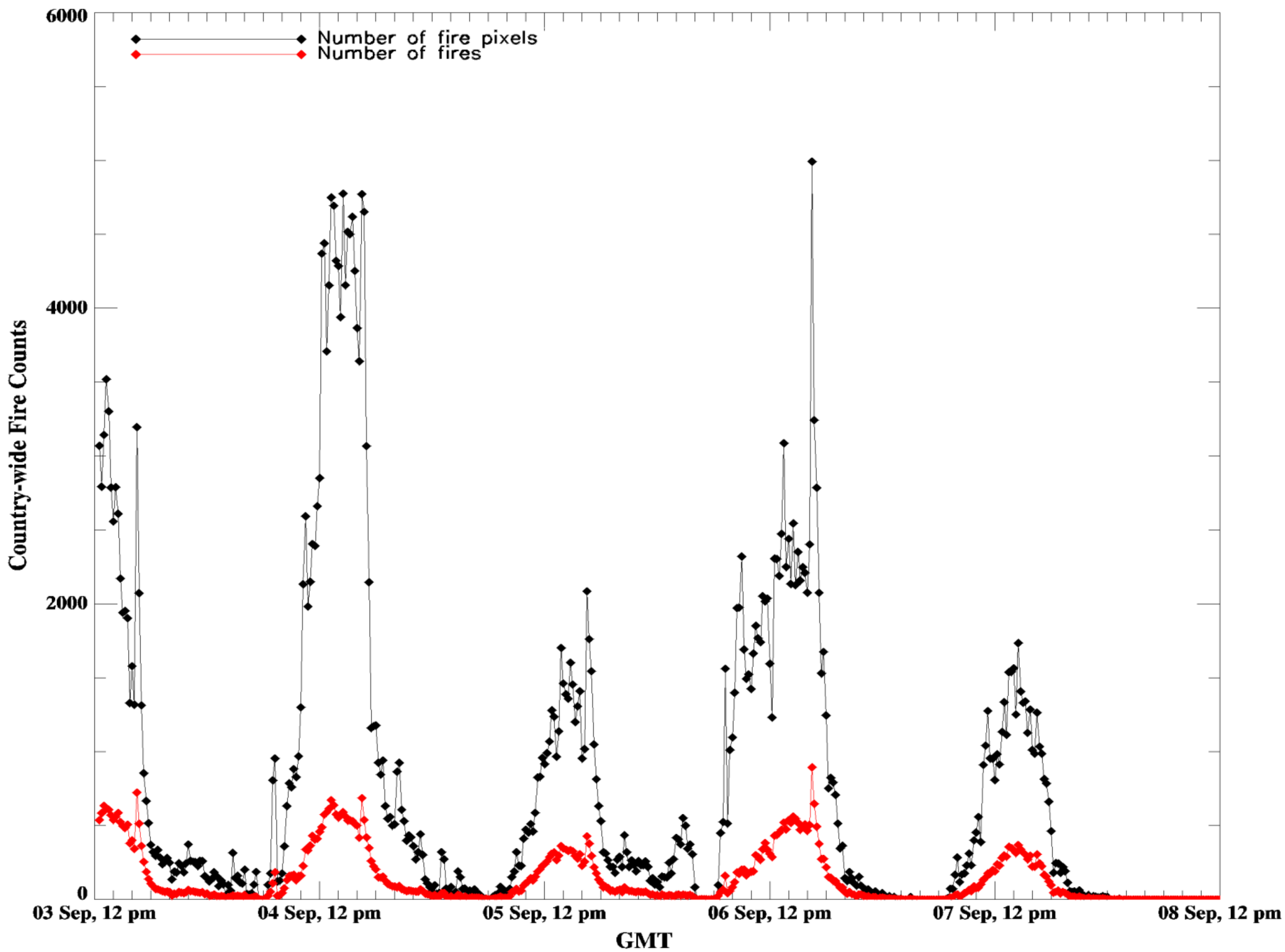


Click to
see animation

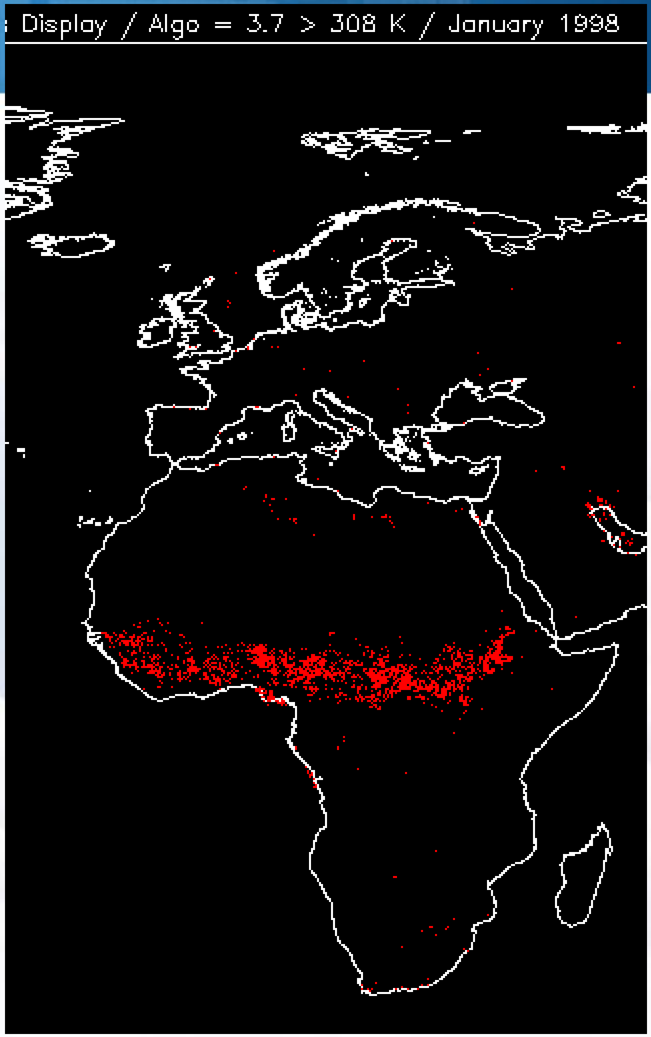
CLICK HERE

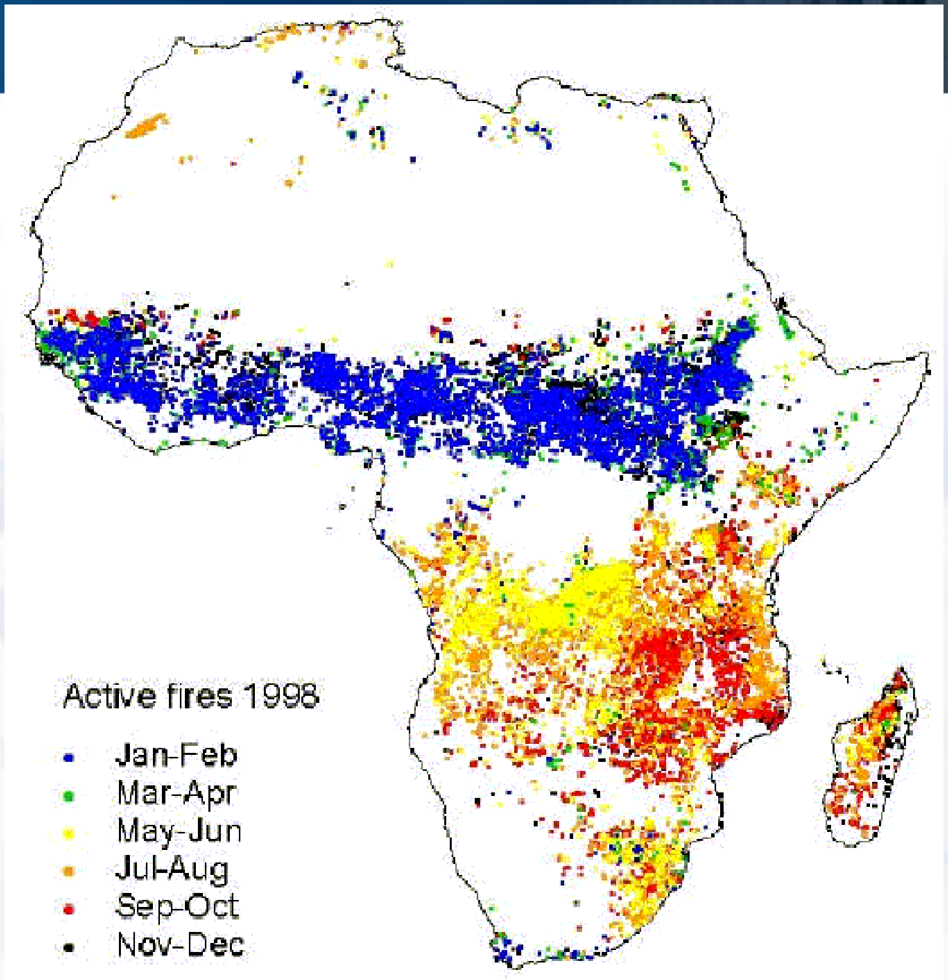
Diurnal cycle of fires over DRC and Angola
MSG-1, Channel 04 (IR3.9), 16 July 2003, 09:00 UTC

Fire Counts: Southern Africa, 3-8 Sept. 2003



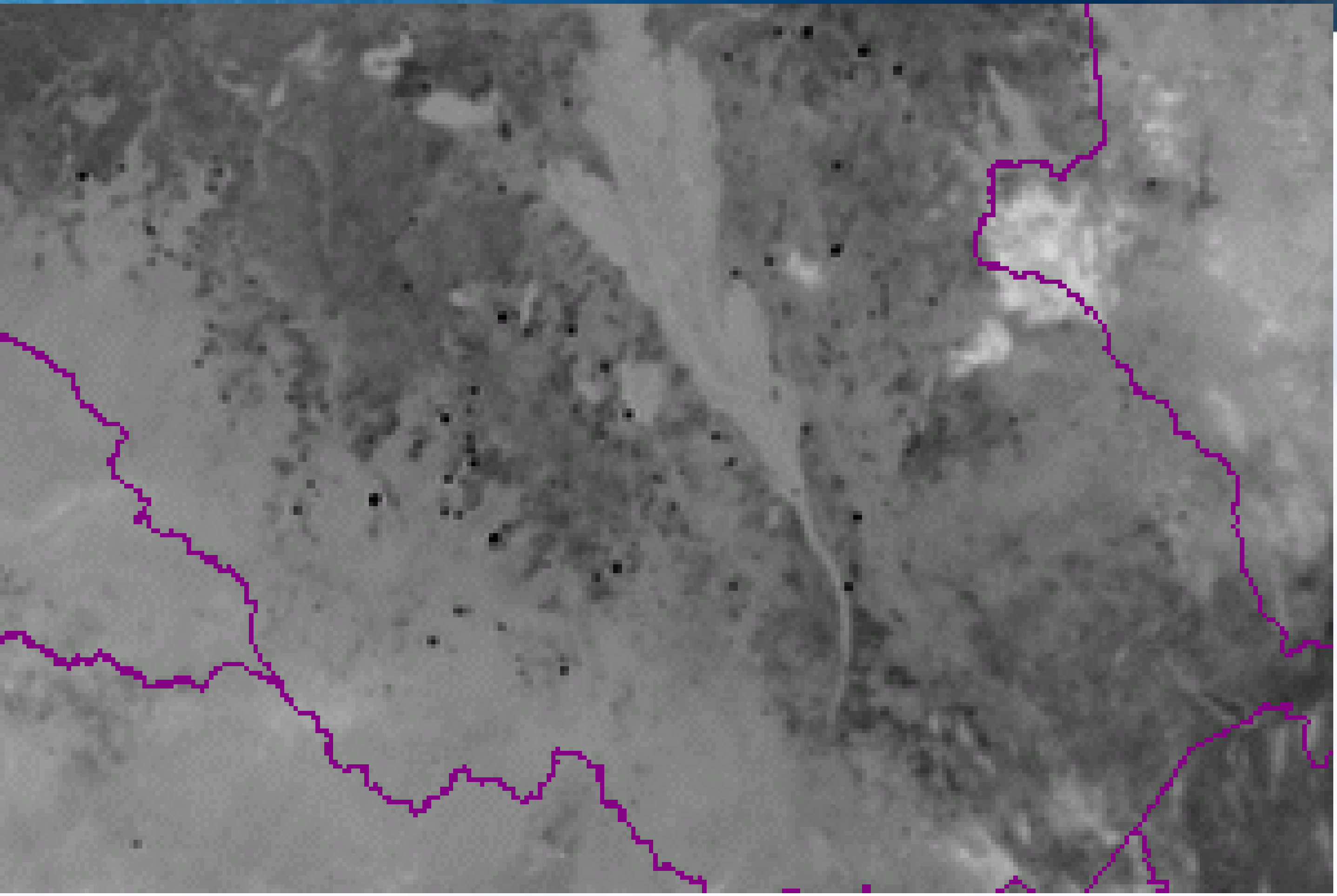
Seasonal Cycle of Fires





Active **fire distribution product** derived from ERS ATSR channel 3.7 µm for 1998

Seasonal Fires in Sudan



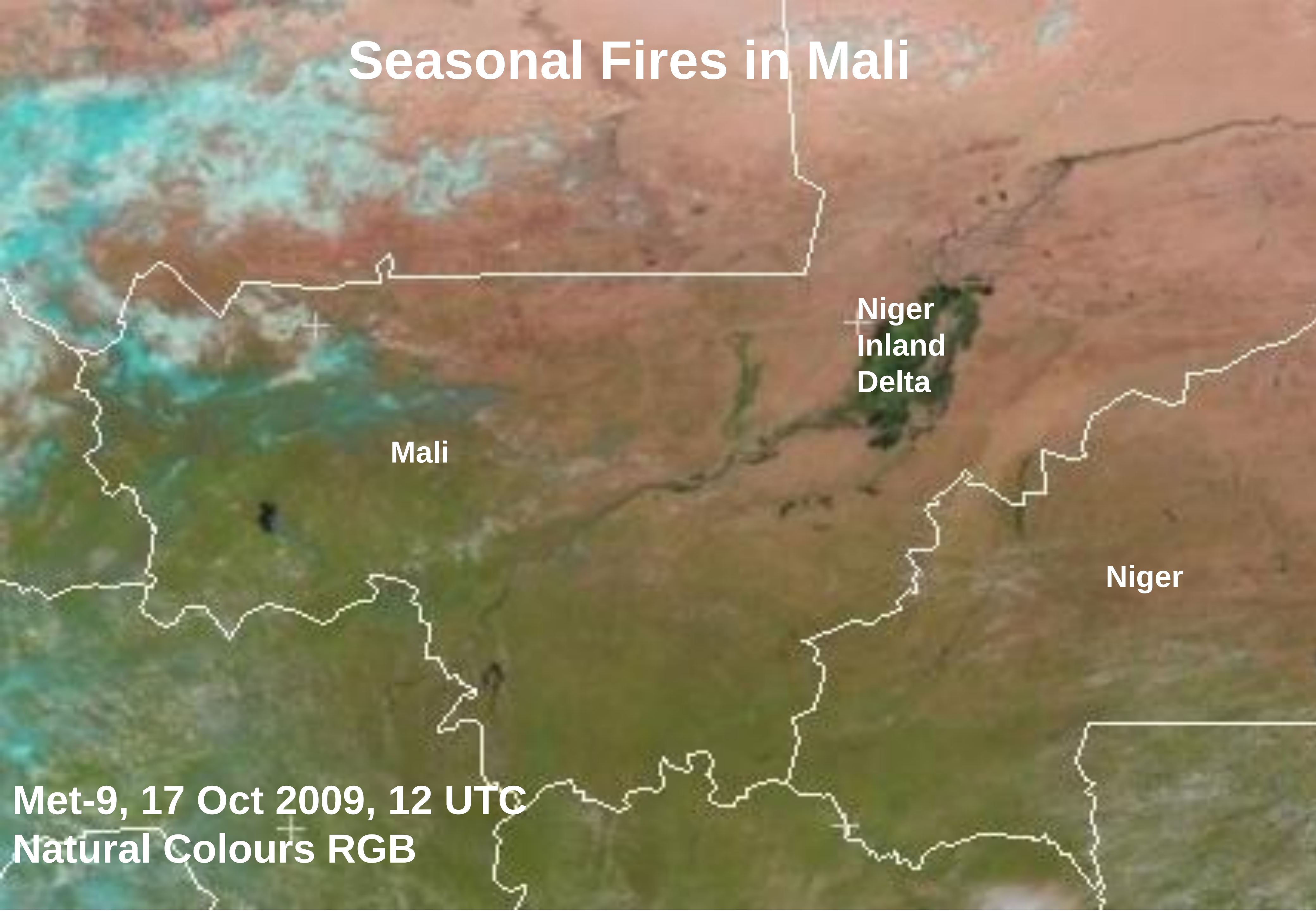
Click to see animation

MSG-1
03 Dec 2004
Channel 04 (IR3.9)

Seasonal Fires in Sudan

Click to see animation

MSG-1
03 Dec 2004
Channel 12 (HRV)

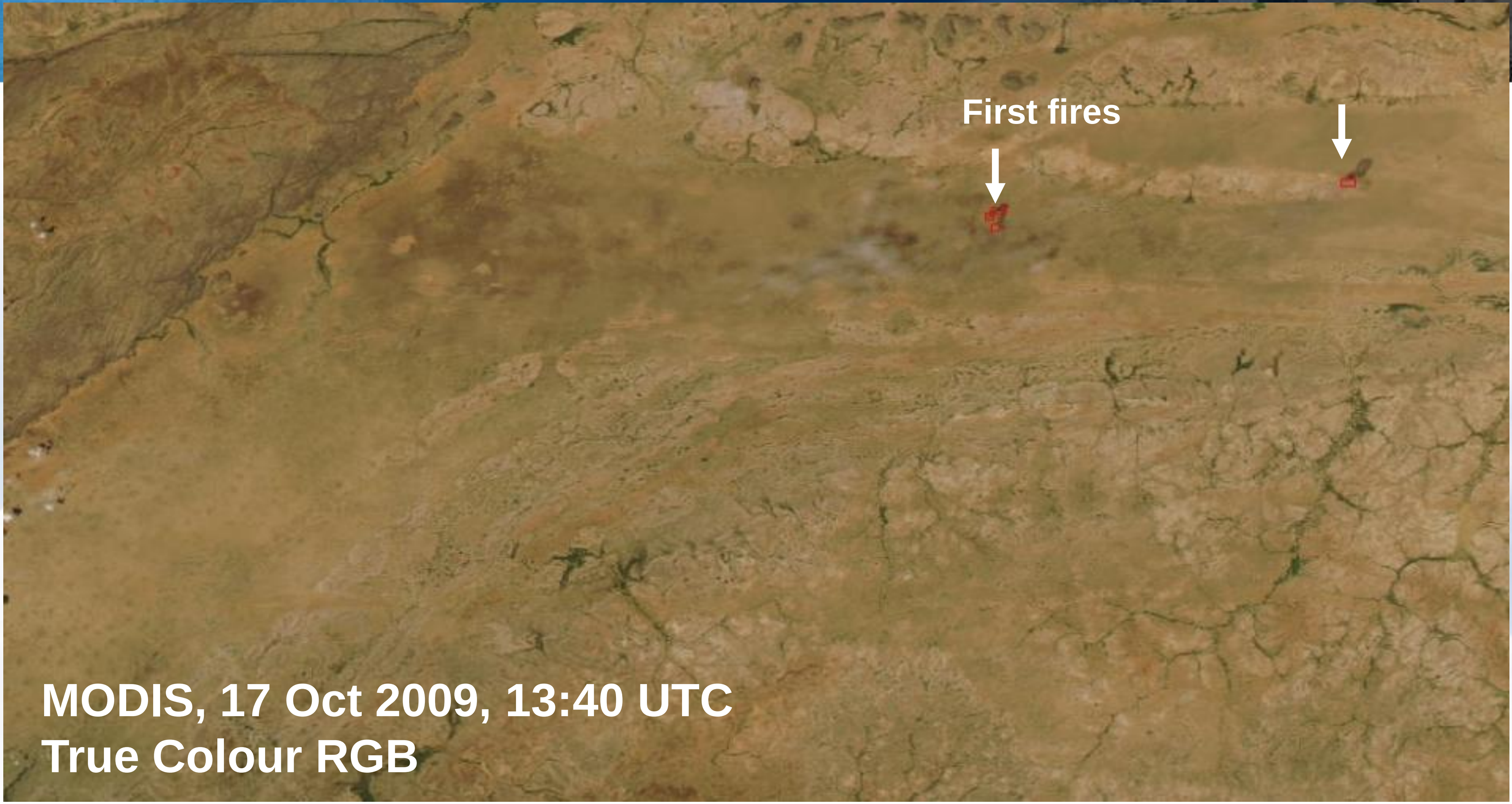

Seasonal Fires in Mali
Niger
Inland
Delta
Mali
Niger
Met-9, 17 Oct 2009, 12 UTC
Natural Colours RGB

Seasonal Fires in Mali
Niger Inland Delta
Mali
Niger
Met-9, 18 Oct 2009, 12 UTC
Natural Colours RGB

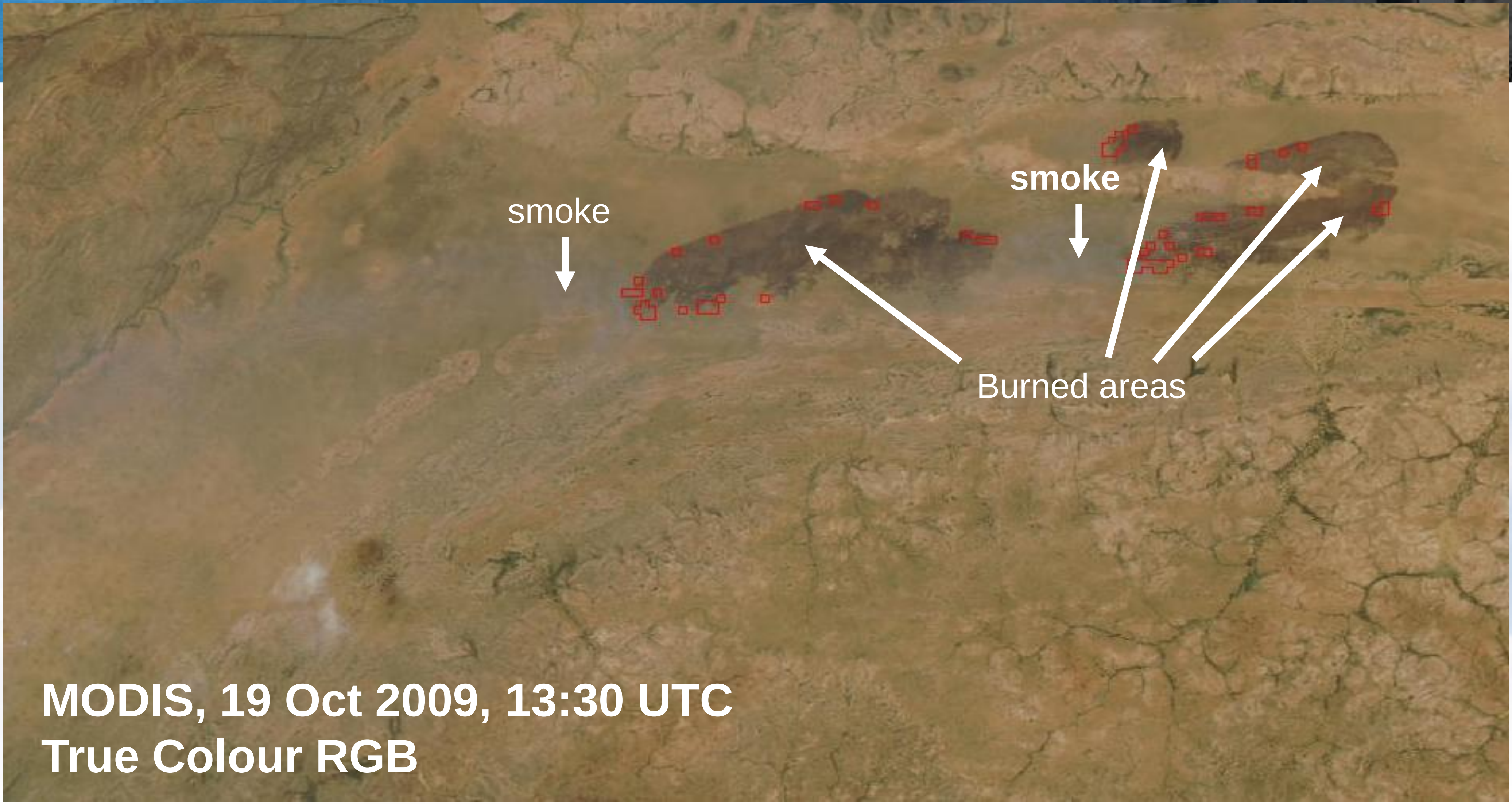

Seasonal Fires in Mali
Niger
Inland
Delta
Mali
Niger
Met-9, 19 Oct 2009, 12 UTC
Natural Colours RGB


Seasonal Fires in Mali
Niger
Inland
Delta
Mali
Niger
Met-9, 20 Oct 2009, 12 UTC
Natural Colours RGB

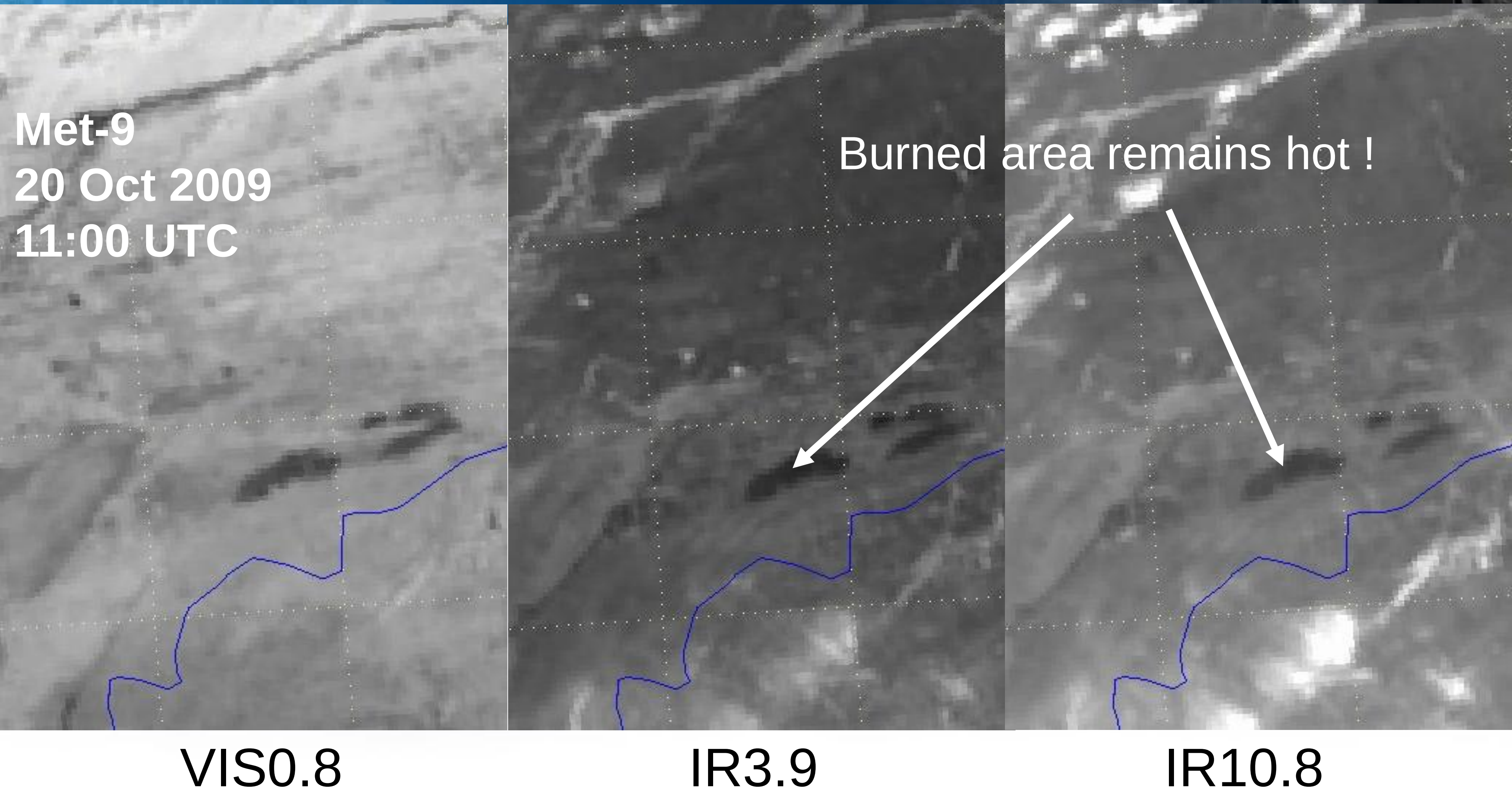
Seasonal Fires in Mali



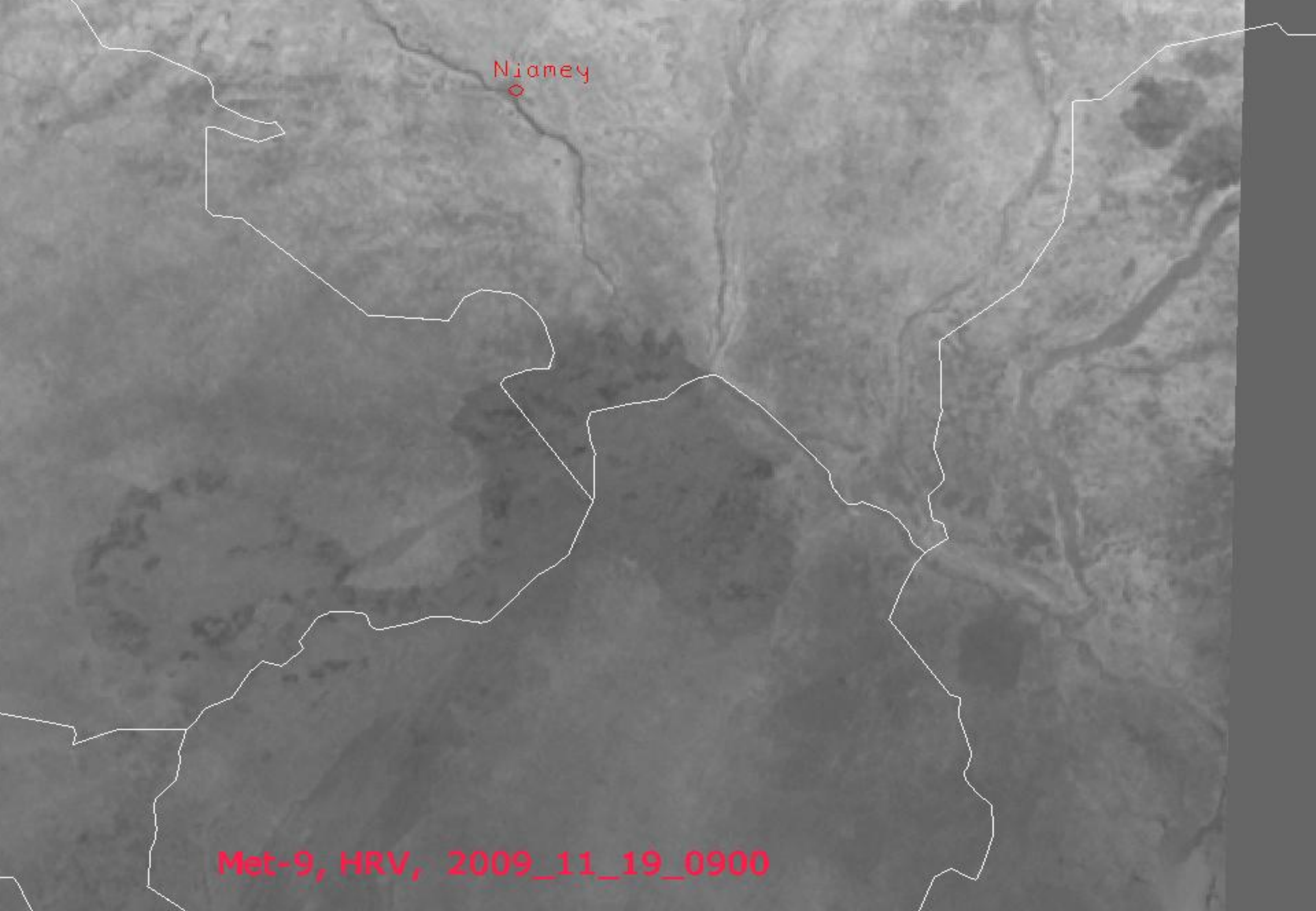
Seasonal Fires in Mali

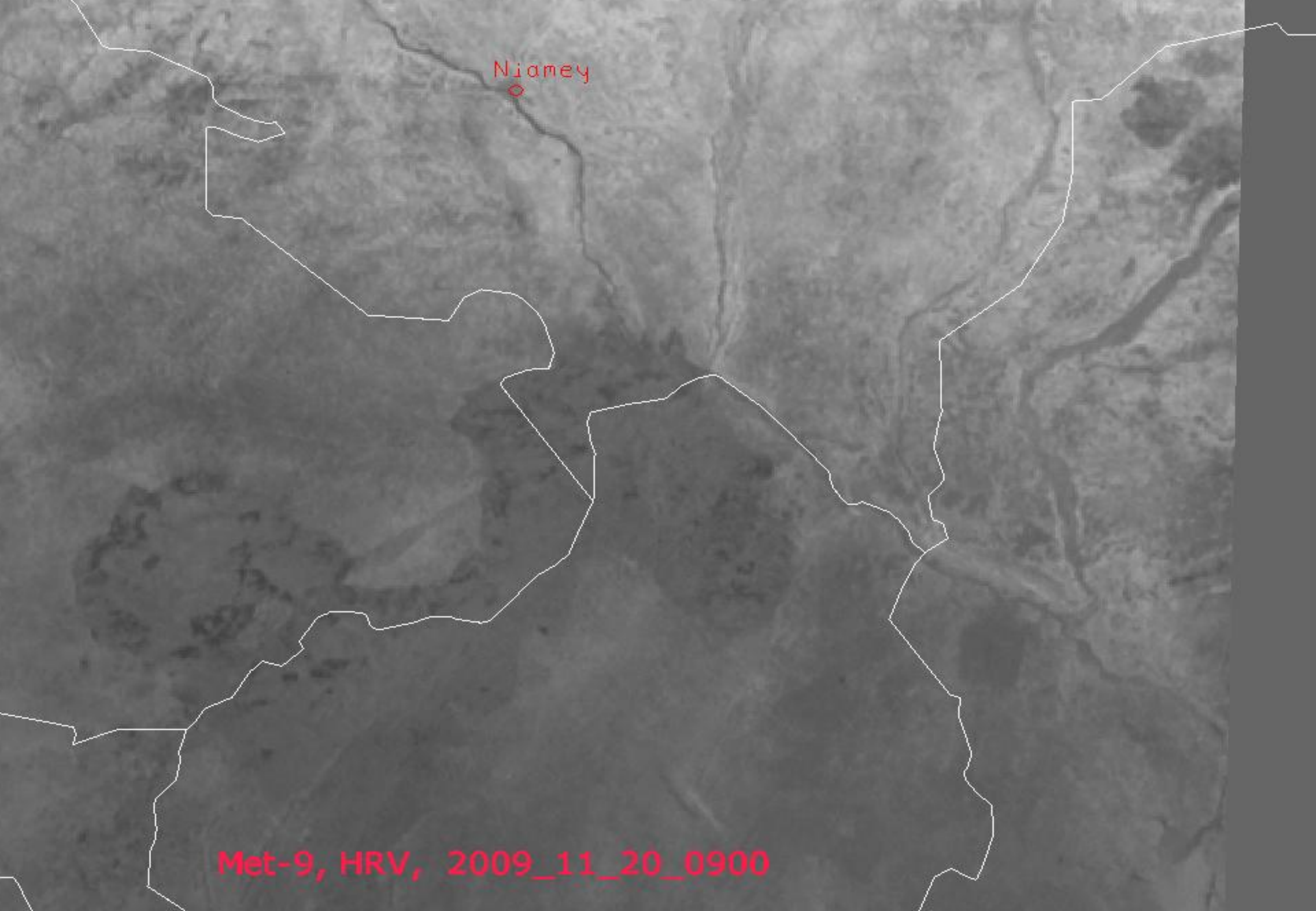


Seasonal Fires in Mali

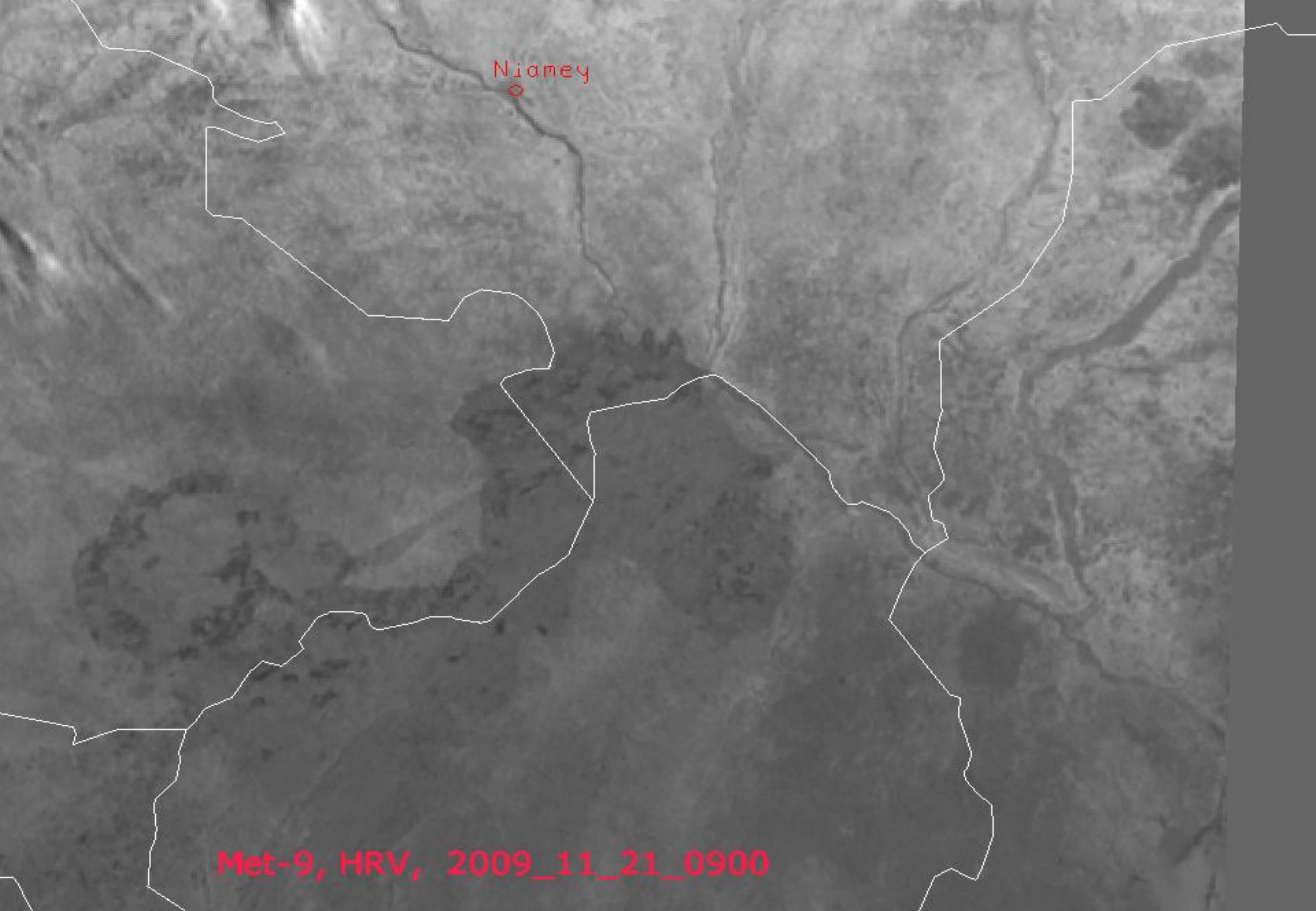


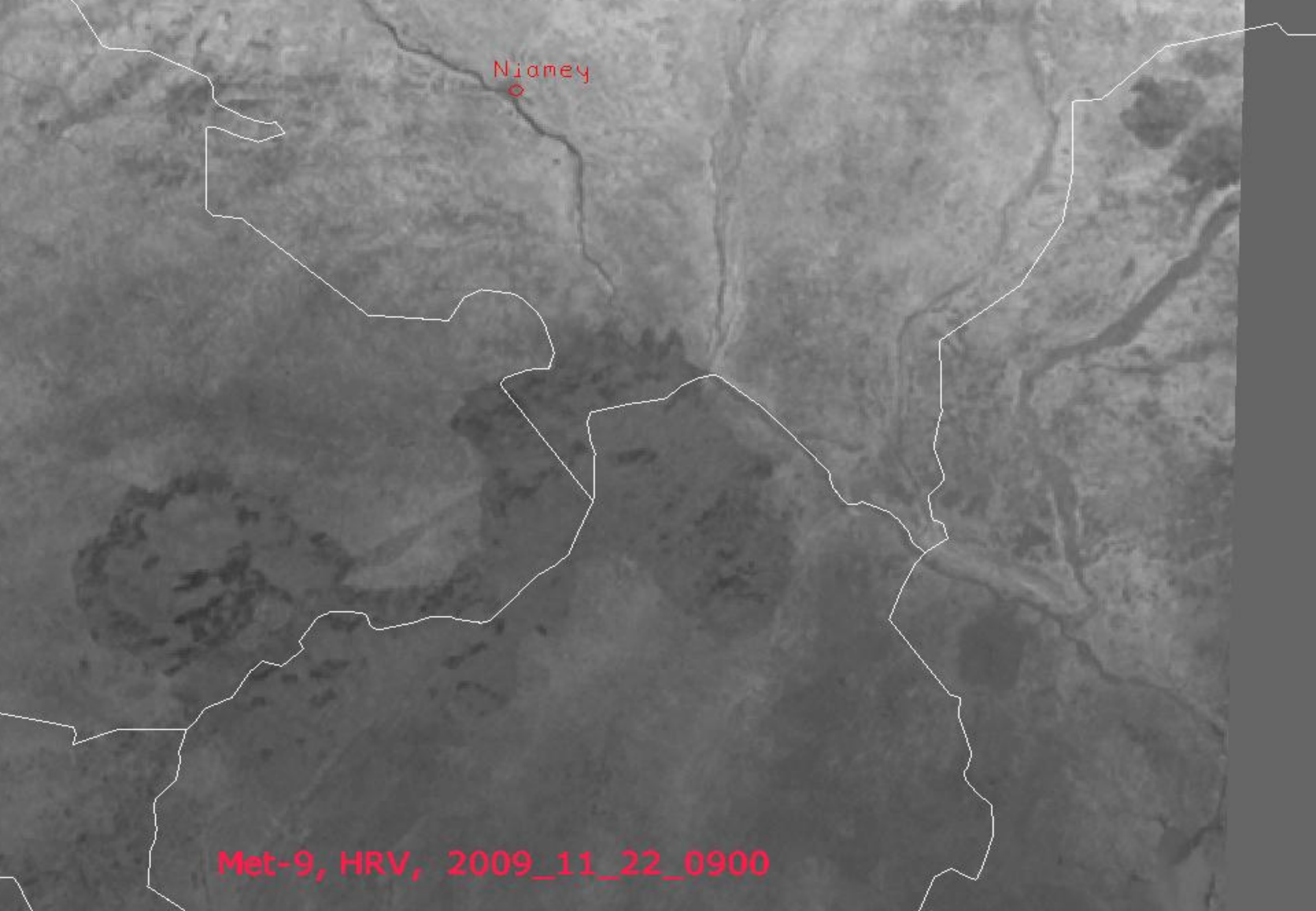

Seasonal Fires in Tri-border Area
Mali - Burkina Faso - Niger
Niger Inland Delta
0 Lon
Niger
Burkina Faso
Quiz feature
25 Nov 2009, 14 UTC

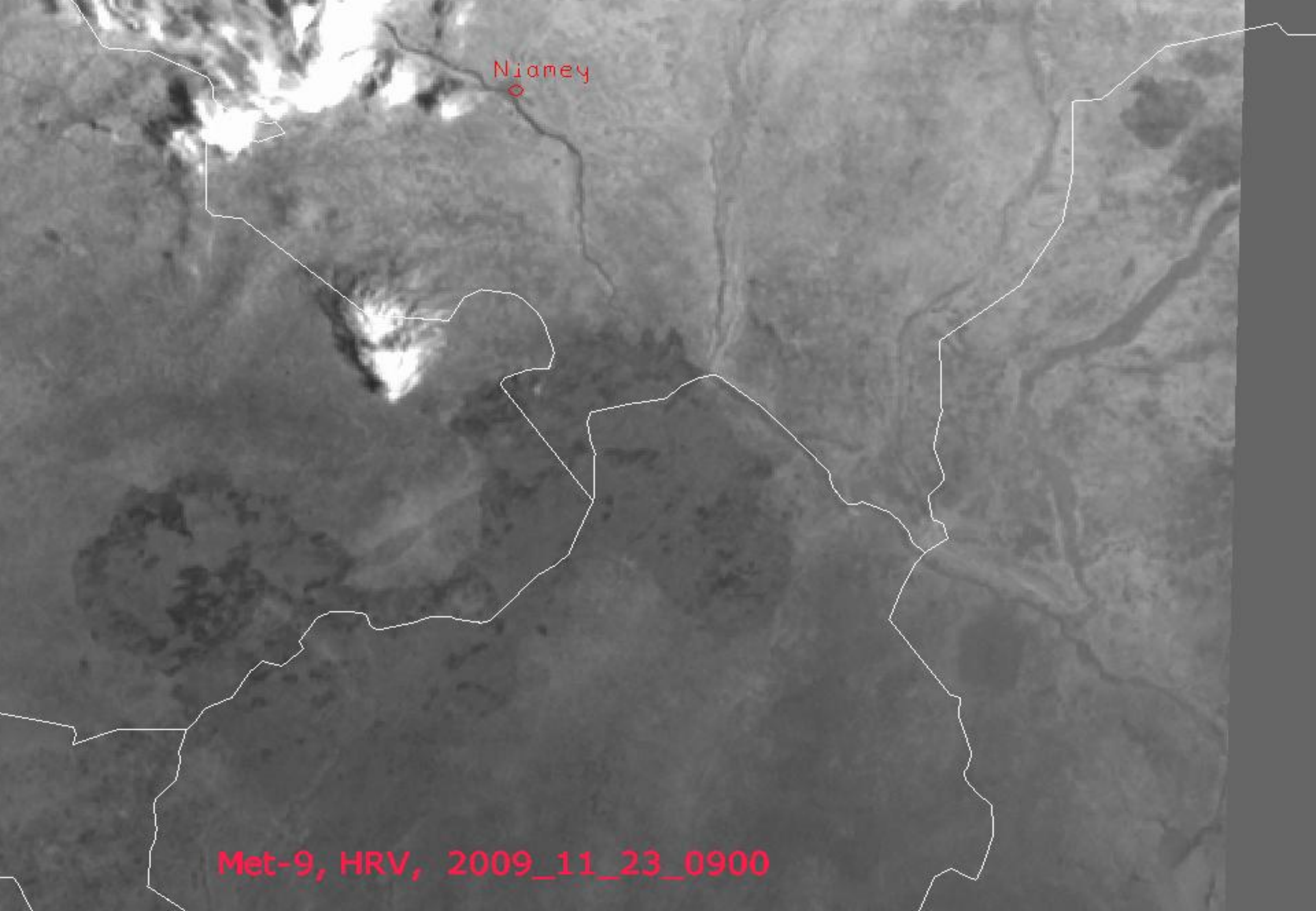

Niamey
Met-9, HRV, 2009_11_19_0900

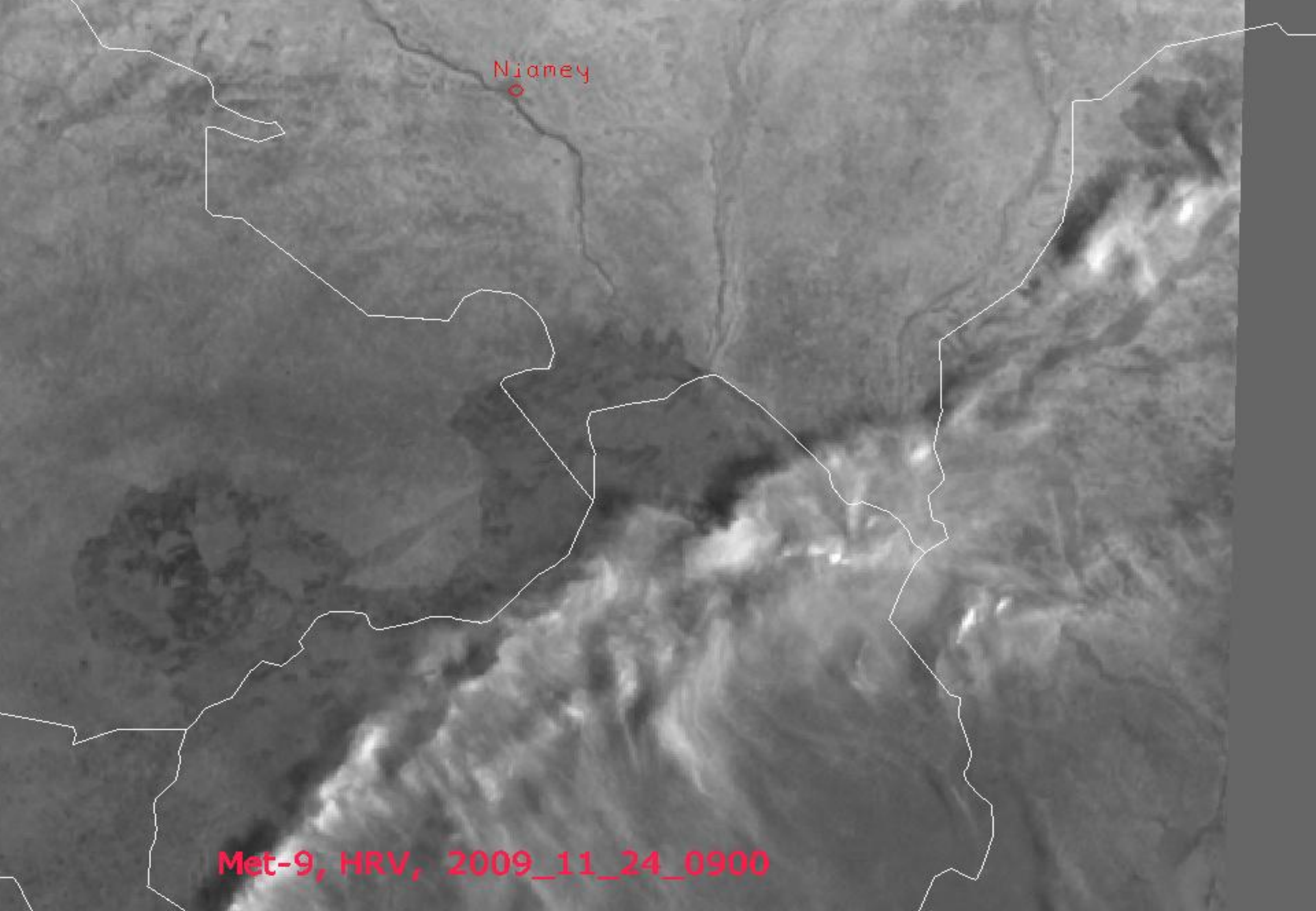


Niamey
Met-9, HRV, 2009_11_20_0900

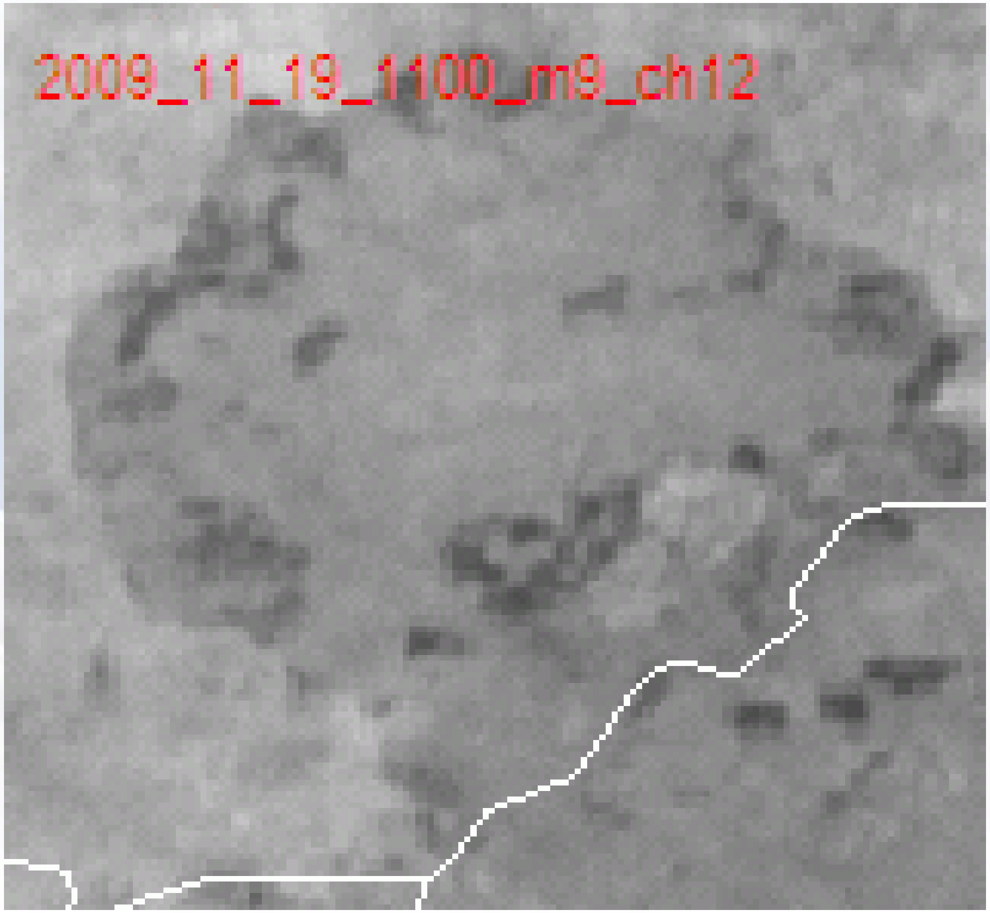

Niamey
Met-9, HRV, 2009_11_21_0900

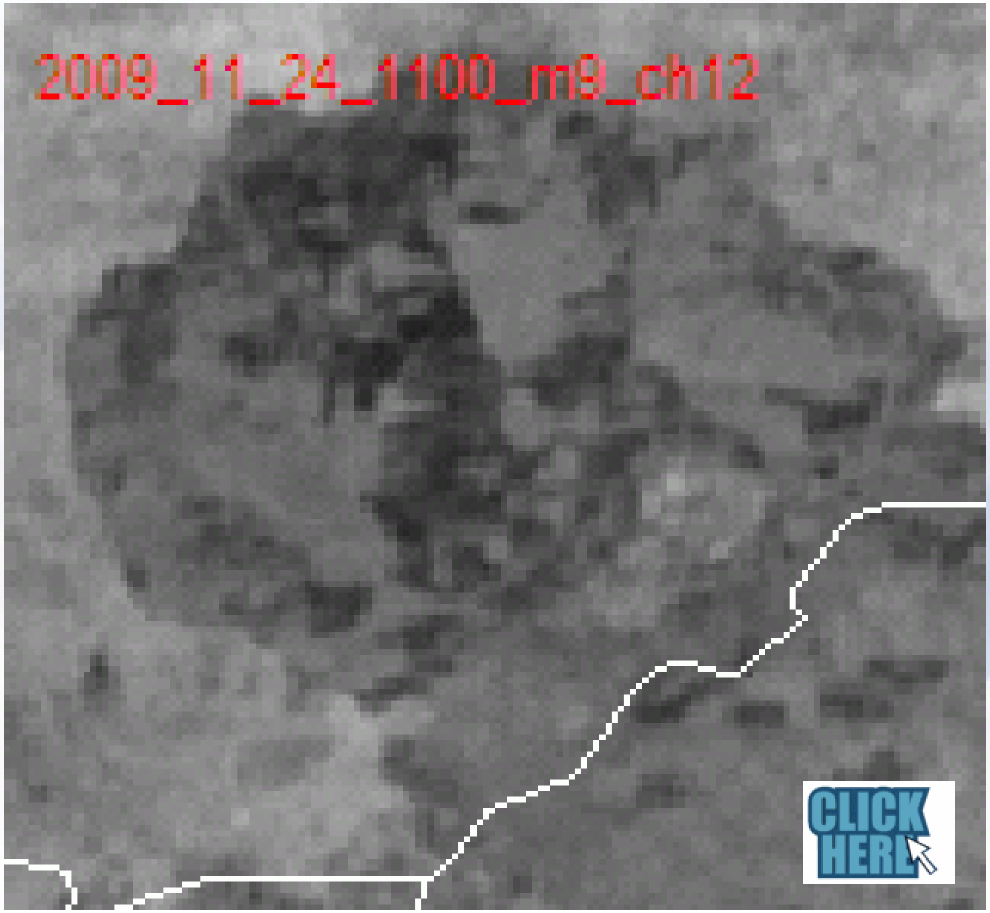

Niamey
Met-9, HRV, 2009_11_22_0900


Niamey
Met-9, HRV, 2009_11_23_0900


Niamey
Met-9, HRV, 2009_11_24_0900

19 Nov vs 24 Nov



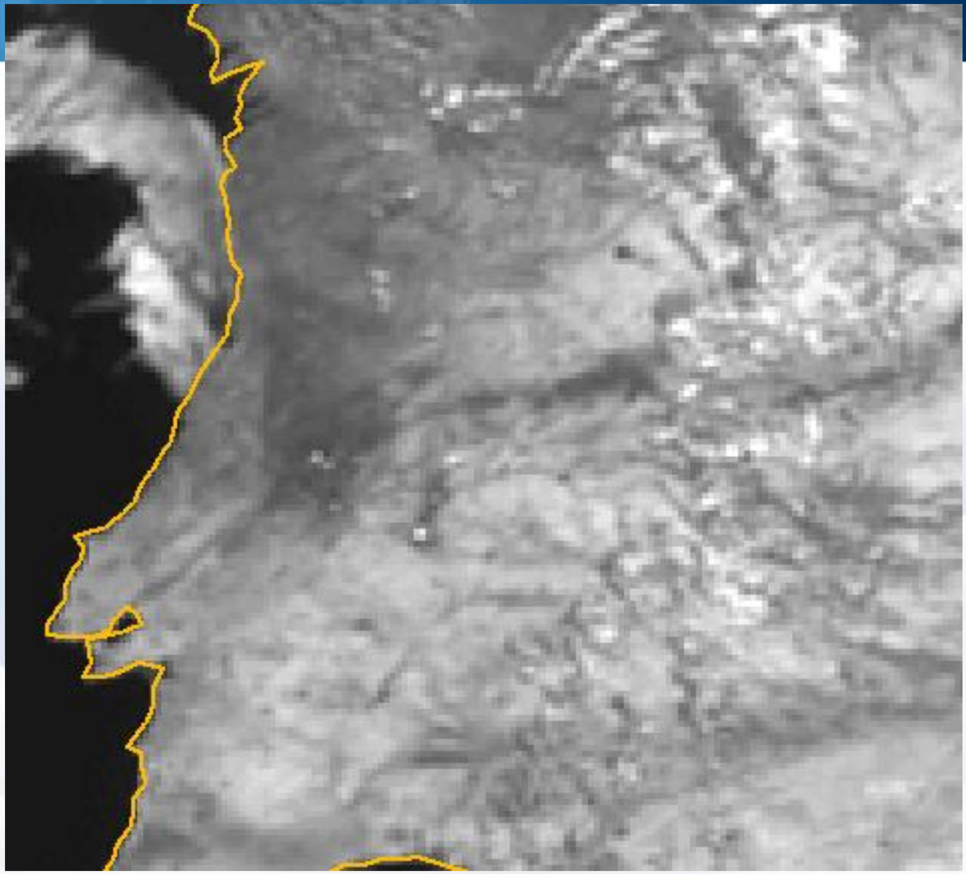


Fires over France
(biggest forest fire in the Var department since 1990)

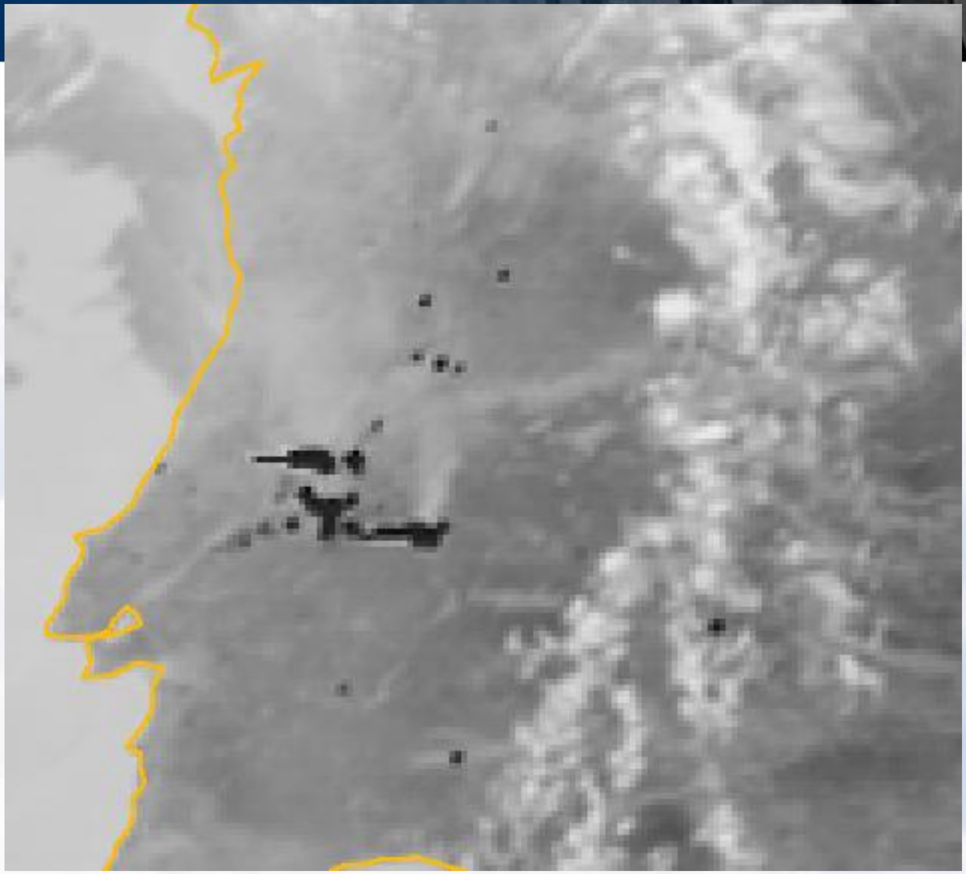
MSG-1, Channel 04 (IR3.9),
17 July 2003, 14:45 UTC

Catastrophic Fires in Portugal

Click to see animation



Channel 03 (1.6 µm)



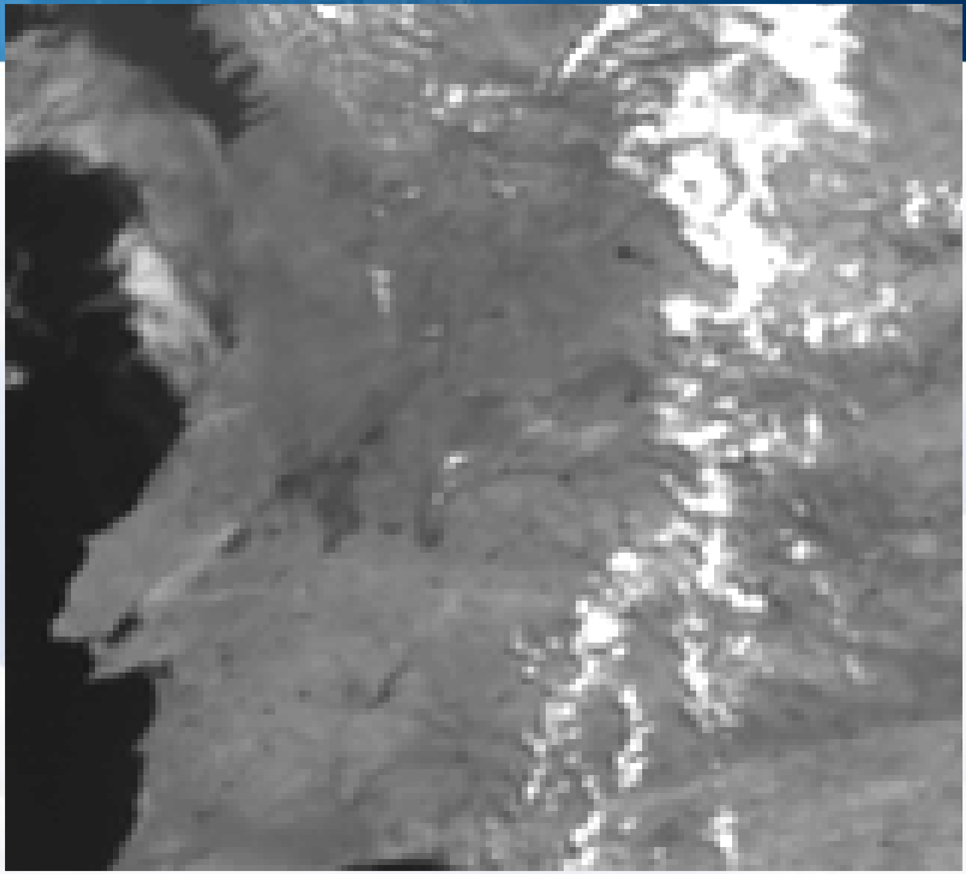
Channel 04 (3.9 µm)

Fires over Portugal and Spain

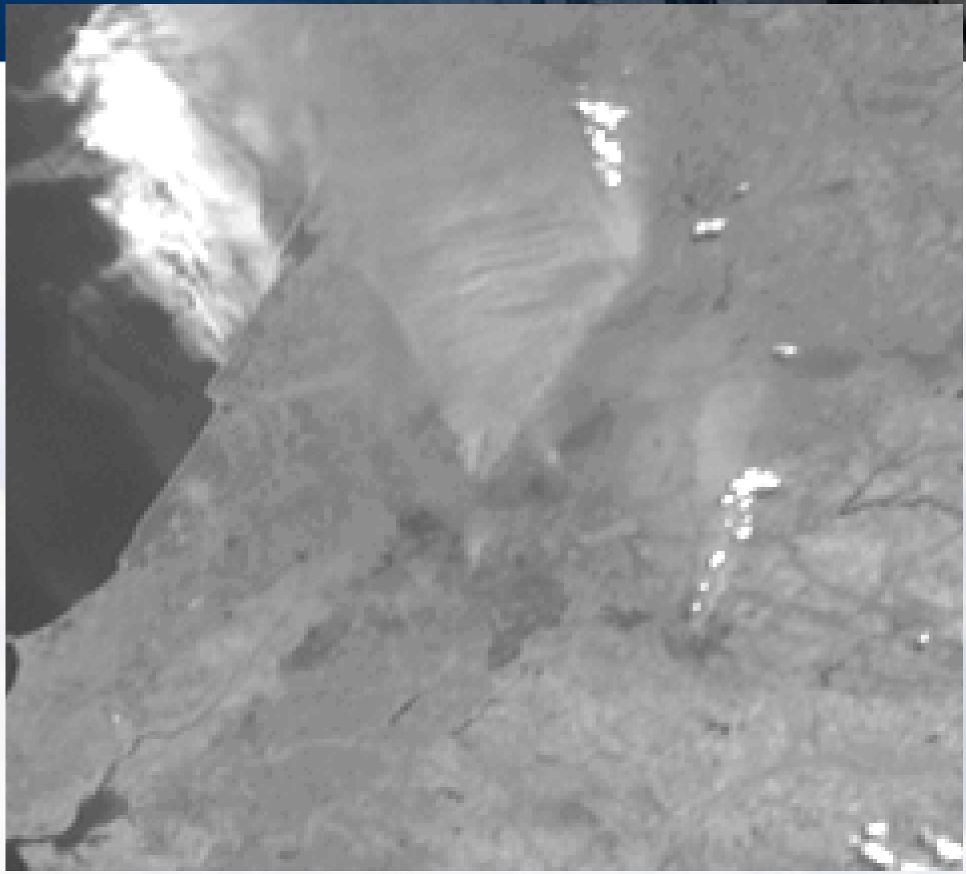
MSG-1, 3 August 2003, 12:00 UTC

Catastrophic Fires in Portugal

Click to see animation



Channel 02 (0.8 µm)

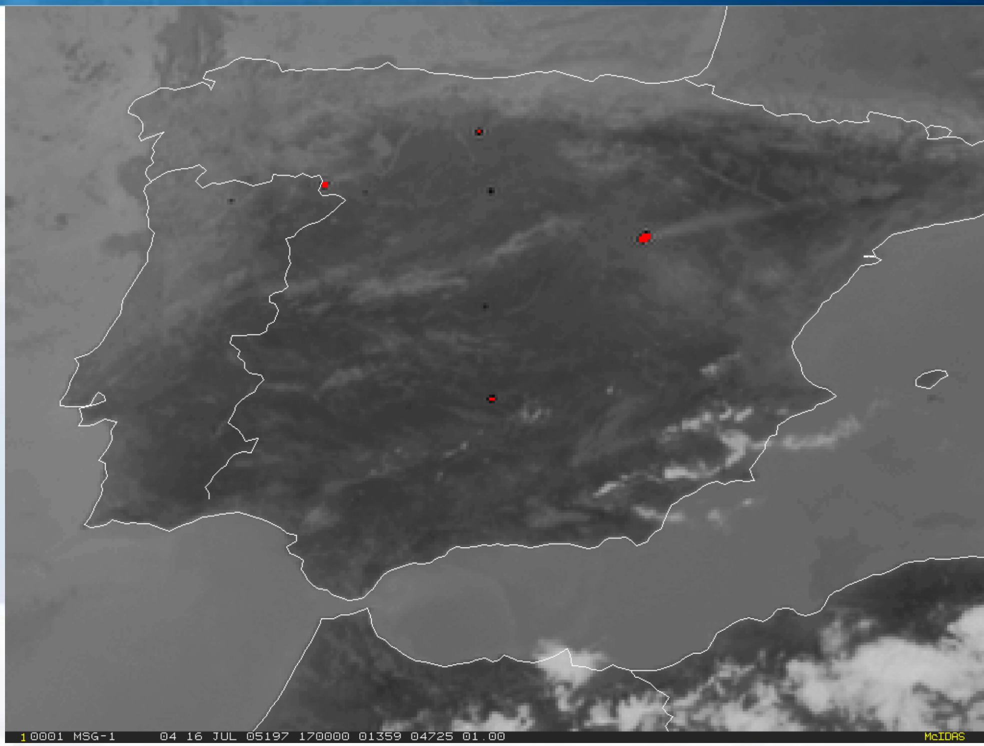


Channel 12 (HRV)

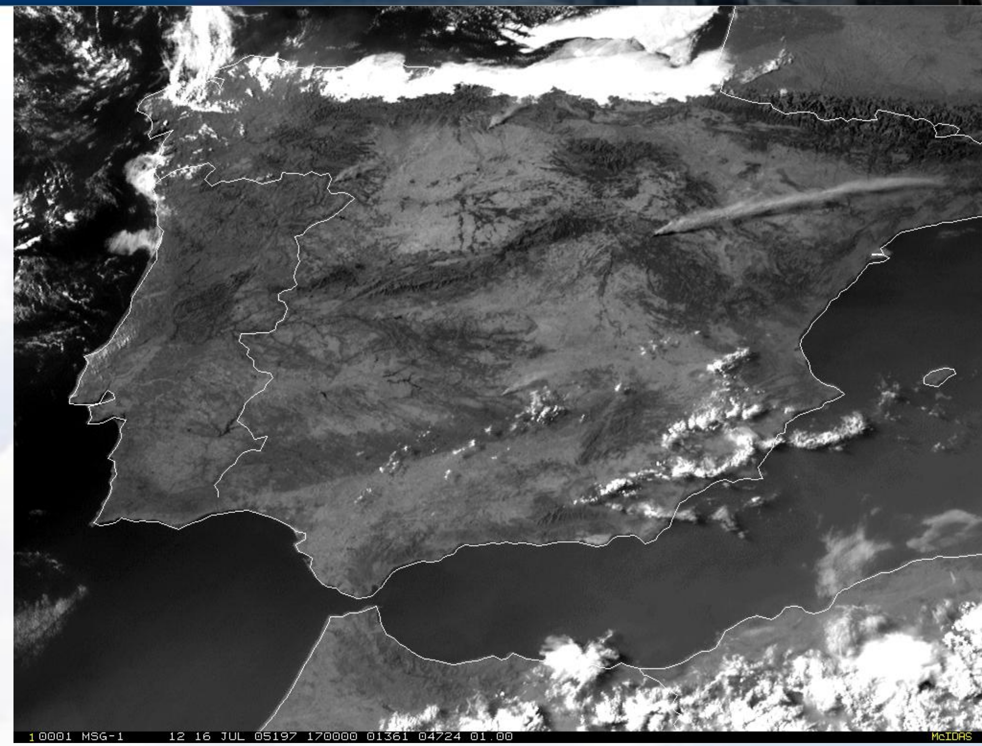
Fires over Portugal and Spain

MSG-1, 3 August 2003, 12:00 UTC

Catastrophic Fire in Spain

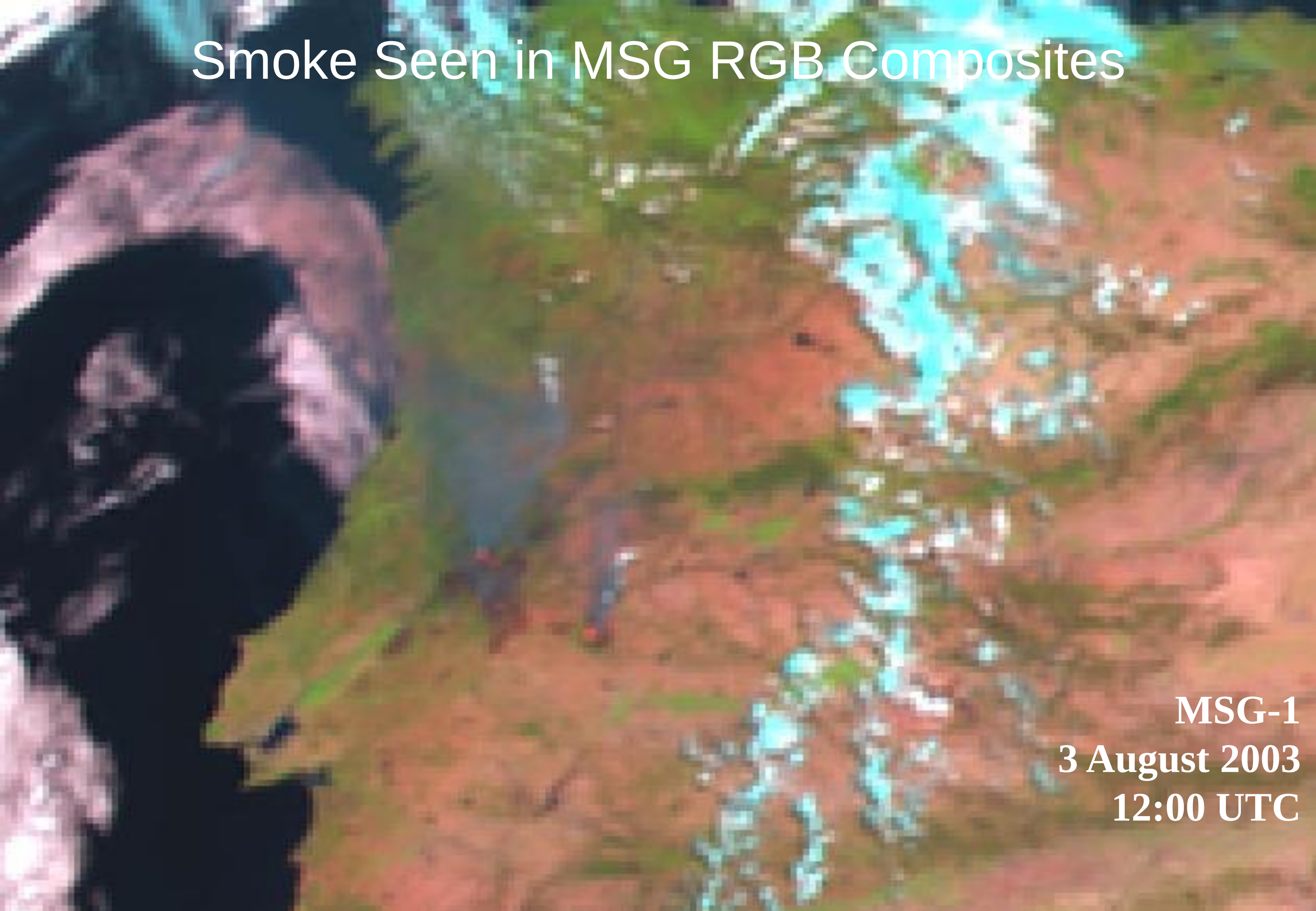


Channel 04 (IR3.9)

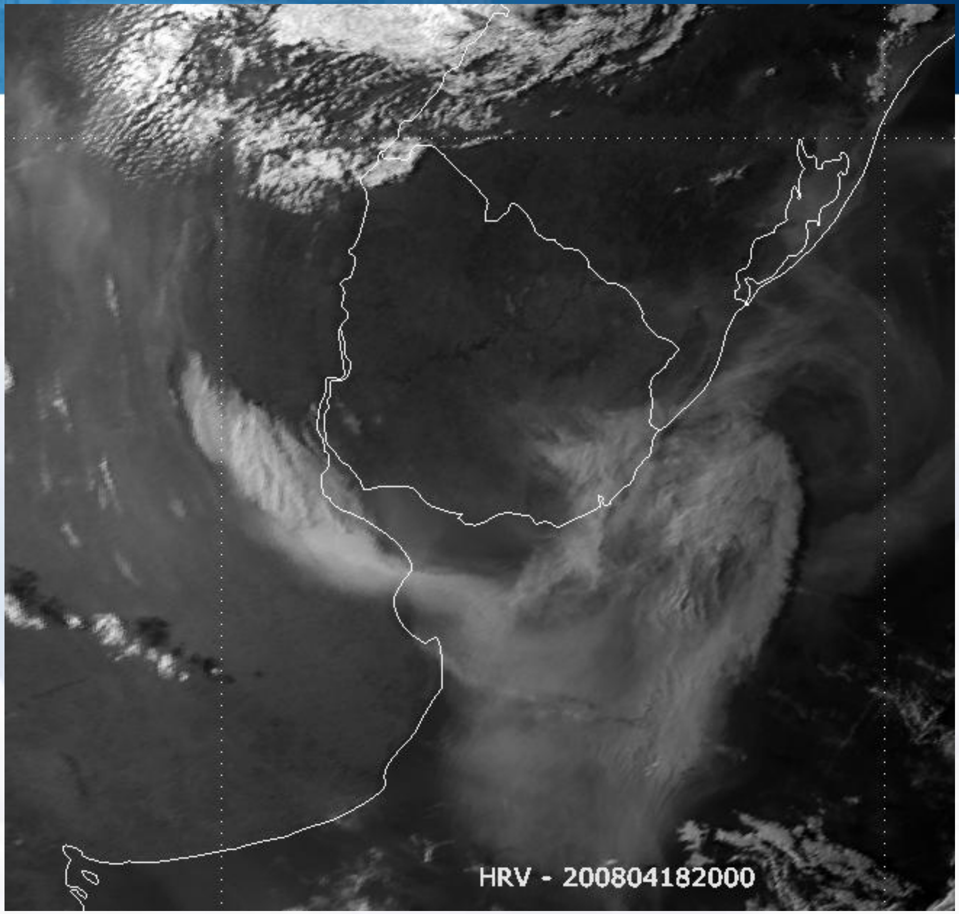


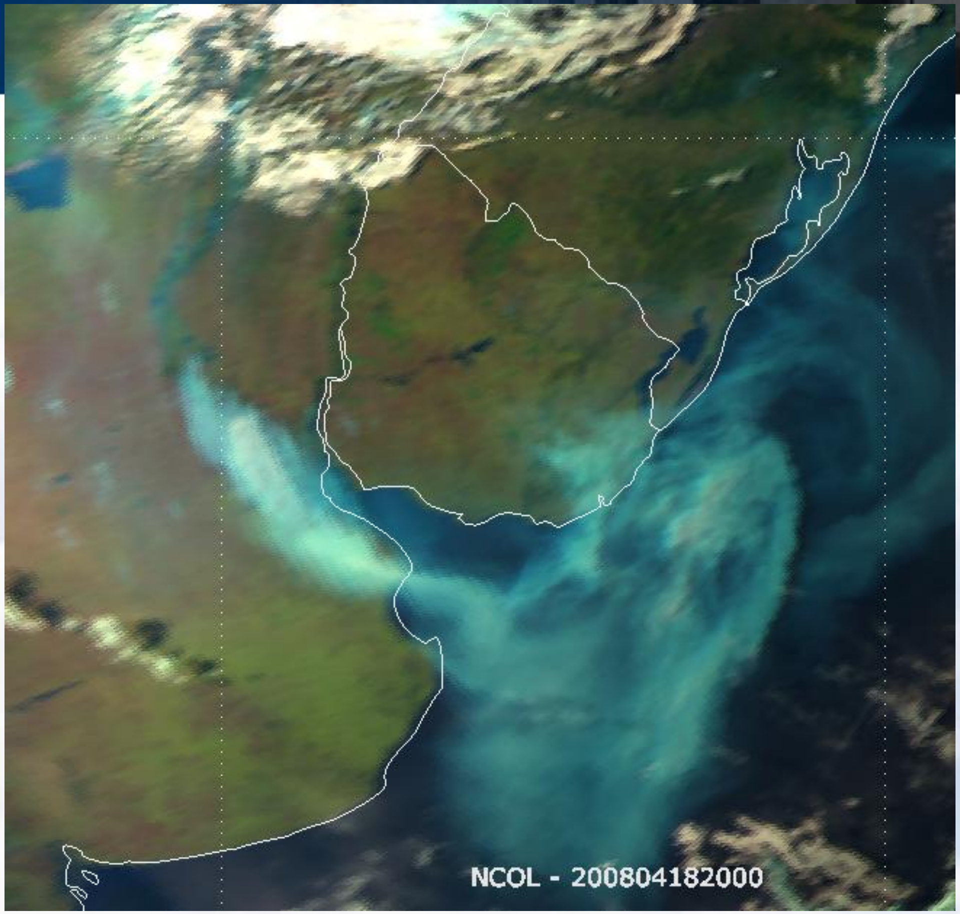
Channel 12 (HRV)

MSG-1, 16 July 2005, 17:00 UTC


Smoke Seen in MSG RGB Composites
MSG-1
3 August 2003
12:00 UTC

Dense Smoke over Argentina and Uruguay



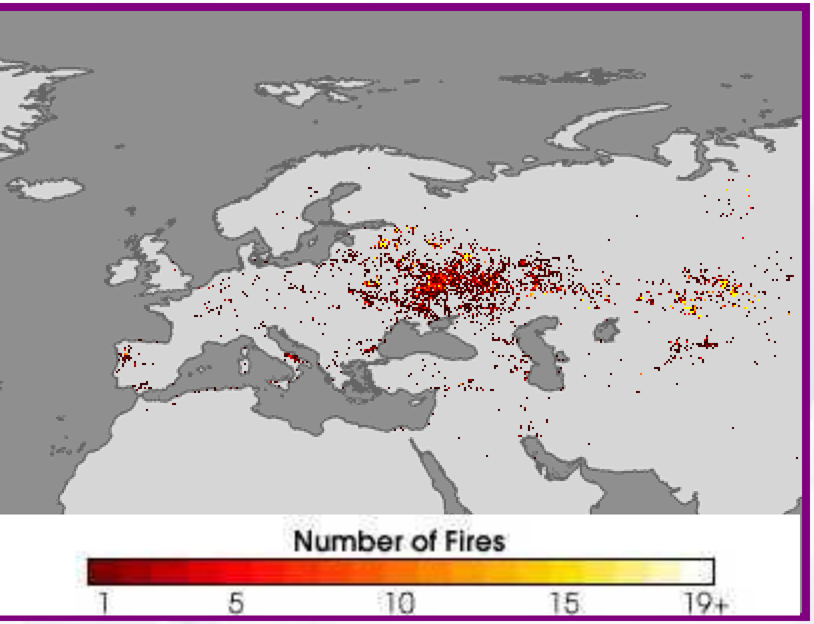


Met-9, 18 Apr 2008, 20:00 UTC

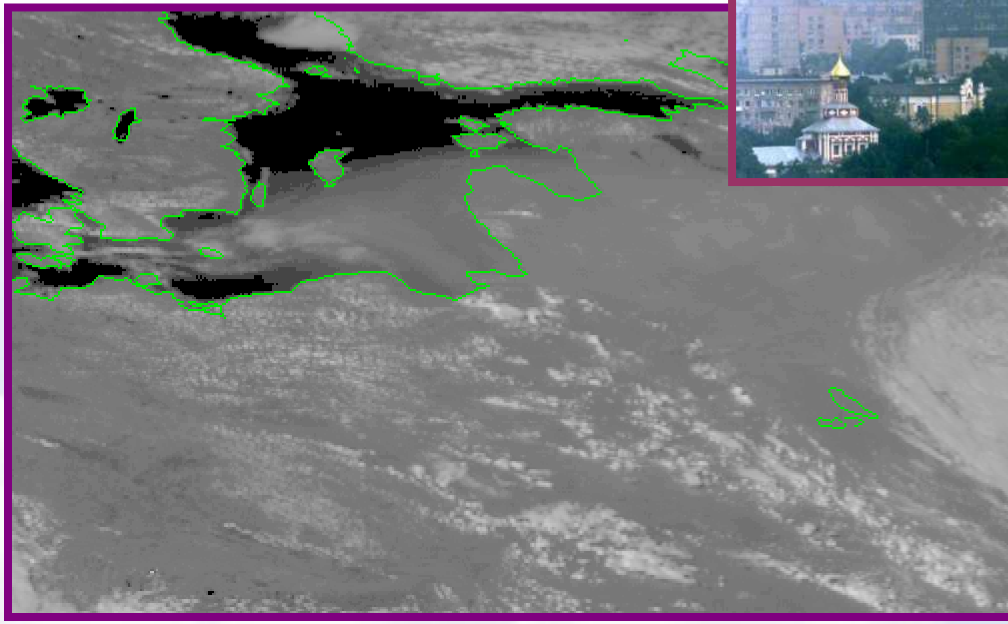
Click to see animation

Click to see animation

Smoke from Russian Fires



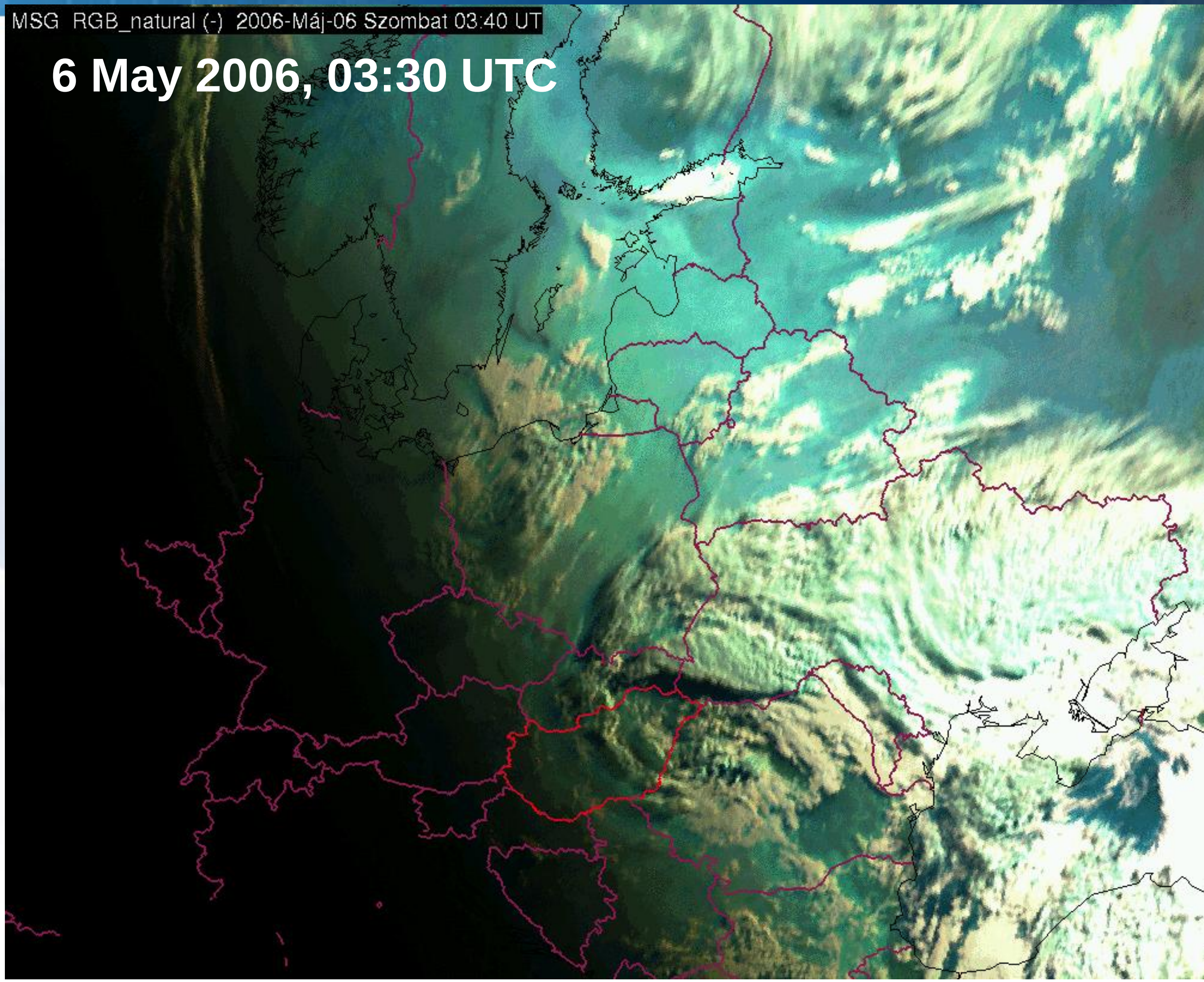
MODIS fire product
15-22 August 2002



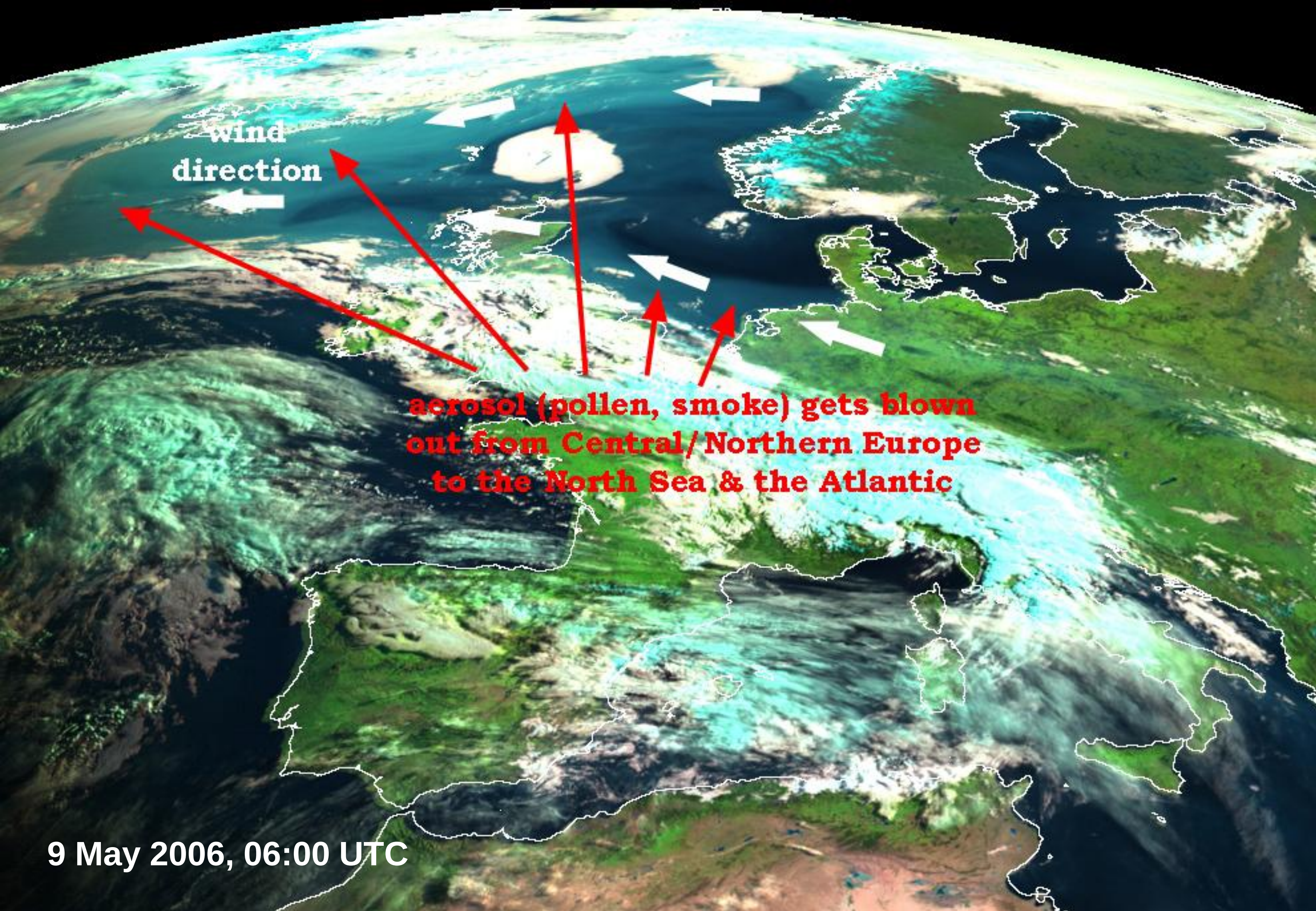
Meteosat-7, VIS channel
9-Sep-2002, 13:30 UTC

Smoke over Russia caused by numerous wildfires during the severe draught in summer 2002

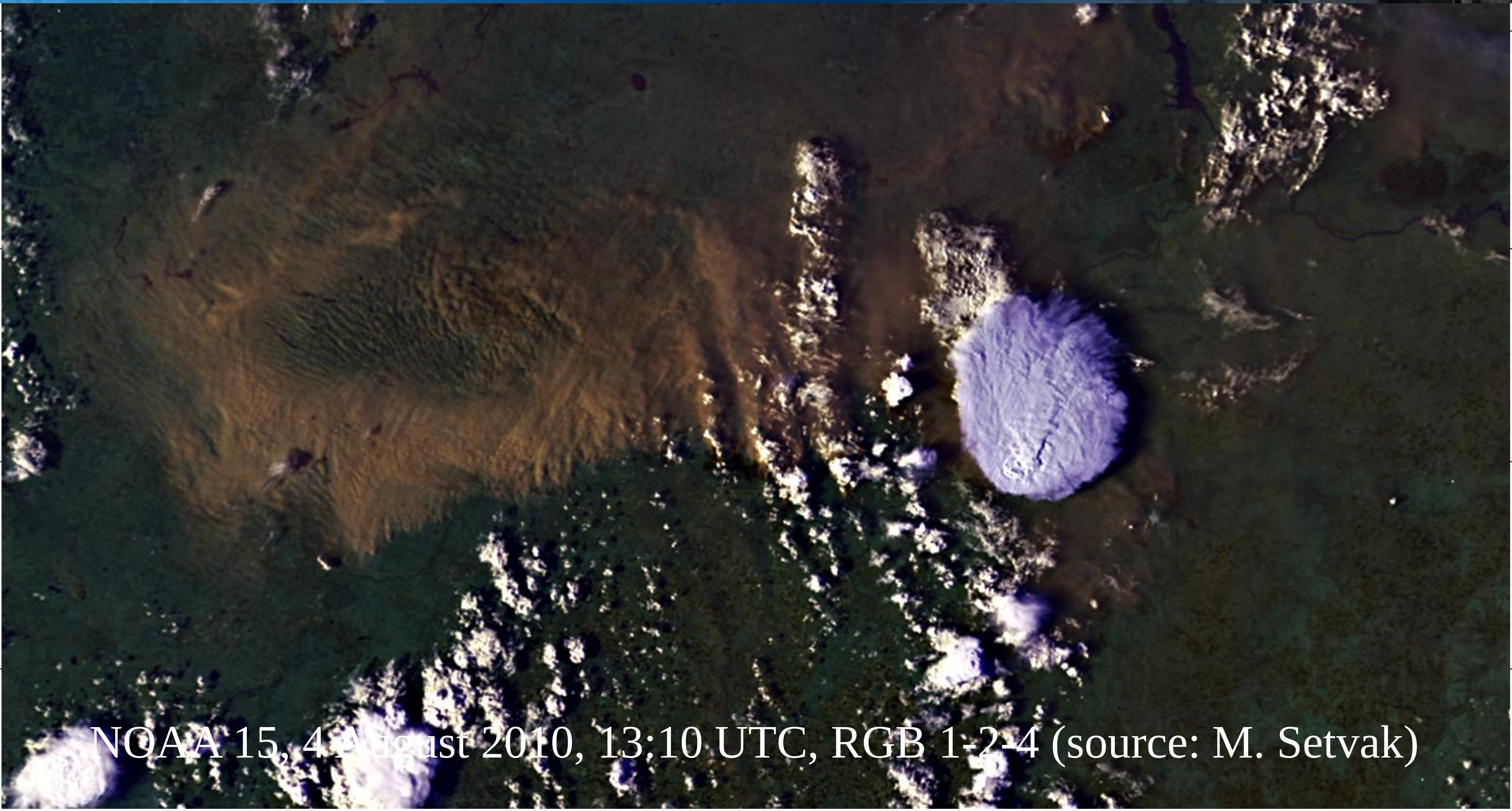
Smoke from Russian / Ukrainian Fires



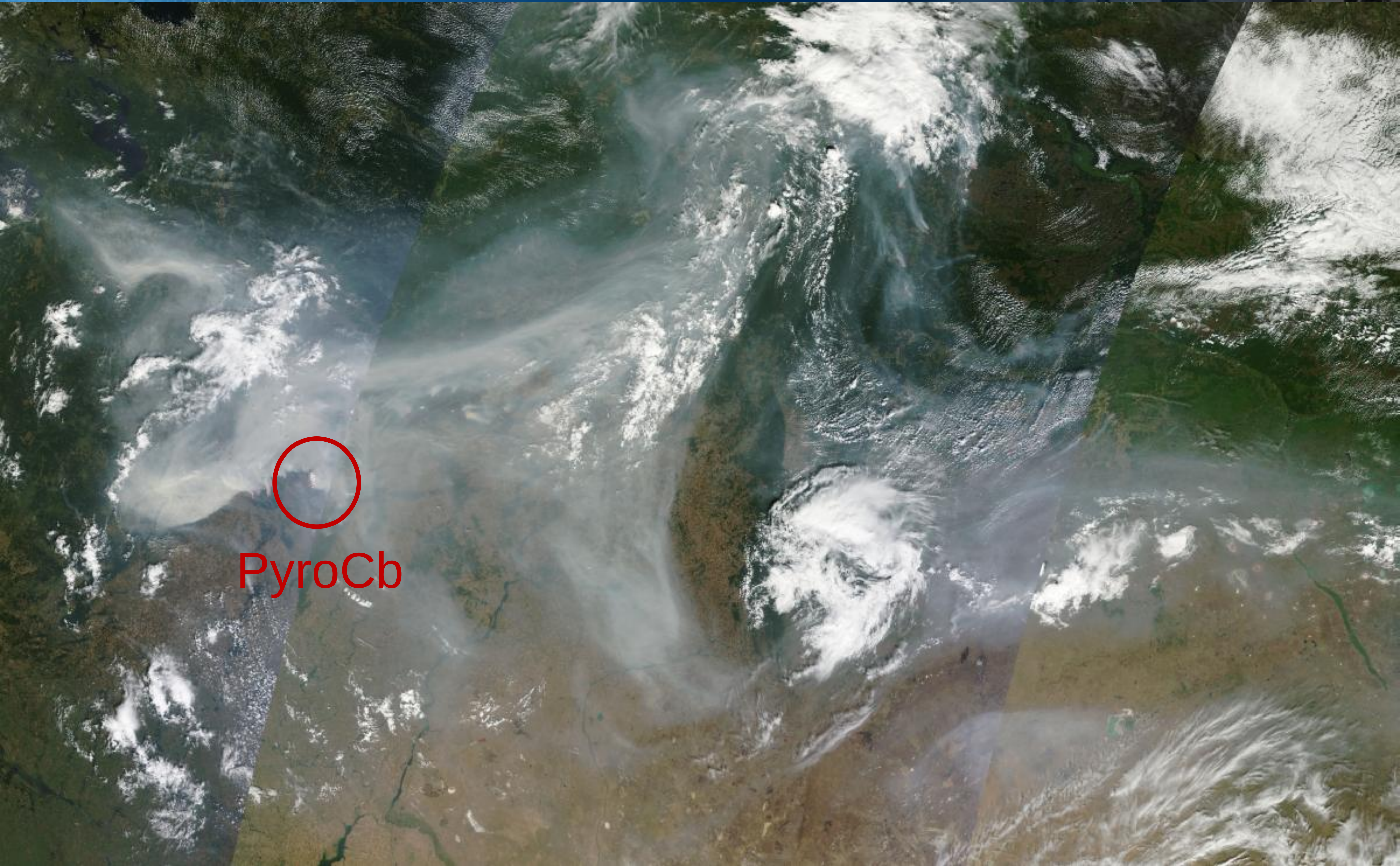
Click to
see animation


wind
direction
aerosol (pollen, smoke) gets blown
out from Central/Northern Europe
to the North Sea & the Atlantic
9 May 2006, 06:00 UTC

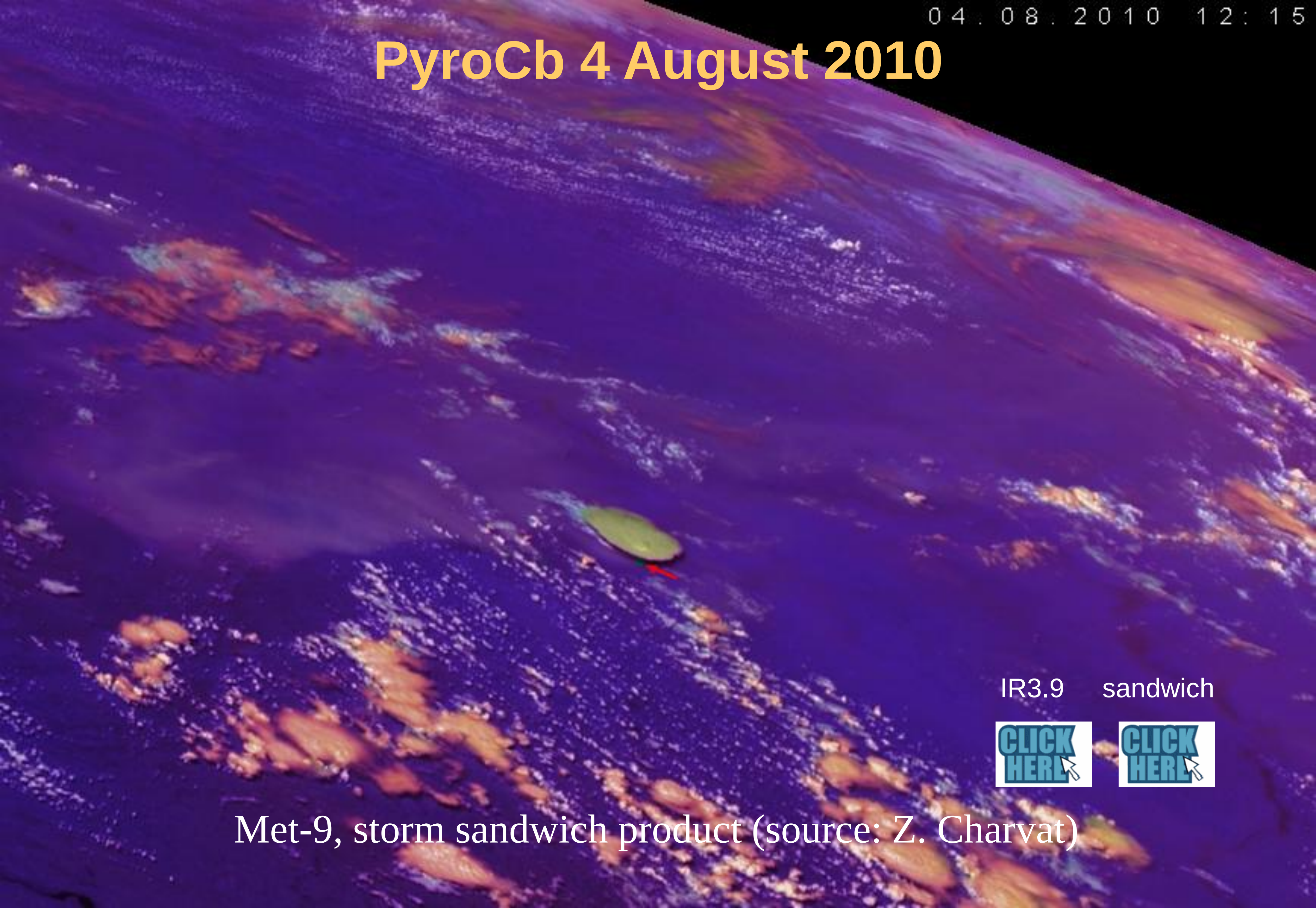
Russian Fires / Smoke August 2010


NOAA 15, 4 August 2010, 13:10 UTC, RGB 1-2-4 (source: M. Setvak)

Smoke 4 August 2010 (MODIS)



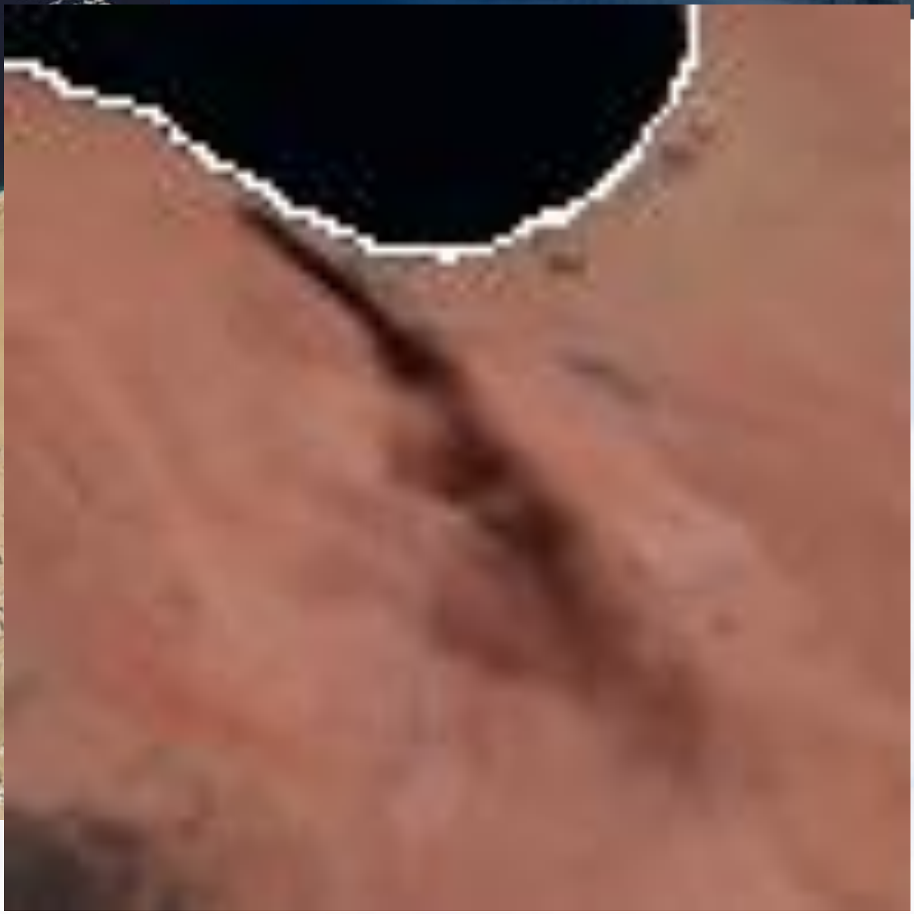
PyroCb 4 August 2010



Met-9, storm sandwich product (source: Z. Charvat)

Smoke from Oil Tank Fire (Libya)

Aqua, MODIS, 20 Aug 2008
True Colour RGB



Met-8, 19 Aug 2008
Nat Colour RGB

Click to see animation

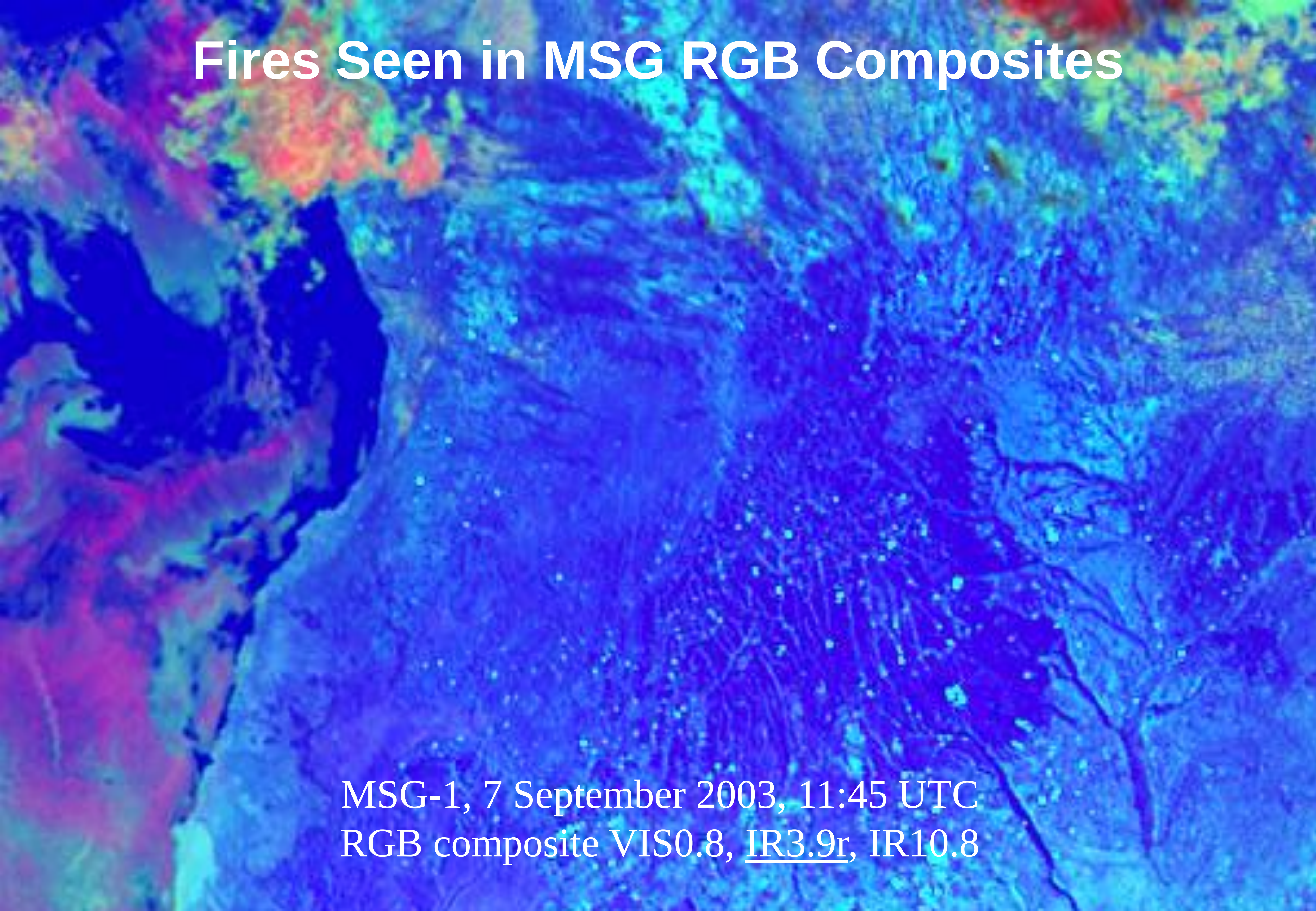
CLICK HERE

Massive Fire at Oil Depot in England

MSG-1, 11 December 2005, 11:45 UTC

RGB Composite HRV + IR3.9

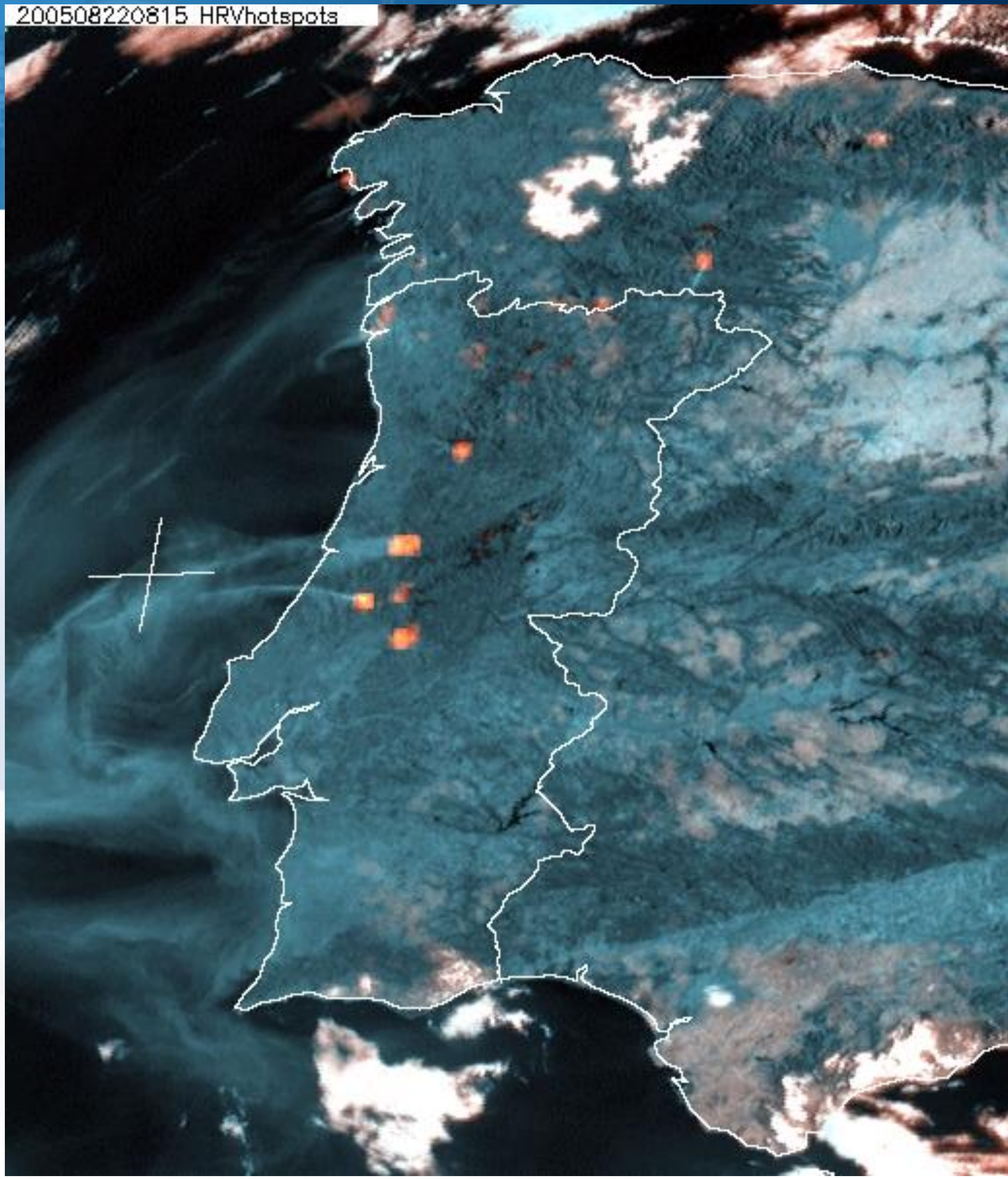
Fires Seen in MSG RGB Composites



MSG-1, 7 September 2003, 11:45 UTC
RGB composite VIS0.8, IR3.9r, IR10.8

Fires Seen in MSG RGB Composites

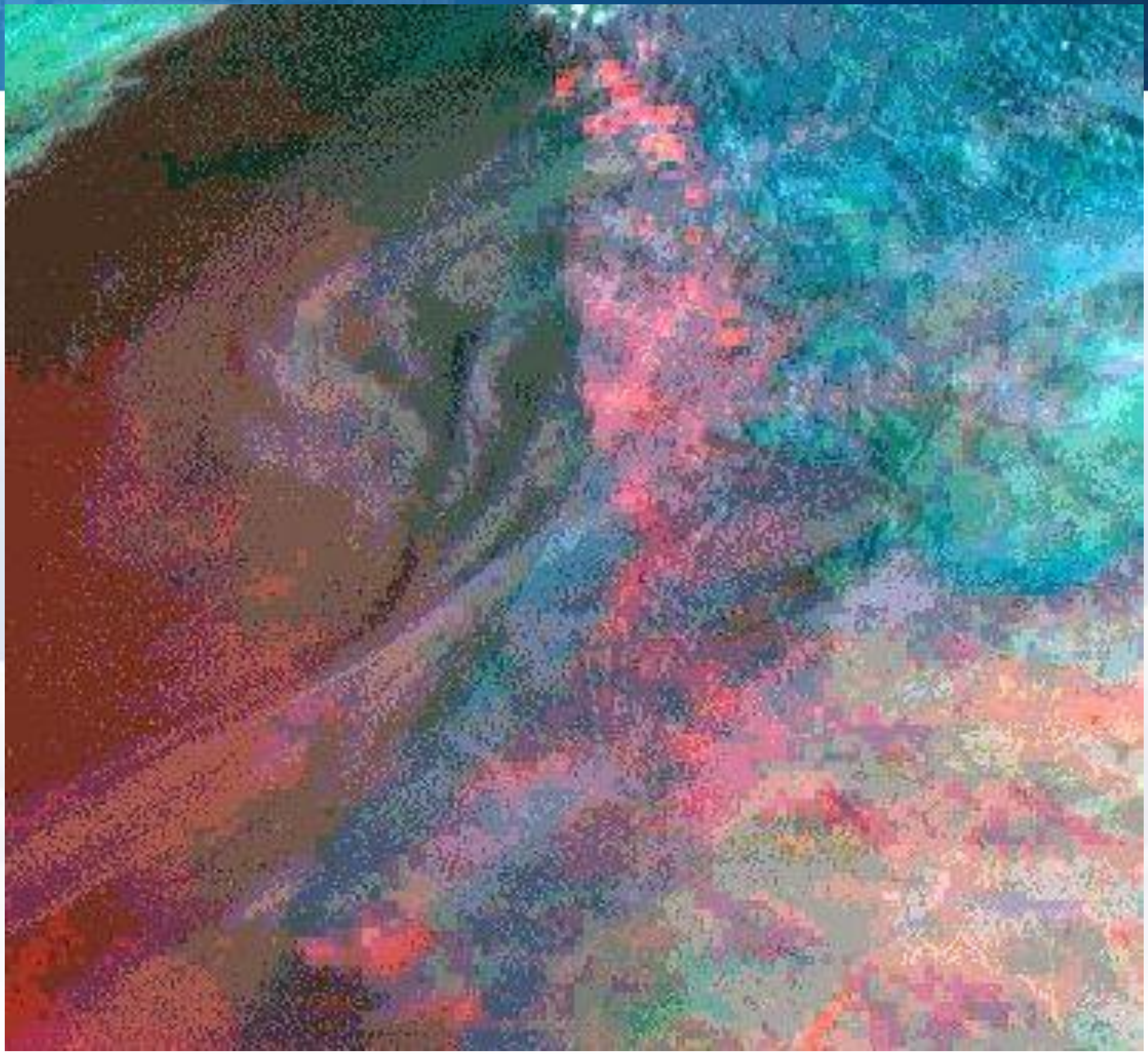
MSG-1, 16 May 2006, 00:00 UTC
RGB composite IR12.0-IR10.8, IR10.8-IR3.9, IR10.8



Forest Fires in Portugal

MSG-1
22 Aug 2005
08:15 UTC
RGB Composite
HRV + IR3.9

Fires Raging in Galicia (Spain)

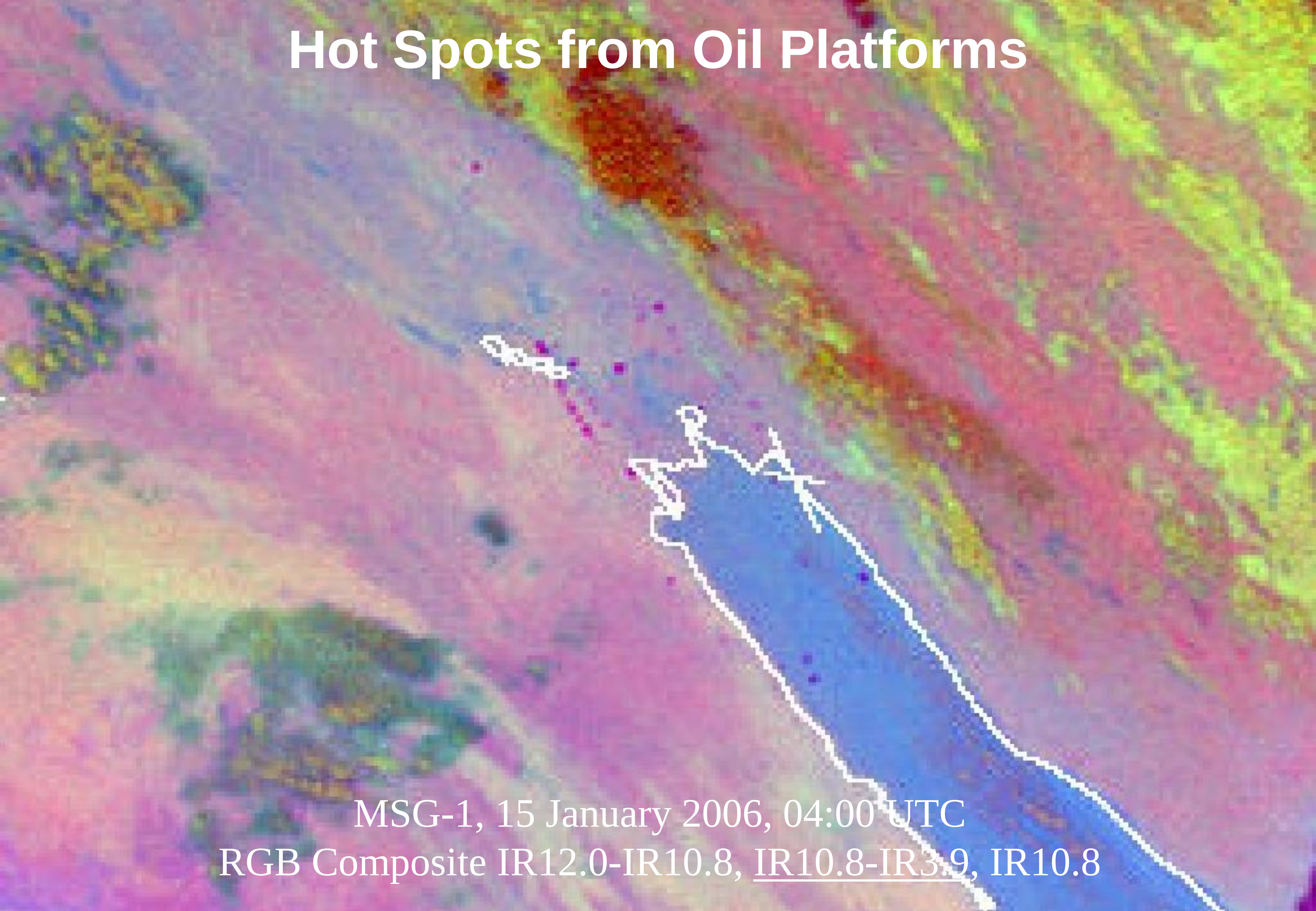


Click to see animation

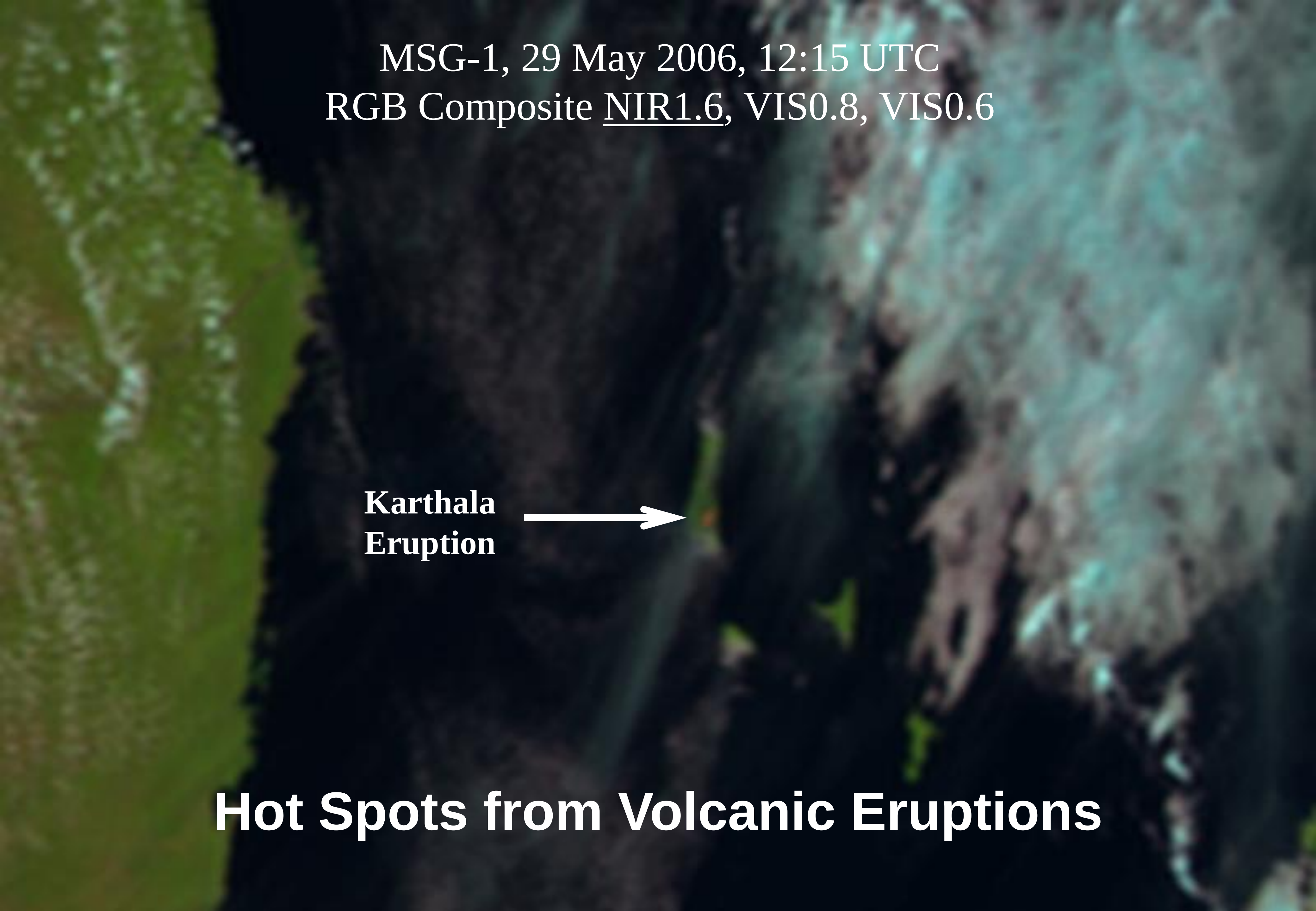
CLICK HERE

MSG-1
7 Aug 2006
RGB Composite
R = HRV+IR3.9
G = HRV+NIR1.6
B = HRV+VIS0.8

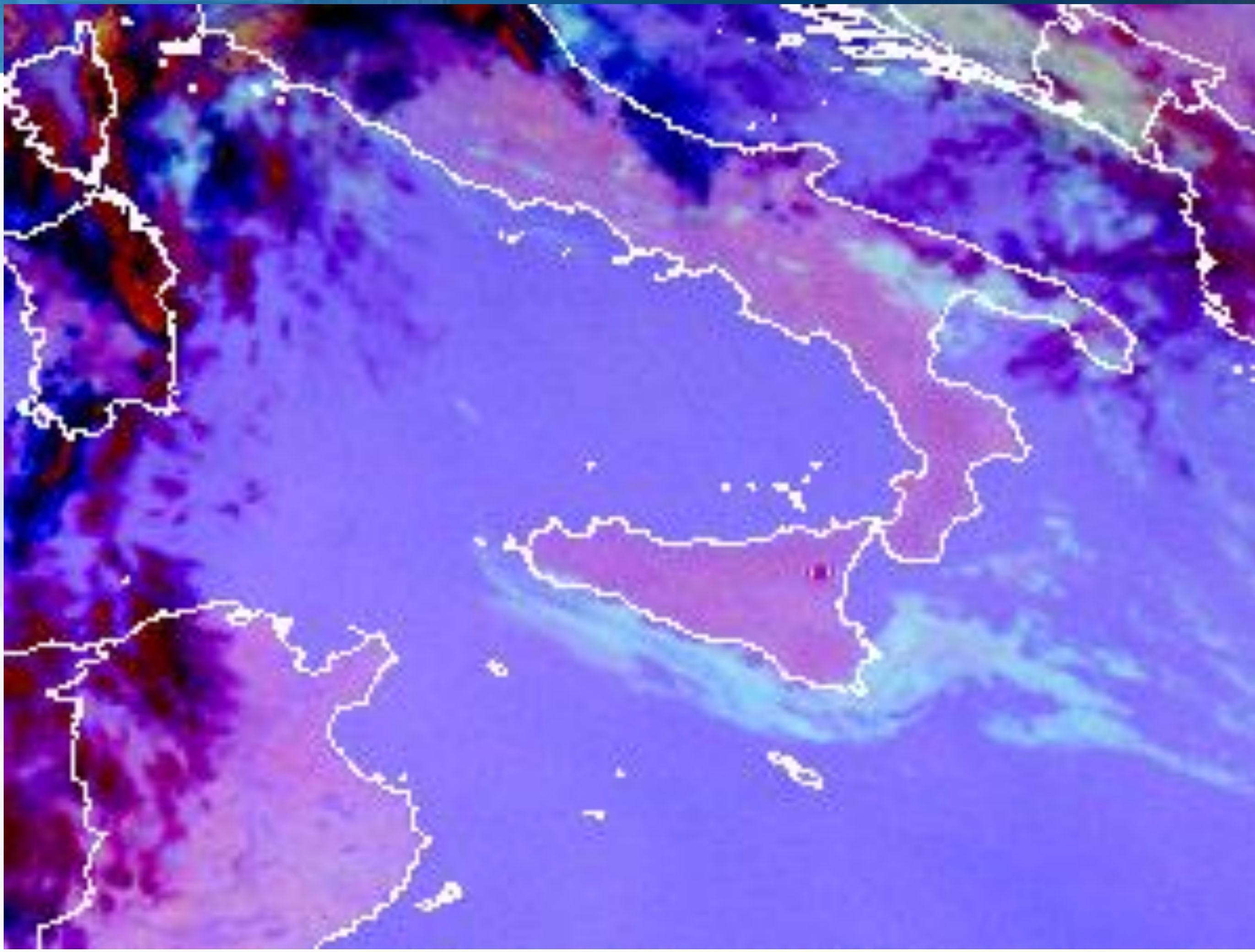
Hot Spots from Oil Platforms



MSG-1, 15 January 2006, 04:00 UTC
RGB Composite IR12.0-IR10.8, IR10.8-IR3.9, IR10.8

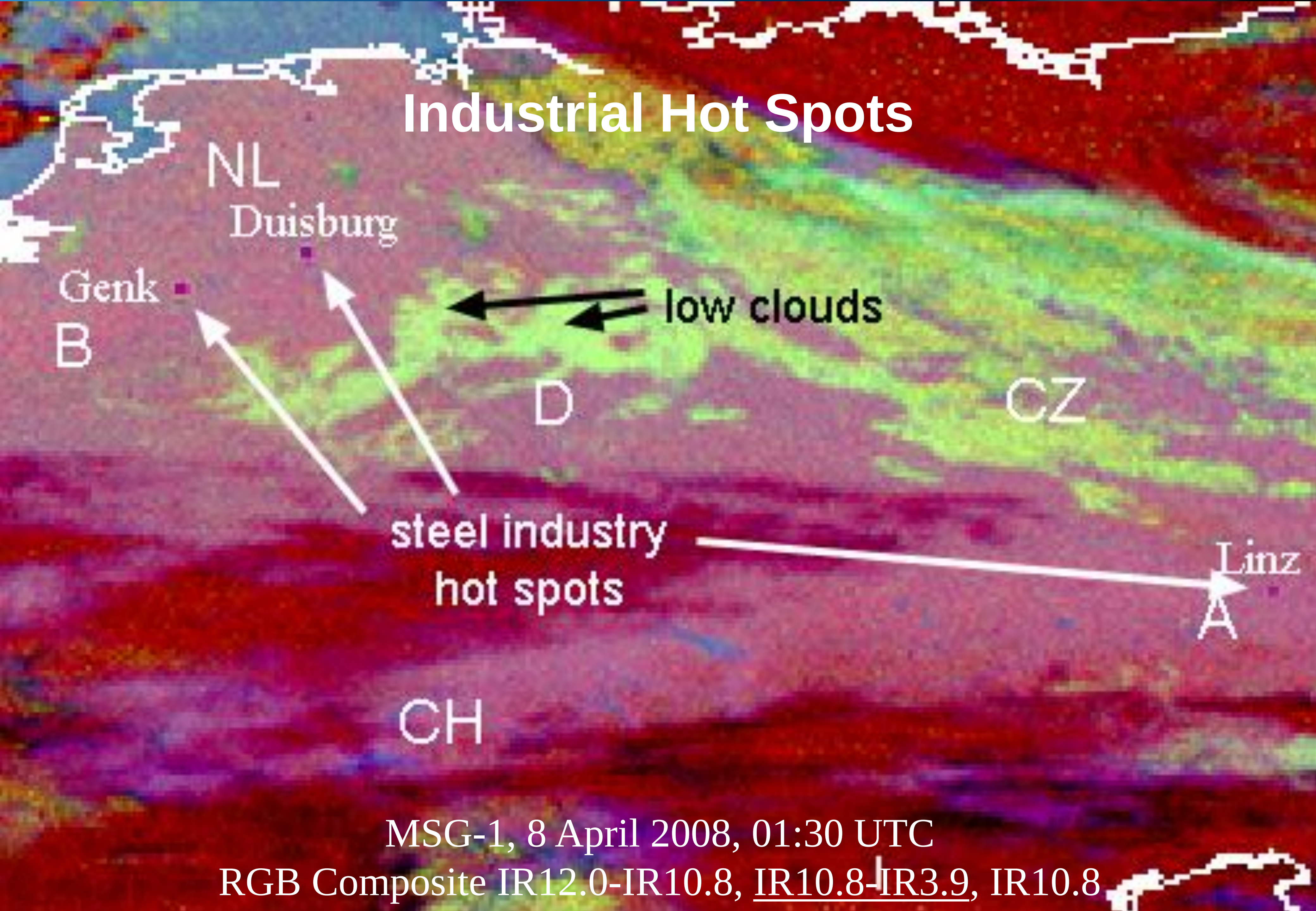

MSG-1, 29 May 2006, 12:15 UTC
RGB Composite NIR1.6, VIS0.8, VIS0.6
Karthala
Eruption
Hot Spots from Volcanic Eruptions

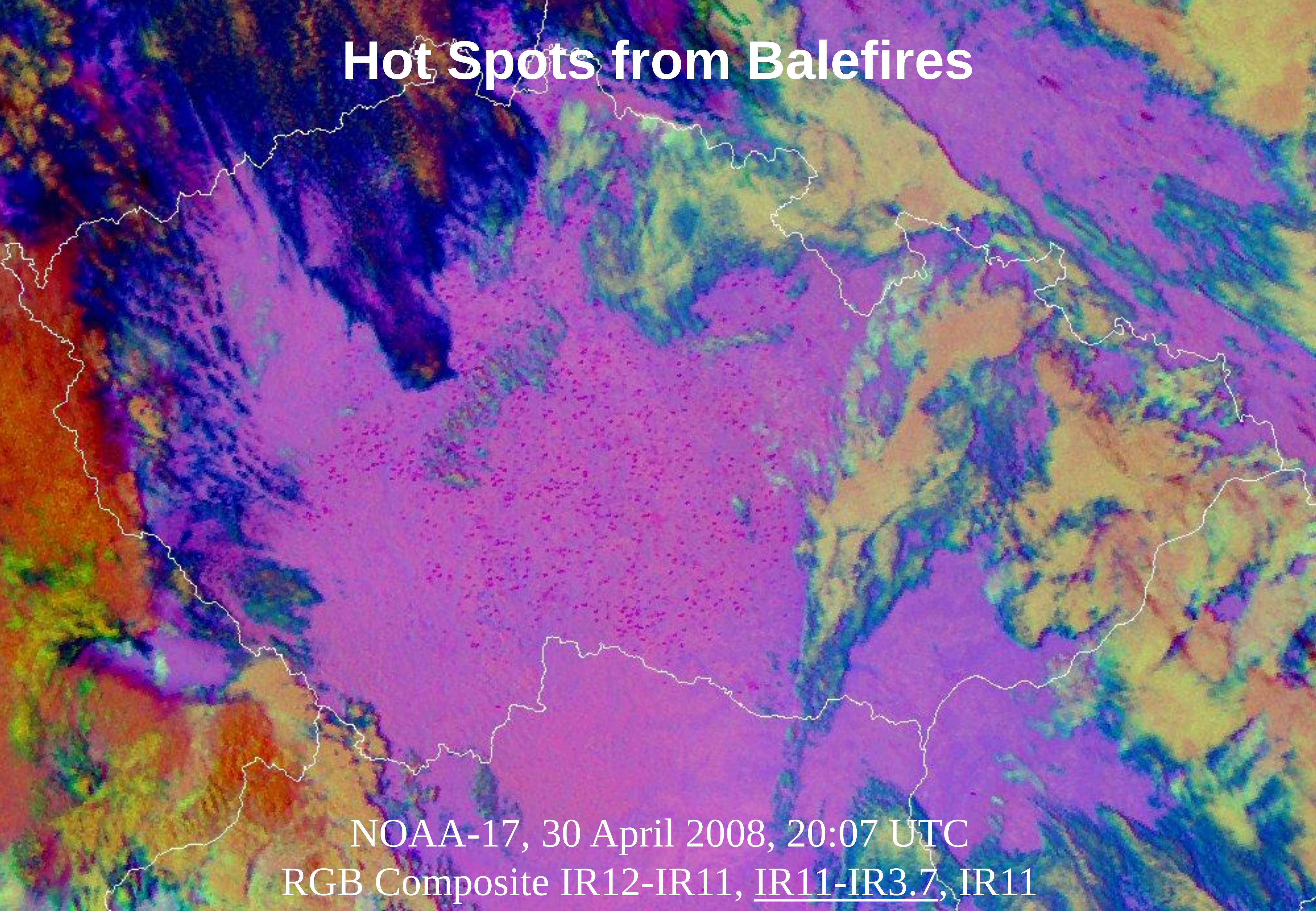
Hot Spot Etna Eruption

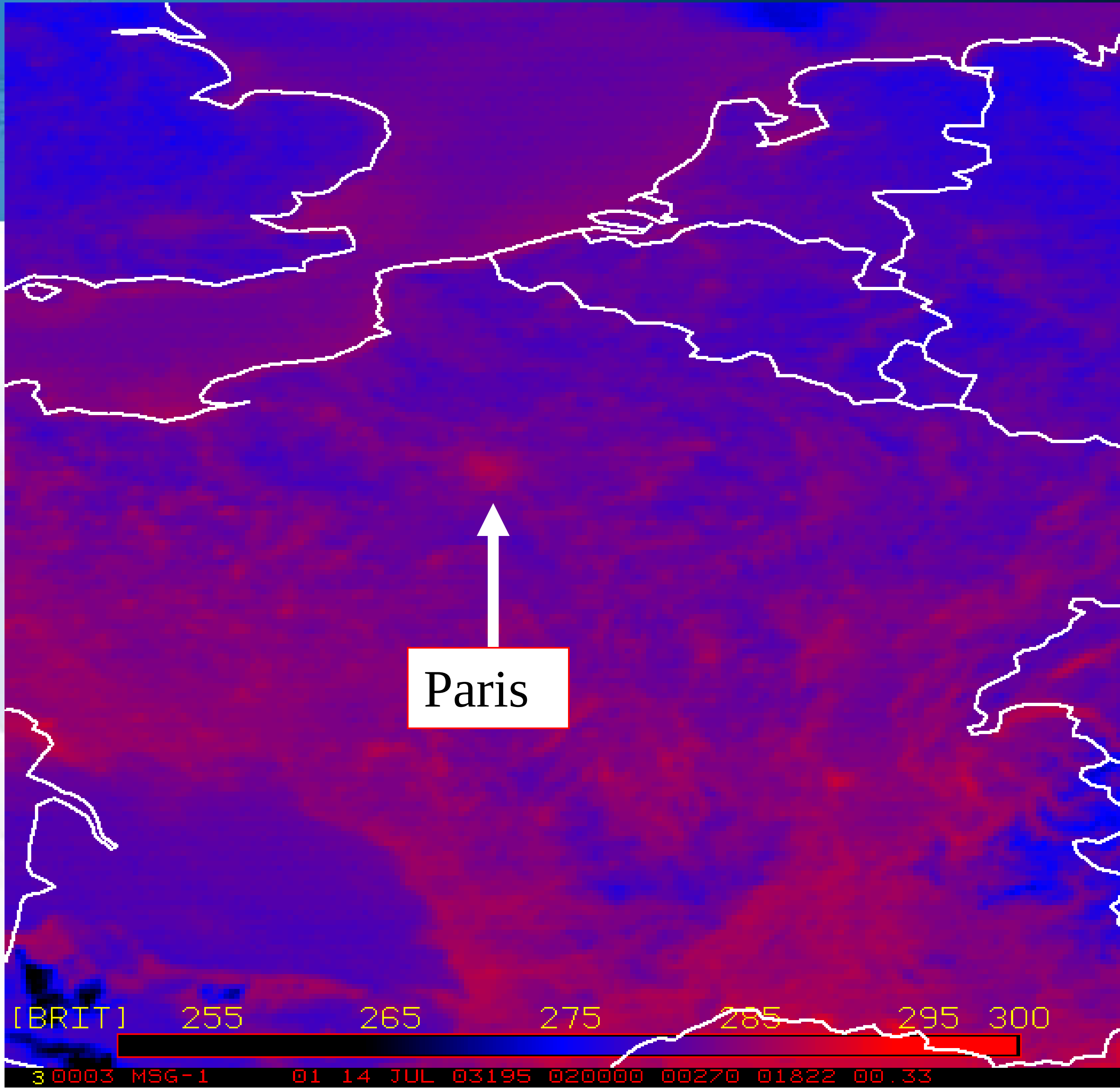


Click to see animation

MSG-1
24 Oct 2006
RGB Composite
R = IR12.0 – IR10.8
G = IR10.8 – IR3.9
B = IR10.8


Industrial Hot Spots
NL
Duisburg
Genk
B
low clouds
D
CZ
steel industry
hot spots
Linz
A
CH
MSG-1, 8 April 2008, 01:30 UTC
RGB Composite IR12.0-IR10.8, IR10.8-IR3.9, IR10.8

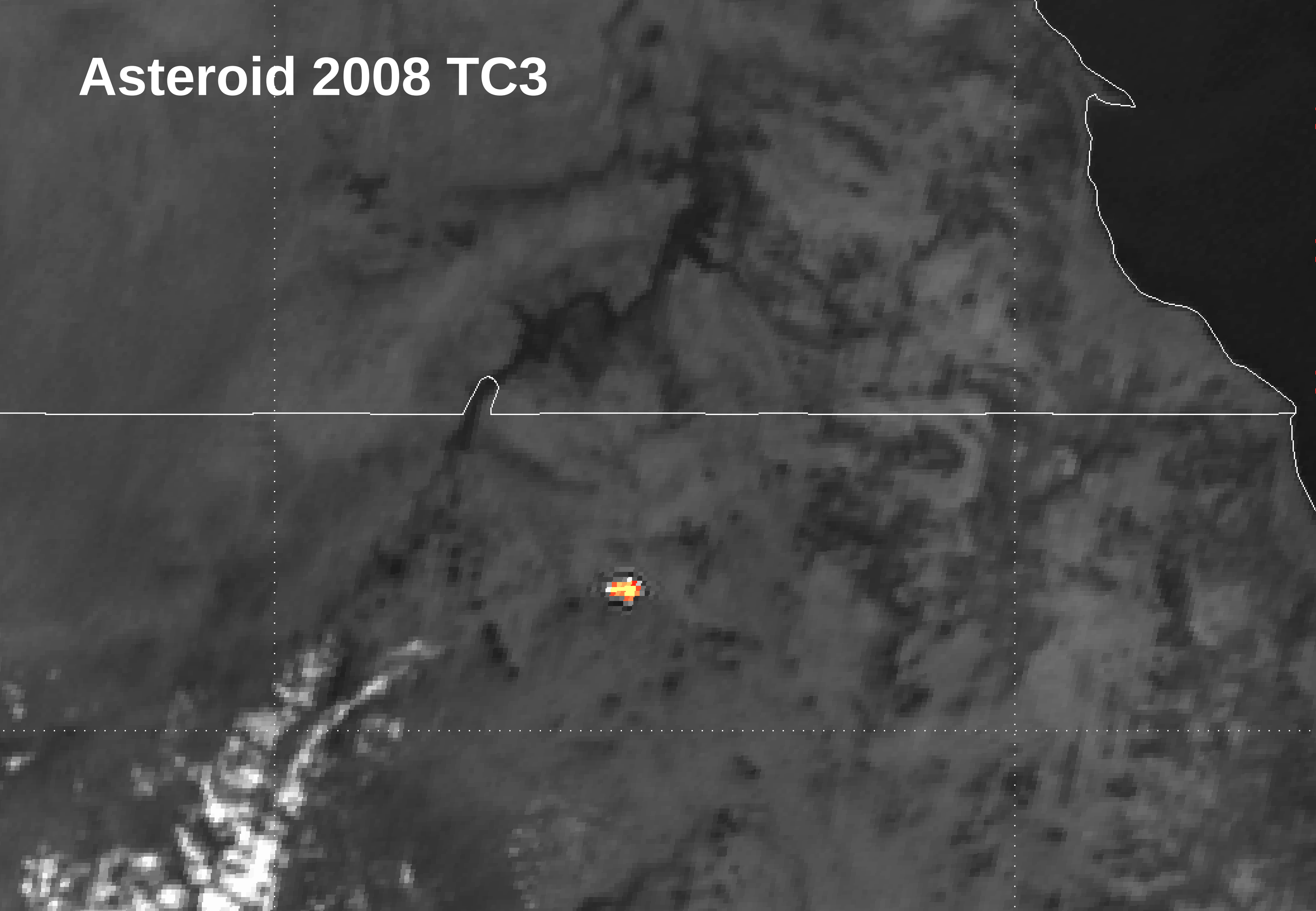

Hot Spots from Balefires
NOAA-17, 30 April 2008, 20:07 UTC
RGB Composite IR12-IR11, IR11-IR3.7, IR11



Urban Heat "Islands"

MSG-1
14 July 2003
02:00 UTC
BT Channel 04 (3.9 µm)

Paris: 287 K
Surrounding: 281 K


Asteroid 2008 TC3

Summary: Fires / Hot Spots

Fire pixel detection should consider:

- Spectral signals (VIS0.6, IR3.9, IR10.8, IR3.9-IR10.8)
- Hot Fires also detectable in NIR1.6
- Fire pixels with large fire fraction also detectable in IR8.7, IR10.8

- Spatial signals (background characterisation, spatial filtering)

- Temporal signals (temporal filtering)

- Importance of cloud mask (additional HRV cloud mask)
- Elimination of sun glint areas
- Saturation of IR3.9 channel (at 336.2 K)
- Artefacts from digital filter

Thank You

And finally, have a look at the EUMeTrain web site

http://www.eumetrain.org/resources/forest_fires.html

This is a very detailed and excellent CAL module !