Dust and smoke discrimination with MSG RGB products

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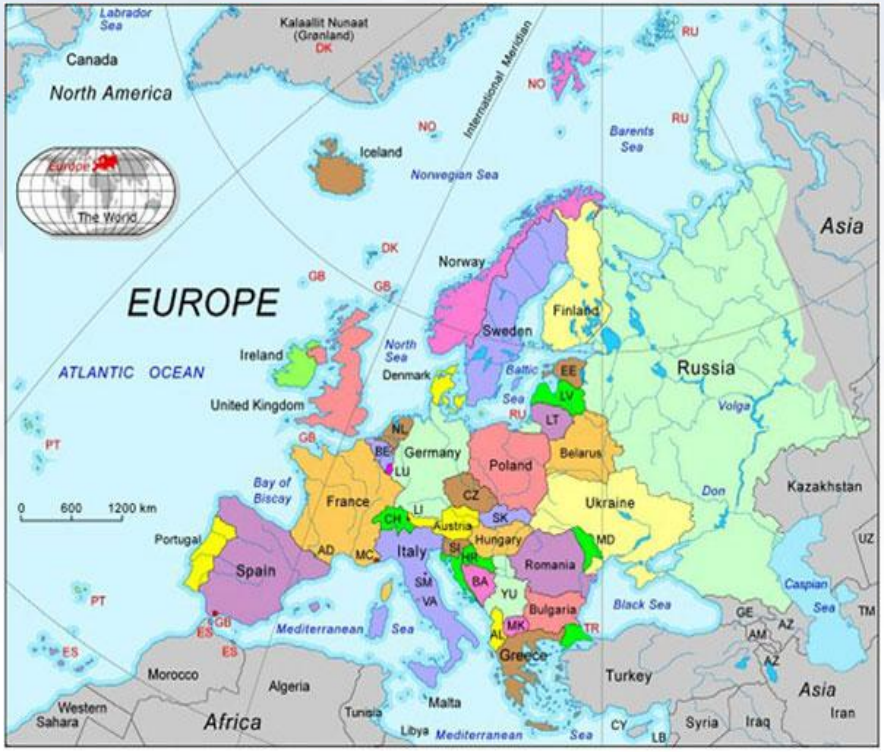
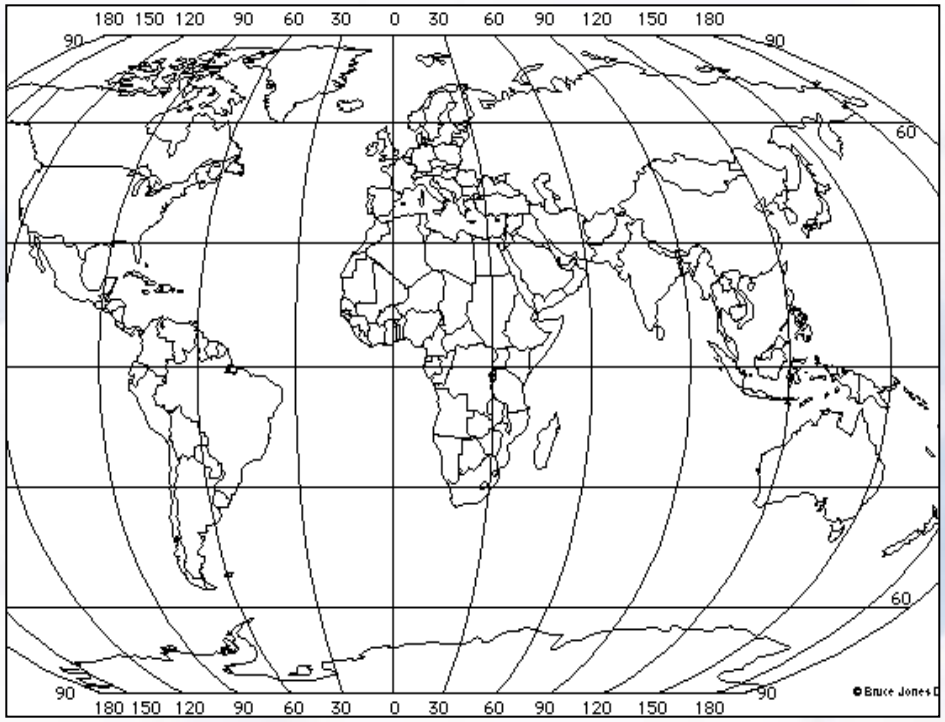
Where are you ?





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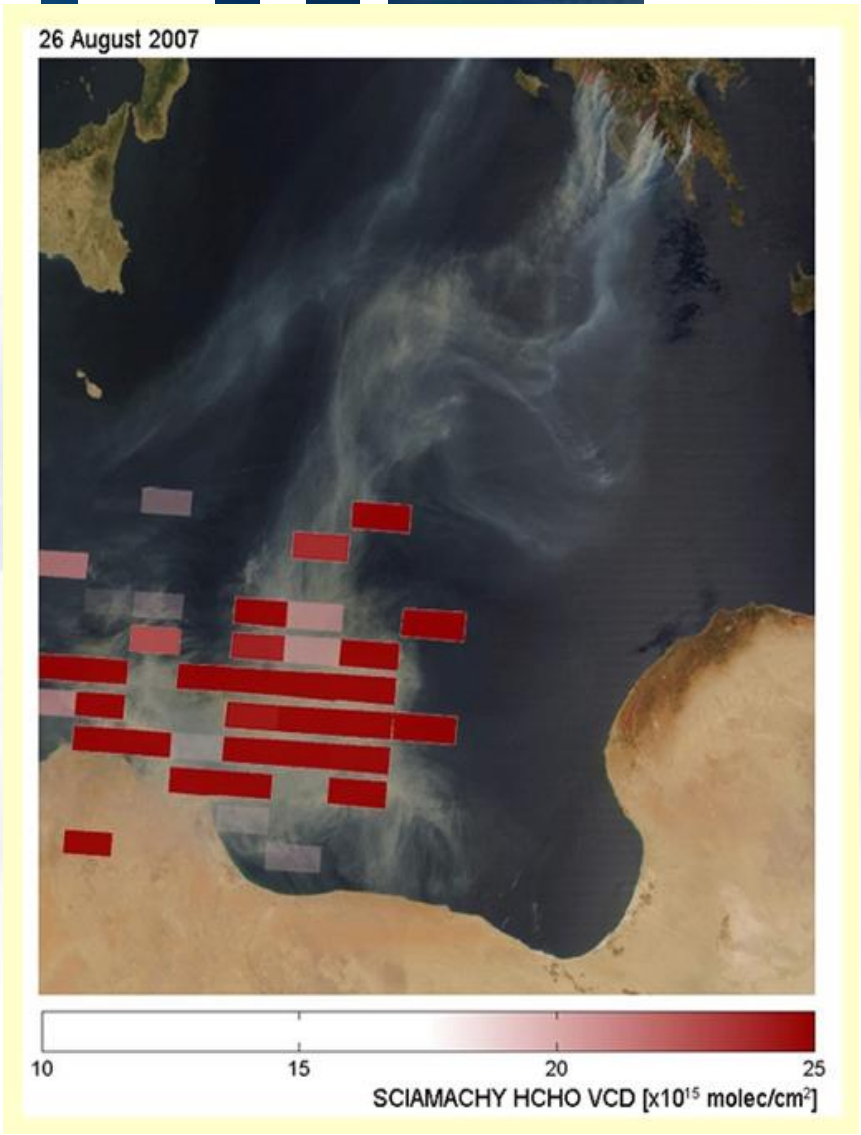
Motivation & Background

Neighbouring impacts of Smoke

Formaldehyde concentration from SCIAMACHY:

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



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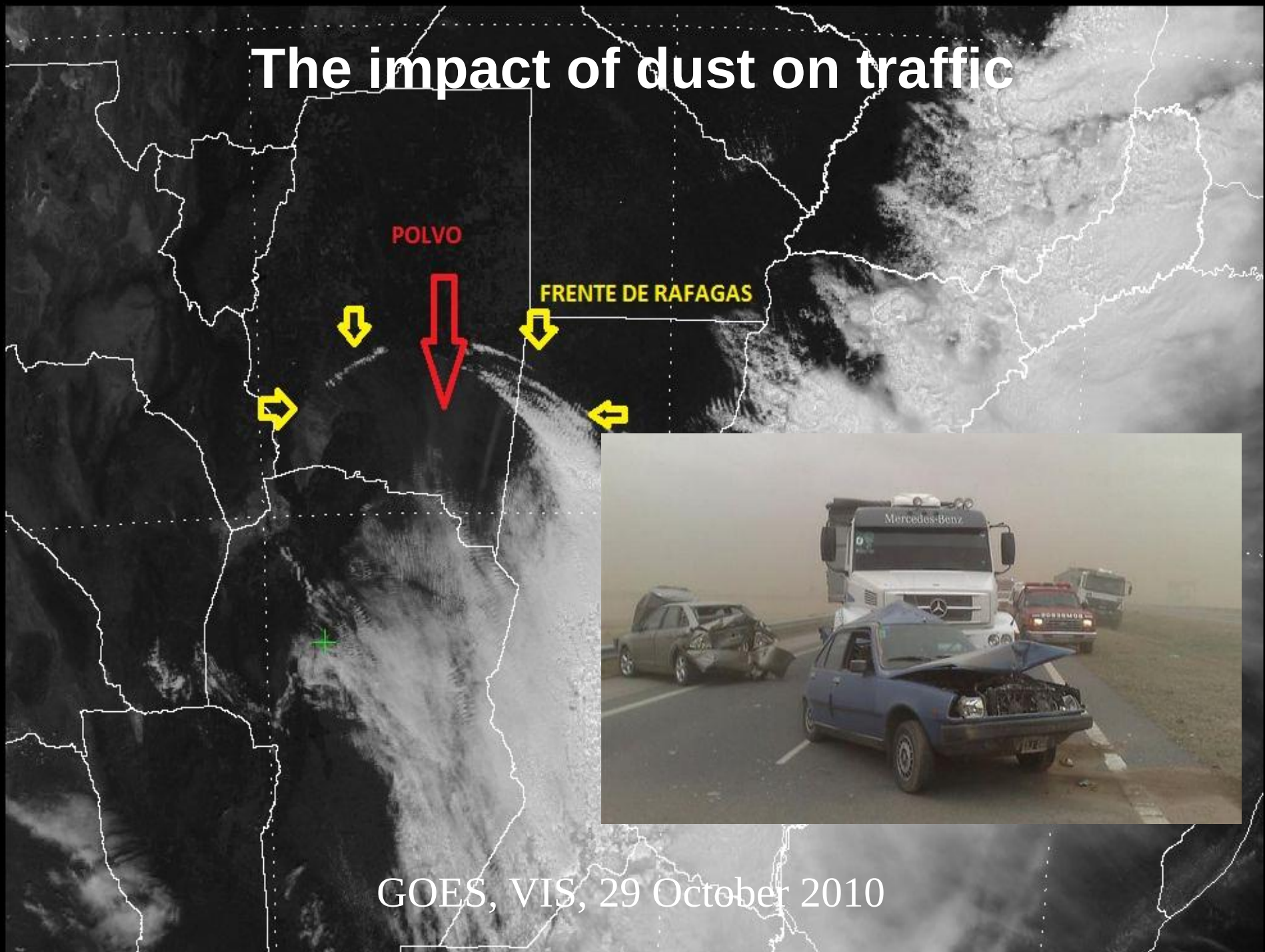
The impact of dust on health

Terra, MODIS, Dust RGB, 11 November 2010

The impact of dust on traffic



GOES, VIS, 29 October 2010

The impact of dust on (air)traffic

Dust squall hits Riyadh, Saudi Arabia, on 10 March 2009

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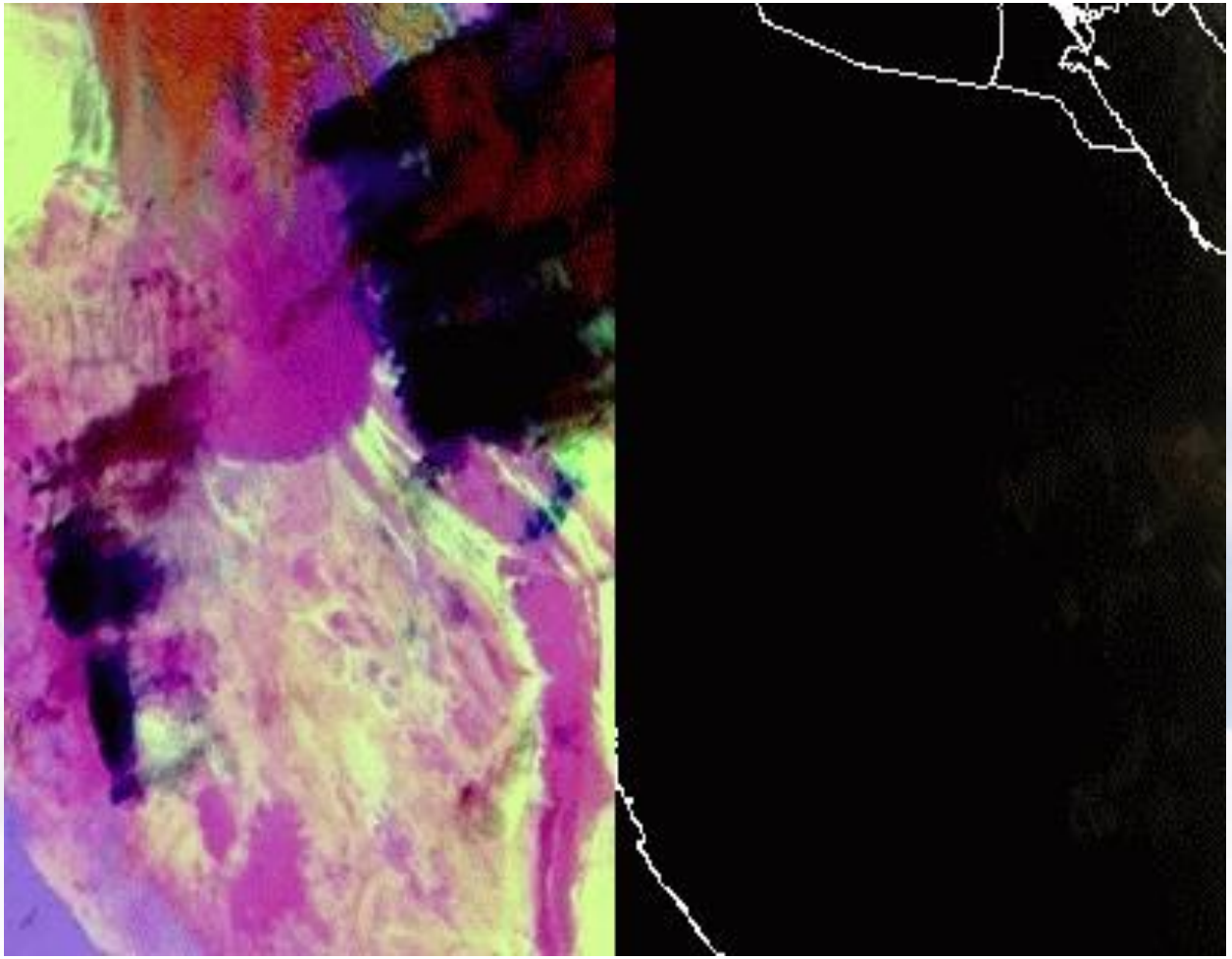
The impact of dust on (air)traffic



Met-8, 5-min rapid scans, 10 March 2009

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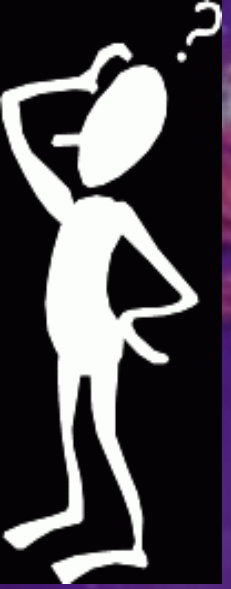

The impact of smoke and dust on clouds & precipitation

4 August 2010, 12:00 UTC

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

3 Window Channels in VIS/NIR
3 Window Channels in IR

Window	Band (um)	Airmass	Band (um)
VIS 0.6	0.56 - 0.71	WV 6.2	5.35 - 7.15
VIS 0.8	0.74 - 0.88	WV 7.3	6.85 - 7.85
NIR 1.6	1.50 - 1.78	IR 9.7	9.38 - 9.94
MIR 3.9	3.40 - 4.20	IR 13.4	12.40 - 14.40
IR 8.7	8.30 - 9.10		
IR 10.8	9.80 - 11.80	High Res VIS	
IR 12.0	11.00 - 13.00	HRV	0.4 - 1.1

Smoke & Dust
Solar Channels

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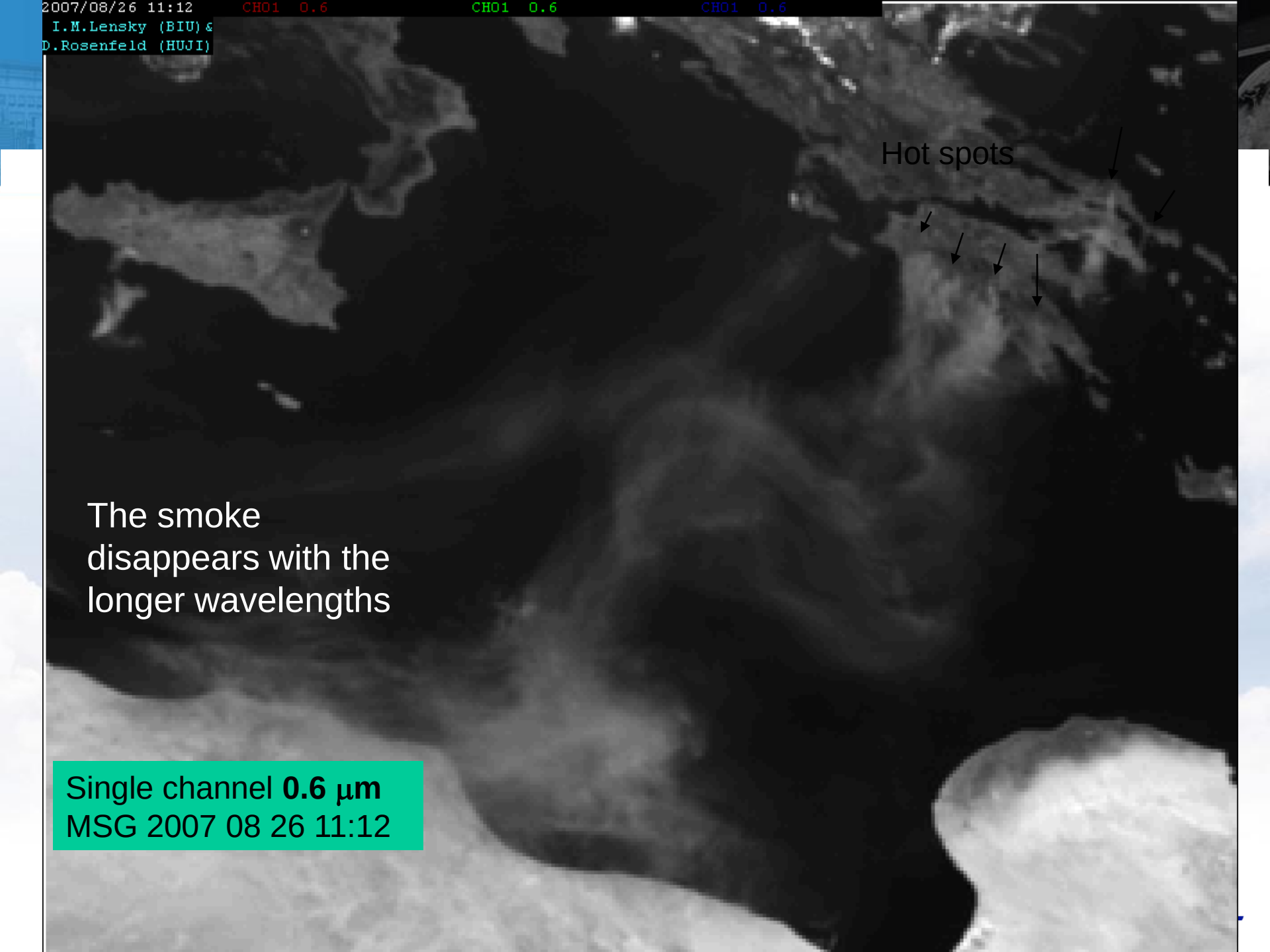
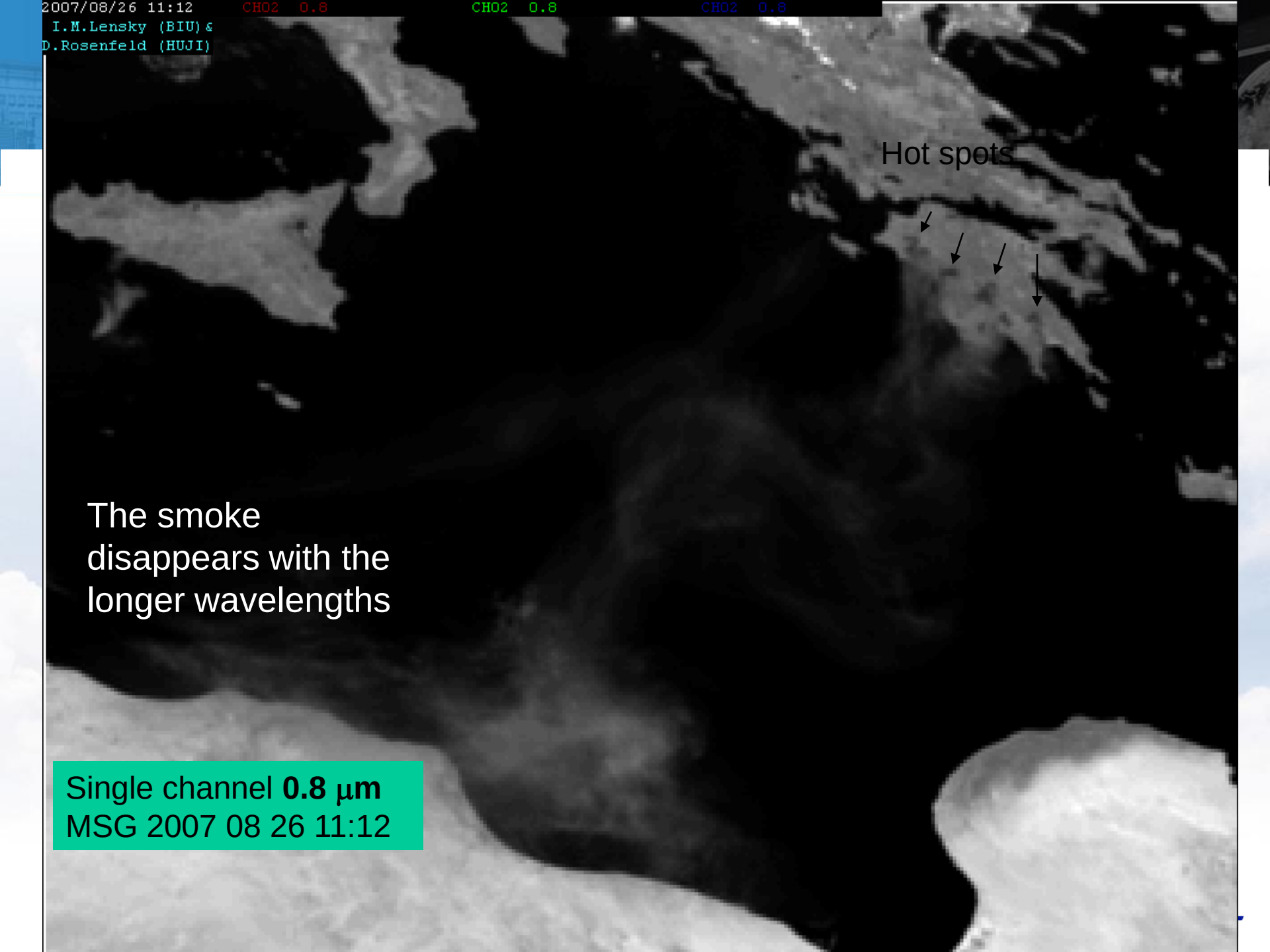
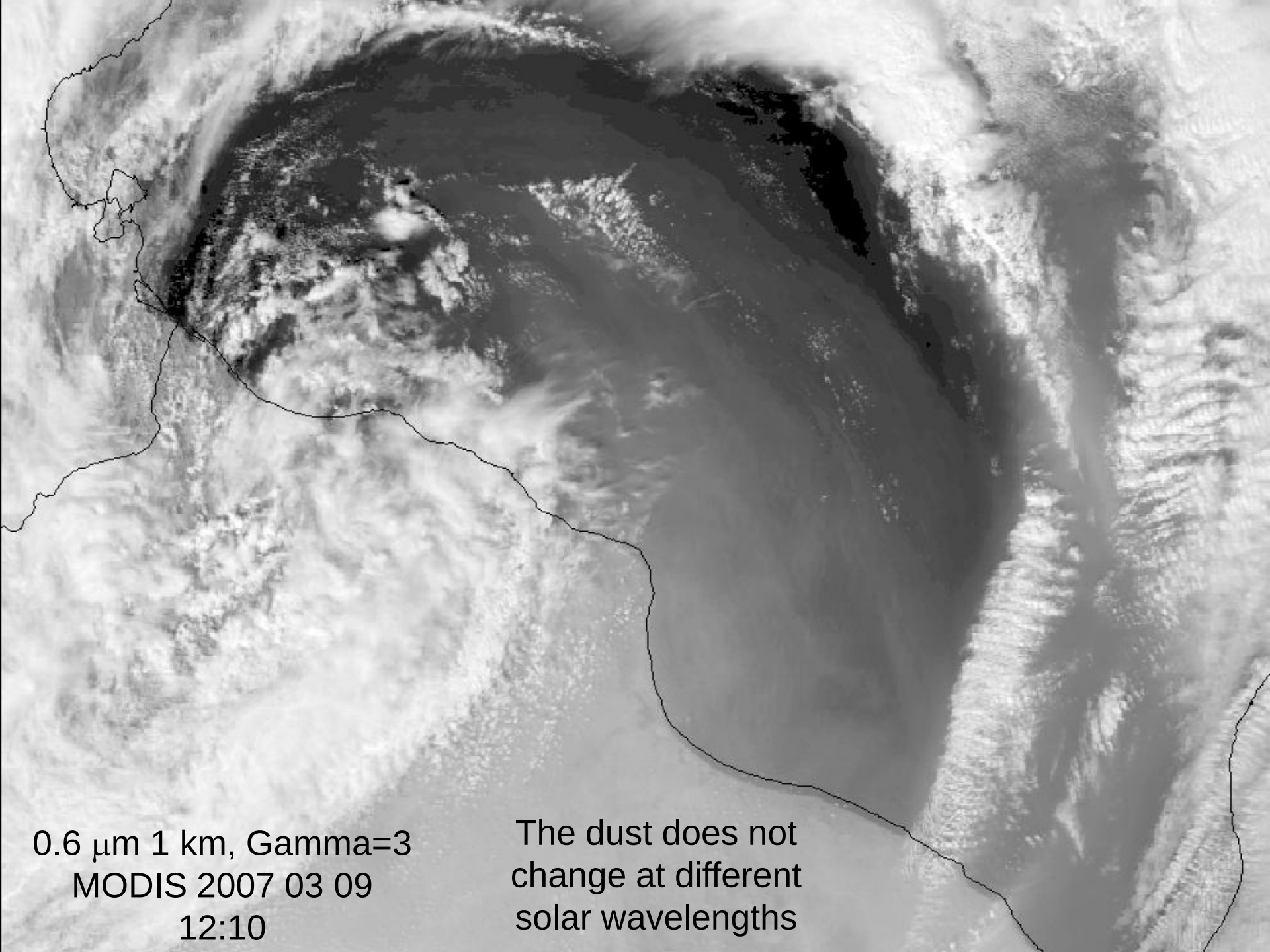

2007/08/26 11:12
CH01 0.6
CH01 0.6
CH01 0.6
I.M.Lensky (BIU) &
D.Rosenfeld (HUJI)
Hot spots
The smoke
disappears with the
longer wavelengths
Single channel **0.6 μm**
MSG 2007 08 26 11:12

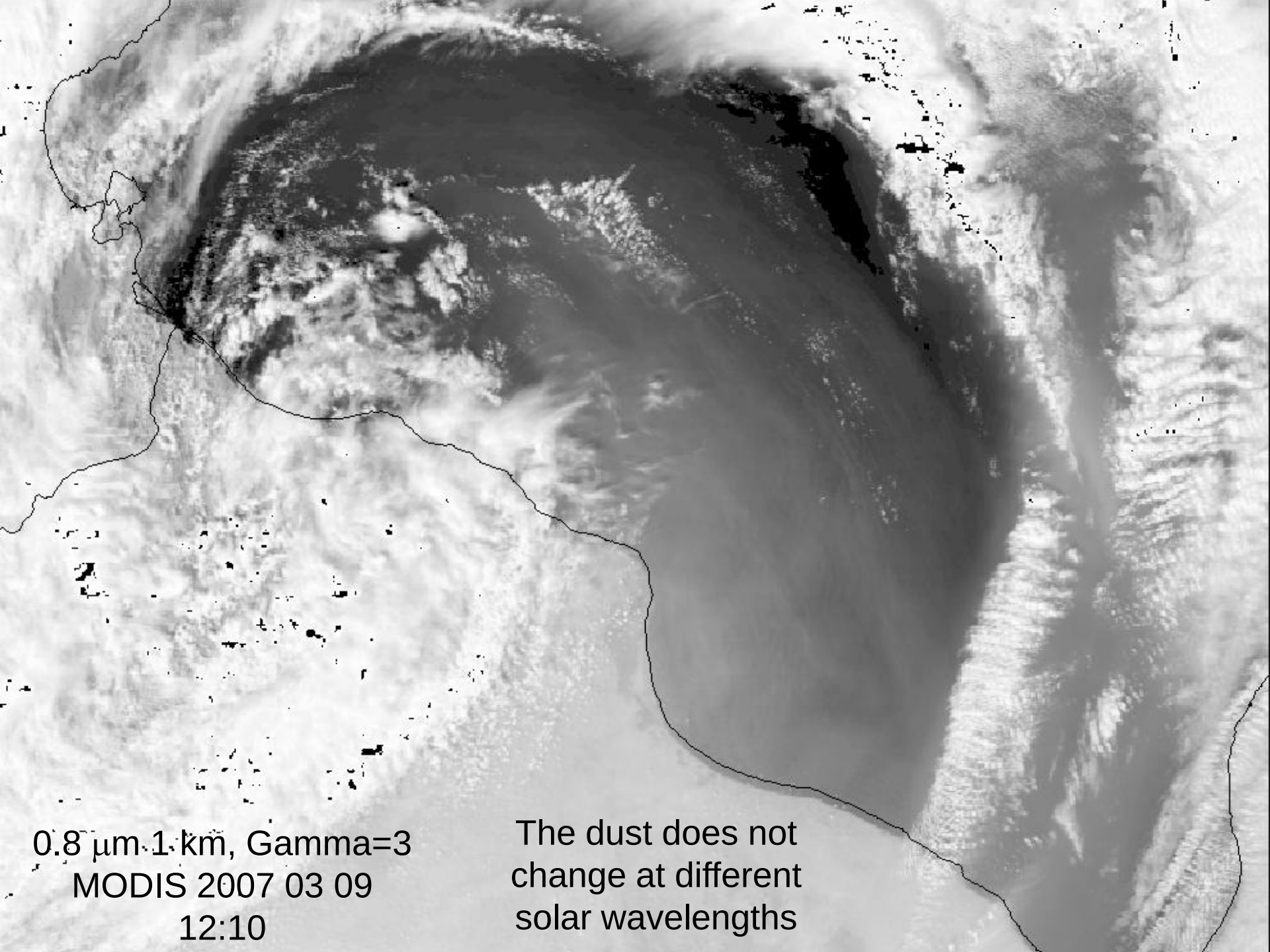

2007/08/26 11:12
CH02 0.8
CH02 0.8
CH02 0.8
I.M.Lensky (BIU) &
D.Rosenfeld (HUJI)
Hot spots
The smoke disappears with the longer wavelengths
Single channel **0.8 μm**
MSG 2007 08 26 11:12


2007/08/26 11:12
CHO3 1.6
CHO3 1.6
CHO3 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



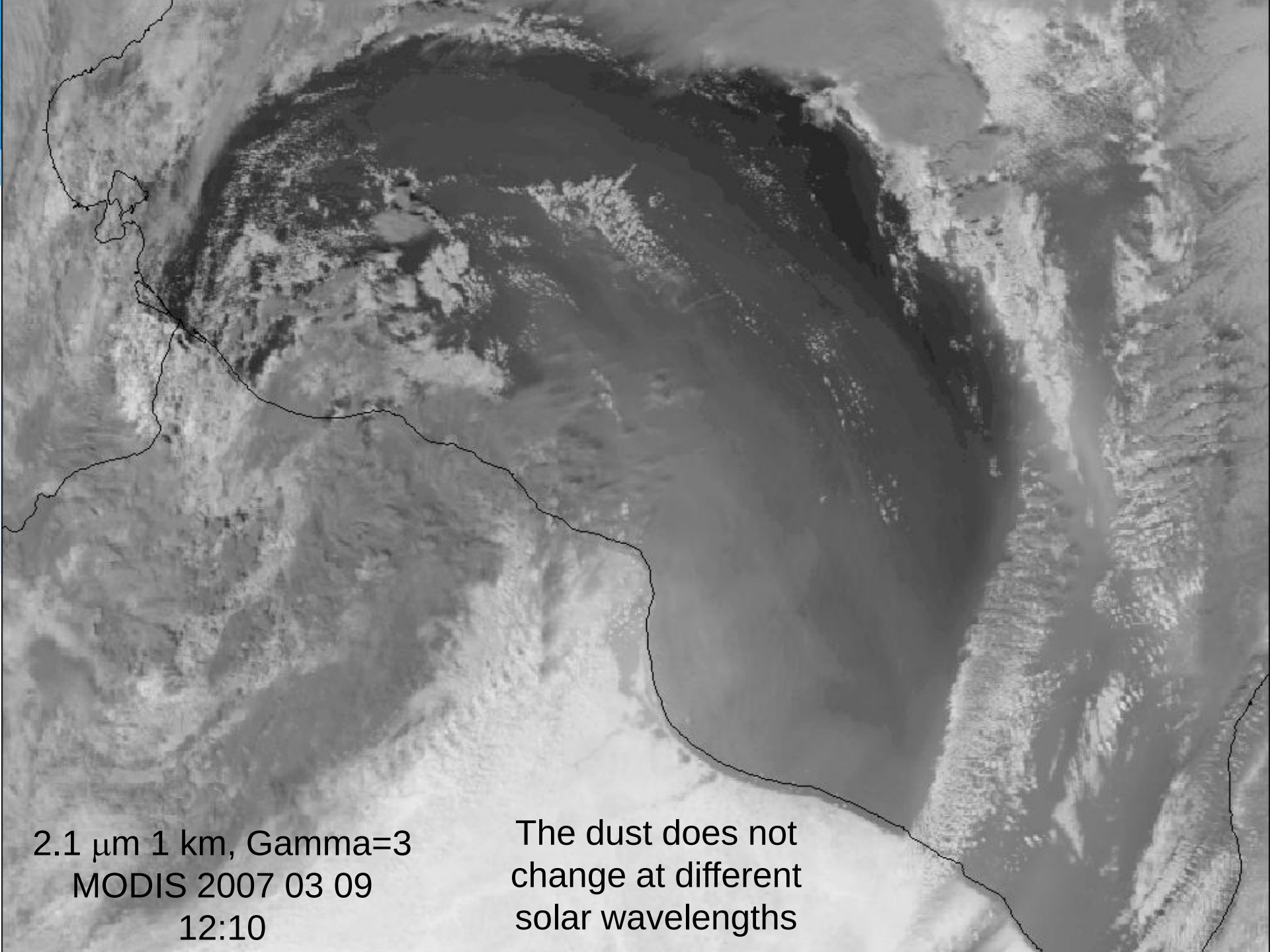
0.6 μm 1 km, Gamma=3
MODIS 2007 03 09
12:10

The dust does not change at different solar wavelengths



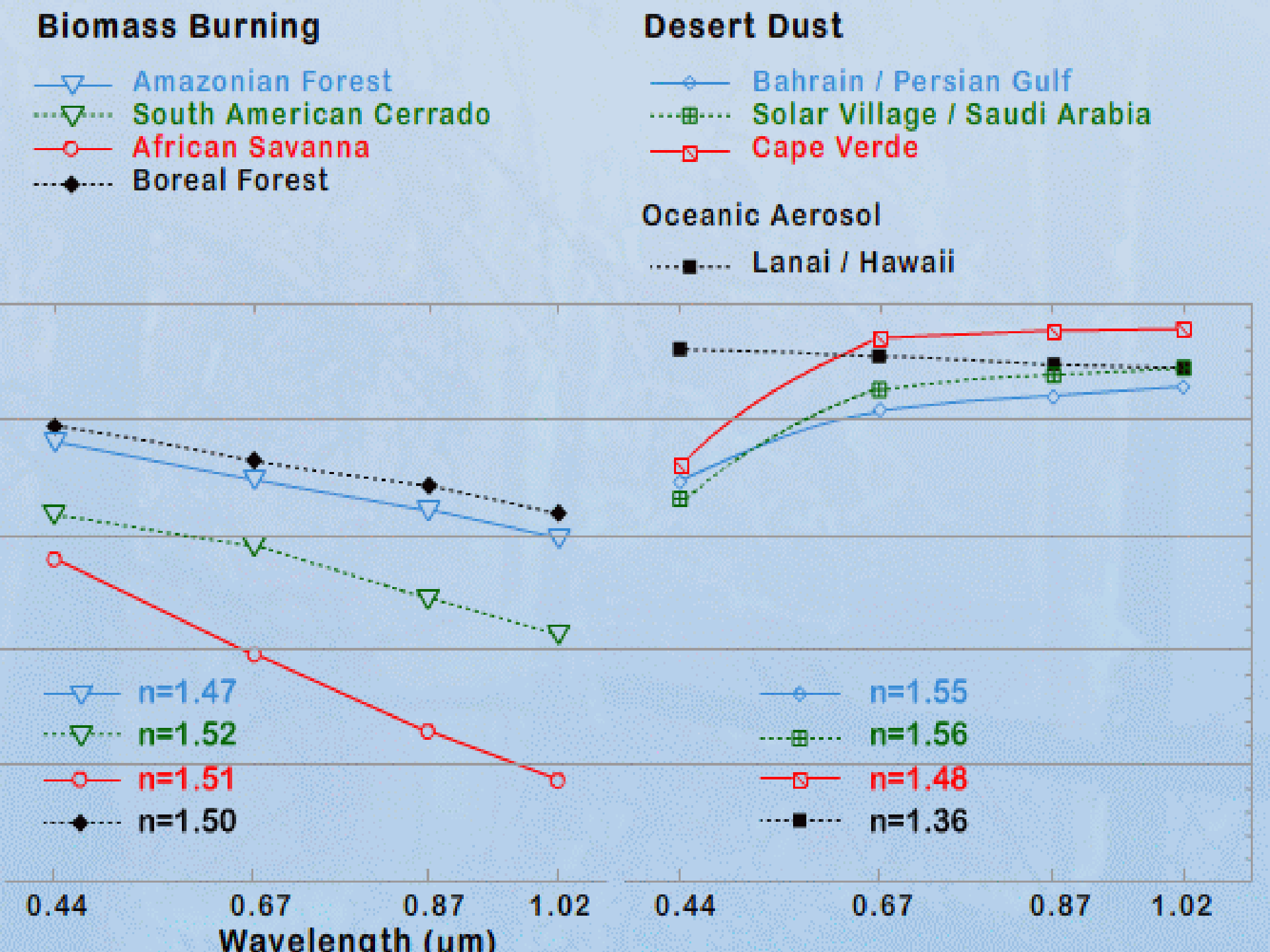
0.8 μm 1 km, Gamma=3
MODIS 2007 03 09
12:10

The dust does not change at different solar wavelengths

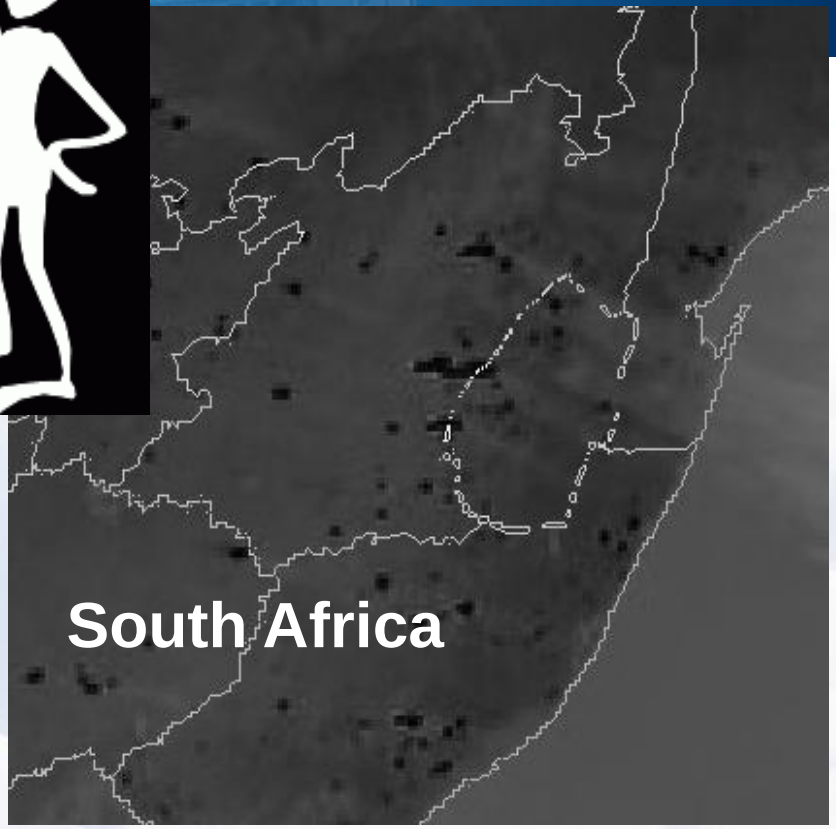


2.1 μm 1 km, Gamma=3
MODIS 2007 03 09
12:10

The dust does not change at different solar wavelengths


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 (um)

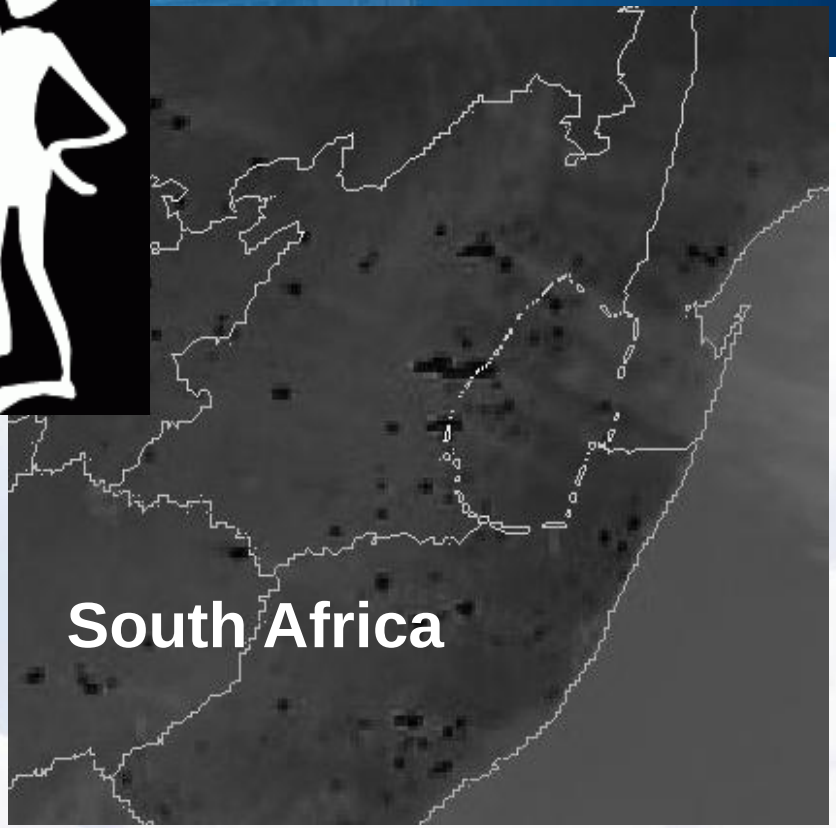
Natural Colours RGB: smoke colour ?



Fire detection using ch. IR3.9

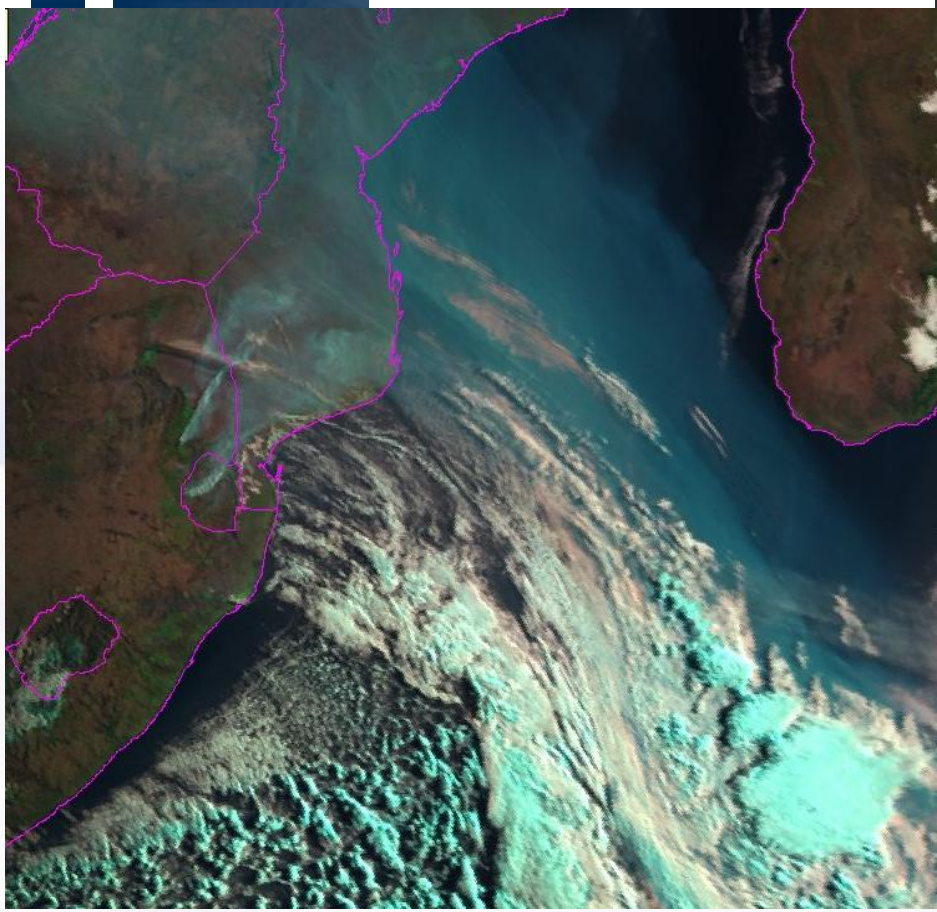
Met-9 imagery on
31 Aug / 1 Sep 2008

Natural Colours RGB: smoke colour ?



Fire detection using ch. IR3.9

Met-9 imagery on
31 Aug / 1 Sep 2008



Visible imagery showing smoke

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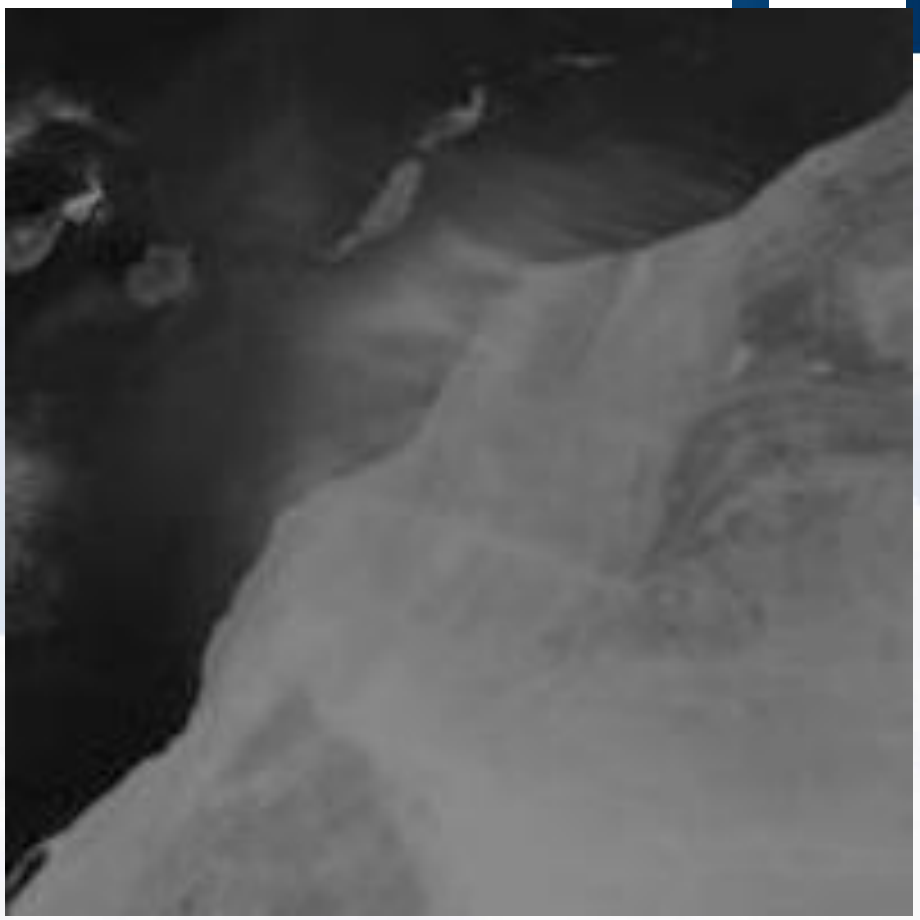
Natural Colours RGB: dust colour ?



Channel 01 (0.6 μm)

3 March 2004 at 12:00 UTC
dust cloud over the Canary Islands

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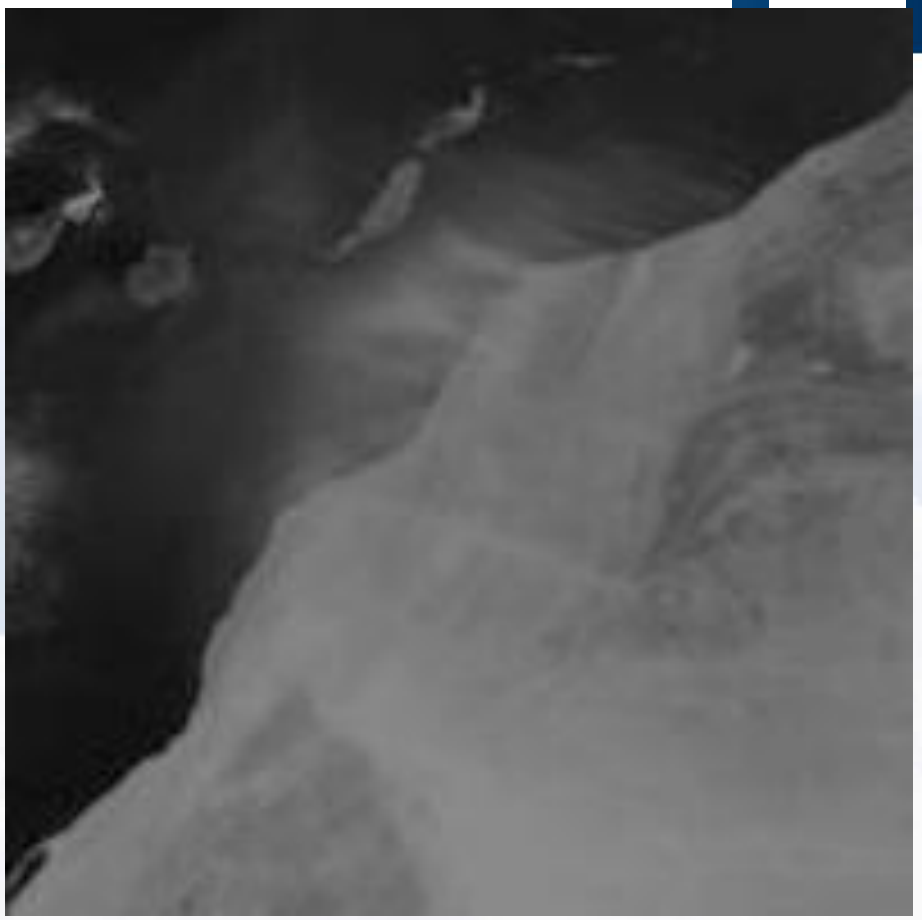
Natural Colours RGB: dust colour ?



Channel 01 (0.6 μm)

RGB Natural Colours

3 March 2004 at 12:00 UTC
dust cloud over the Canary Islands

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Natural Colours RGB: smoke & dust

Metop-A, AVHRR, 22 October 2007 at 18:16 UTC

Catastrophic fires California

Smoke & Dust
IR Channels

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Seeing Through Forest Fire Smoke and Fire Fighting
with Short Wave Infrared (SWIR) Cameras

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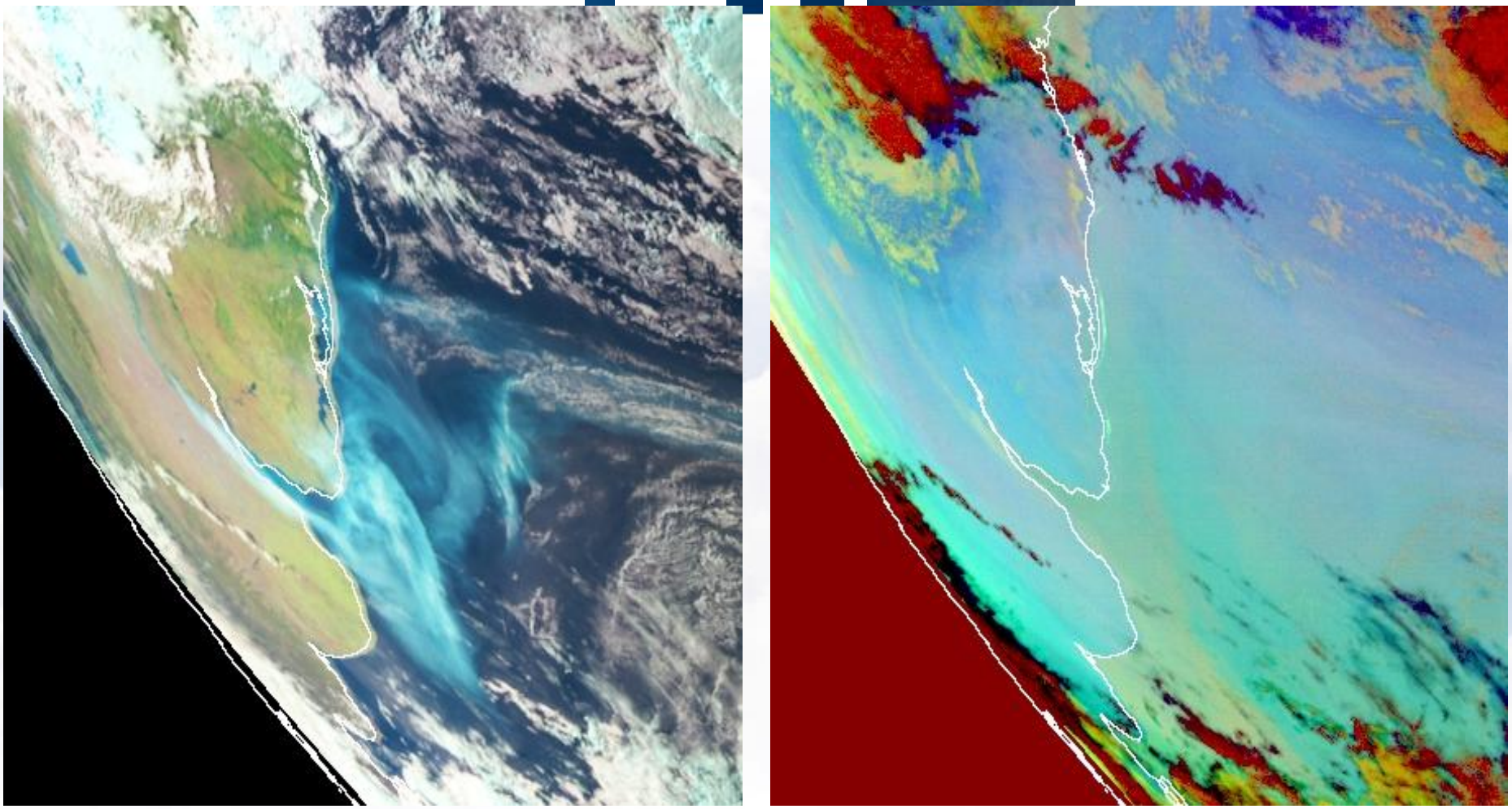
Dense Smoke over Argentina and Uruguay



Met-9, 18 April 2008, 19:15 UTC

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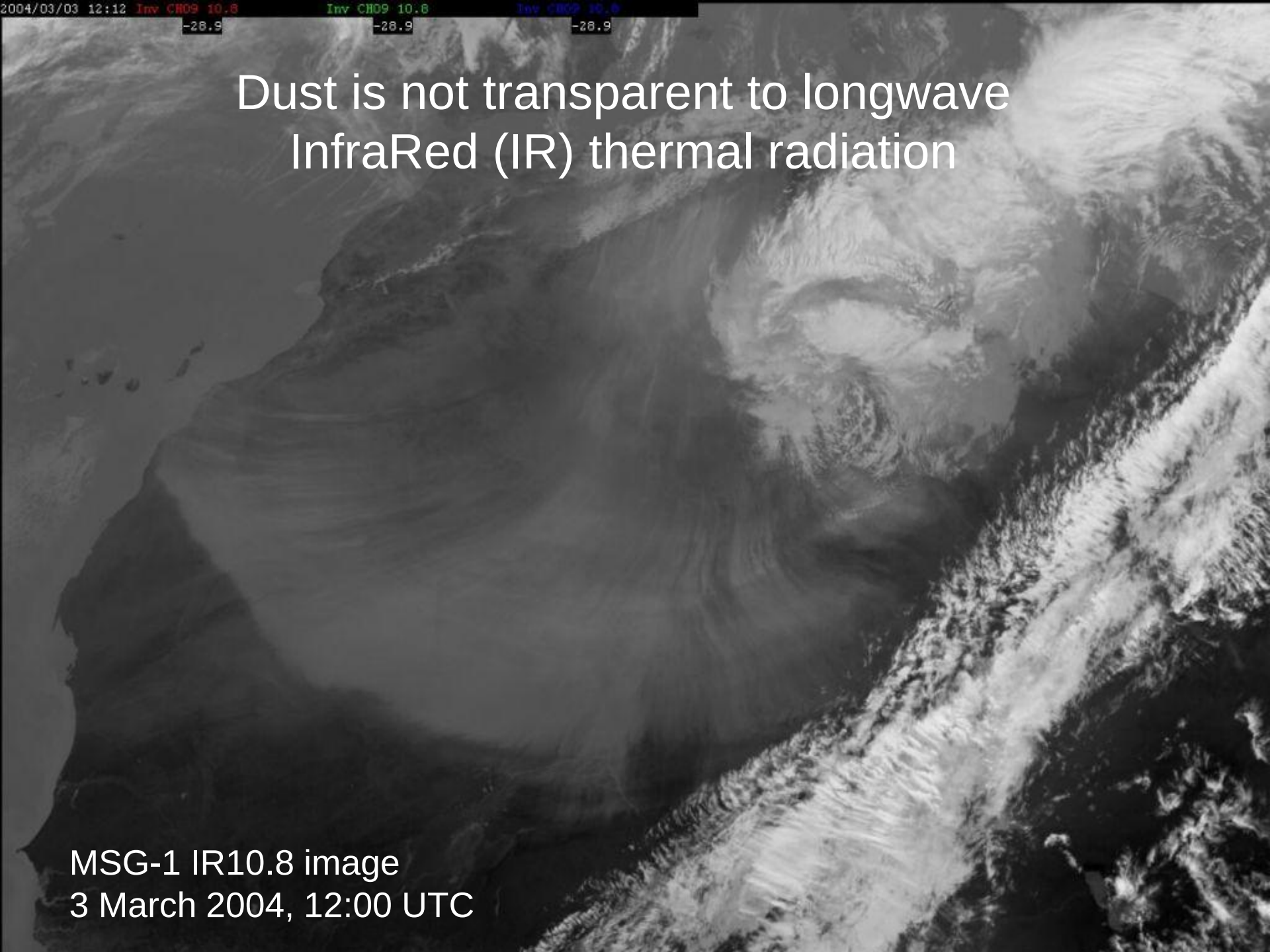
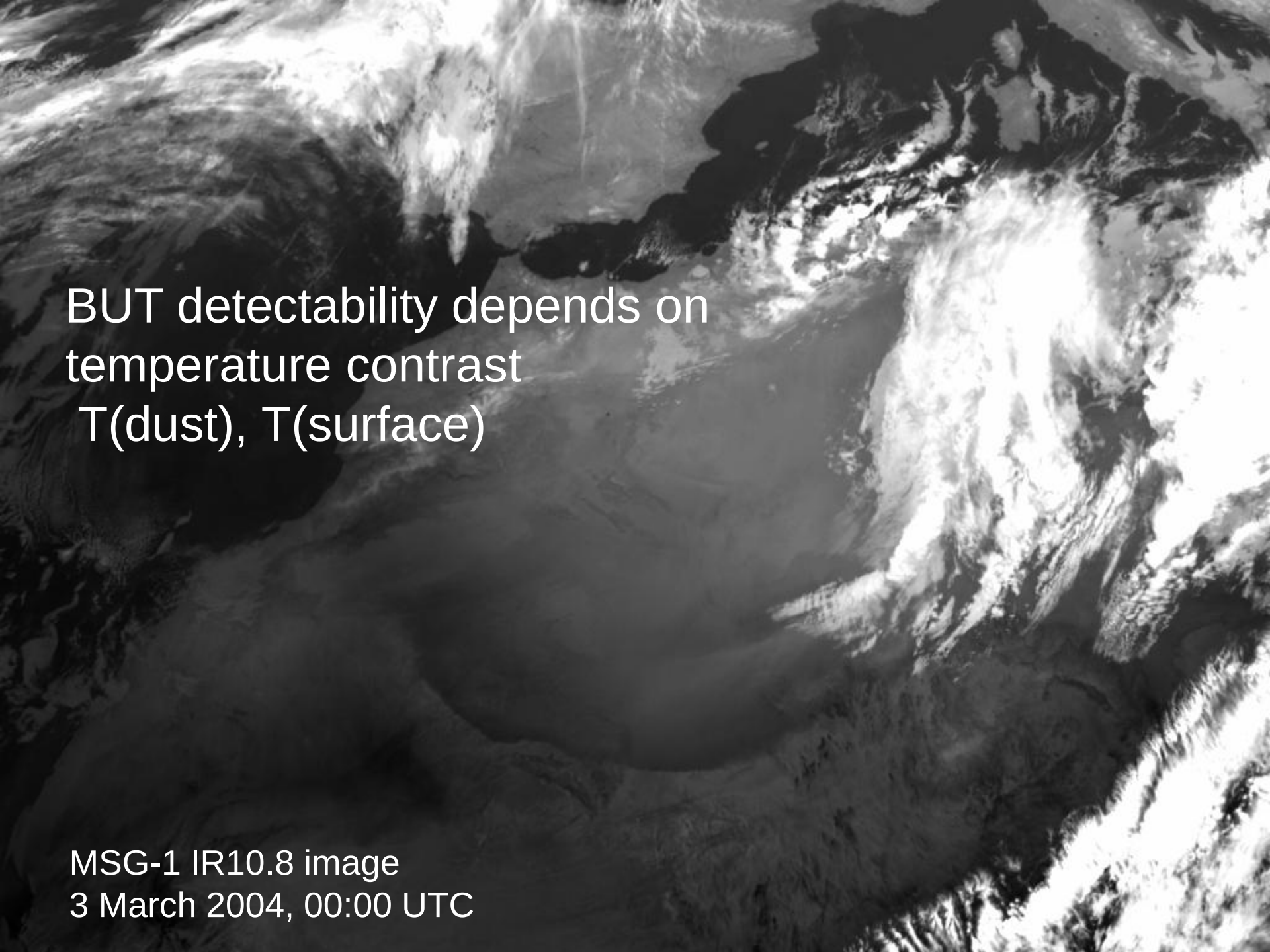
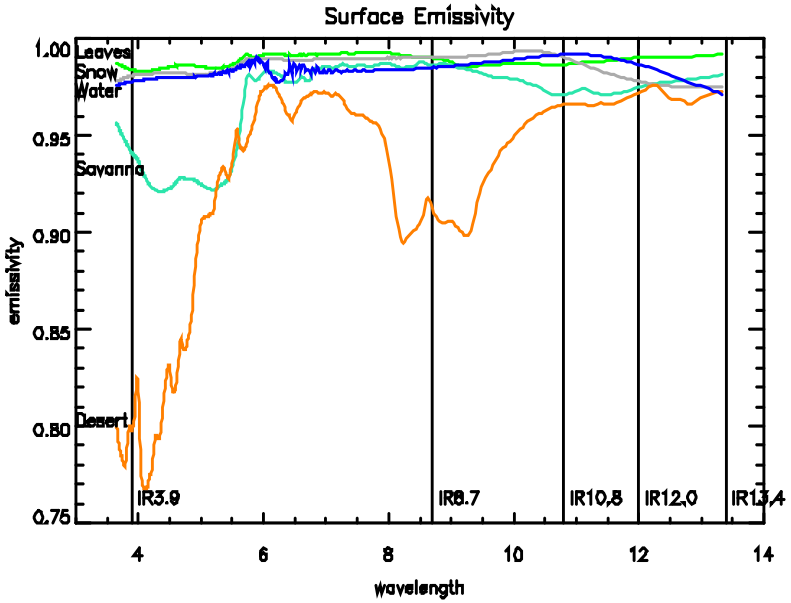
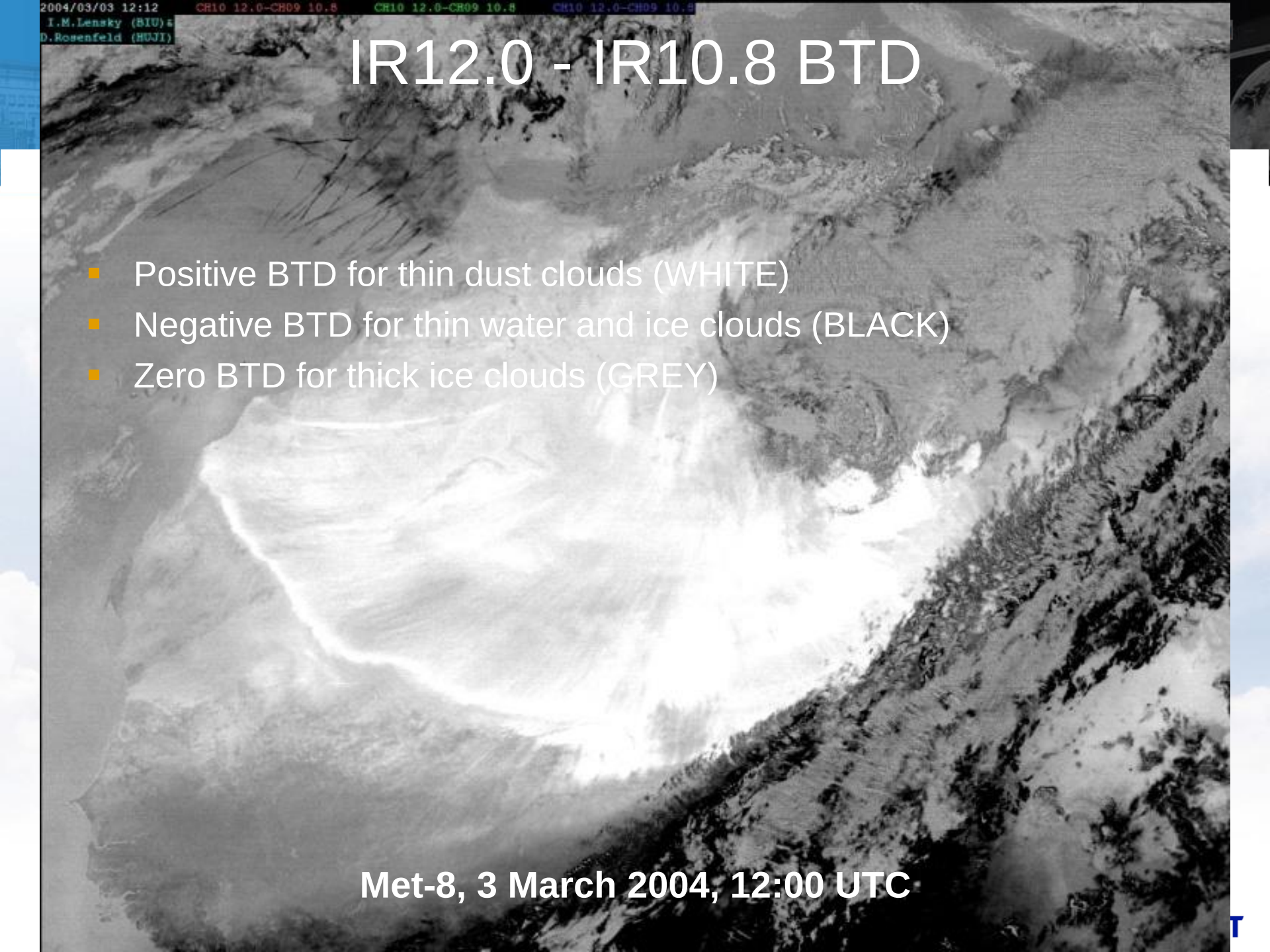

2004/03/03 12:12 Inv CH09 10.8
Inv CH09 10.8
-28.9
-28.9
Dust is not transparent to longwave
InfraRed (IR) thermal radiation
MSG-1 IR10.8 image
3 March 2004, 12:00 UTC


BUT detectability depends on
temperature contrast
T(dust), T(surface)
MSG-1 IR10.8 image
3 March 2004, 00:00 UTC

IR10.8 – IR8.7 BTD



- Large positive BTD for desert surfaces (WHITE)
- Small positive BTD for dust and water clouds(DARK GREY)

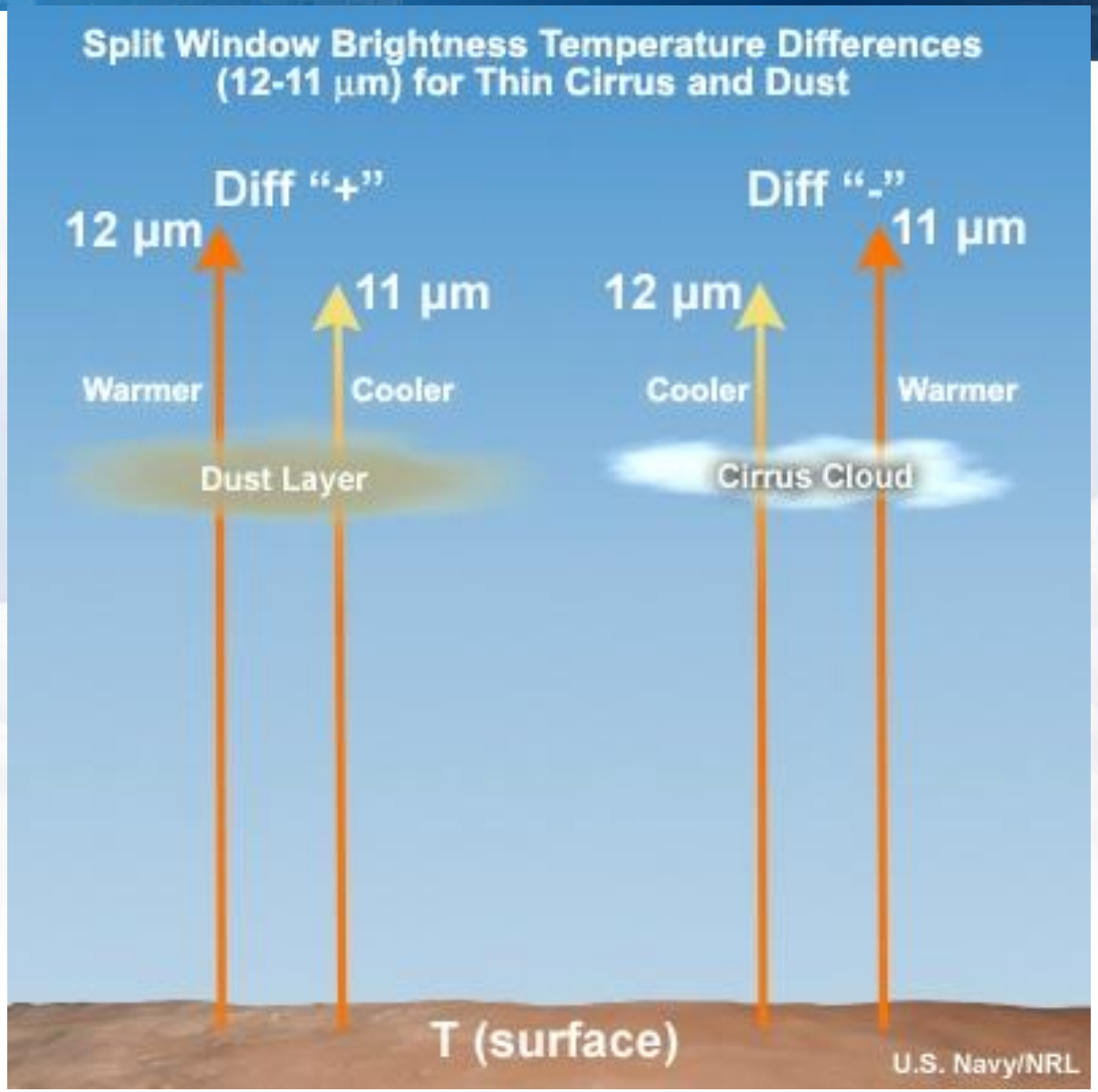


IR12.0 - IR10.8 BTD

- Positive BTD for thin dust clouds (WHITE)
- Negative BTD for thin water and ice clouds (BLACK)
- Zero BTD for thick ice clouds (GREY)

Met-8, 3 March 2004, 12:00 UTC

Transmission Spectra for Dust & Ice Clouds



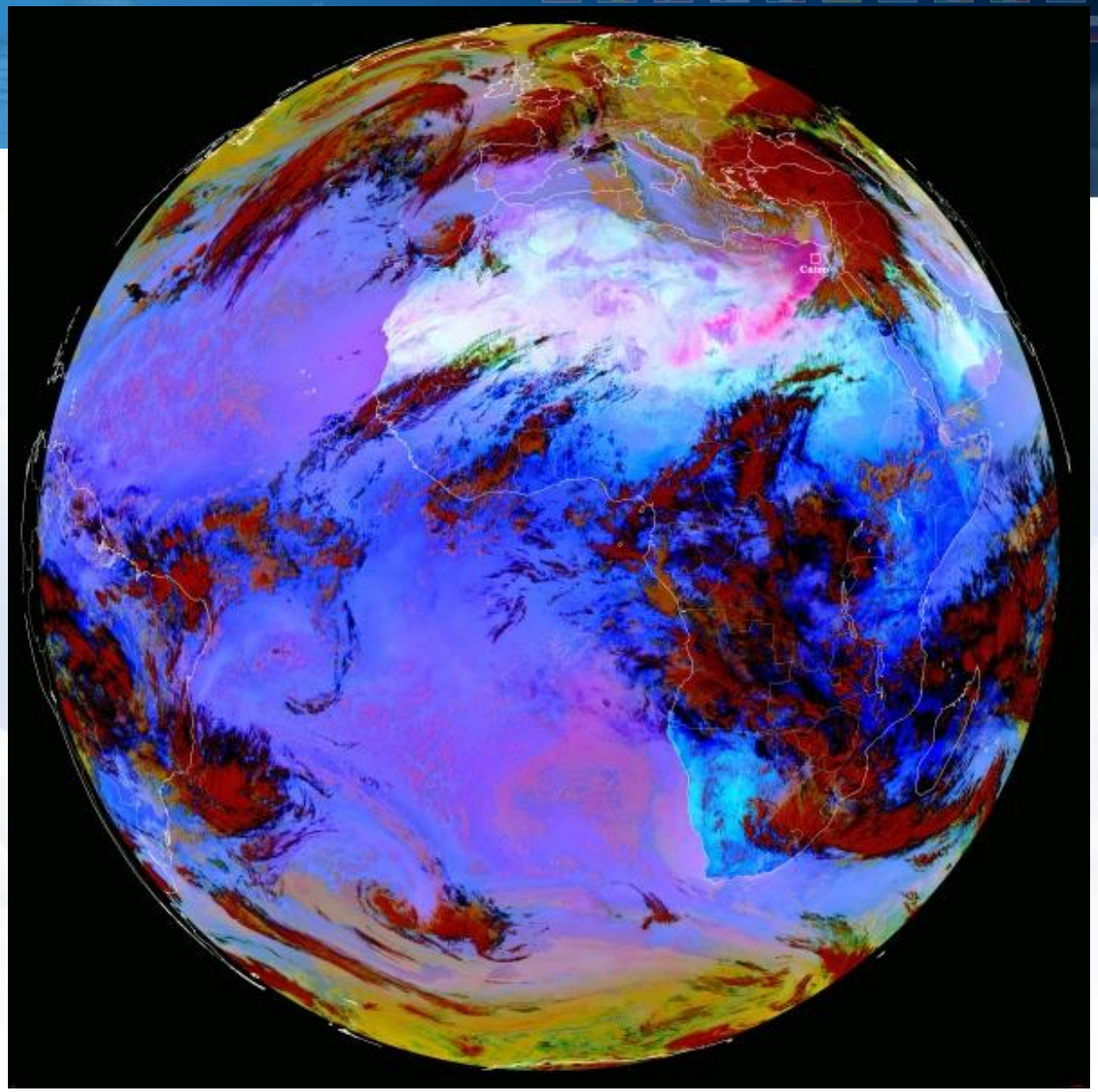
The Dust RGB Product

RGB 10-09, 09-07, 09 ("24-hour Dust Microphysics")

devised by: D. Rosenfeld

Recommended Range and Enhancement:

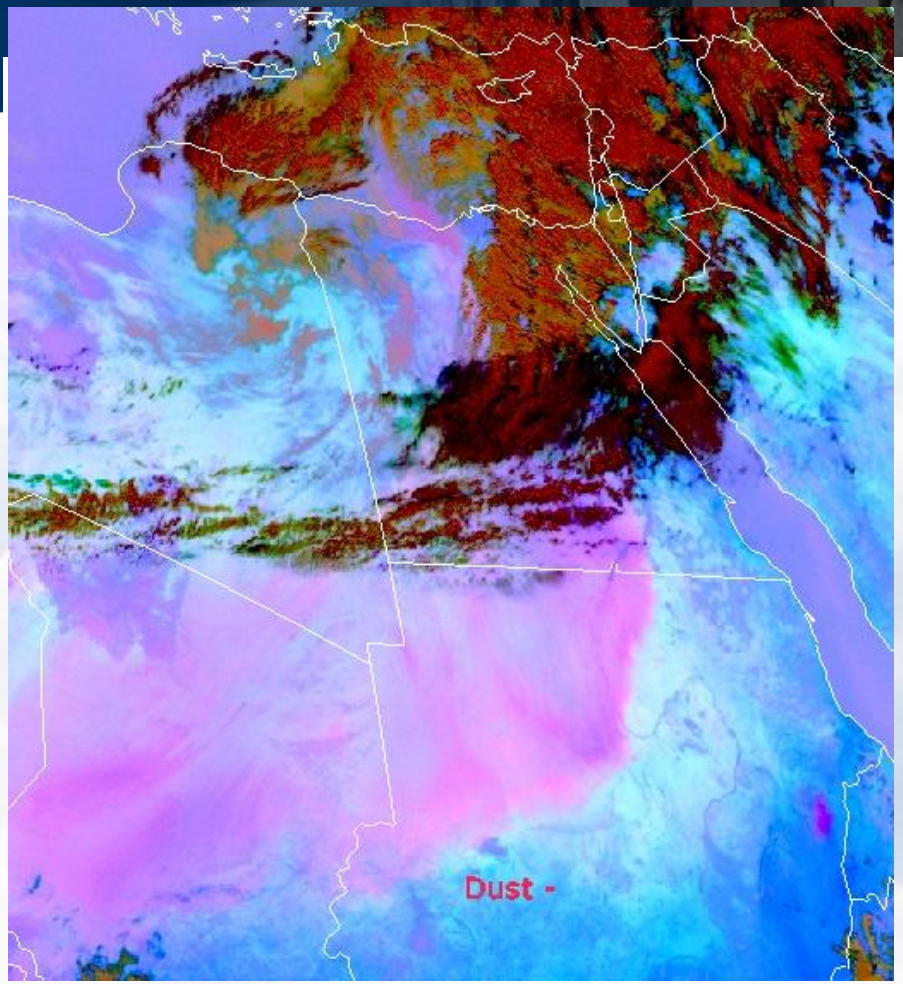
Beam	Channel	Range	Gamma
Red	IR12.0 - IR10.8	-4 … +2 K	1.0
Green	IR10.8 - IR8.7	0 … +15 K	2.5
Blue	IR10.8	+261 … +289 K	1.0



RGB
24-hour
Dust
Microphysics
Global View

MSG-1
22 January 2004
12:00 UTC

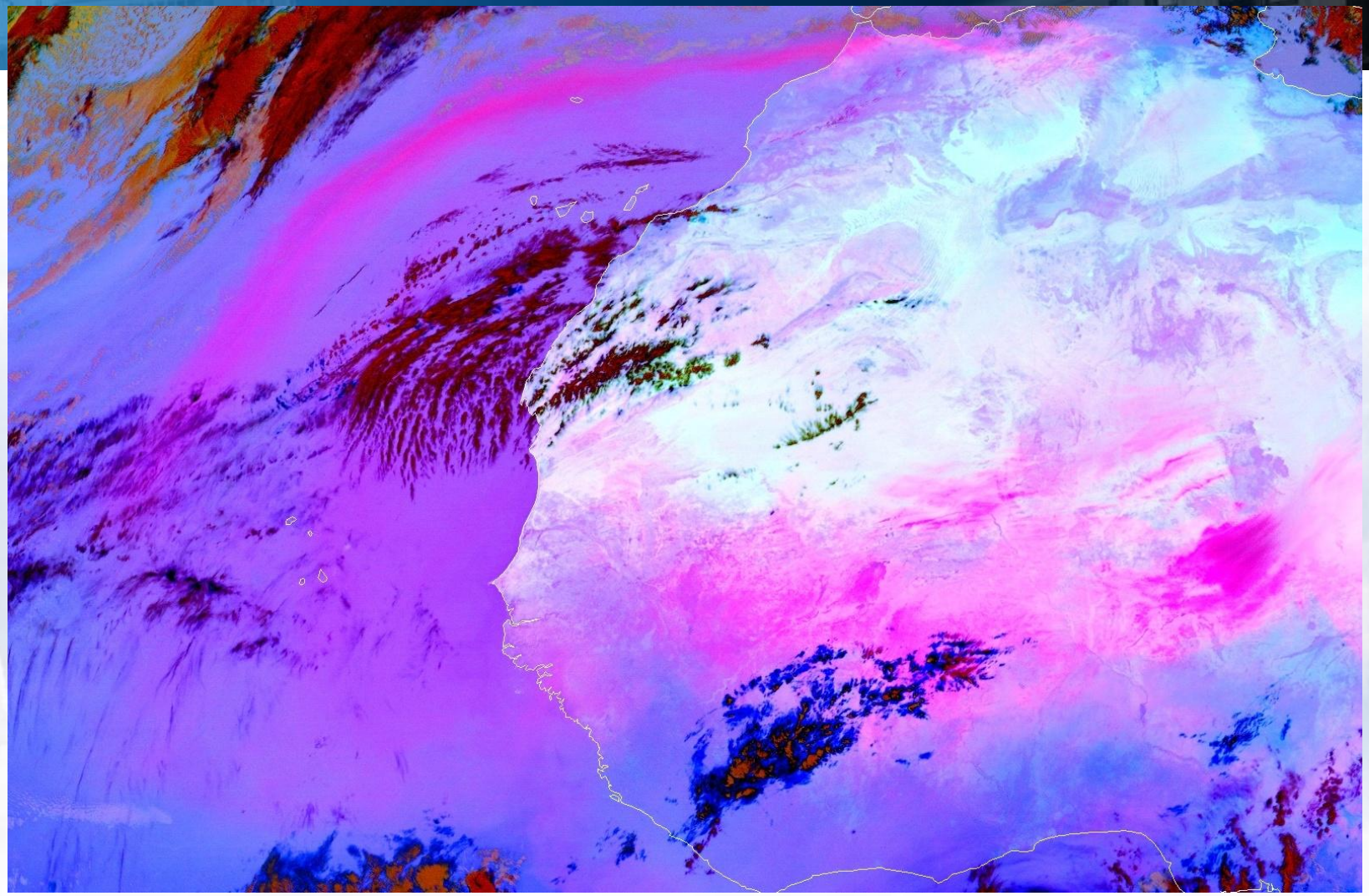
Comparison: Night versus Day



MSG-1, 10 May 2007

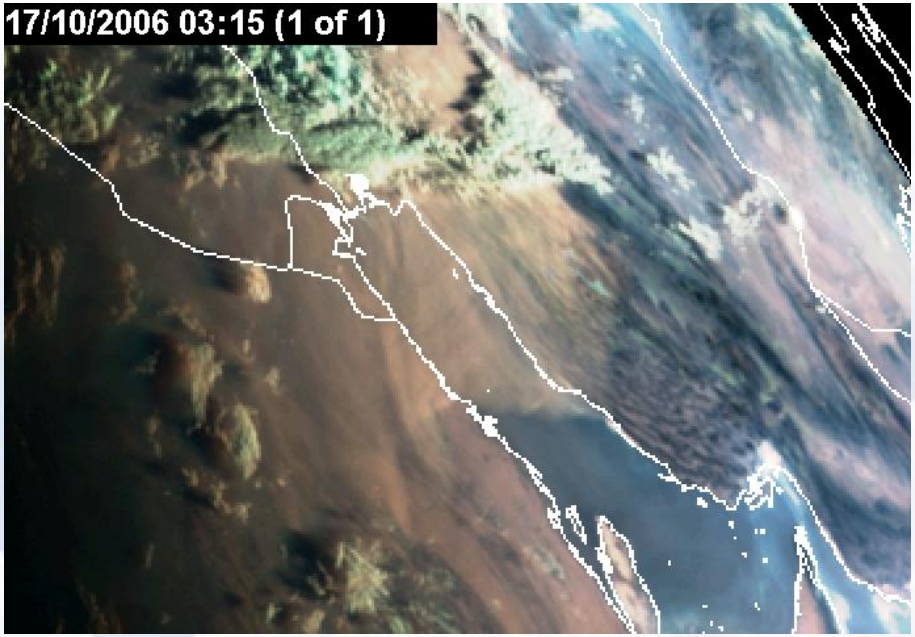
Which is night, which is day ?

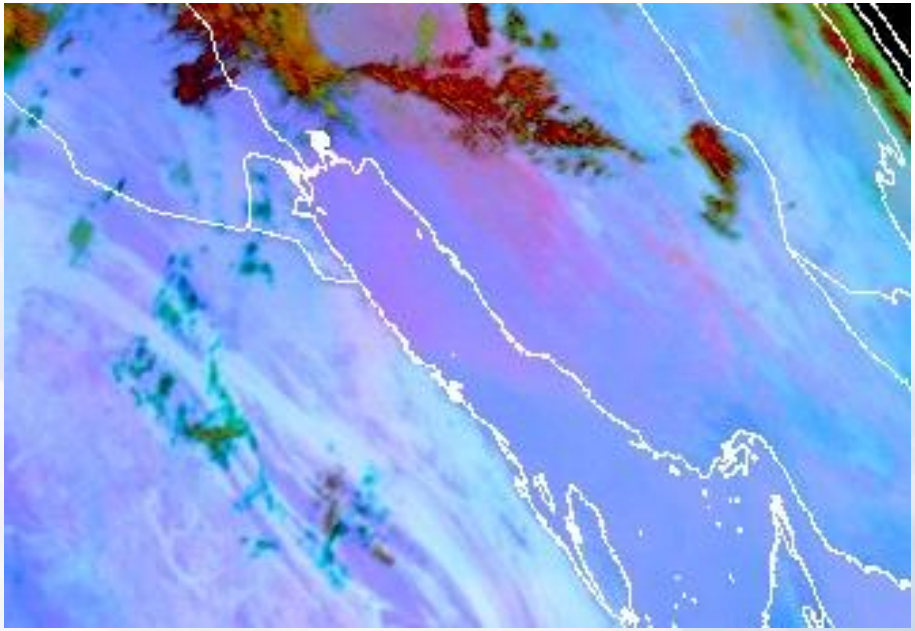
Example: High-level Dust over Ocean



MSG-1, 6 March 2004, 12:00 UTC

Example: Low-level Dust over Ocean





03:15 UTC
Natural Colours RGB

05:00 UTC
Dust RGB

MSG-1, 17 October 2006

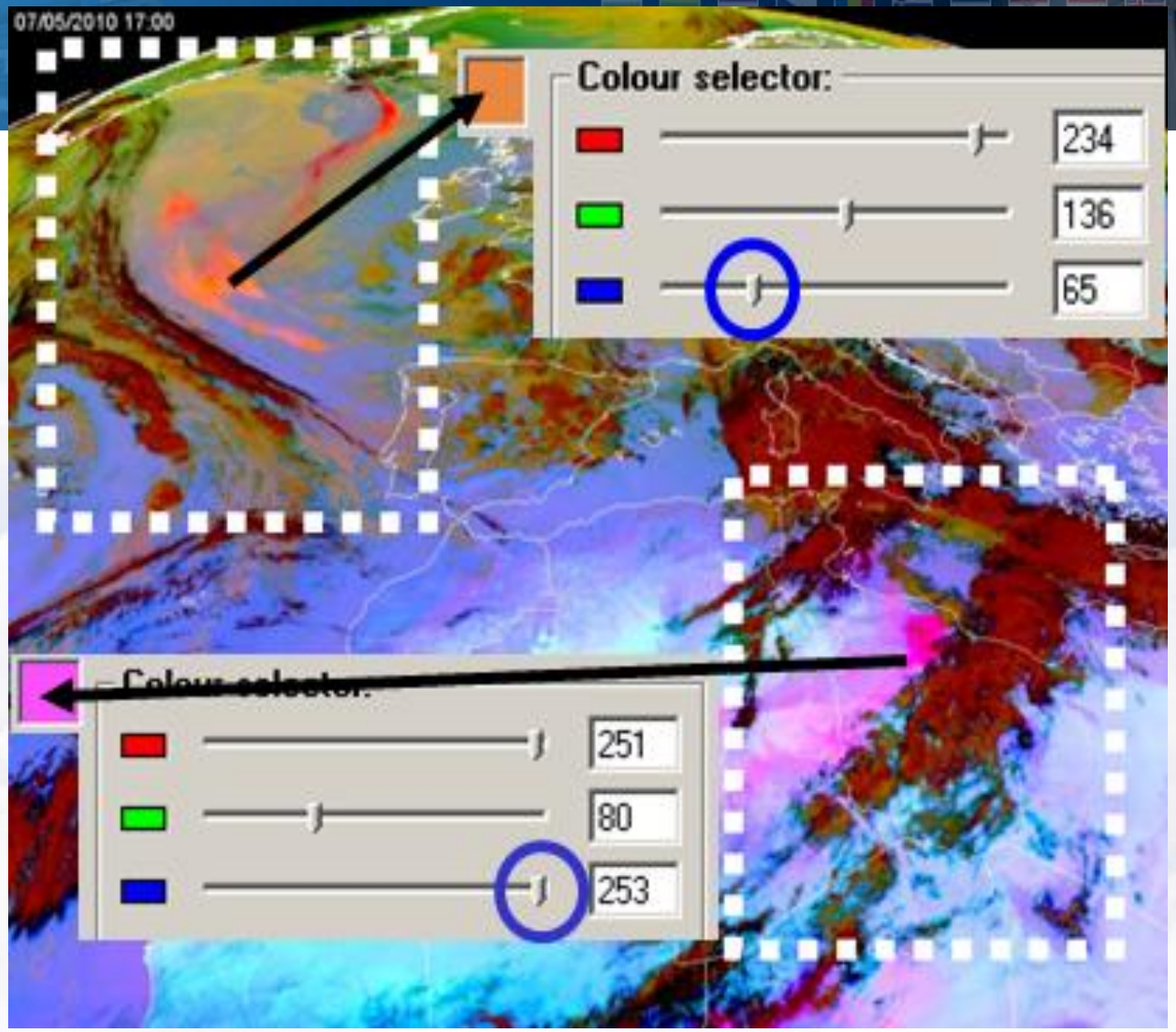
Volcanic Ash Cloud
Iceland Eruption
7 May, 22:00 UTC

Vulkaanas

Why this colour difference
between Ash and Dust clouds ?

Zand

MSG, Dust RGB



The dust cloud is much warmer (lower level) than the ash cloud, which travelled at a height of 6-10 km.

The Dust RGB: Interpretation of Colours
1. Thin Dust Clouds

The Dust RGB: Interpretation of Colours
2. Very Thick Dust Clouds

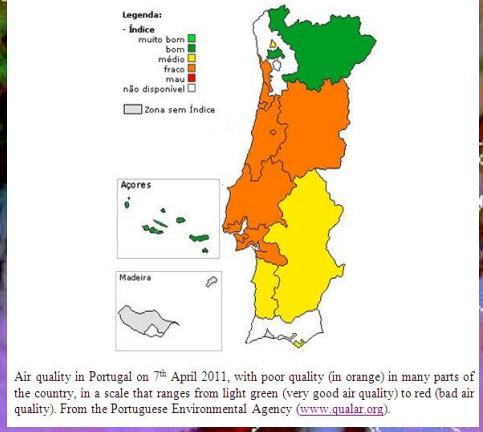
	Night	Day
High (4-5 km)		
Mid (2-3 km)		
Low (0-1 km)		

Challenges to using the Dust RGB product

- **Low dust clouds**
  - **at night**
  - **over Ocean**
  - **obscured by higher clouds**

Synoptic-scale Dust Outbreaks (Cyclone NW Africa)

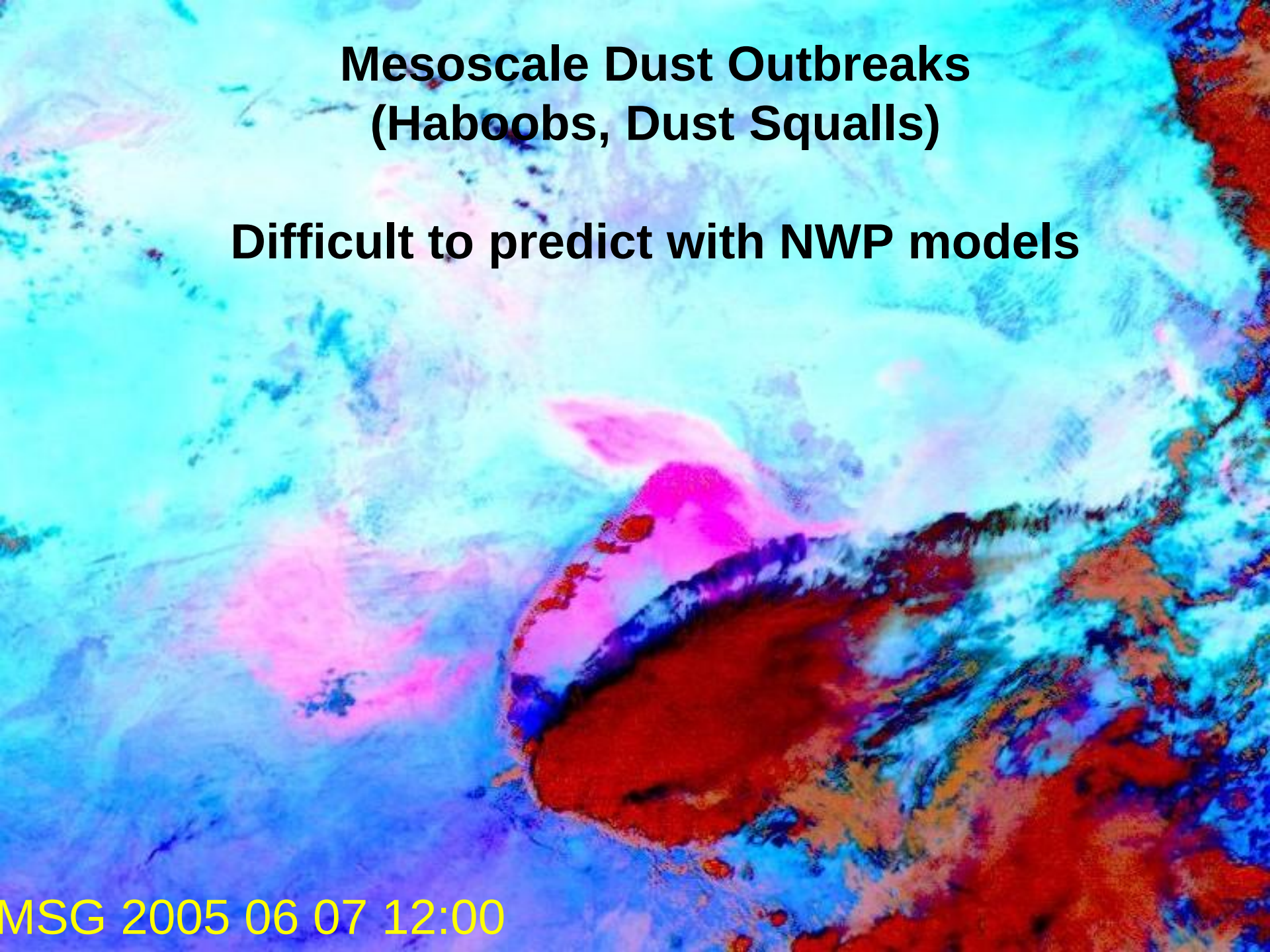
“Easy” to predict with NWP models



Air quality in Portugal on 7th April 2011, with poor quality (in orange) in many parts of the country, in a scale that ranges from light green (very good air quality) to red (bad air quality). From the Portuguese Environmental Agency (www.qualar.org).

Met-9, 5 April 2011, 18:00 UTC

m9 M9 – M9 (All Bands) DUST – 2011-04-05 18:00UTC


Mesoscale Dust Outbreaks
(Haboobs, Dust Squalls)
Difficult to predict with NWP models
MSG 2005 06 07 12:00

Key Messages: Natural Colours RGB

- The Natural Colours RGB can be used during daytime only
- Smoke has bluish colours; dust has brownish colours
- Detection easier over ocean (dark background)
- Dust & smoke change macrophysical and microphysical properties of clouds (impact on precipitation)

Key Messages: Dust RGB

- The Dust RGB can be used during day and night
- Dust Level identification is difficult but not totally impossible
- More contrast to backgroud over land than over ocean
- Over ocean visible imagery is preferable during the day (e.g. Natural Colour RGB)
- Smoke difficult to see in IR images and Dust RGB