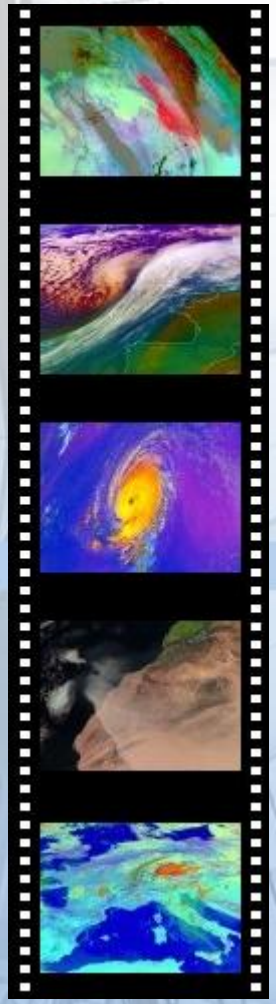

Dust & Smoke Detection with MSG SEVIRI RGB Products

Dr. Jochen Kerkmann
Satellite Meteorologist, Training Officer
(jochen.kerkmann@eumetsat.int)

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7 MSG Window Channels

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

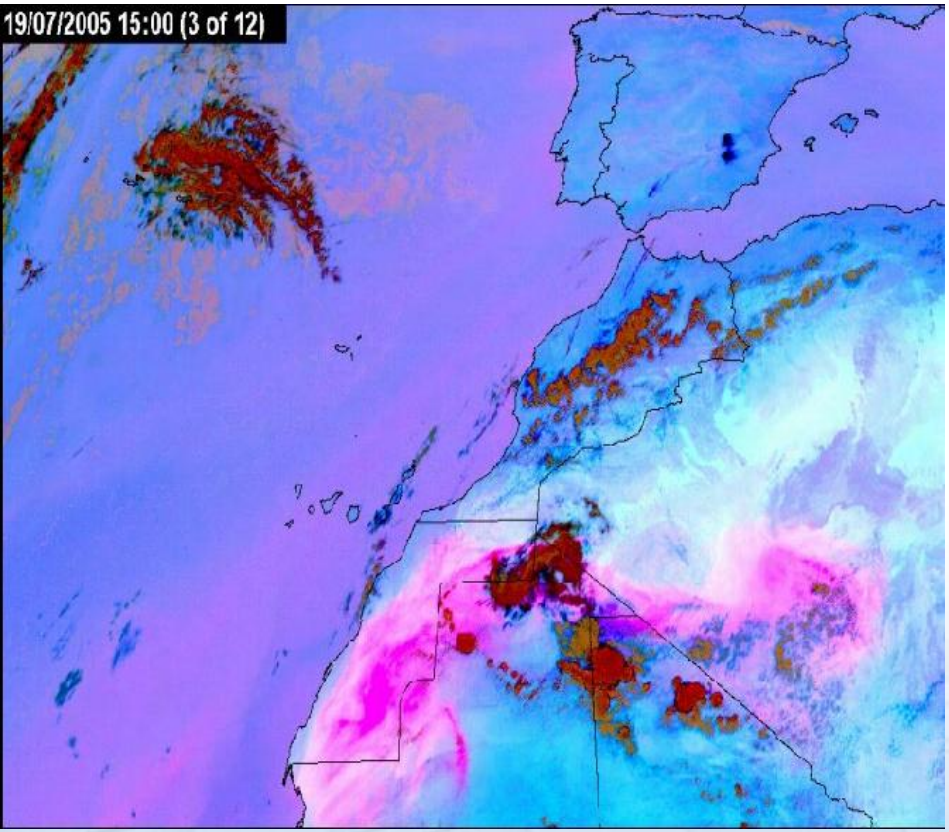
3 km data sampling intervals, except HRV (1 km)
Images each 15 minutes (5 minutes Met-8 rapid scan)

3 MSG 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

Introduction to RGB Products

RGB Products – How ?

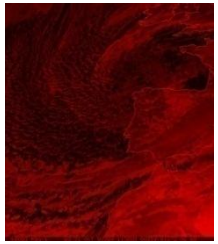


How do we get a picture like this?

EUMETSAT

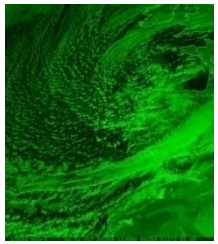
RGB Image Composites: Natural Colours RGB

Ch. NIR1.6



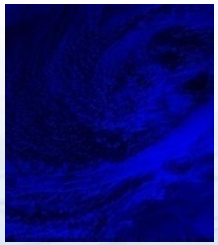
+

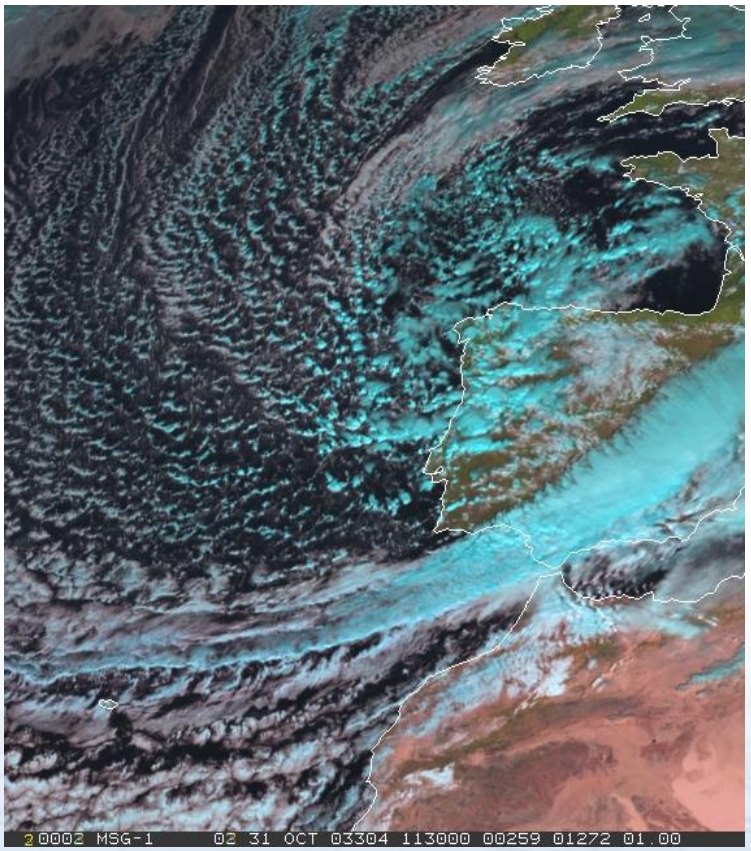
Ch. VIS0.8



+

Ch. VIS0.6





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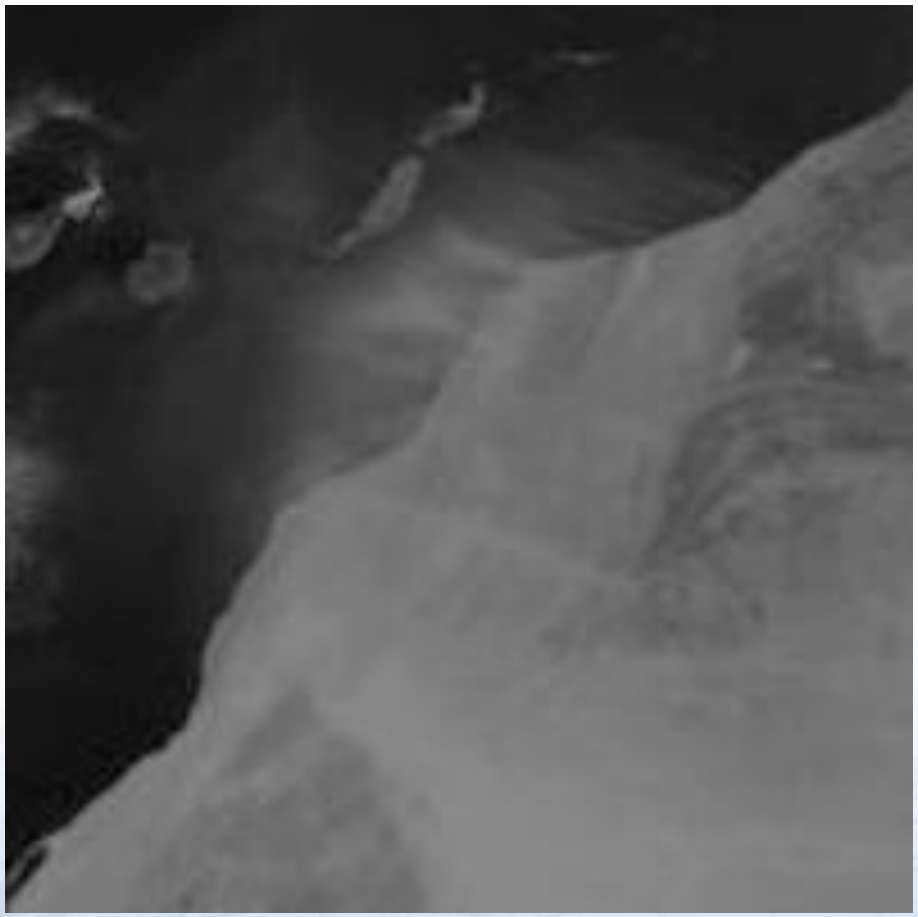
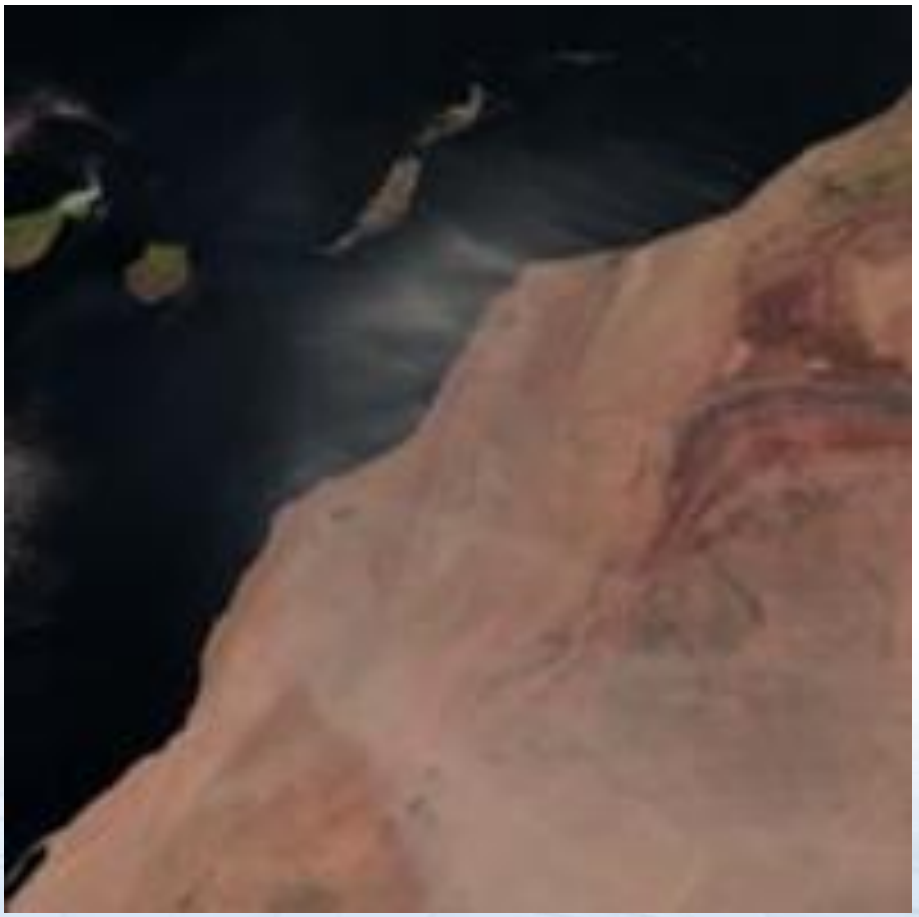
Natural Colours RGB: dust colour



Channel 01 (0.6 μm)



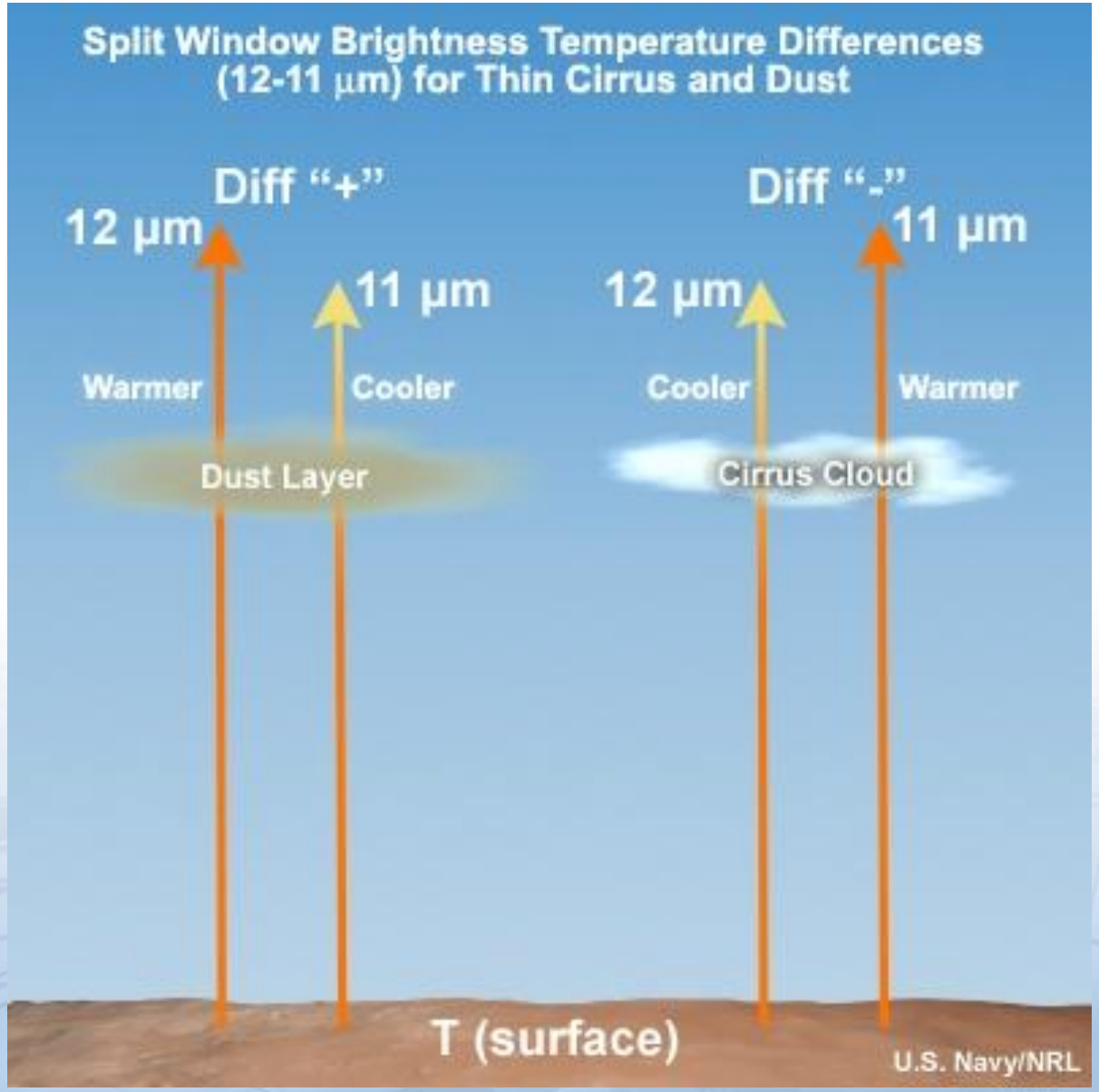
RGB Natural Colours

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

EUMETSAT

The IR Window Differences
IR12.0 - IR10.8
IR10.8 - IR8.7

Transmission Spectra for Dust & Ice Clouds



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Effect on Brightness Temperatures

BTD IR12.0 - IR10.8 > 0 ***for thin dust (ash) clouds***

BTD IR12.0 - IR10.8 < 0 ***for thin ice clouds***

(neglecting other effects)

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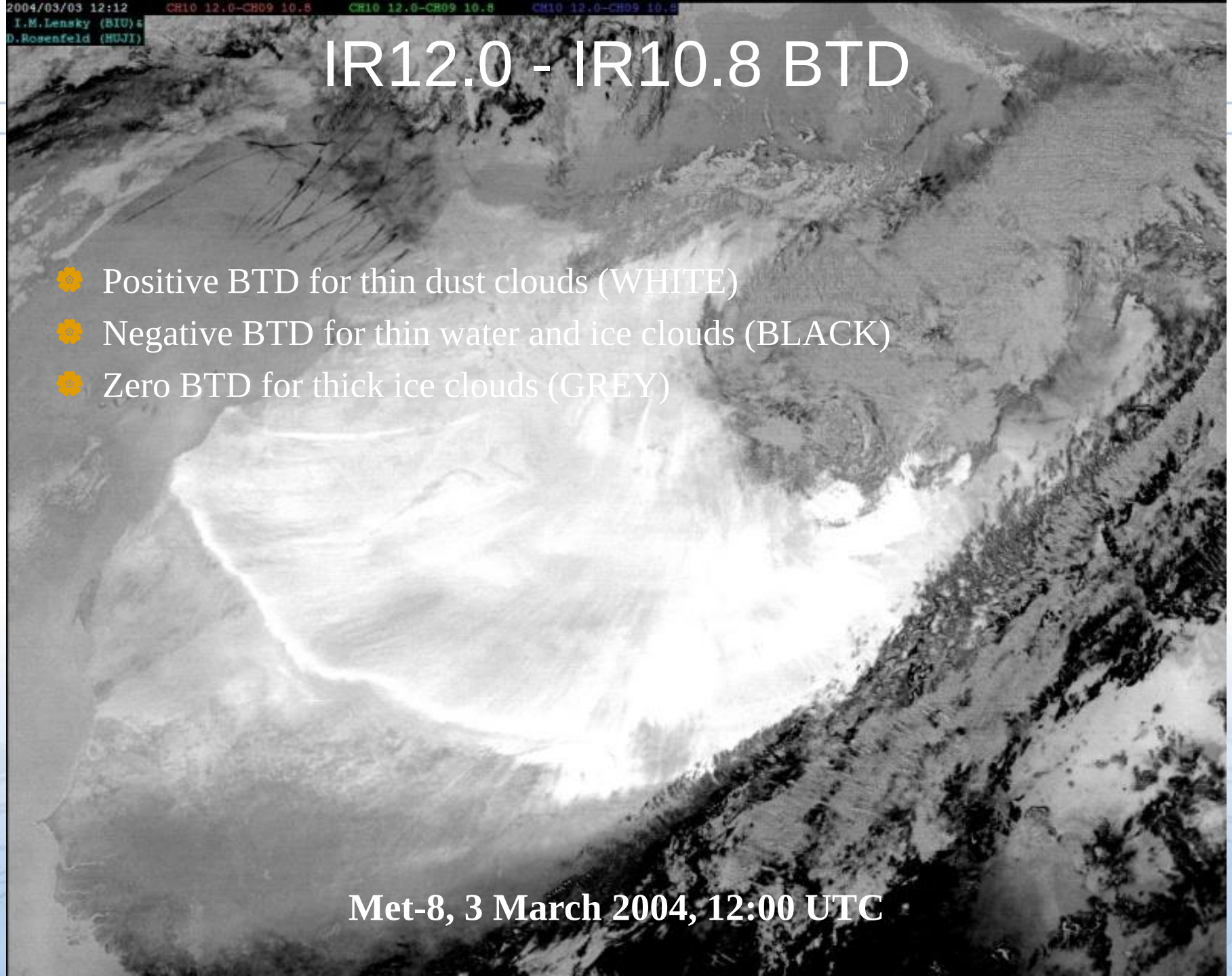


IR12.0 - IR10.8 BTD

- 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

Challenges to using the 12.0-10.8 um difference product

- Low dust clouds:
  - at night
  - over Ocean
  - obscured by higher clouds
- Mid & High dust clouds:
  - Low dust concentrations

EUMETSAT

The Dust RGB Product

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

devised by: D. Rosenfeld

Recommended Range and Enhancement:

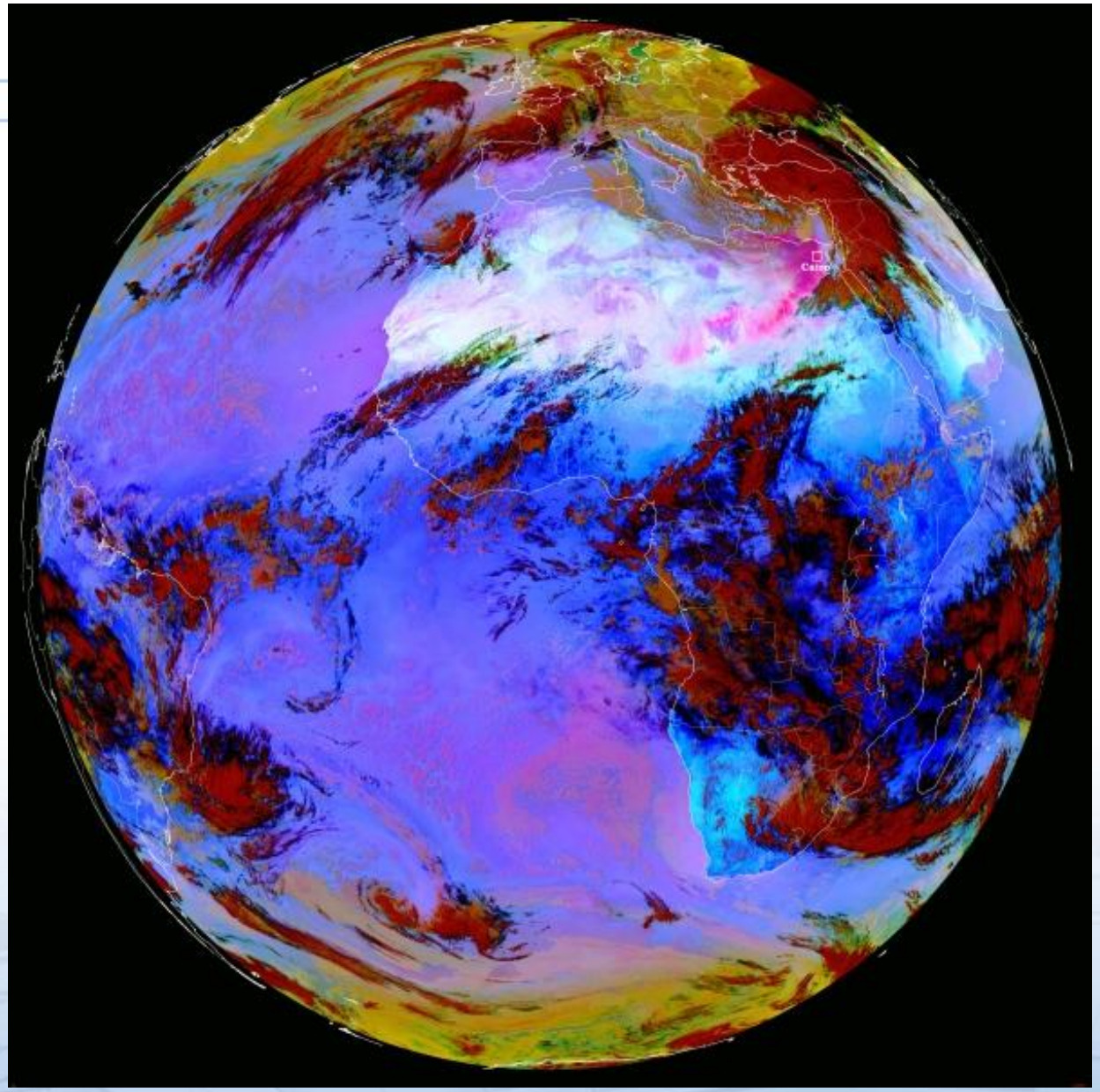
Beam	Channel	Range	Gamma
Red	IR12.0 - IR10.8	-4 ... +2 K	1.0
Green	IR10.8 - IR8.7	0 ... +15 K	2.5
Blue	IR10.8	+261 ... +289 K	1.0

Physical Interpretation (for dust/ash/water/ice clouds)

R = Difference IR12.0 - IR10.8
Optical Thickness, Tsurf-Tcloud

G = Difference IR10.8 - IR8.7
Optical Thickness, Tsurf-Tcloud, Phase

B = Channel IR10.8
Top Temperature

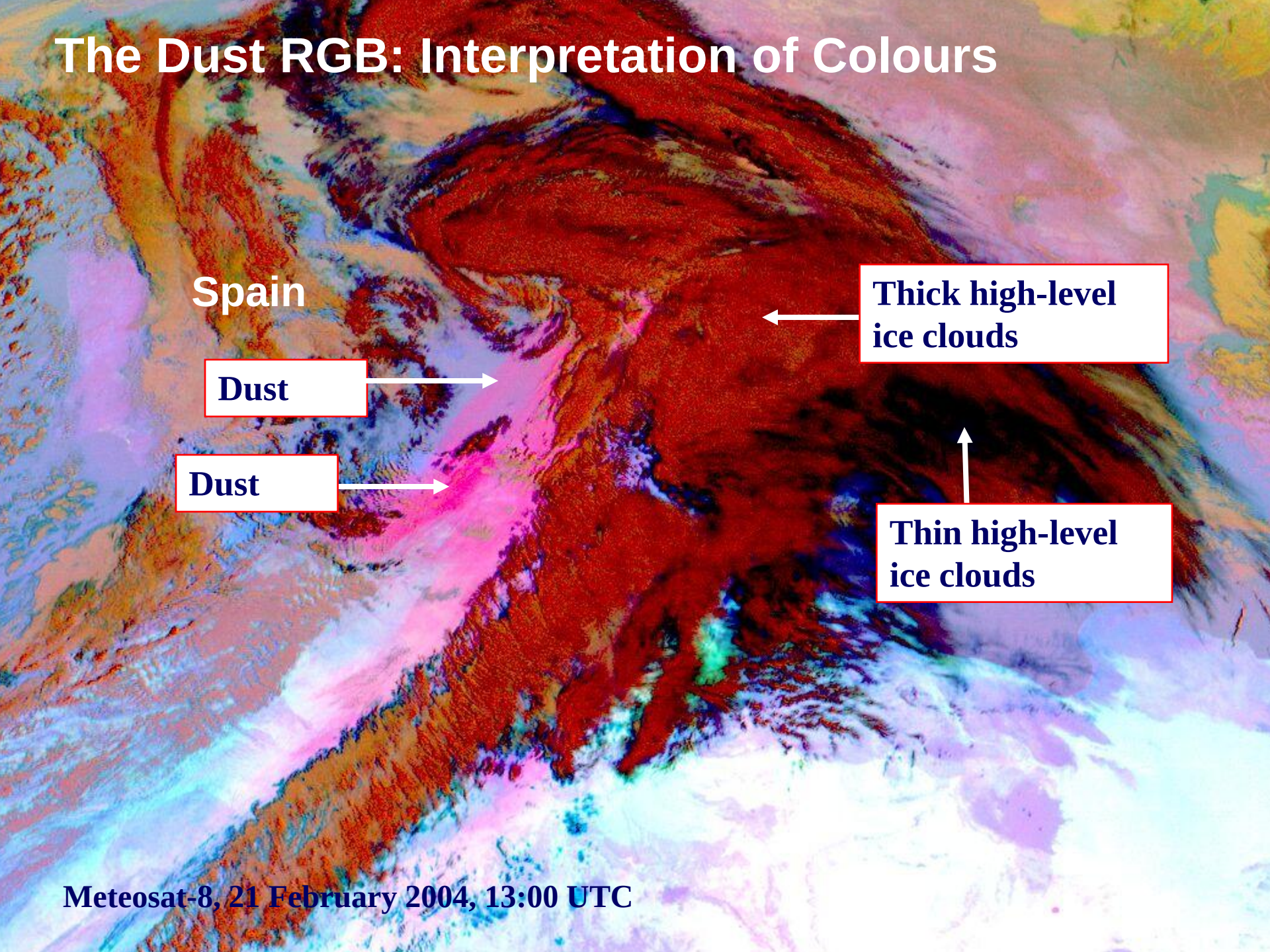


RGB 24-hour Dust Microphysics Global View

MSG-1
22 January 2004
12:00 UTC

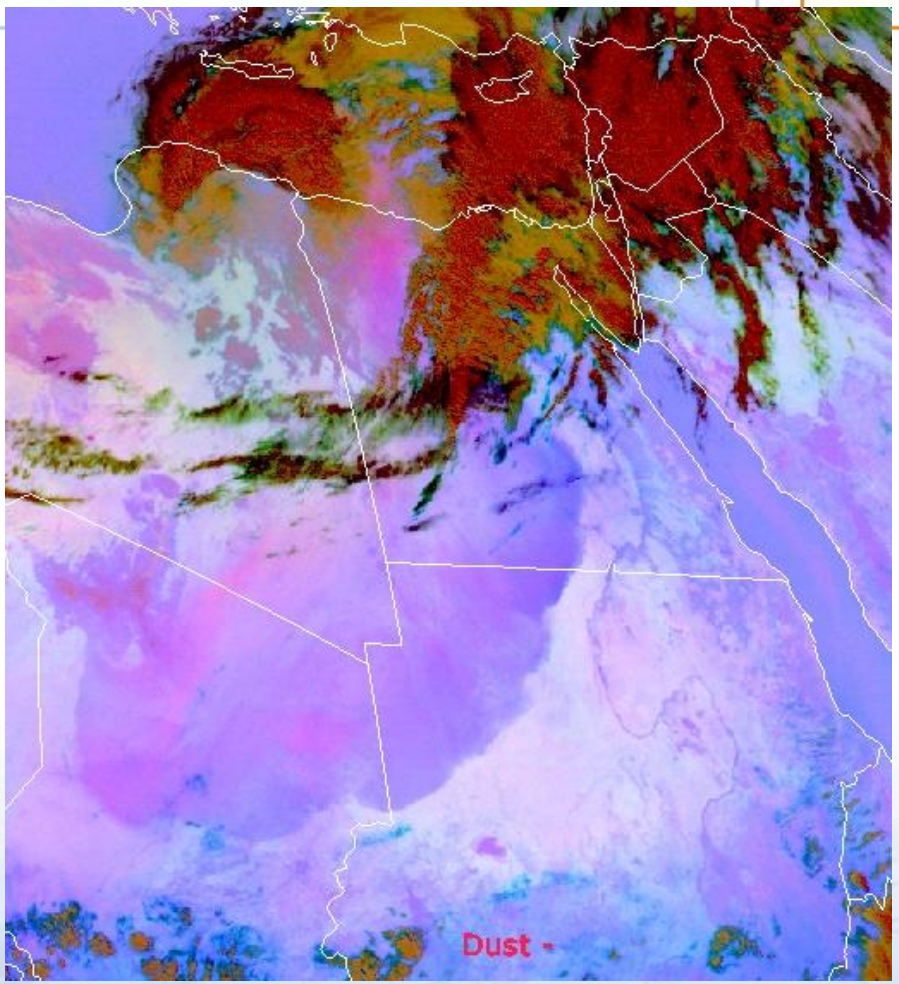
EUMETSAT

The Dust RGB: Interpretation of Colours

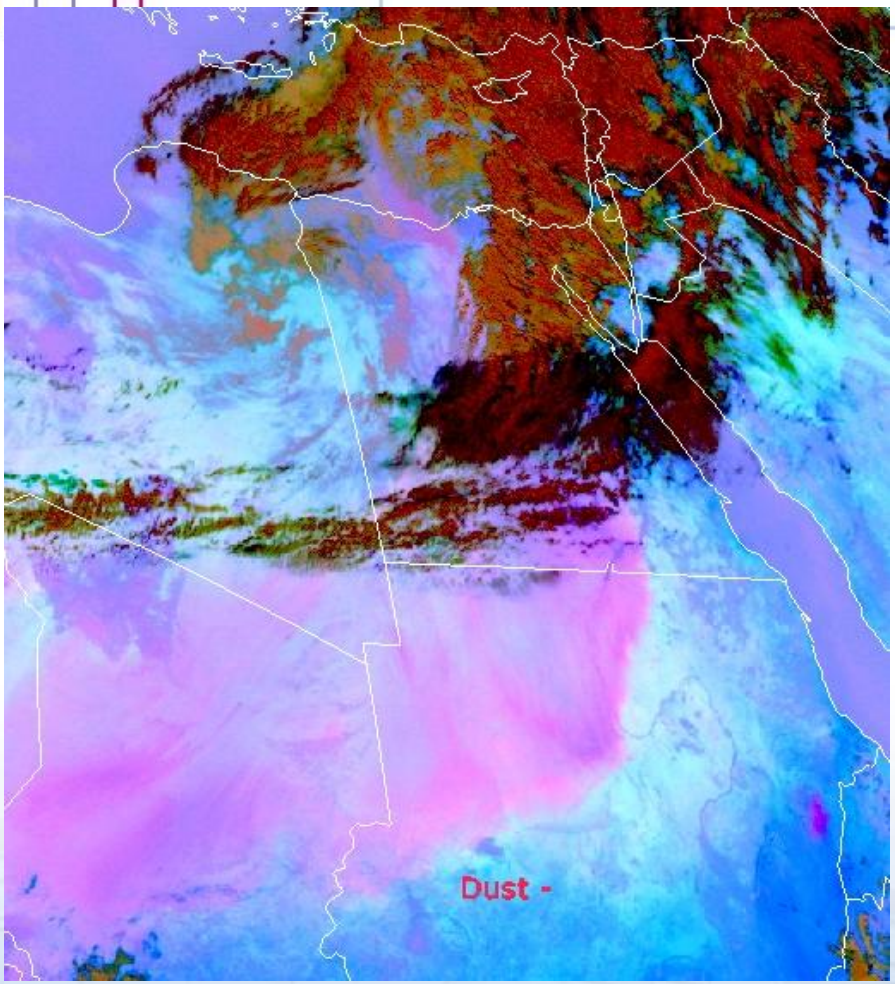


Meteosat-8, 21 February 2004, 13:00 UTC

Comparison: Night vs Day



00:00 UTC

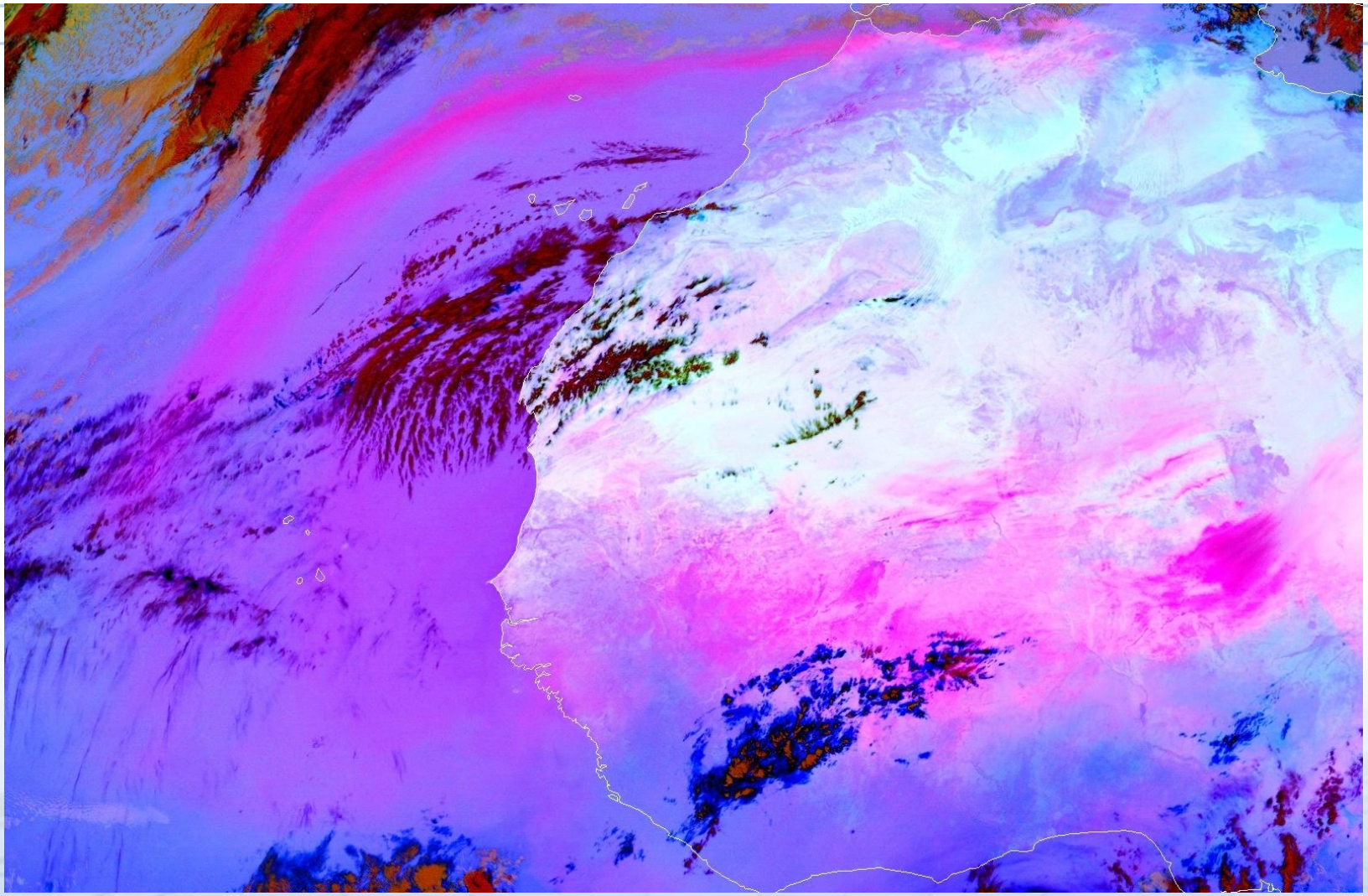


07:15 UTC

MSG-1, 10 May 2007

EUMETSAT

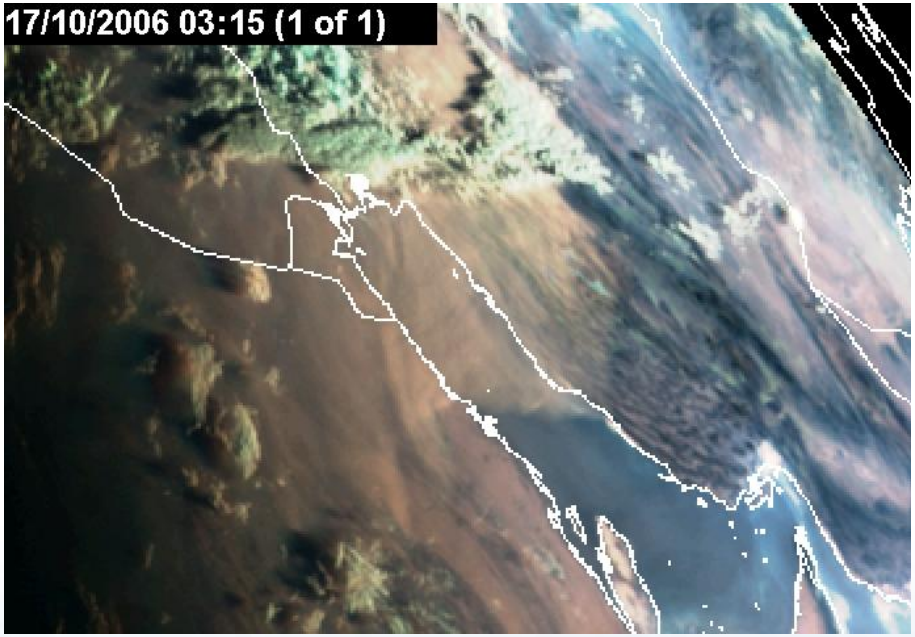
Example: Dust over Ocean

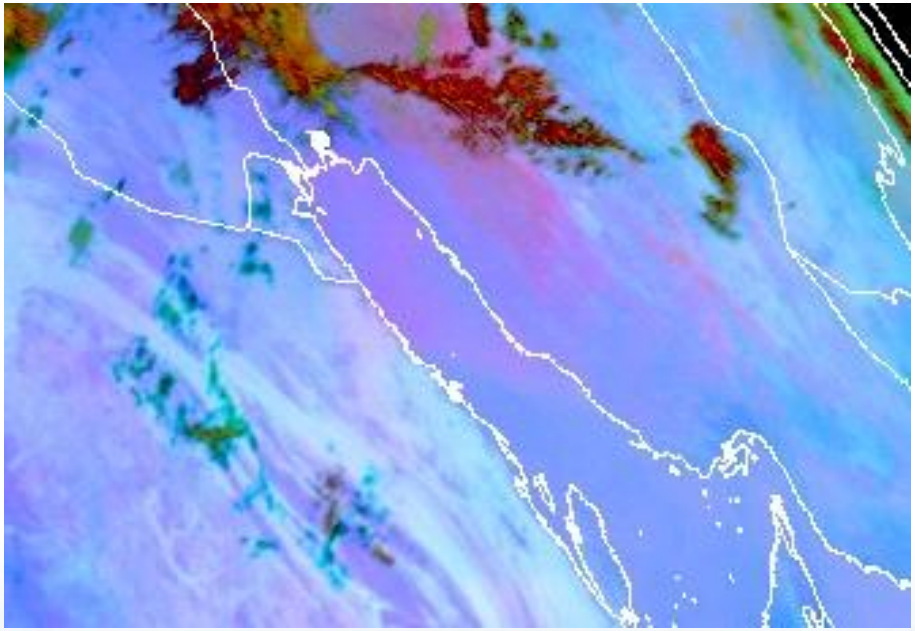


MSG-1, 6 March 2004, 12:00 UTC

EUMETSAT

Example: Dust over Ocean





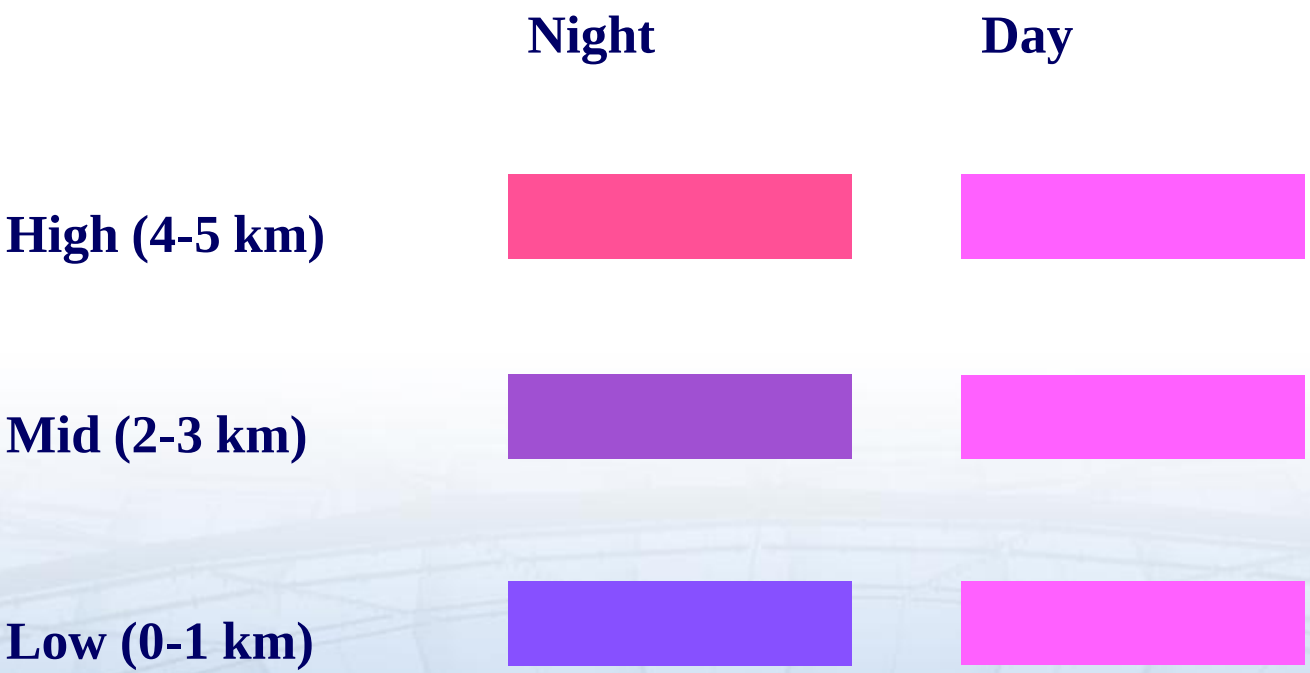
03:15 UTC
Natural Colours RGB

05:00 UTC
Dust RGB

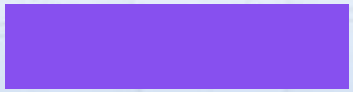
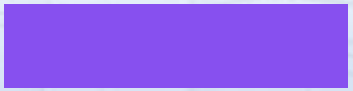
MSG-1, 17 October 2006

EUMETSAT

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

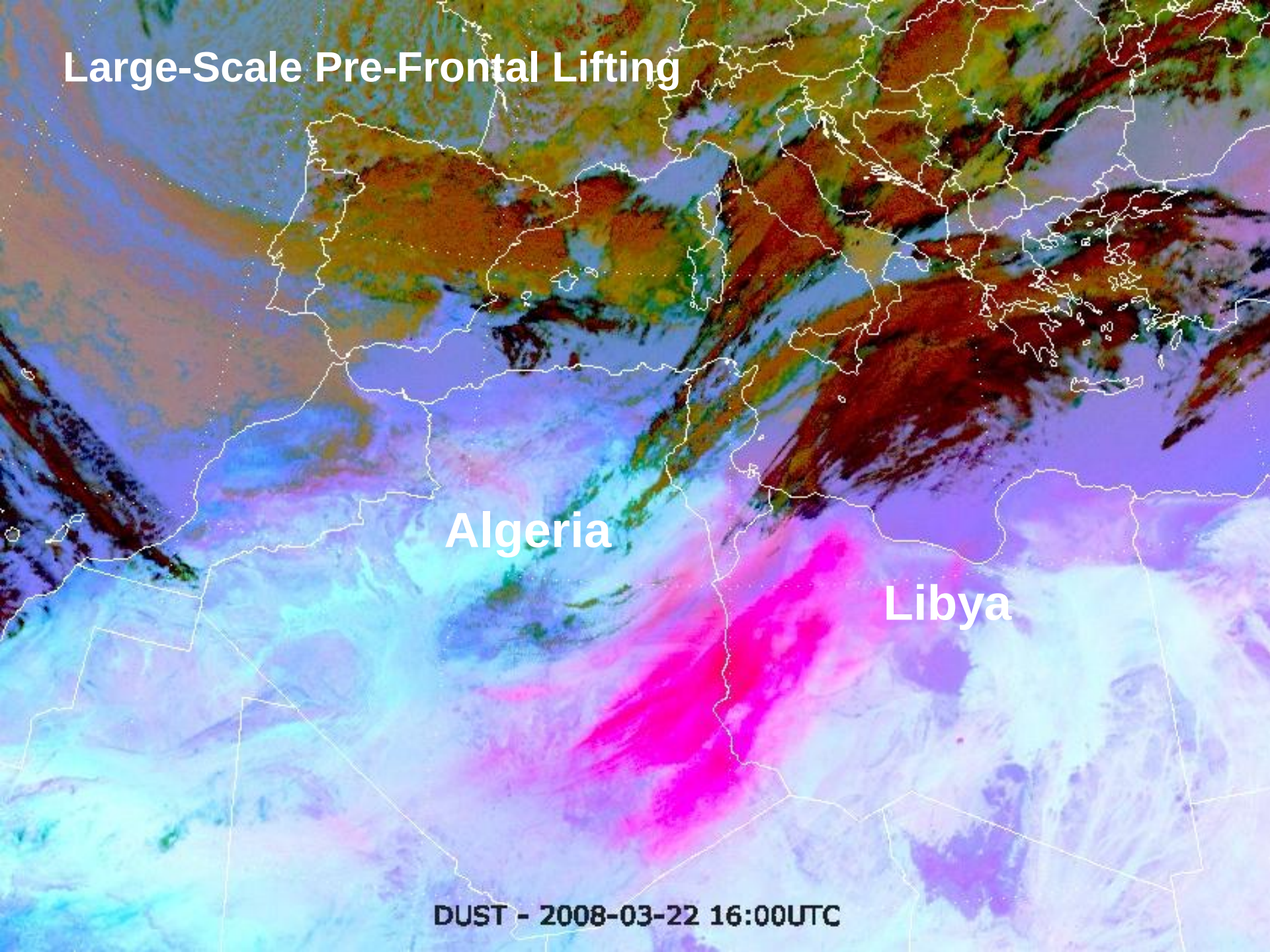


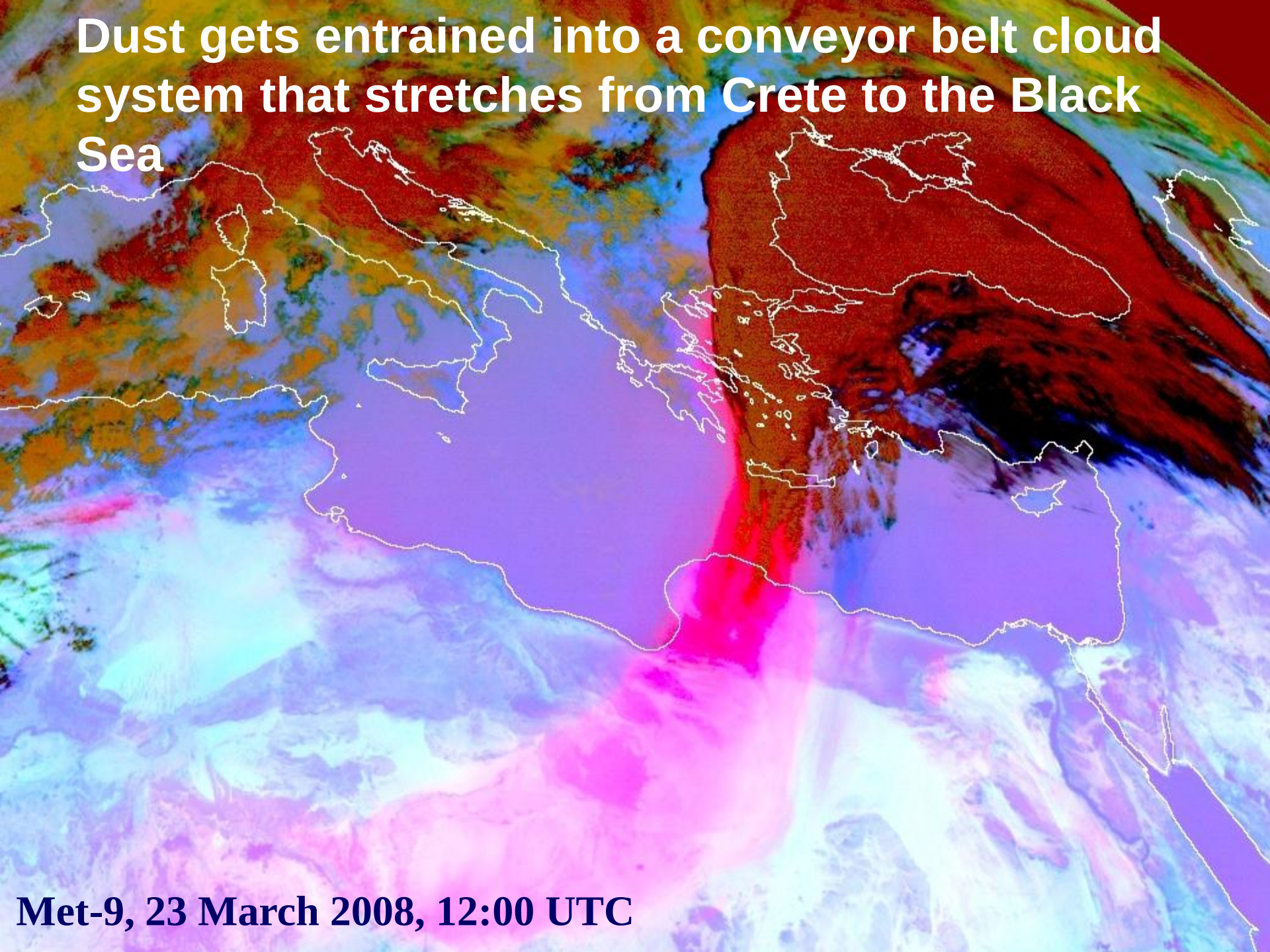
The Dust RGB: Interpretation of Colours
2. Very Thick Dust Clouds

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

EUMETSAT

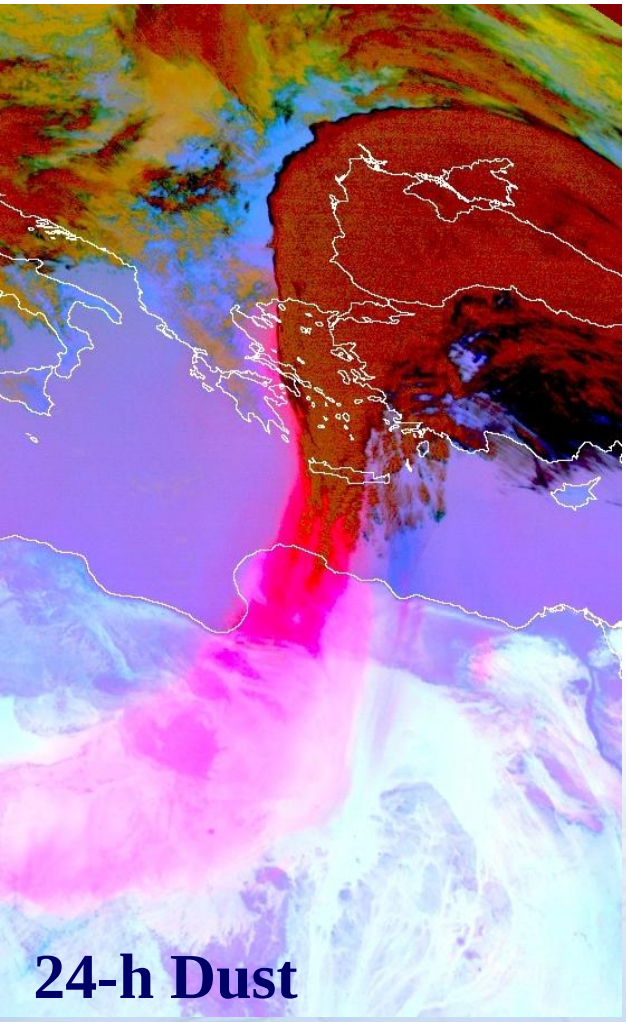
Types of Dust Outbreaks

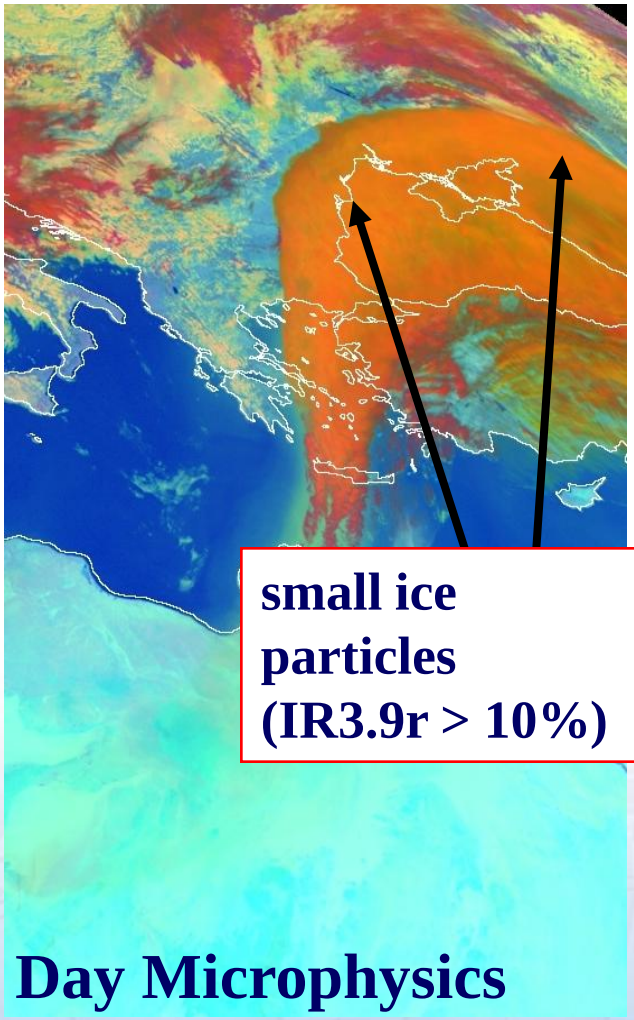

Large-Scale Pre-Frontal Lifting
Algeria
Libya
DUST - 2008-03-22 16:00UTC

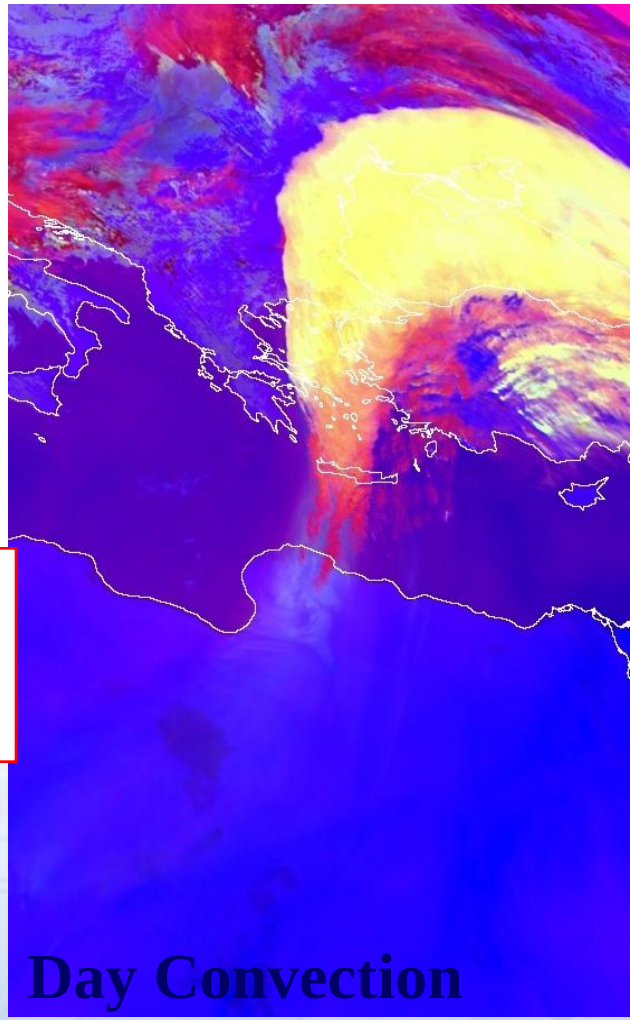

Dust gets entrained into a conveyor belt cloud system that stretches from Crete to the Black Sea
Met-9, 23 March 2008, 12:00 UTC

Dust Changes Cloud Microphysics

cloud glaciates very quickly with lots of needle hydrometeors present
dust acts as very efficient ice nuclei







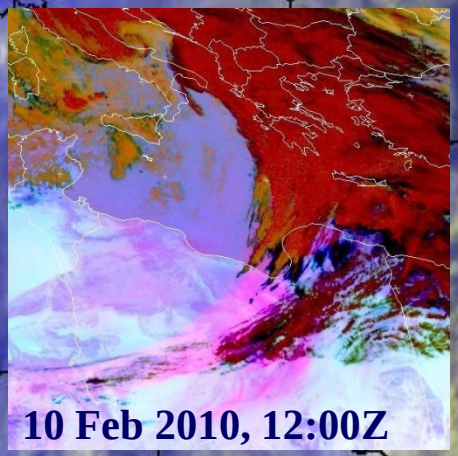
Met-9, 23 March 2008, 12:00 UTC

EUMETSAT

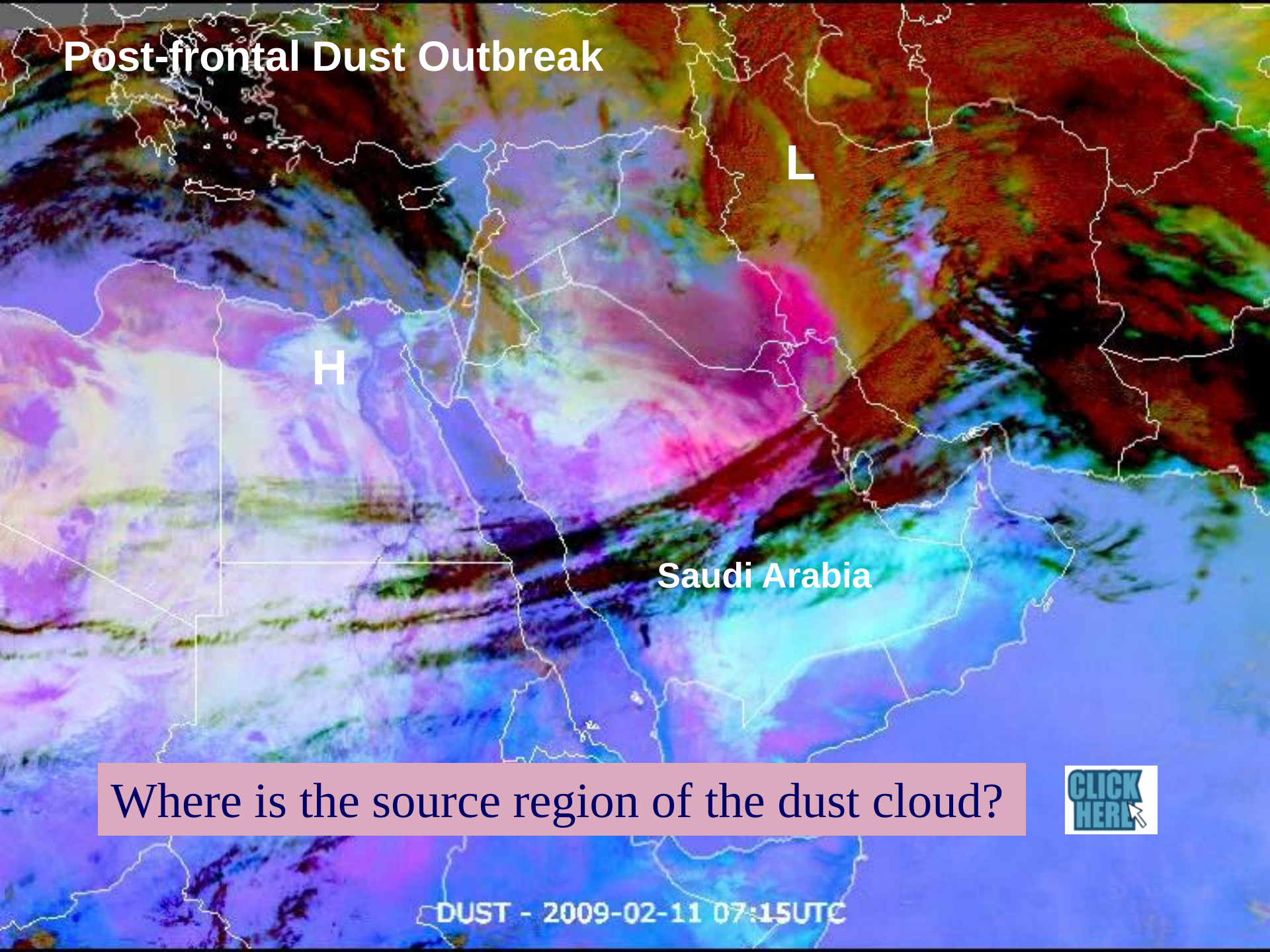
Dust causes Granular Structure of Cirrus Shield

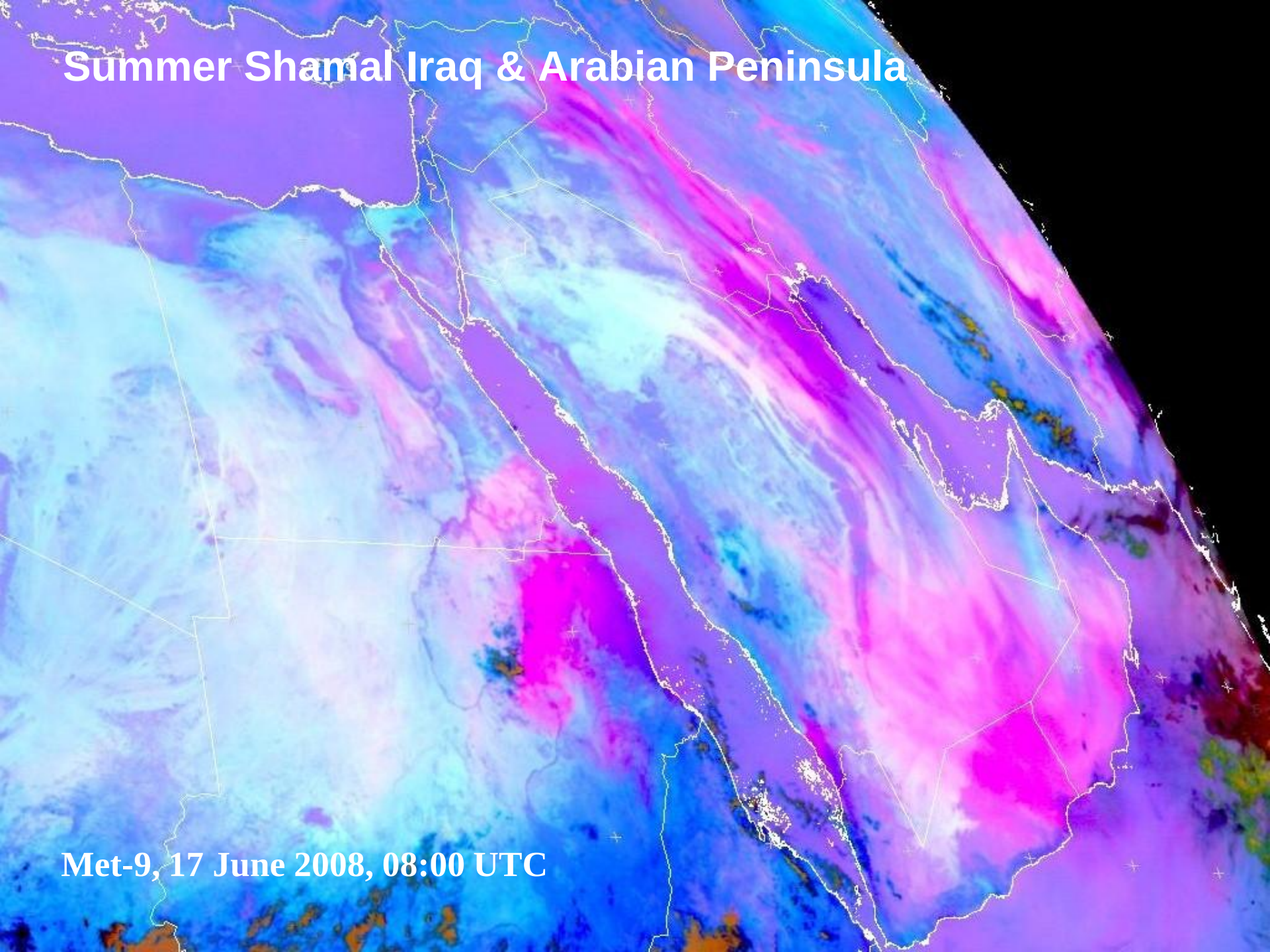
Poland

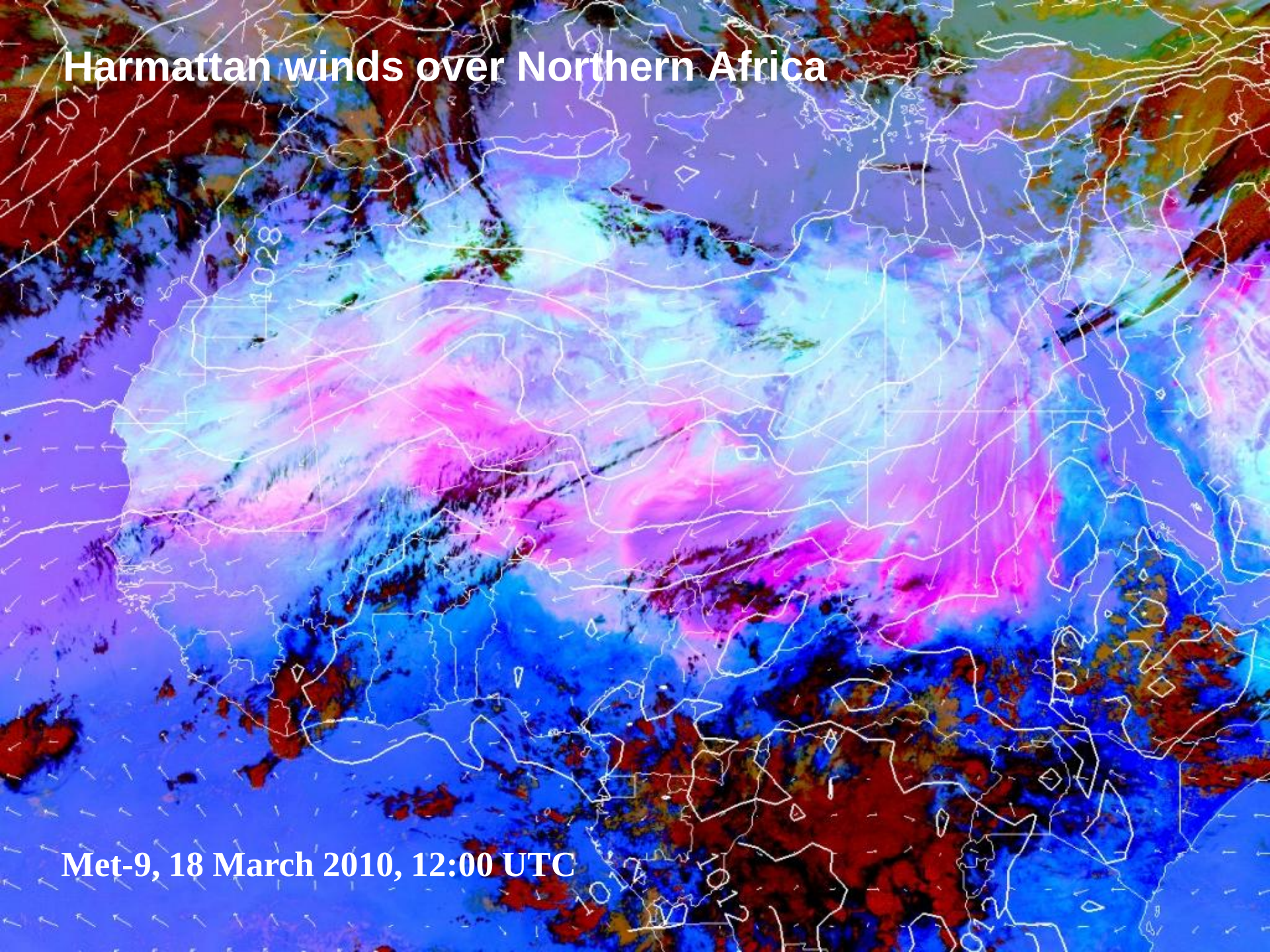
Ukraine



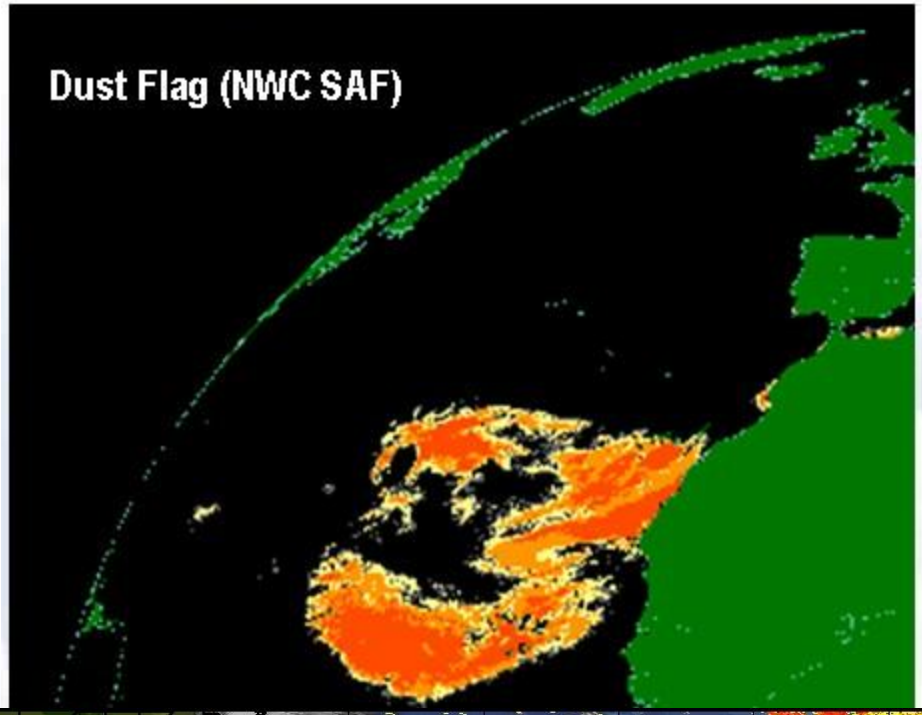
Met-9, 11 February 2010, 06:00 UTC, HRV
Source: K. Kollath, Hungary

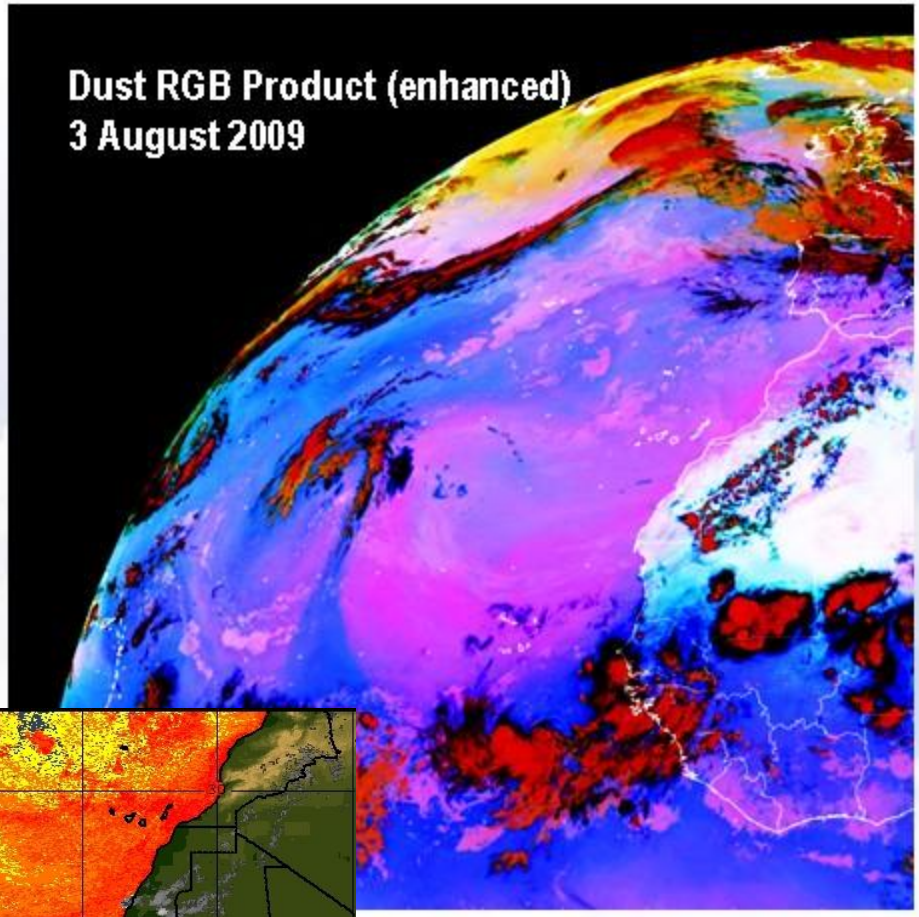

Post-frontal Dust Outbreak
L
H
Saudi Arabia
Where is the source region of the dust cloud?
CLICK HERE
DUST - 2009-02-11 07:15UTC

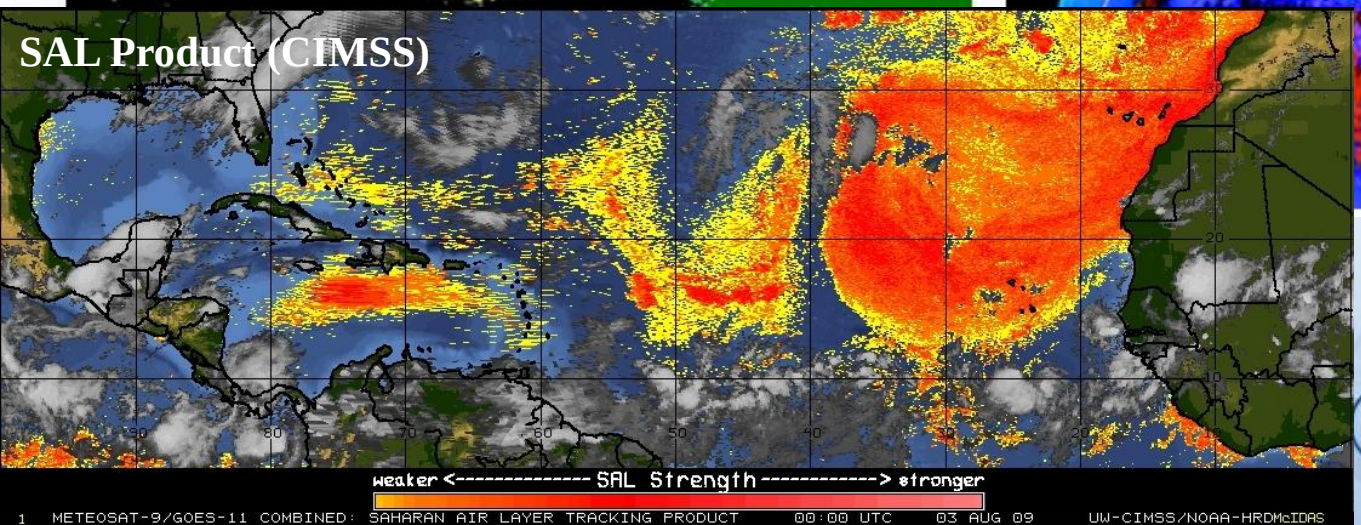

Summer Shamal Iraq & Arabian Peninsula
Met-9, 17 June 2008, 08:00 UTC


Harmattan winds over Northern Africa
Met-9, 18 March 2010, 12:00 UTC

Northeast Trade Winds over the North Atlantic







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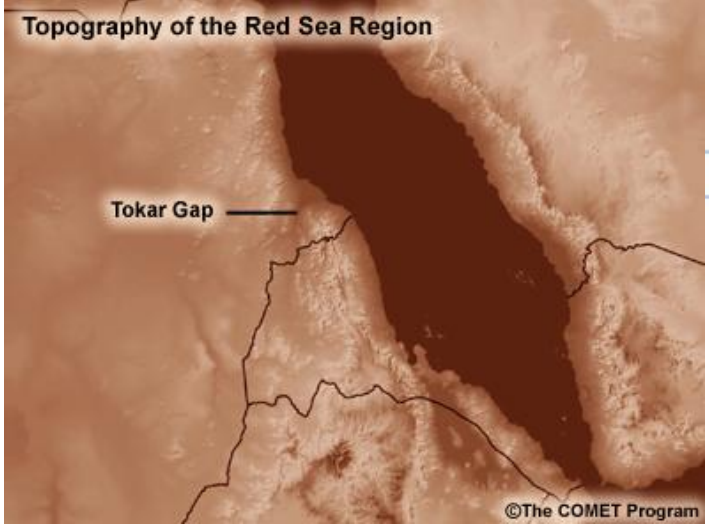
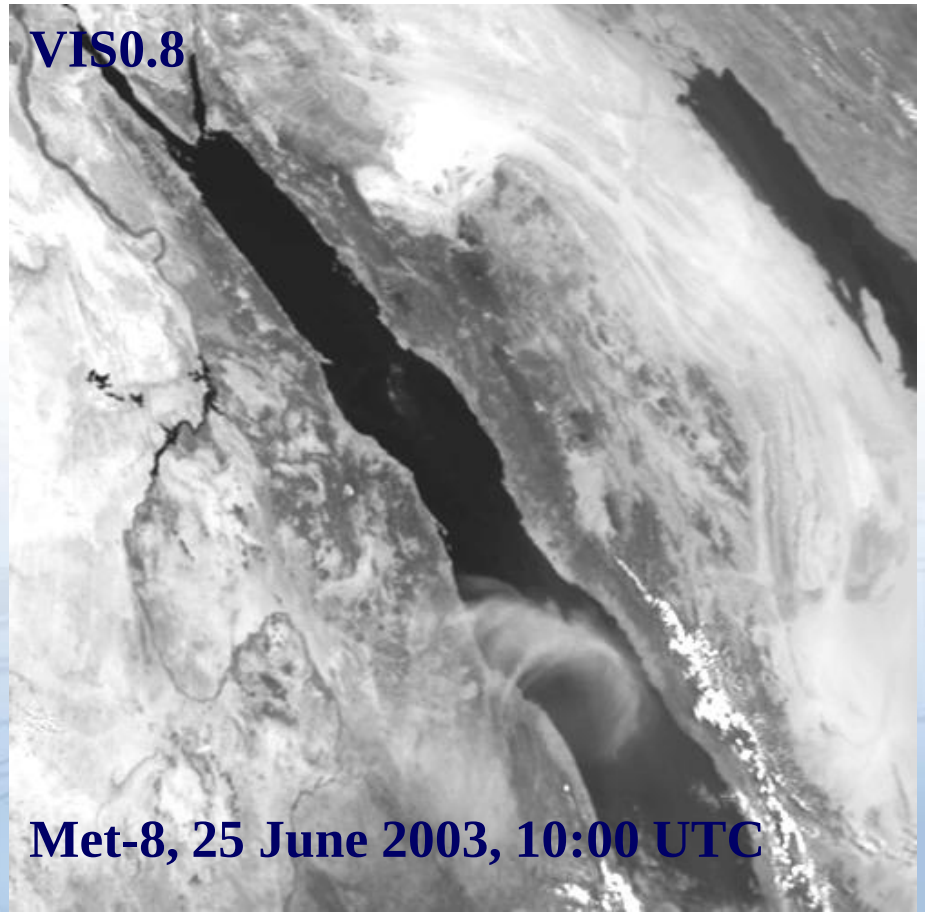
Mountain Gap Winds

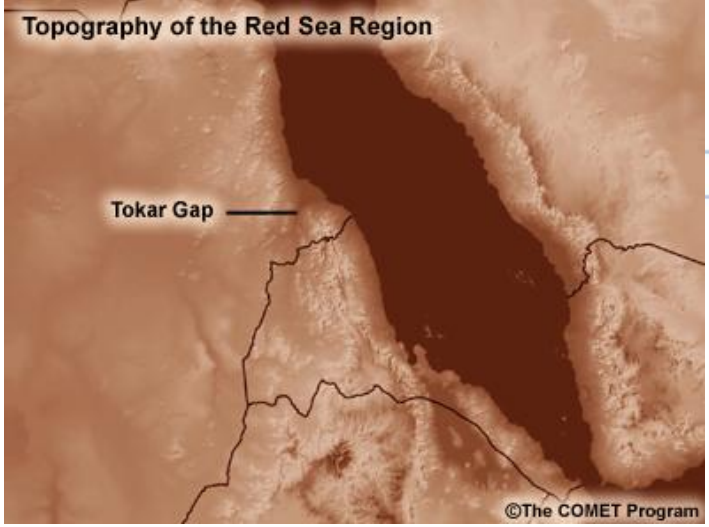


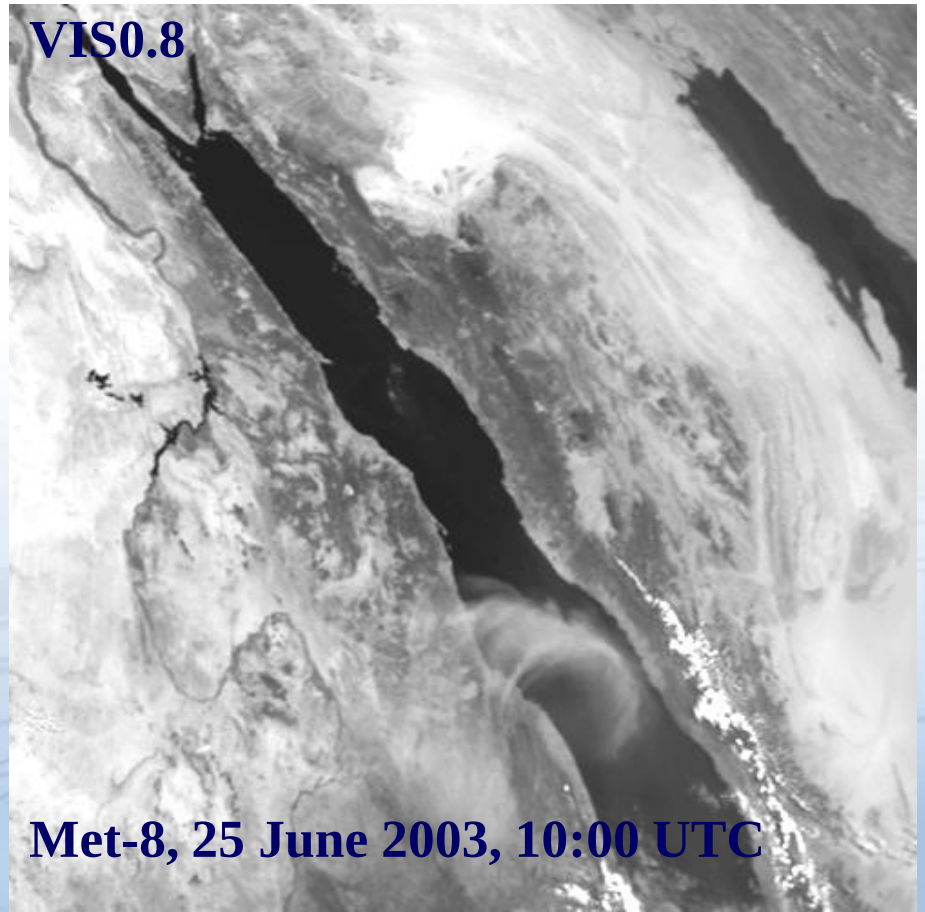
Outline the dust areas!

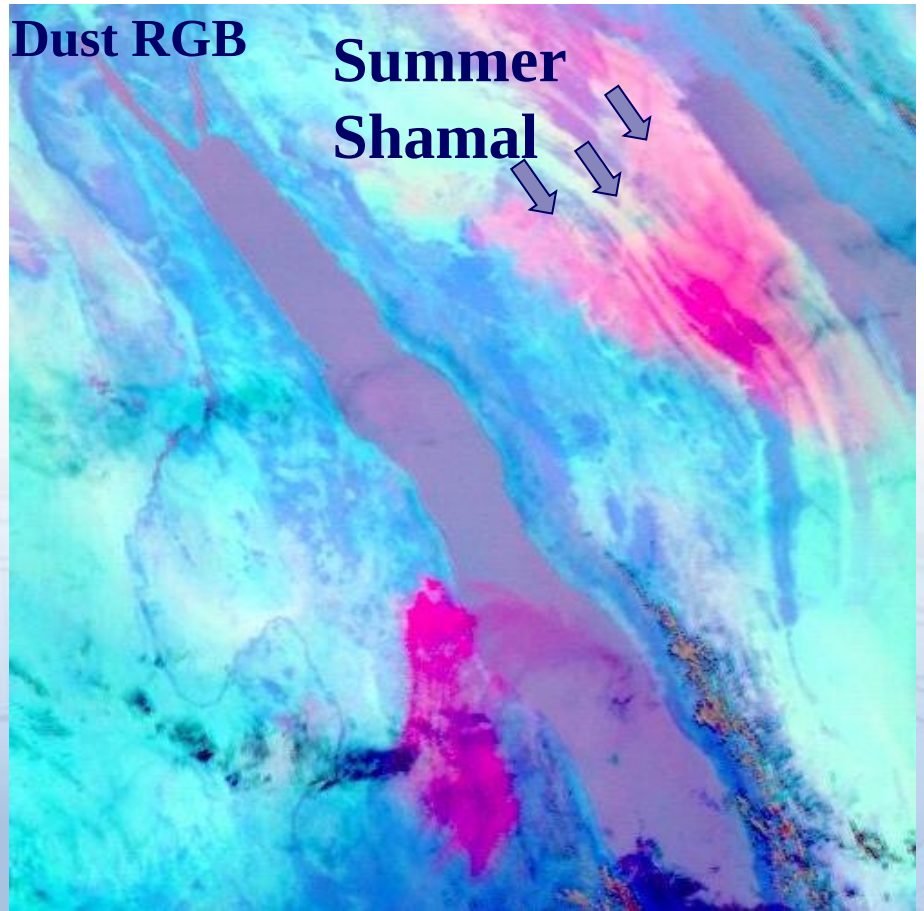


EUMETSAT

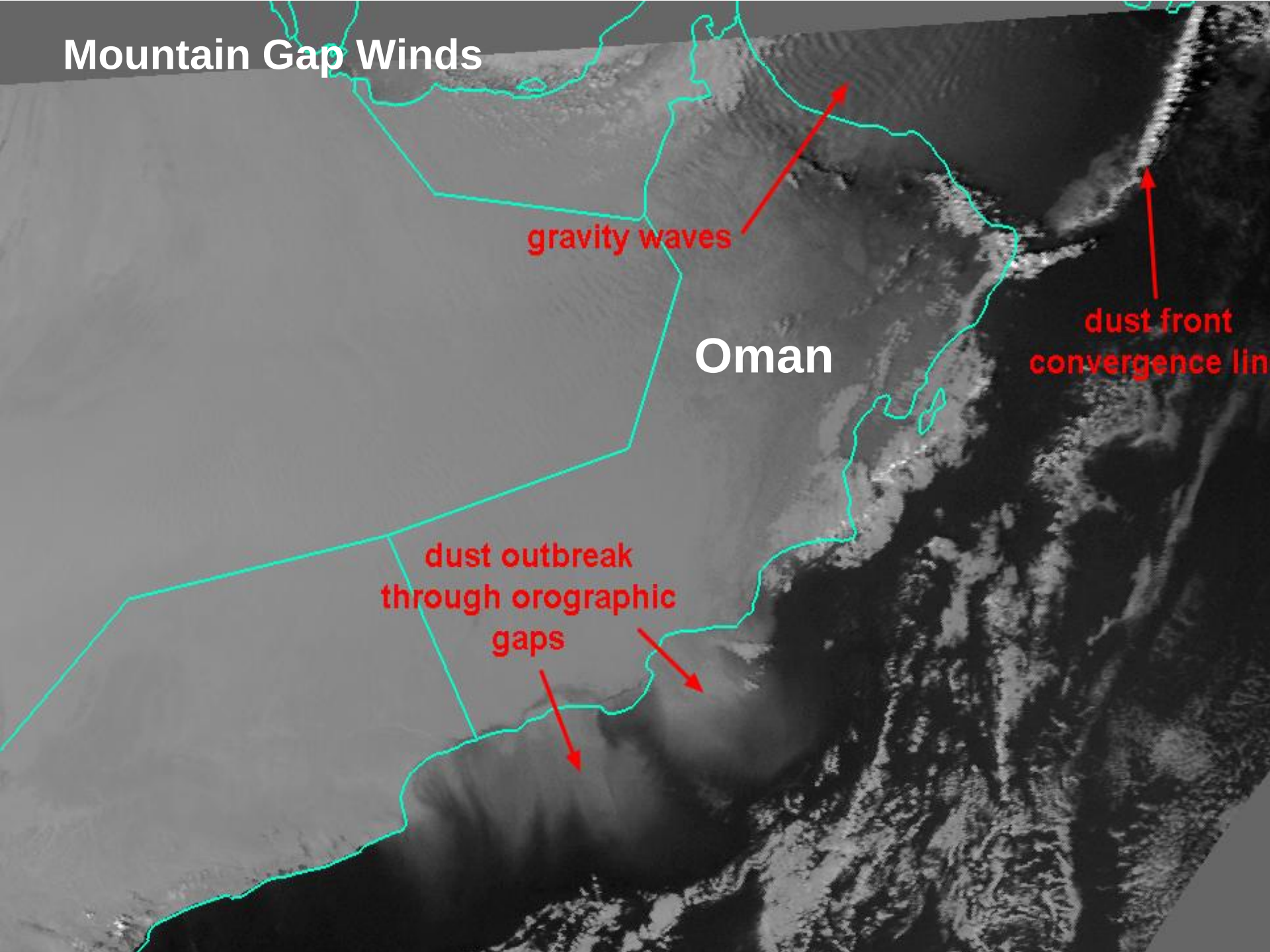
Mountain Gap Winds





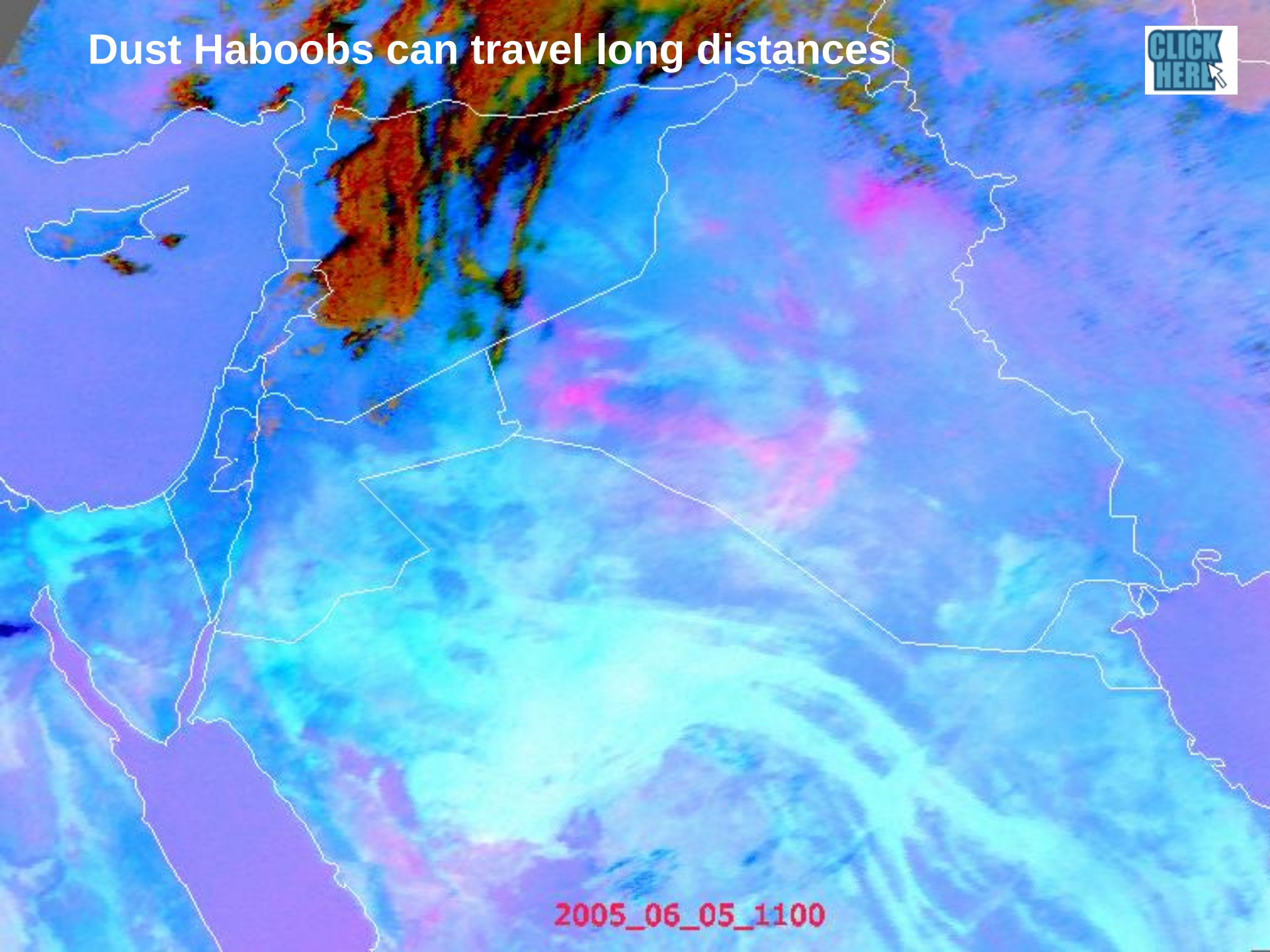


Mountain Gap Winds

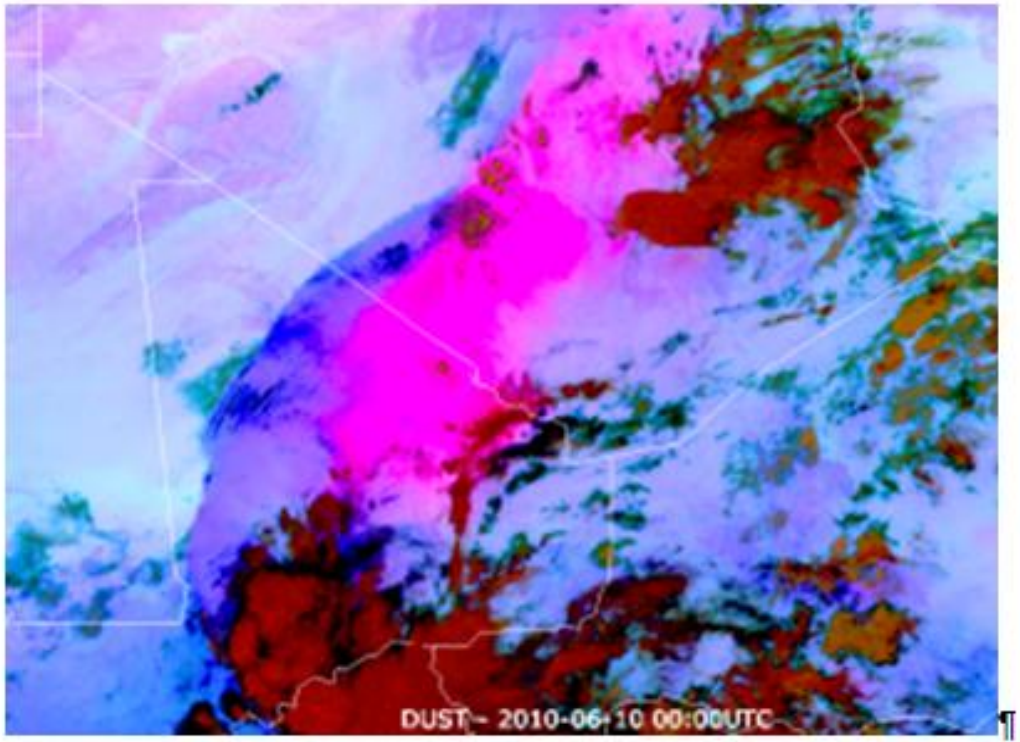



Convective Outflow Winds
(Haboobs, Dust Squalls)
MSG 2005 06 07 12:00

Dust Haboobs can travel long distances



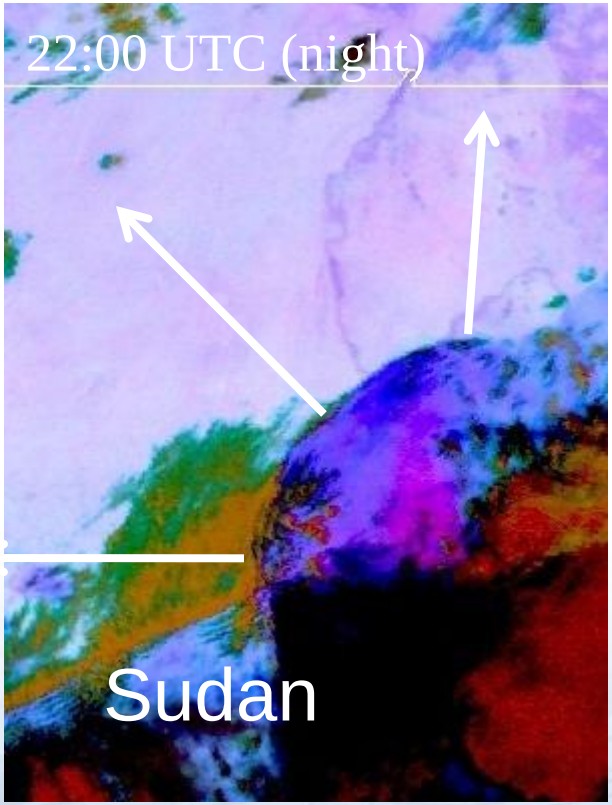
Dust Haboobs can travel long distances

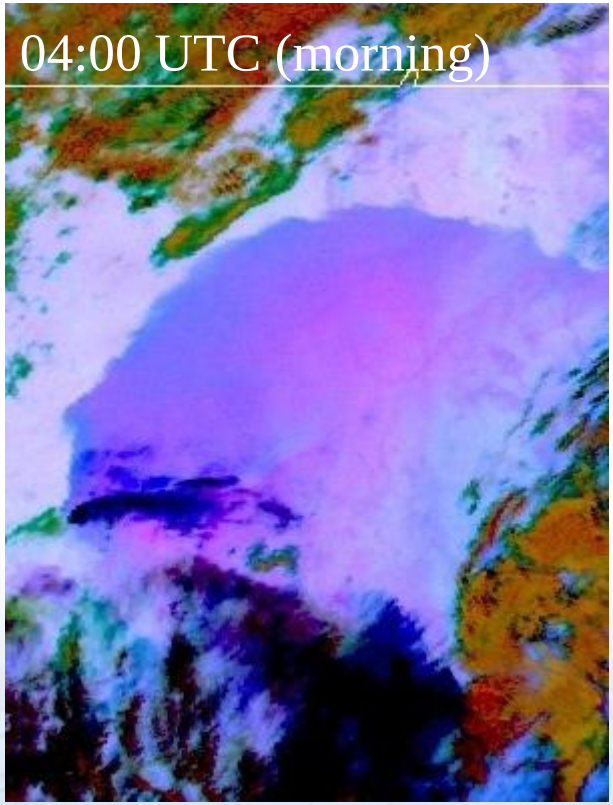


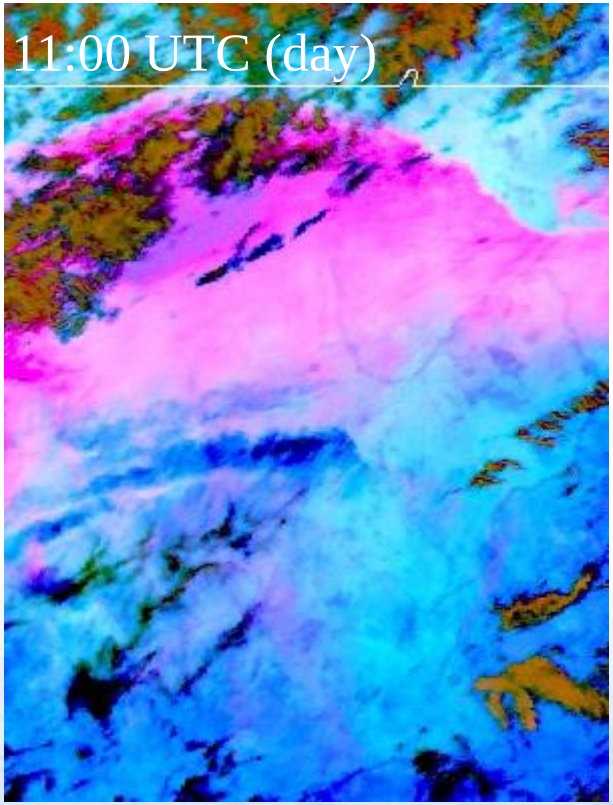
34-hour sequence of MSG (Meteosat-9) Dust RGB products on 9-10 June 2010. Source: EUMETSAT. Images created by HansPeter Roesli.

This MSG Dust RGB sequence shows a large dust squall over Niger, Mali and southern Algeria (highlight), triggered by a thunderstorm system visible in the lower part of the images, that travelled hundreds of kilometers westwards over the Sahara. This shows how long a distance strong haboobs can propagate and how well defined they can be at night. On 9 June, daytime convection lifts part of the low-lying dust higher up -- above the boundary layer -- where westerly winds carry it back in an easterly direction. The higher level dust can be seen very well in the late afternoon and night hours (highlight) by its bright magenta colour (as compared to the dark magenta colour of the low-level dust squall). Note that towards the end of this animation, the westward propagation of the dust squall slows down as it approaches a deformation zone.

Dust Haboobs can travel fast at night (undular bore?)

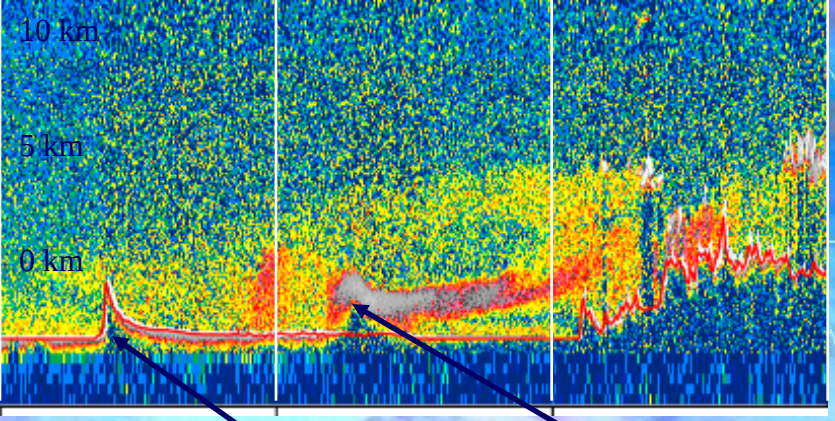






Met-8, 29-30 April 2007

EUMETSAT



14.83
55.45
South

20.93
54.06

27.03
52.59

33.11
50.99
North

< Calipso Track

27.03, 52.59

20.93, 54.06

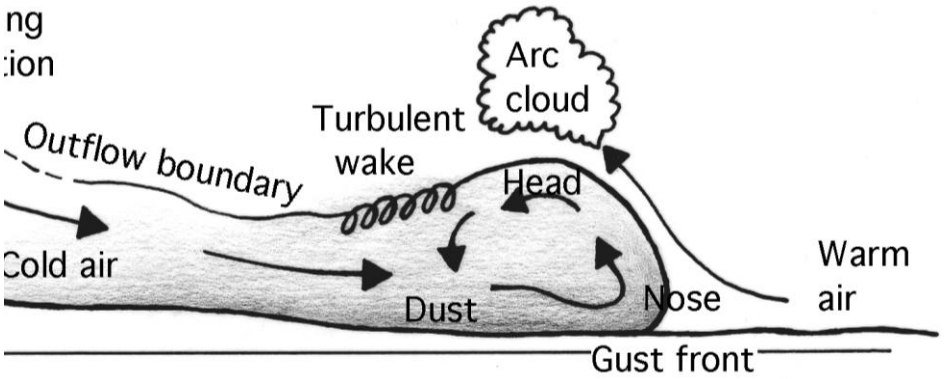
14.83, 55.45

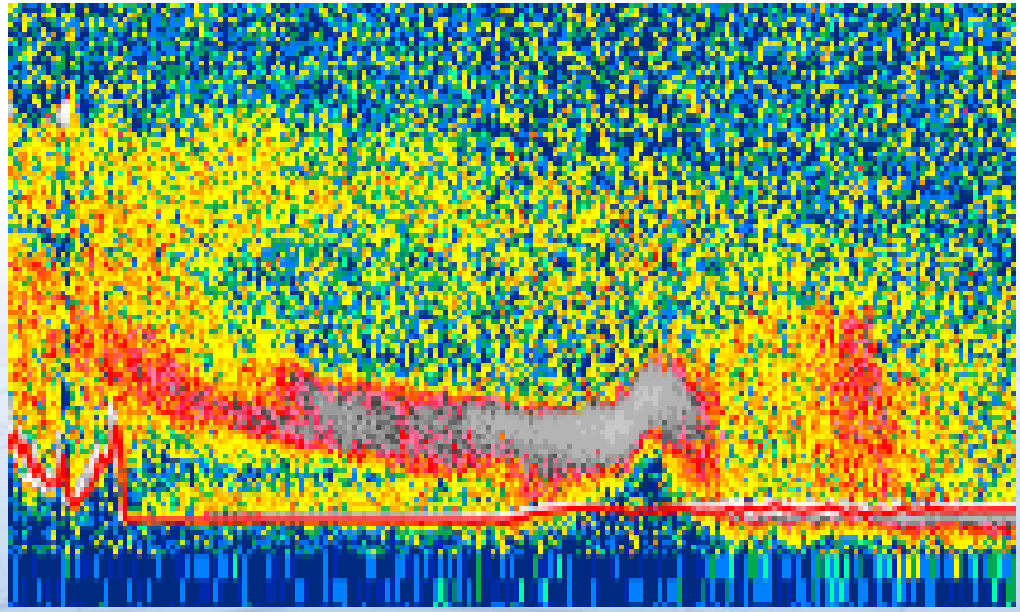
Dust Outbreak
Middle East
26 March 2011

MSG 26 Mar 2011, 10:00 UTC
CALIPSO 26 Mar 2011, 09:52 UTC

Middle East Dust Storm 26 March 2011

Conceptual Model

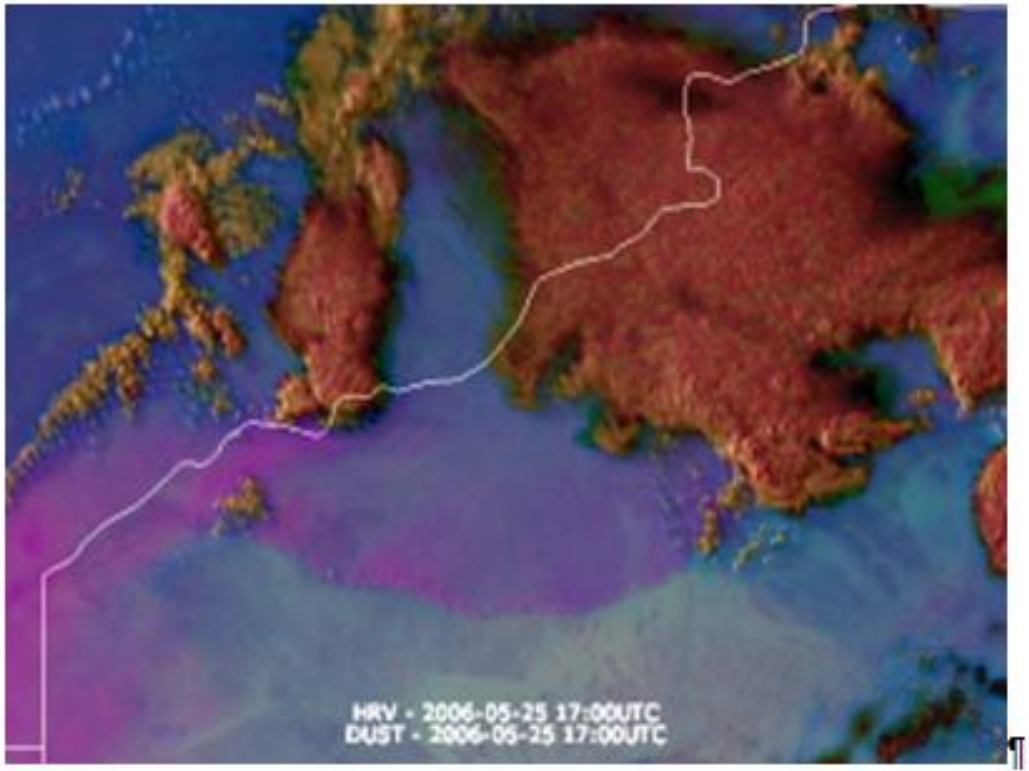




Calipso Data

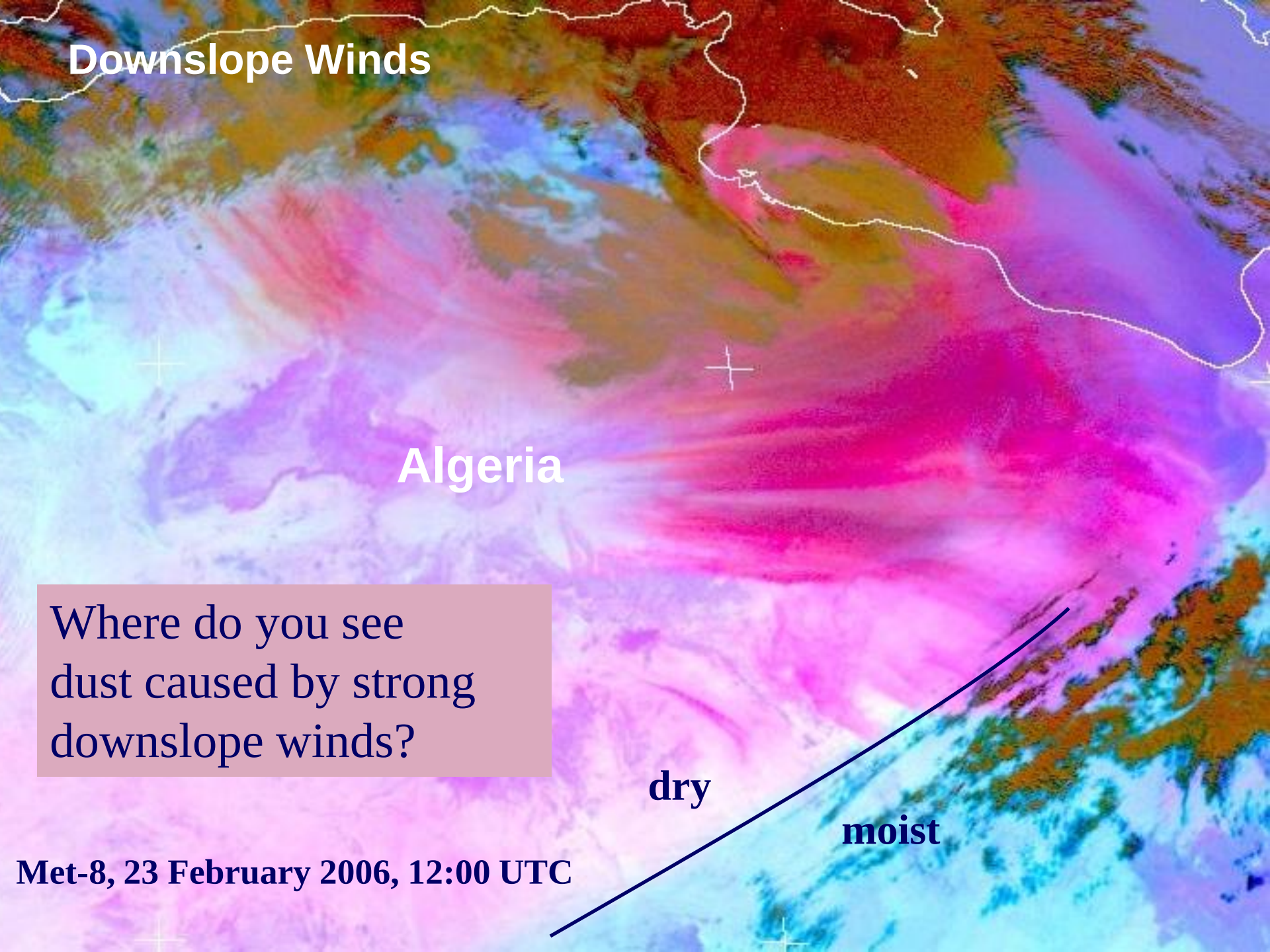
EUMETSAT

Combination of HRV & Dust RGB



5-hour sequence of MSG (Meteosat-8) blended HRV and Dust RGB products on 25 May 2006 from 12:00 to 17:00 UTC. Source: EUMETSAT. Images created by HansPeter Roesli.

Note that this animation shows the HRV / Dust RGB "sandwich product", which is an image combination of the HRV channel and the Dust RGB product, allowing one to spatially co-locate the cloud features like the storm's overshooting top and outflow boundaries (at high resolution) with the dust clouds seen in the Dust RGB (at lower resolution). During daytime, this blended product is probably the best geostationary satellite product to monitor haboobs.


Downslope Winds
Algeria
Where do you see dust caused by strong downslope winds?
dry
moist
Met-8, 23 February 2006, 12:00 UTC

SUMMARY

Summary: Key Messages 1

- 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)

Summary: Key Messages 2

- Dust changes cloud microphysics
- Mesoscale dust outbreaks cannot be forecasted with dust model (satellite data!)
- HRV / Dust RGB blended product very useful during daytime
- Haboobs can travel very fast at night!

Thank you for your attention !

More info: www.eumetsat.int