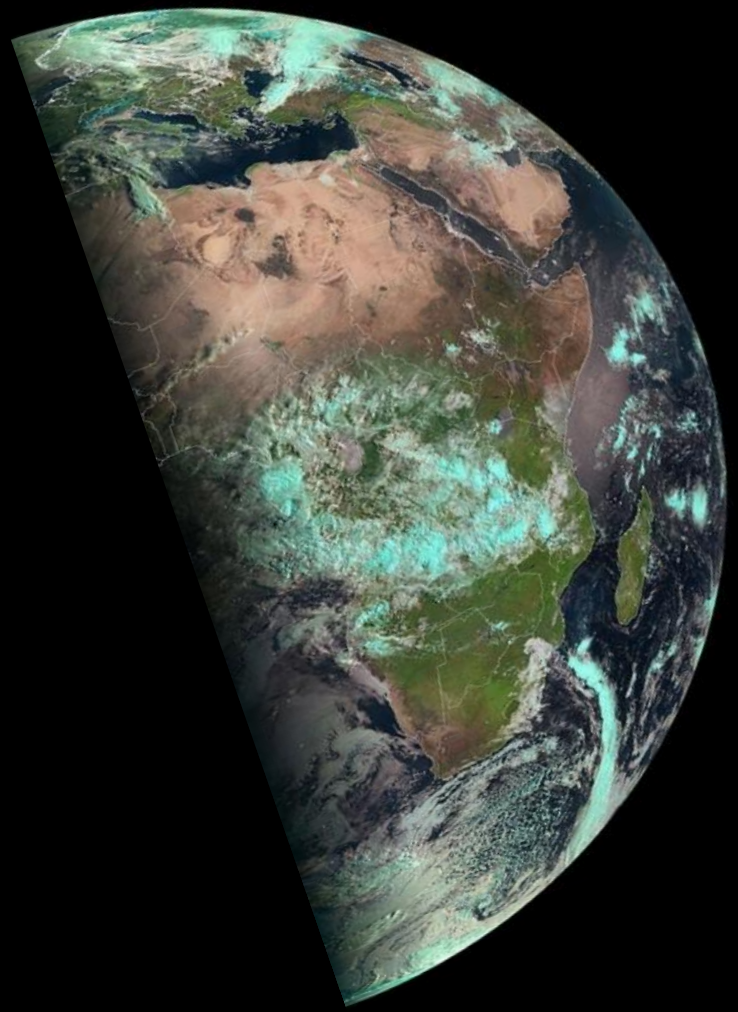
ابراهيم آل عبد السلام

مدير مركز الامتياز لتطبيقات الأقمار الاصطناعية- مسقط

Ibrahim.AbdulSalam@caa.gov.om



RGB images

RGB products

RGB composites

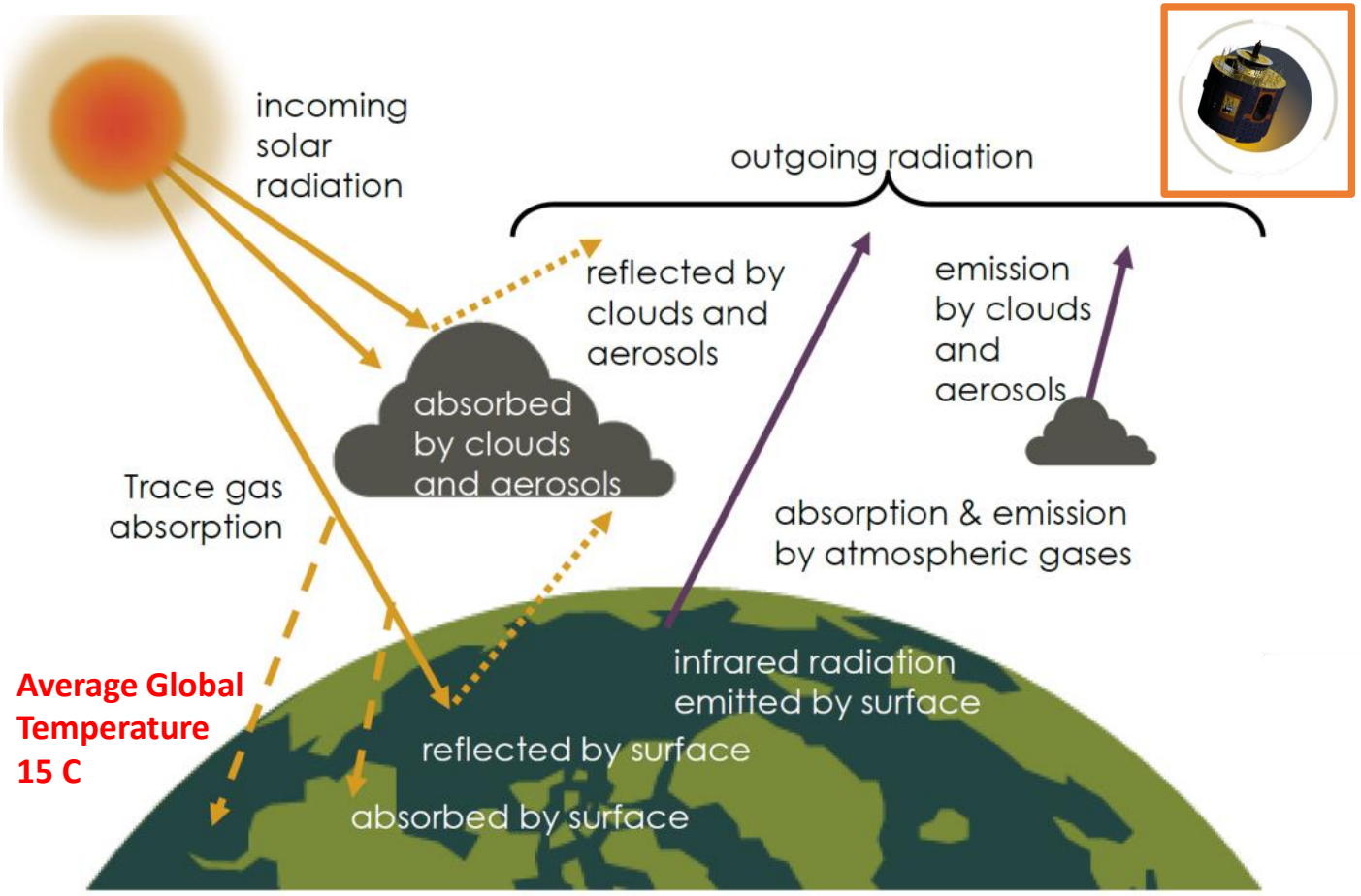
Electromagnetic radiation

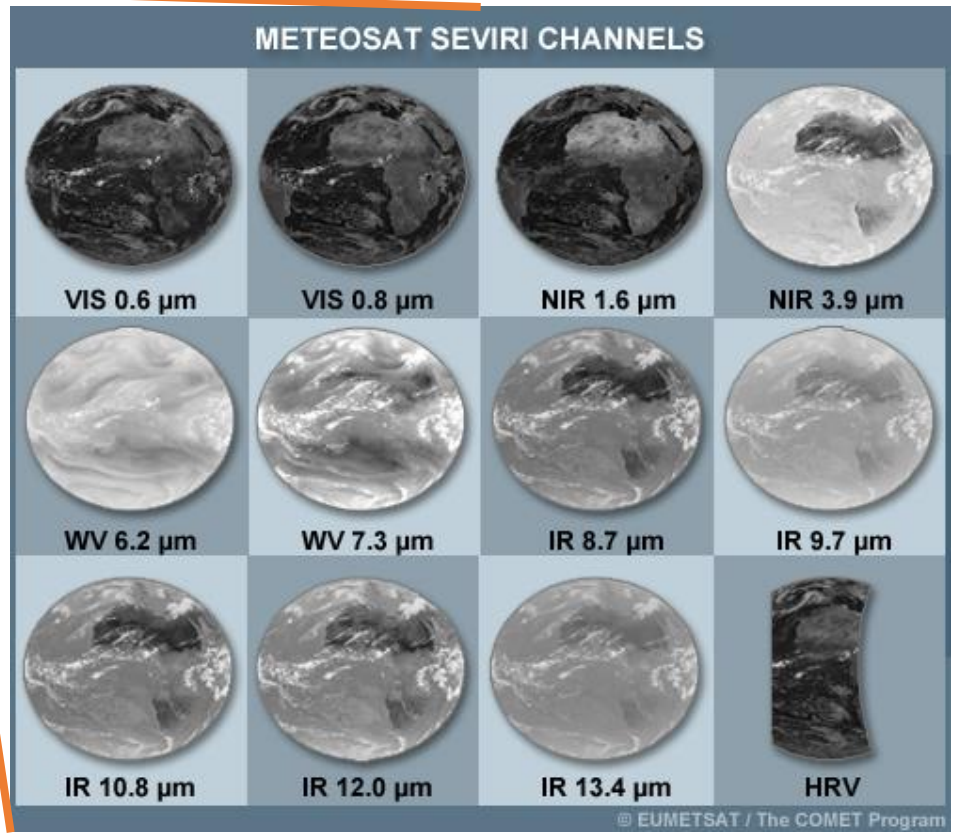
Sun

and

Earth's Atmosphere and Surfaces!

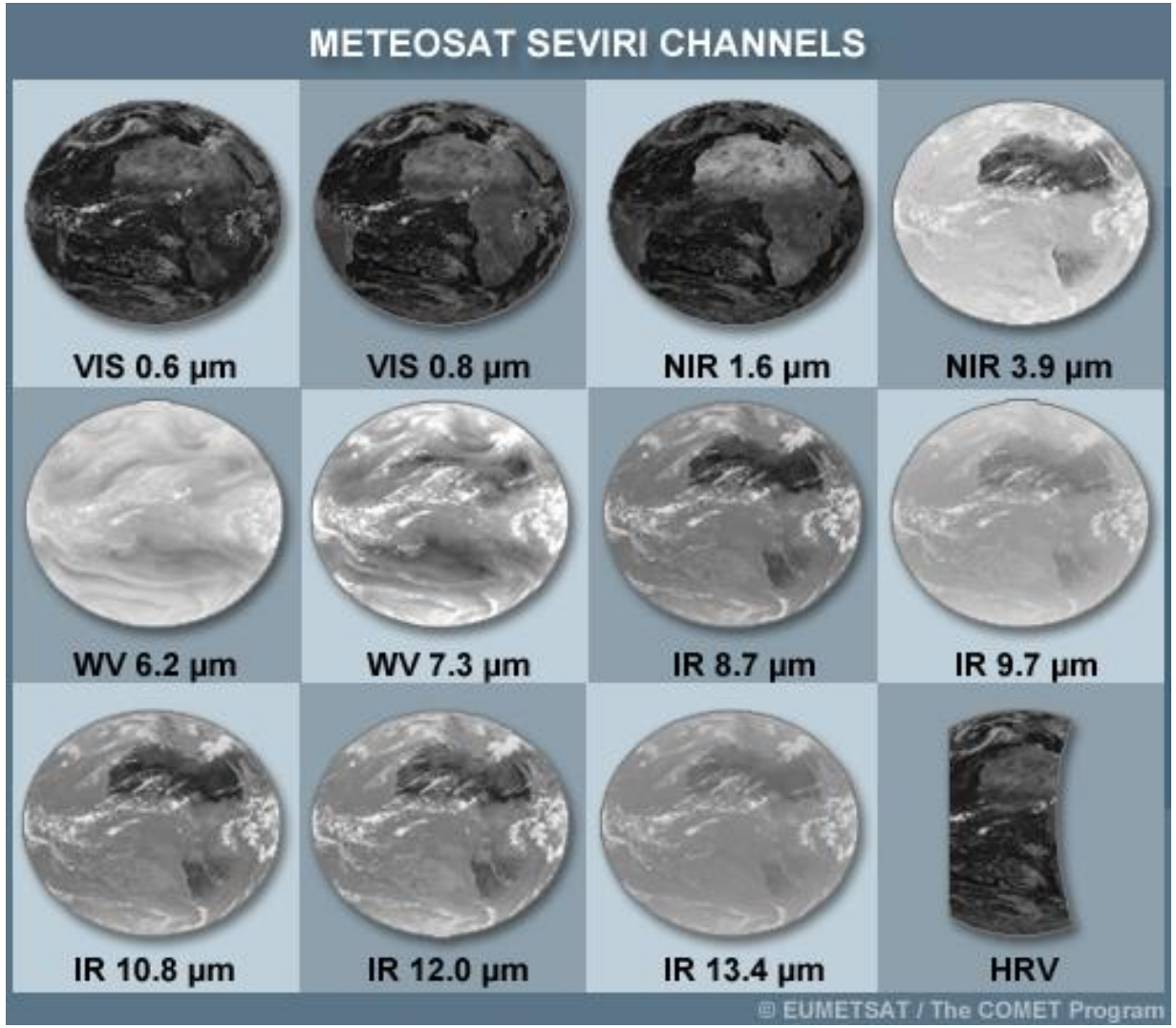
Electromagnetic radiation: Sun , Earth's Atmosphere and Surface





Credit: https://tinyurl.com/HEISatelliteWorkshop

SEVIRI Channels (Spinning Enhanced Visible and Infrared Imager)



- Satellite imaging instrument can have **different channels**
- Each sensing **distinct electromagnetic bands**
- Reveal the different **spectral signatures** of atmospheric and surface features.
- There are several advantages to using these channels **individually**.

slido

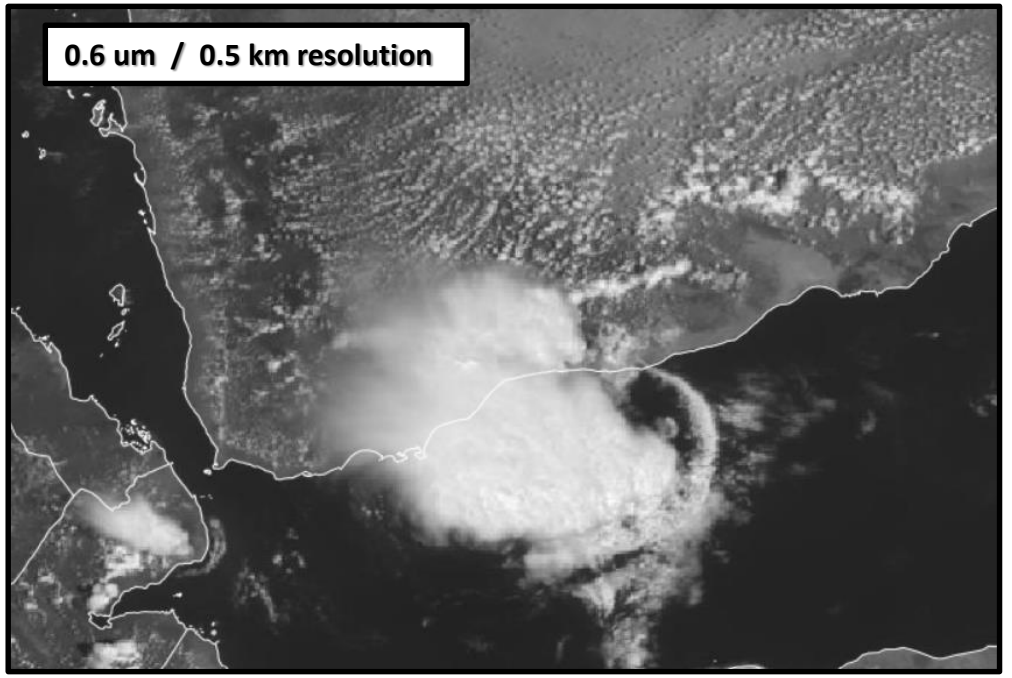
ما هي مزايا استخدام القنوات بشكل فردي؟

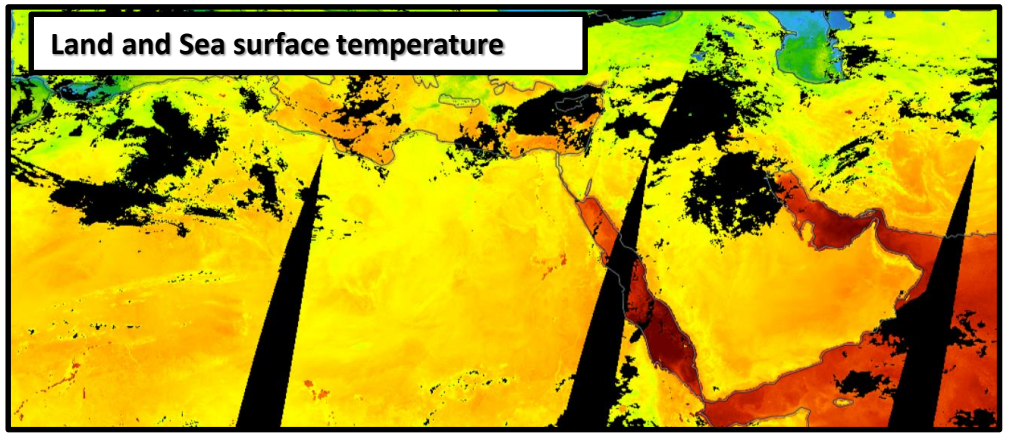
What are the advantages of using individual channels?

- **Feature Detection (in some cases , some features)**
- **Higher Spatial Resolution !**
- **Quantitative Analysis**

  - Temperature Measurement
  - Surface Reflectance and solar insulation

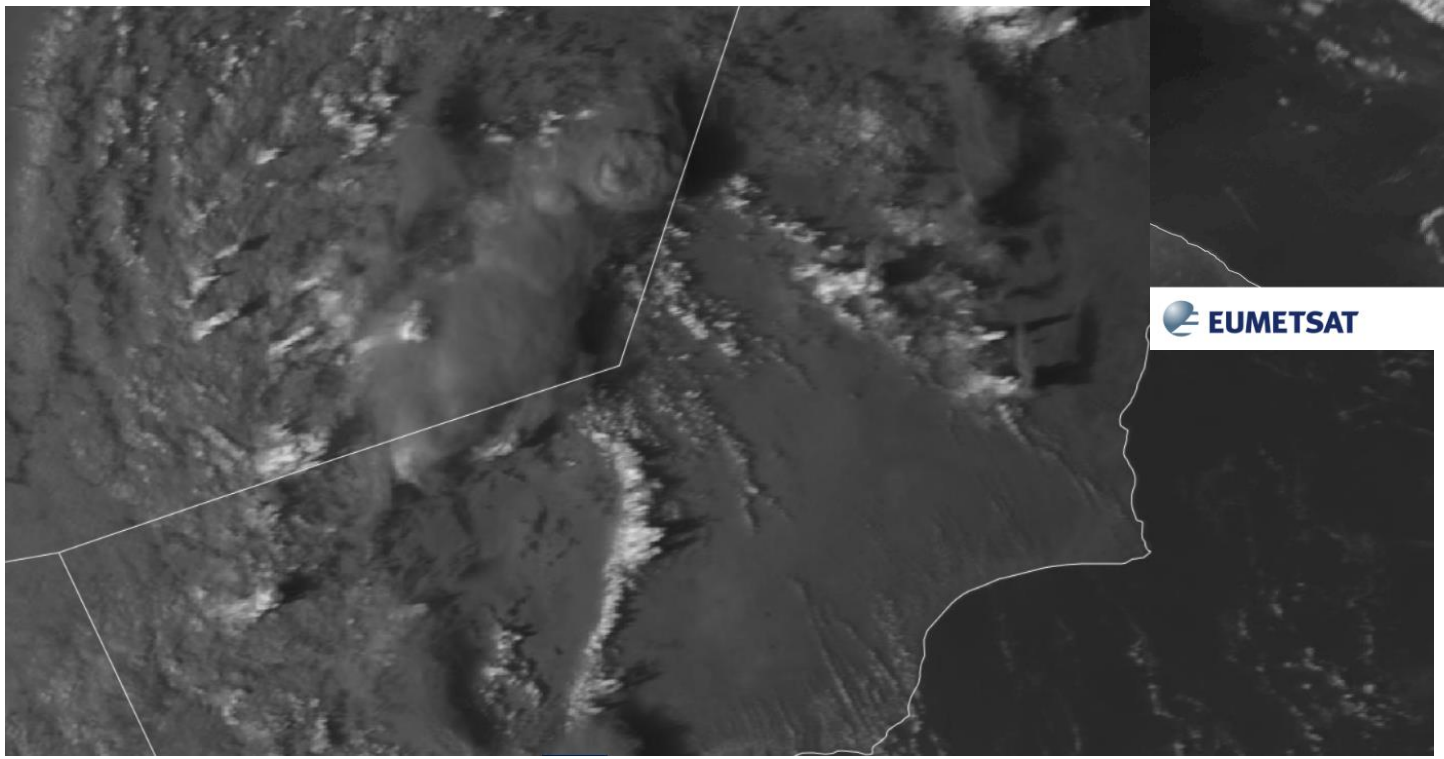
- **Historical Comparisons,**
  Climate Studies and climate change
- **Lower Computational Demand (Quick View)**

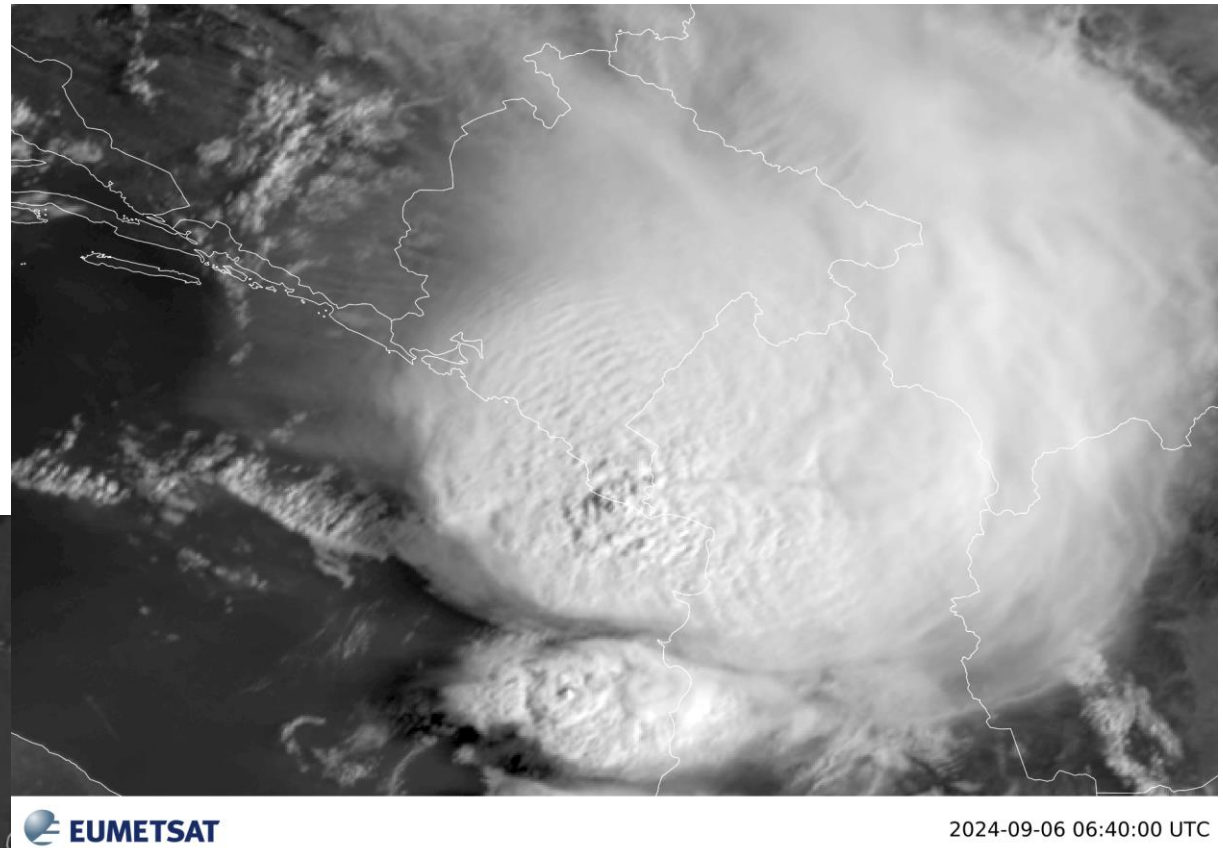




Feature Identification

Visible Image 0.6 um : Cloud top features like over shooting above anvil features , Storm Stages





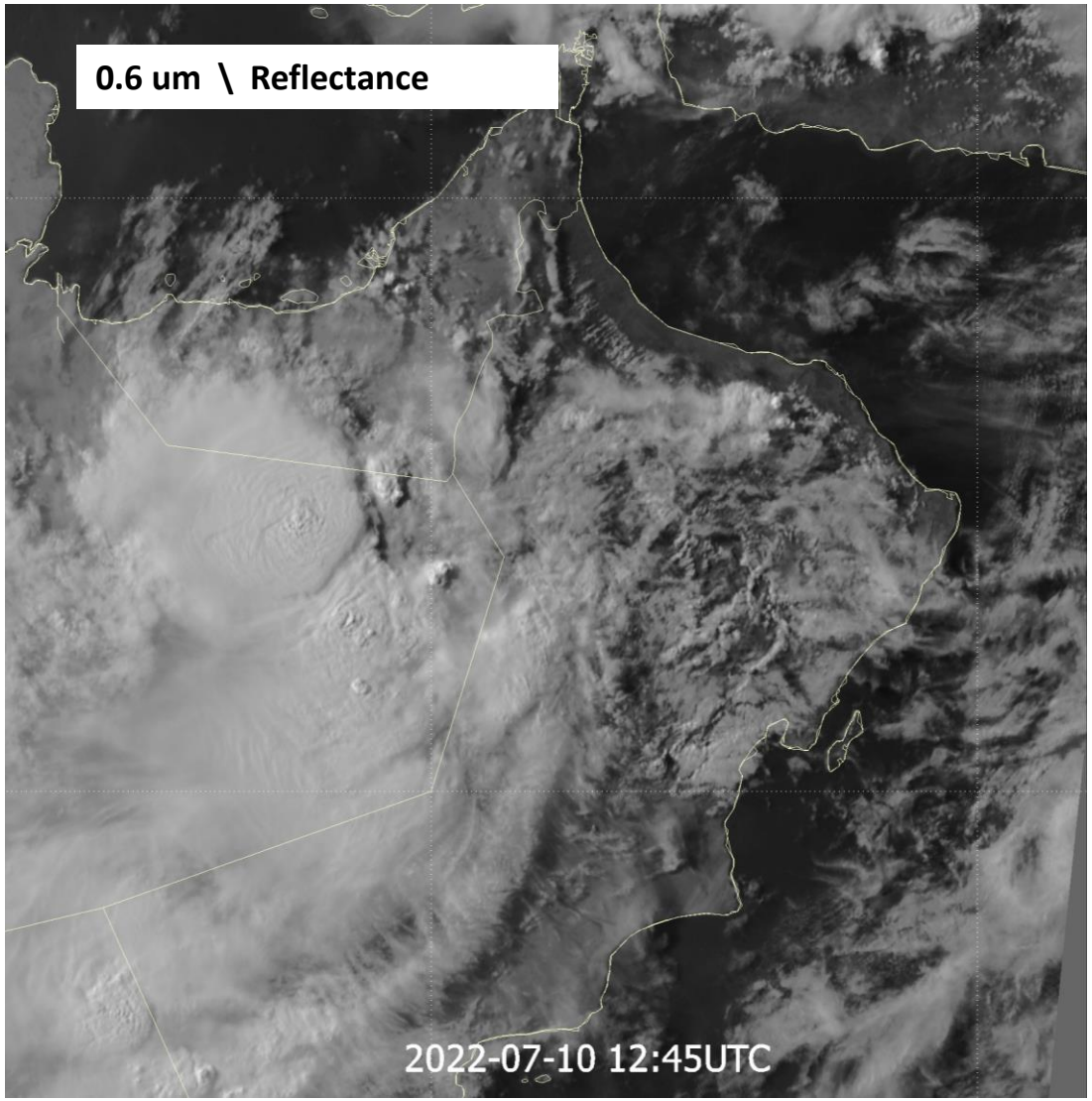
- **Some Satellite can have limited number of High spatial resolution channels !**

Range of reflectance (From sensor)
0 to 100 % (كمية الاشعاع \ عدد الفوتونات)
0 to 255 degree of shade

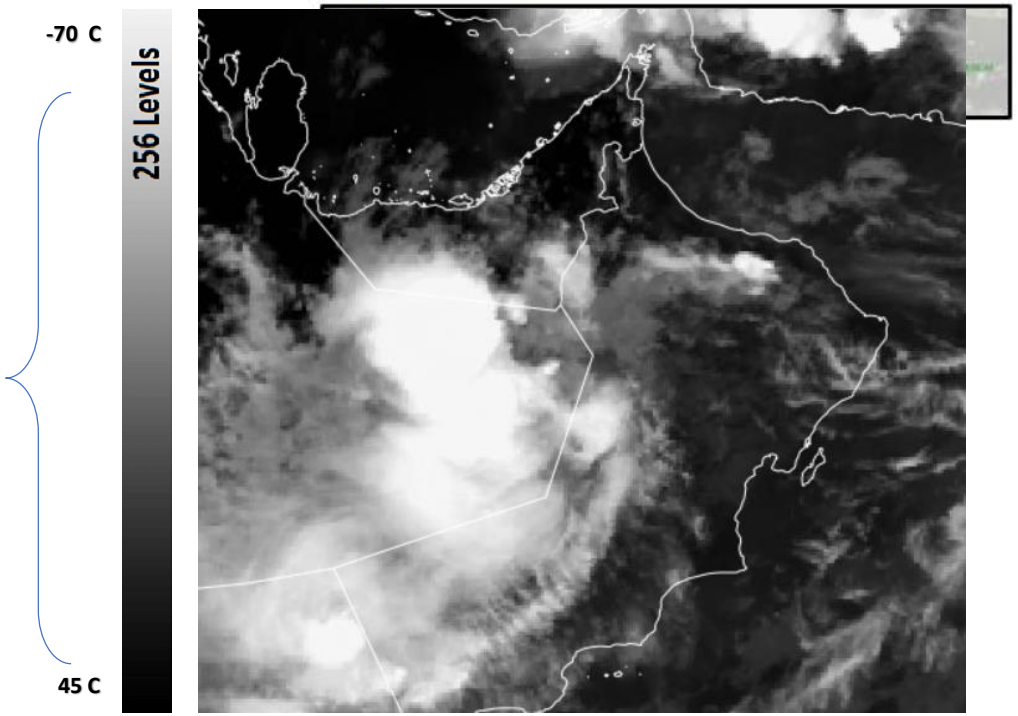
Think about Radiometric Resolution!

Feature Identification

Visible Image 0.6 um :
Cloud top features like over shooting above anvil features , Storm Stages and gravity waves and turbulence



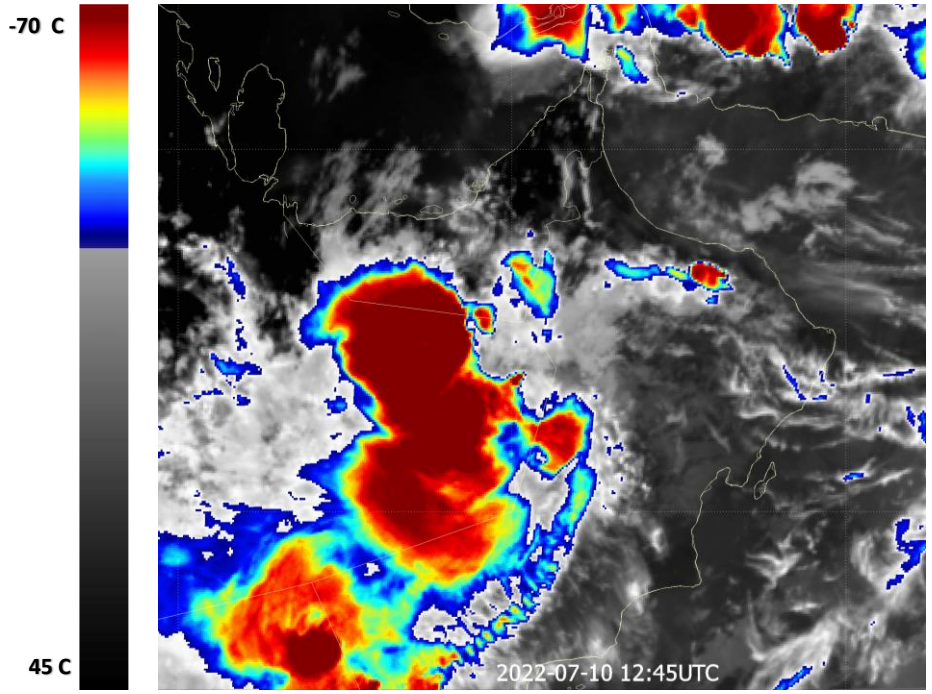
Giving a range of temperature (for example: 45 to -70) 0 to 255 degree of shade

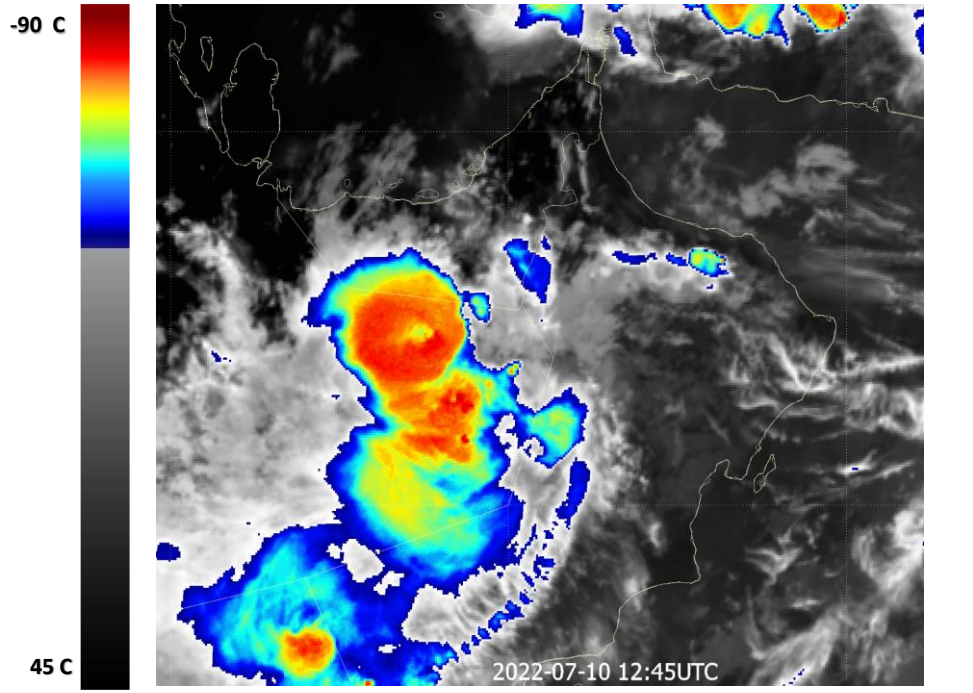


Feature Identification

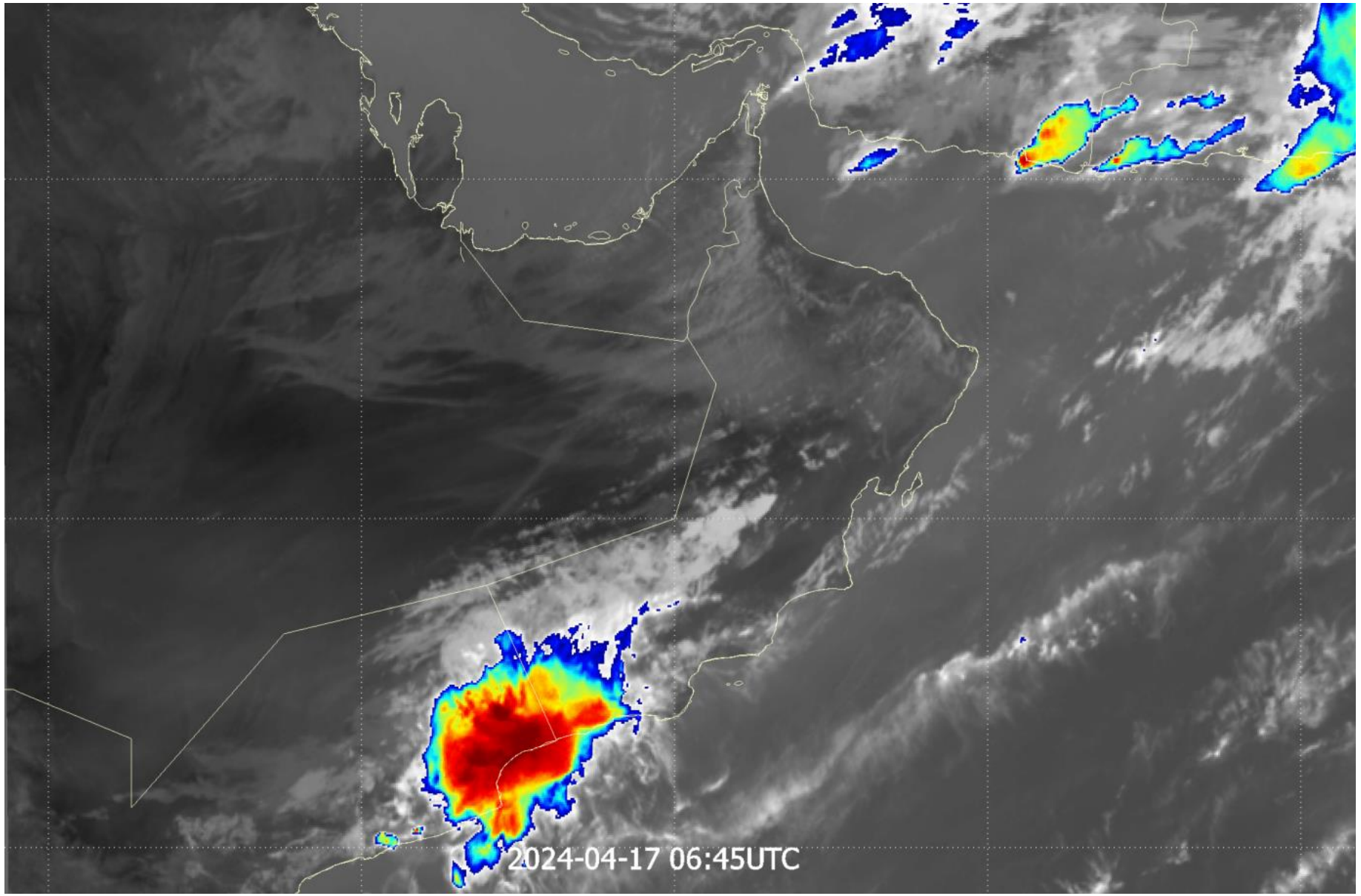
IR 10.8:

- Cloud Top Temperature , above anvil features , Storm Stages ….

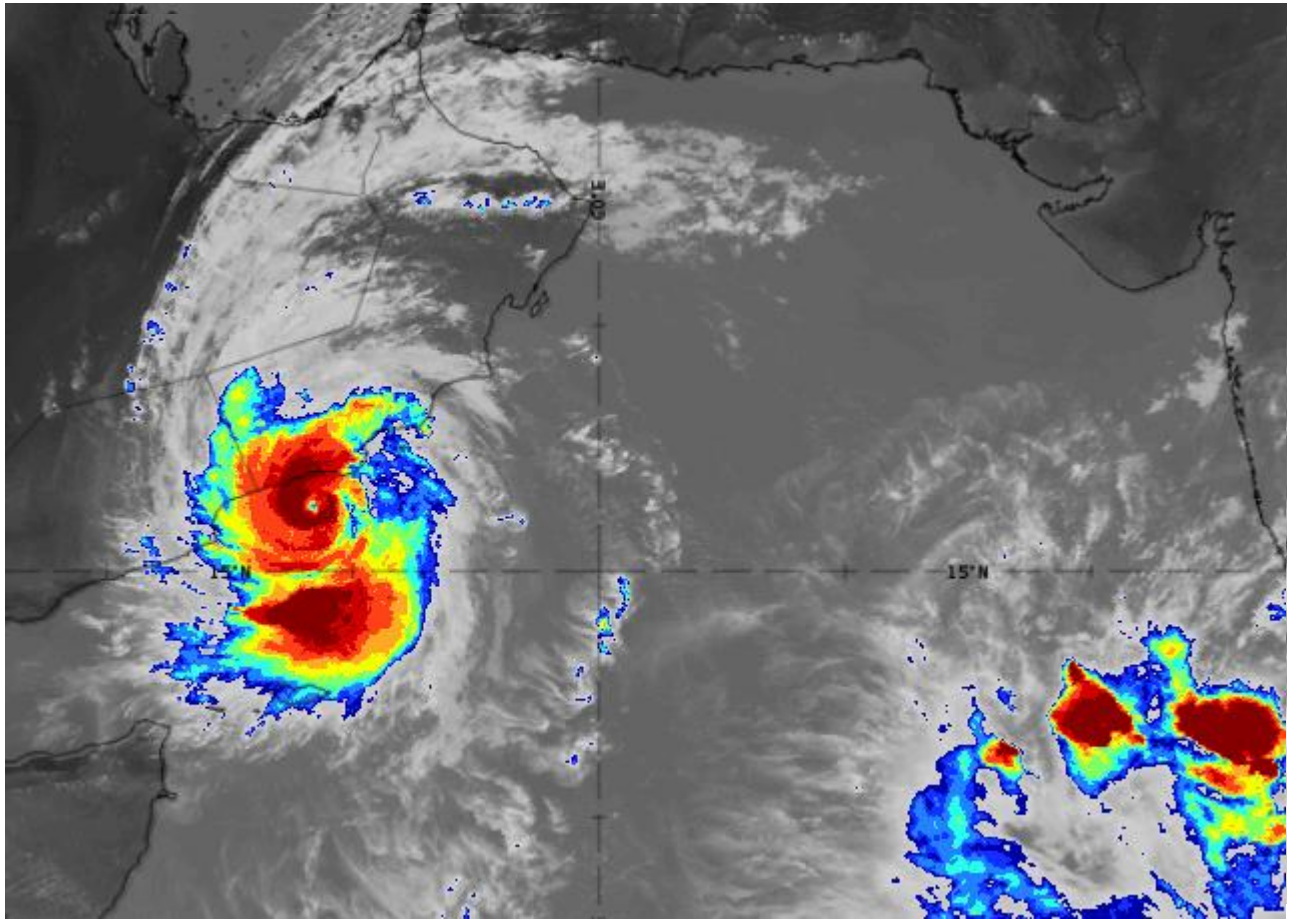




What do you see in this image?

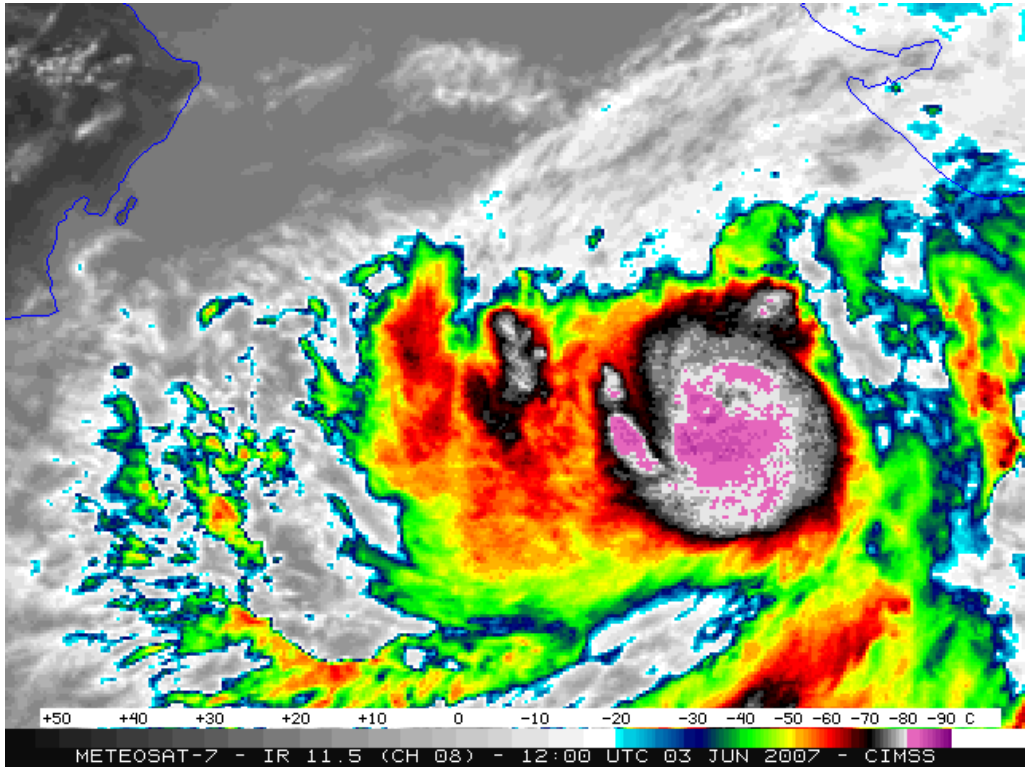


Color enhancement of single channels

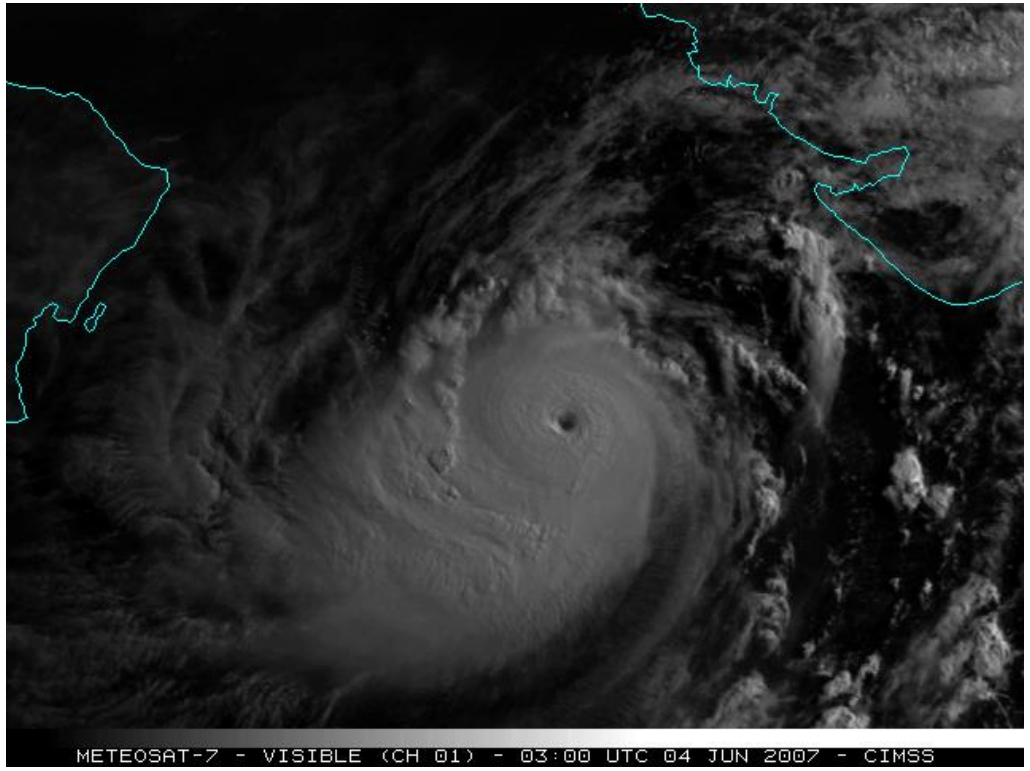


Tropical Cyclone Gonu

Colour Enhanced IR Image Animation



Visible Channel Animation

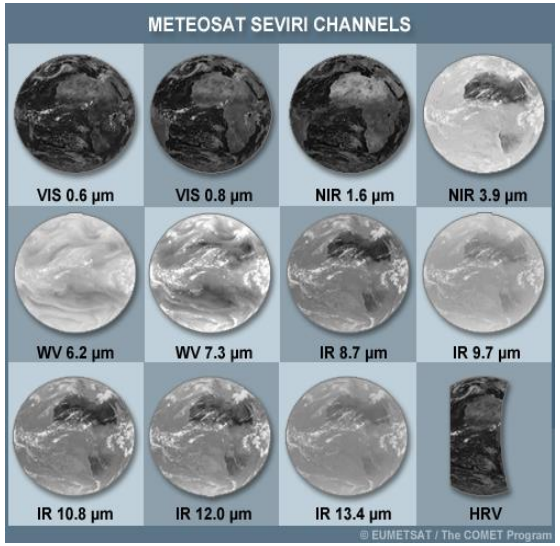


So, there are many advantages of using individual channels

However!

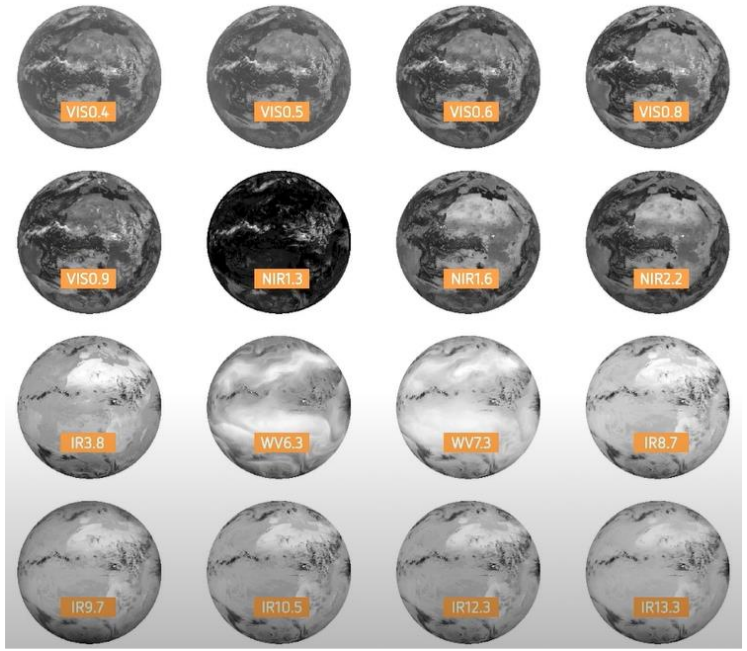
They are too many for a forecaster to deal with ,individually

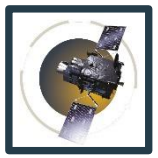
Channel	Centre wavelength (µm)	Range (µm)	Sampling distance at subsatellite point (km)
VIS0.6	0.635	0.56 – 0.71	3
VIS0.8	0.81	0.74 – 0.88	3
NIR1.6	1.60	1.50 – 1.78	3
IR3.9	3.92	3.48 – 4.36	3
WV6.2	6.25	5.35 – 7.15	3
WV7.3	7.35	6.85 – 7.85	3
IR8.7	8.70	8.30 – 9.10	3
IR9.7	9.66	9.38 – 9.94	3
IR10.8	10.80	9.80 – 11.80	3
IR12.0	12.00	11.00 – 13.00	3
IR13.4	13.40	12.40 – 14.40	3
HRV	(broadband)	0.5 – 0.9	1



MSG

Spectral Channel	Central Wavelength, λ_0 (µm)	Spectral Width, $\Delta\lambda_0$ (µm)	On-ground spatial sampling distance (km)
VIS 0.4	0.444	0.060	1.0
VIS 0.5	0.510	0.040	1.0
VIS 0.6	0.640	0.050	1.0 / 0.5
VIS 0.8	0.865	0.050	1.0
VIS 0.9	0.914	0.020	1.0
NIR 1.3	1.380	0.030	1.0
NIR 1.6	1.610	0.050	1.0
NIR 2.2	2.250	0.050	1.0 / 0.5
IR1 3.8	3.800	0.400	2.0 / 1.0
IR1 6.3	6.300	1.000	2.0
IR1 7.3	7.350	0.500	2.0
IR2 8.7	8.700	0.400	2.0
IR2 9.7	9.660	0.300	2.0
IR3 10.5	10.500	0.700	2.0 / 1.0
IR3 12.3	12.300	0.500	2.0
IR3 13.3	13.300	0.600	2.0





MTG

- It is more **challenging** to compare channels to identify features and complex phenomena.

  Many features and phenomena are hidden / not visible in single channels.

- Forecaster needs a Comprehensive View to make quicker dictions and take actions.

We need to combine images / merge channels!

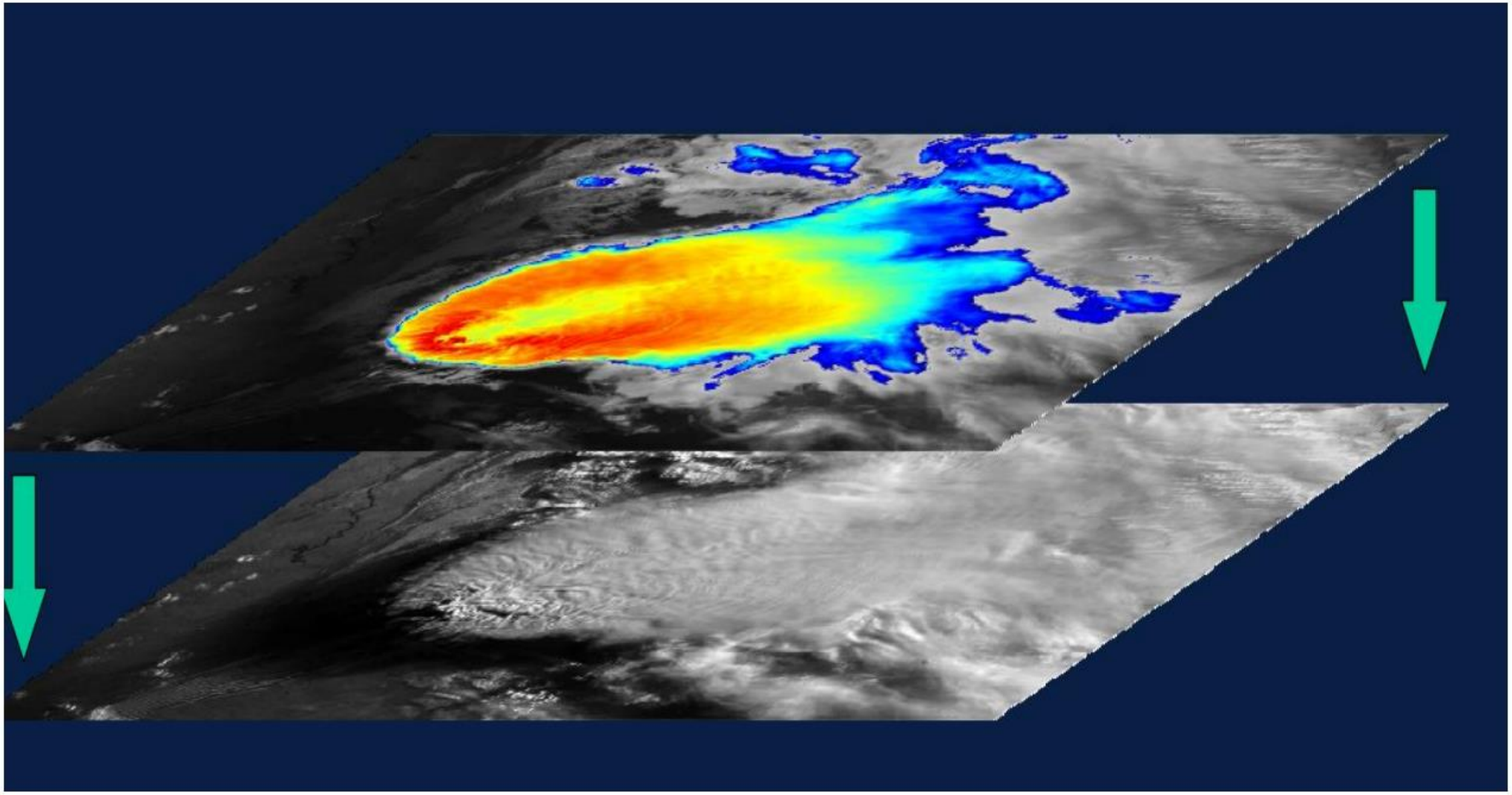
Very Good Approach!

To place

Transparent, Color Enhanced IR

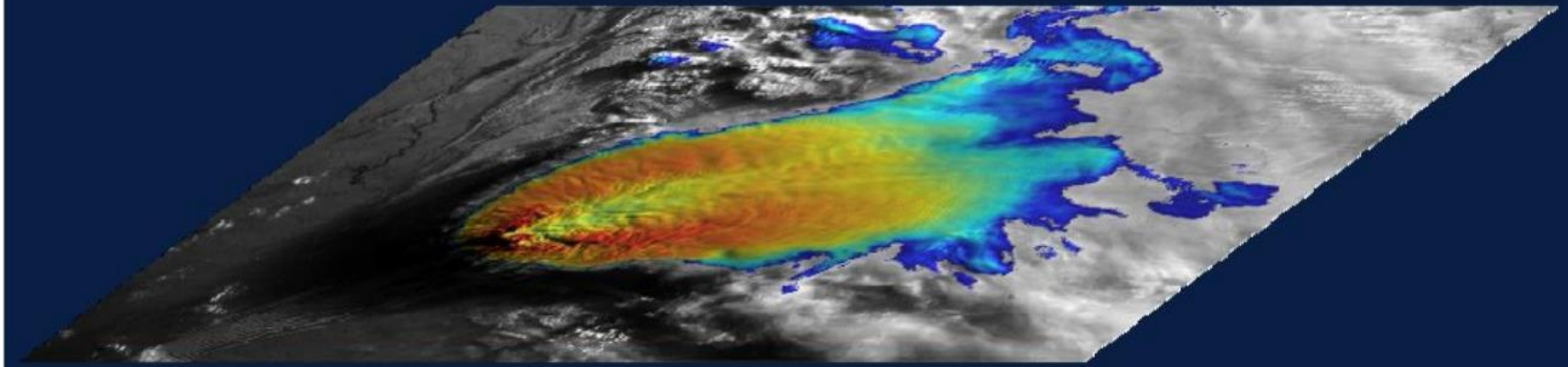
On top of

Visible



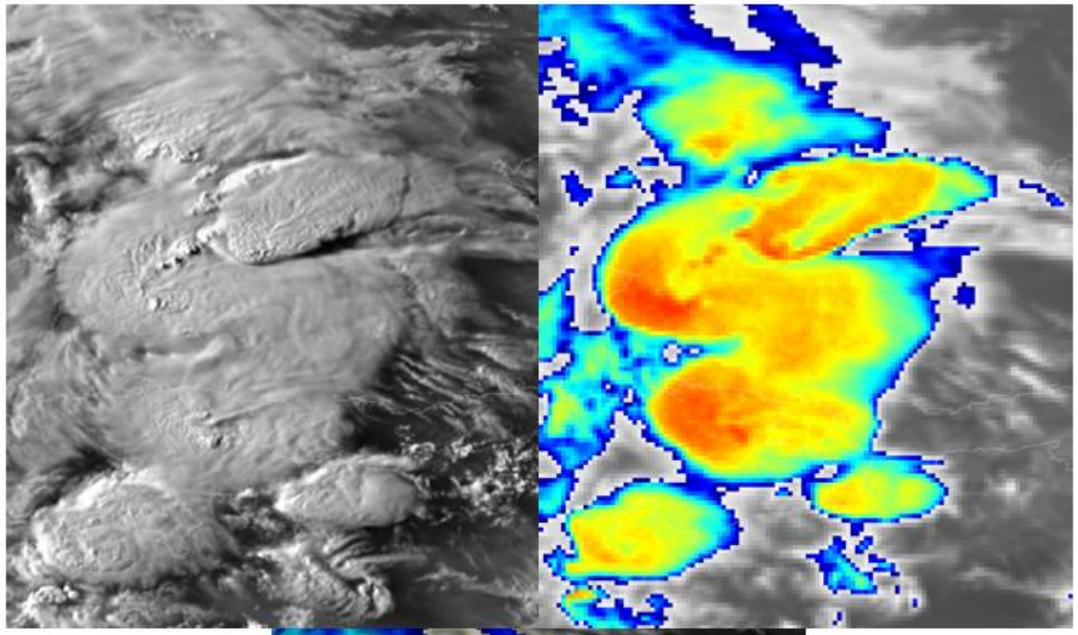
Credit : EUMETSAT

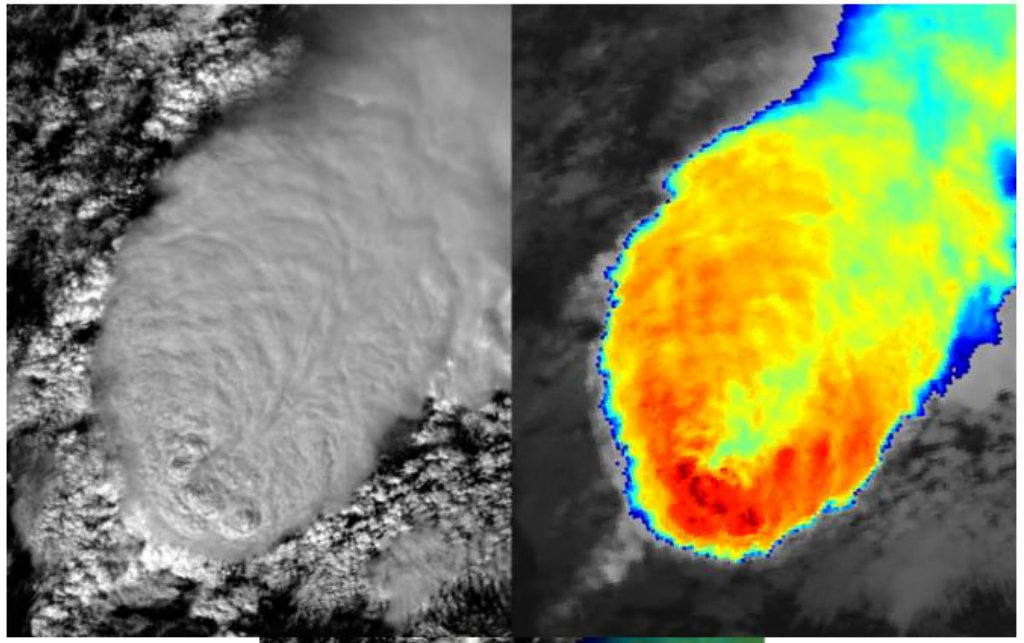
Sandwich Products

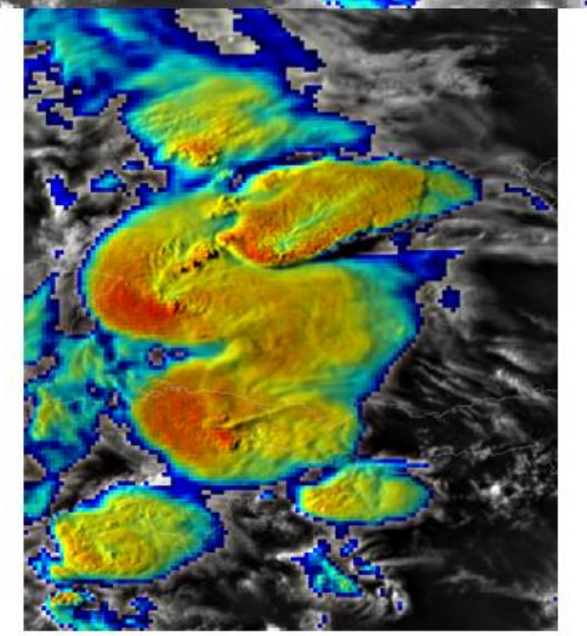


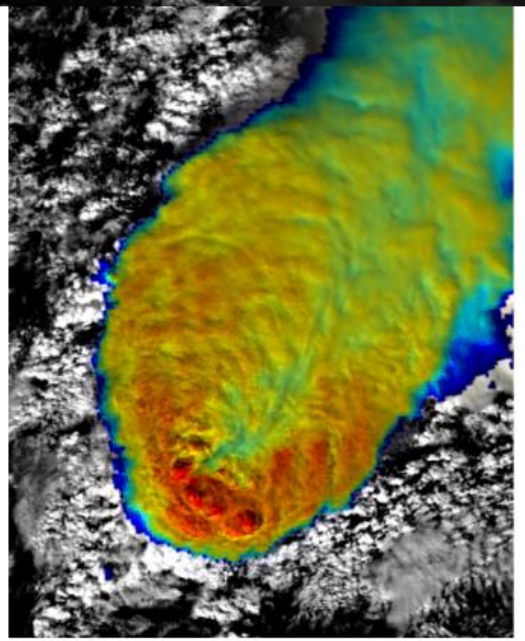
Credit : EUMETSAT

Allowing observation many important features simultaneously, in one single product.







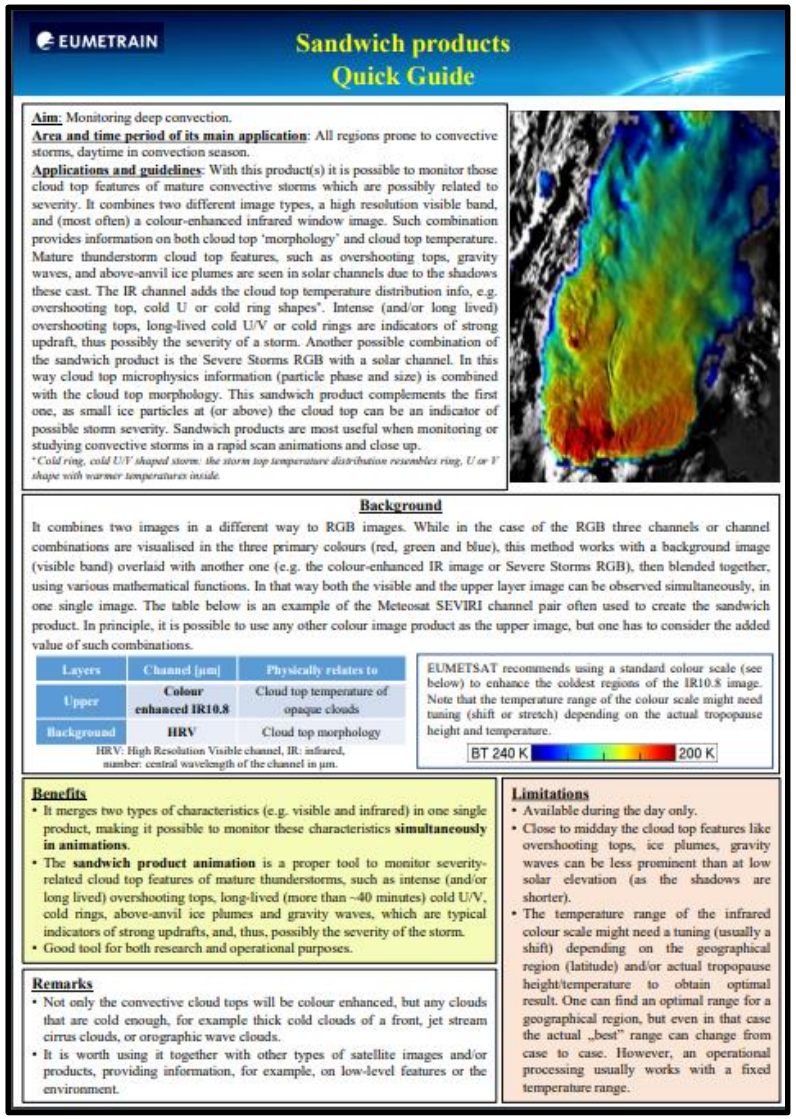


Credit : EUMETSAT

More Details:

https://resources.eumetrain.org/data/5/507/navmenu.php?tab=5&page=1.0.0

Quick Guide



EUMETRAIN

Sandwich products Quick Guide

Aim: Monitoring deep convection.

Area and time period of its main application: All regions prone to convective storms, daytime in convection season.

Applications and guidelines: With this product(s) it is possible to monitor those cloud top features of mature convective storms which are possibly related to severity. It combines two different image types, a high resolution visible band, and (most often) a colour-enhanced infrared window image. Such combination provides information on both cloud top 'morphology' and cloud top temperature. Mature thunderstorm cloud top features, such as overshooting tops, gravity waves, and above-anvil ice plumes are seen in solar channels due to the shadows these cast. The IR channel adds the cloud top temperature distribution info, e.g. overshooting top, cold U or cold ring shapes*. Intense (and/or long lived) overshooting tops, long-lived cold U/V or cold rings are indicators of strong updraft, thus possibly the severity of a storm. Another possible combination of the sandwich product is the Severe Storms RGB with a solar channel. In this way cloud top microphysics information (particle phase and size) is combined with the cloud top morphology. This sandwich product complements the first one, as small ice particles at (or above) the cloud top can be an indicator of possible storm severity. Sandwich products are most useful when monitoring or studying convective storms in a rapid scan animations and close up.

** Cold ring, cold U/V shaped storm: the storm top temperature distribution resembles ring, U or V shape with warmer temperatures inside.*

Background

It combines two images in a different way to RGB images. While in the case of the RGB three channels or channel combinations are visualised in the three primary colours (red, green and blue), this method works with a background image (visible band) overlaid with another one (e.g. the colour-enhanced IR image or Severe Storms RGB), then blended together, using various mathematical functions. In that way both the visible and the upper layer image can be observed simultaneously, in one single image. The table below is an example of the Meteosat SEVIRI channel pair often used to create the sandwich product. In principle, it is possible to use any other colour image product as the upper image, but one has to consider the added value of such combinations.

Layers	Channel [µm]	Physically relates to
Upper	**Colour enhanced IR10.8**	Cloud top temperature of opaque clouds
Background	**HRV**	Cloud top morphology

HRV: High Resolution Visible channel, IR: infrared, number: central wavelength of the channel in µm.

EUMETSAT recommends using a standard colour scale (see below) to enhance the coldest regions of the IR10.8 image. Note that the temperature range of the colour scale might need tuning (shift or stretch) depending on the actual tropopause height and temperature.

BT 240 K — 200 K

Benefits

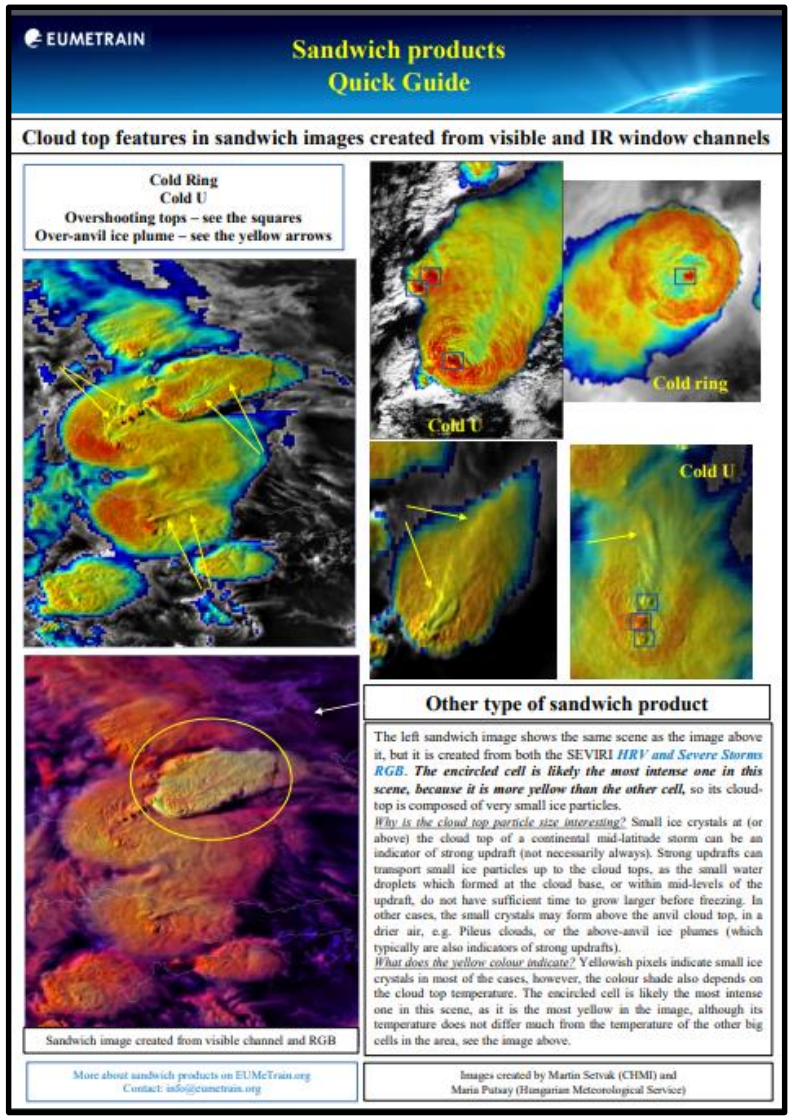
- It merges two types of characteristics (e.g. visible and infrared) in one single product, making it possible to monitor these characteristics **simultaneously in animations**.
- The **sandwich product animation** is a proper tool to monitor severity-related cloud top features of mature thunderstorms, such as intense (and/or long lived) overshooting tops, long-lived (more than ~40 minutes) cold U/V, cold rings, above-anvil ice plumes and gravity waves, which are typical indicators of strong updrafts, and, thus, possibly the severity of the storm.
- Good tool for both research and operational purposes.

Limitations

- Available during the day only.
- Close to midday the cloud top features like overshooting tops, ice plumes, gravity waves can be less prominent than at low solar elevation (as the shadows are shorter).
- The temperature range of the infrared colour scale might need a tuning (usually a shift) depending on the geographical region (latitude) and/or actual tropopause height/temperature to obtain optimal result. One can find an optimal range for a geographical region, but even in that case the actual „best" range can change from case to case. However, an operational processing usually works with a fixed temperature range.

Remarks

- Not only the convective cloud tops will be colour enhanced, but any clouds that are cold enough, for example thick cold clouds of a front, jet stream cirrus clouds, or orographic wave clouds.
- It is worth using it together with other types of satellite images and/or products, providing information, for example, on low-level features or the environment.



EUMETRAIN

Sandwich products Quick Guide

Cloud top features in sandwich images created from visible and IR window channels

Cold Ring
Cold U
Overshooting tops – see the squares
Over-anvil ice plume – see the yellow arrows

Cold U

Cold ring

Cold U

Sandwich image created from visible channel and RGB

Other type of sandwich product

The left sandwich image shows the same scene as the image above it, but it is created from both the SEVIRI ***HRV and Severe Storms RGB***. ***The encircled cell is likely the most intense one in this scene, because it is more yellow than the other cell,*** so its cloud-top is composed of very small ice particles.

Why is the cloud top particle size interesting? Small ice crystals at (or above) the cloud top of a continental mid-latitude storm can be an indicator of strong updraft (not necessarily always). Strong updrafts can transport small ice particles up to the cloud tops, as the small water droplets which formed at the cloud base, or within mid-levels of the updraft, do not have sufficient time to grow larger before freezing. In other cases, the small crystals may form above the anvil cloud top, in a drier air, e.g. Pileus clouds, or the above-anvil ice plumes (which typically are also indicators of strong updrafts).

What does the yellow colour indicate? Yellowish pixels indicate small ice crystals in most of the cases, however, the colour shade also depends on the cloud top temperature. The encircled cell is likely the most intense one in this scene, as it is the most yellow in the image, although its temperature does not differ much from the temperature of the other big cells in the area, see the image above.

More about sandwich products on EUMeTrain.org
Contact: info@eumetrain.org

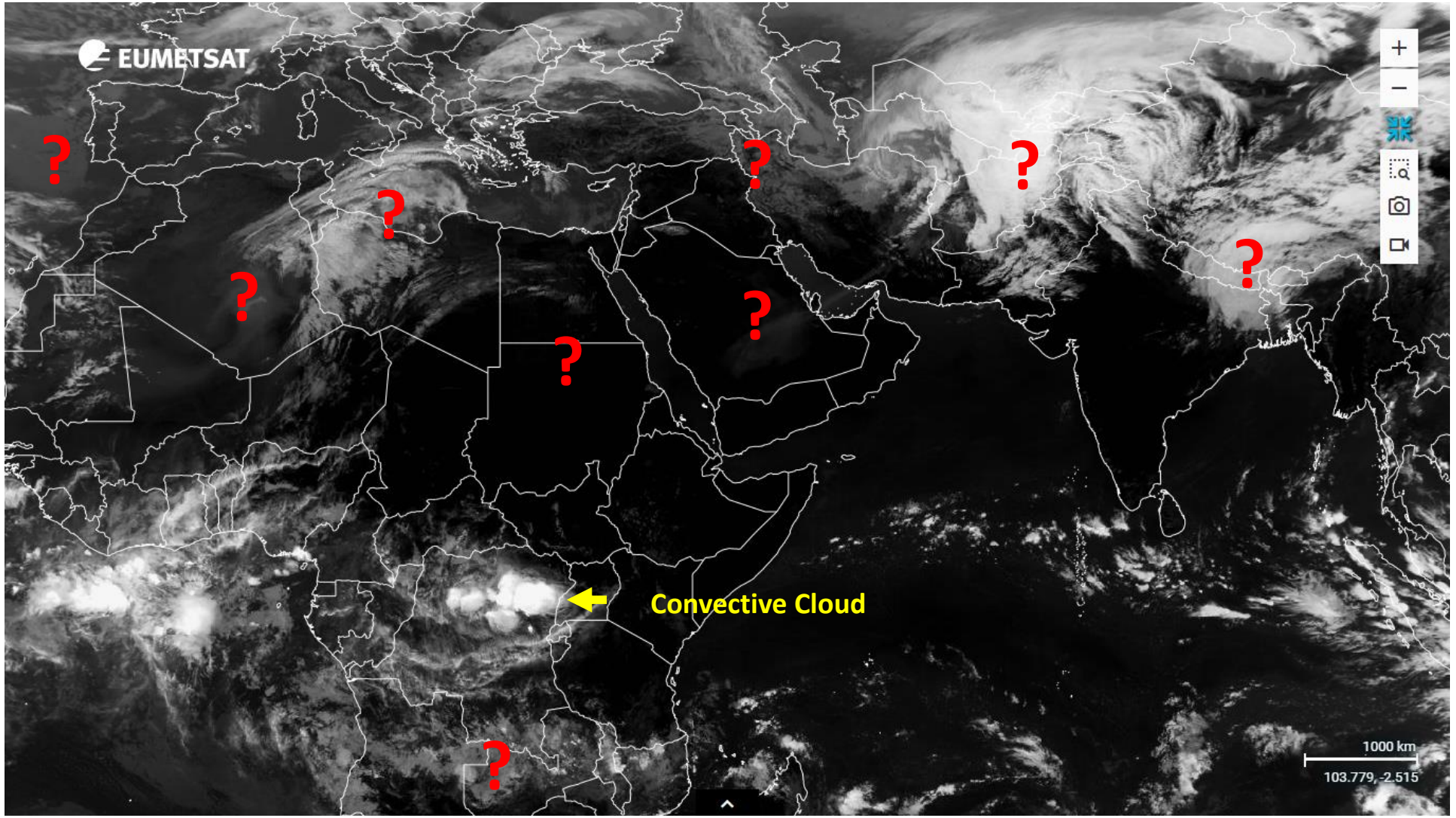
Images created by Martin Setvak (CHMI) and Maria Putsay (Hungarian Meteorological Service)

More Quick Guides

https://resources.eumetrain.org/rgb_quick_guides/index.html

https://satelliteliaisonblog.com/page/4/?s=Sandwich

RGB Images !


EUMETSAT
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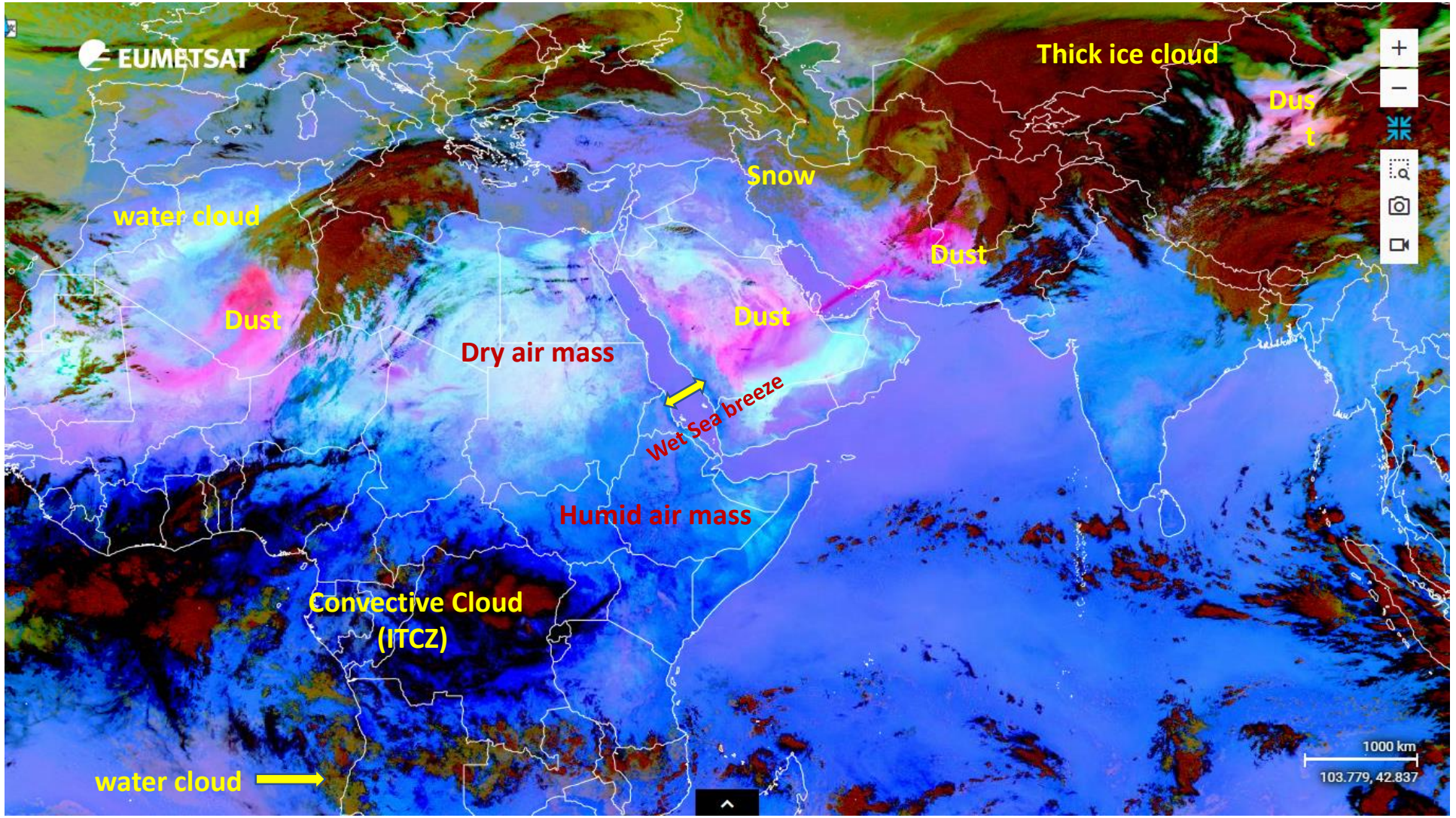
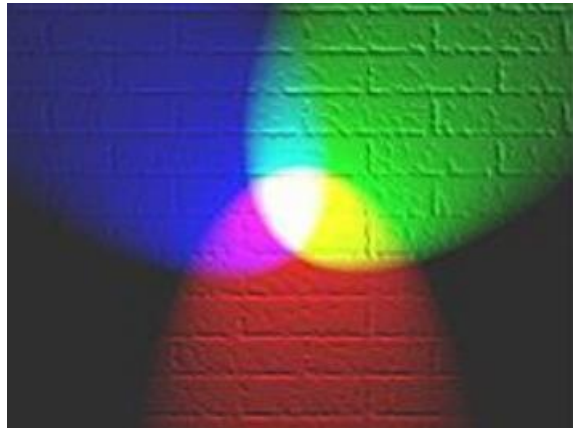
Convective Cloud
1000 km
103.779, -2.515


EUMETSAT
Thick ice cloud
Dus
t
Snow
water cloud
Dust
Dust
Dust
Dry air mass
Wet Sea breeze
Humid air mass
Convective Cloud
(ITCZ)
water cloud
1000 km
103.779, 42.837

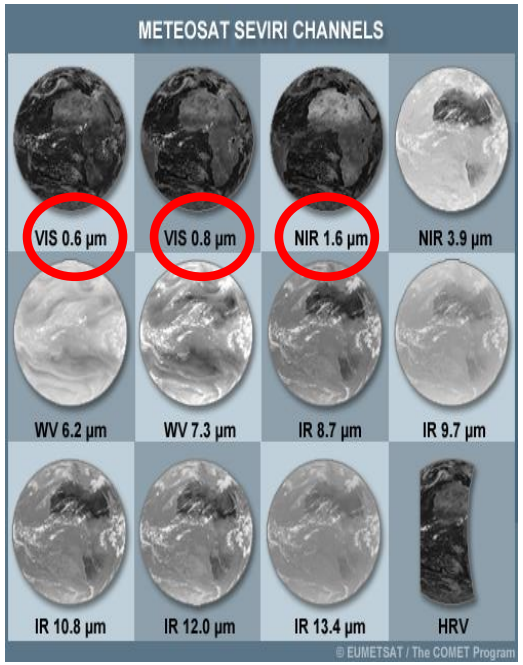
How is RGB image (or RGB composite) made ?

Every spectral channel could be assigned to one of the RGB primary components

- **Red**
- **Green**
- **Blue**



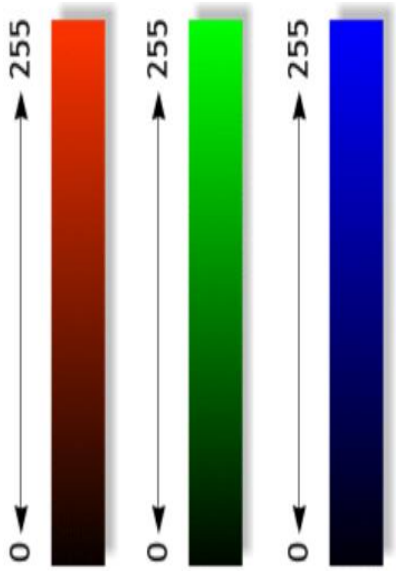
Allows analysis of 3 (or more) spectral characteristics in one image!

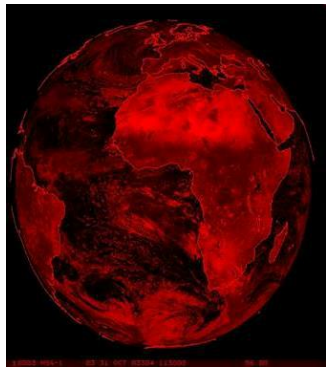


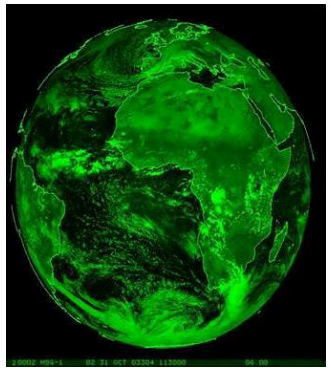
Red=NIR 1.6 µm

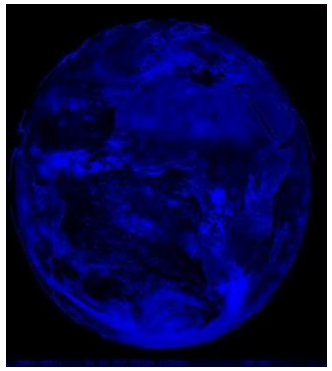
Green =VIS 0.8 µm

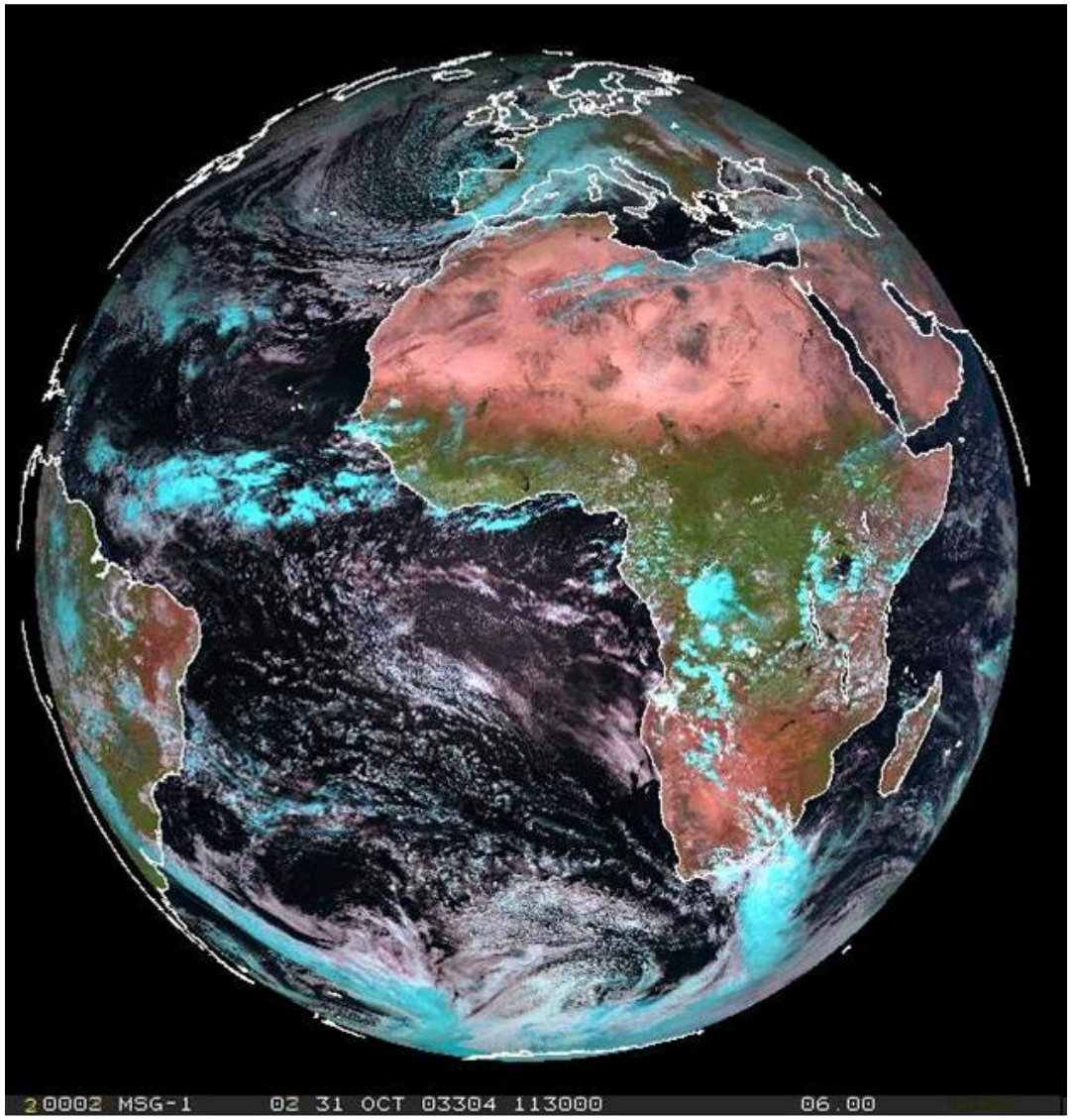
Blue=VIS 0.6 µm

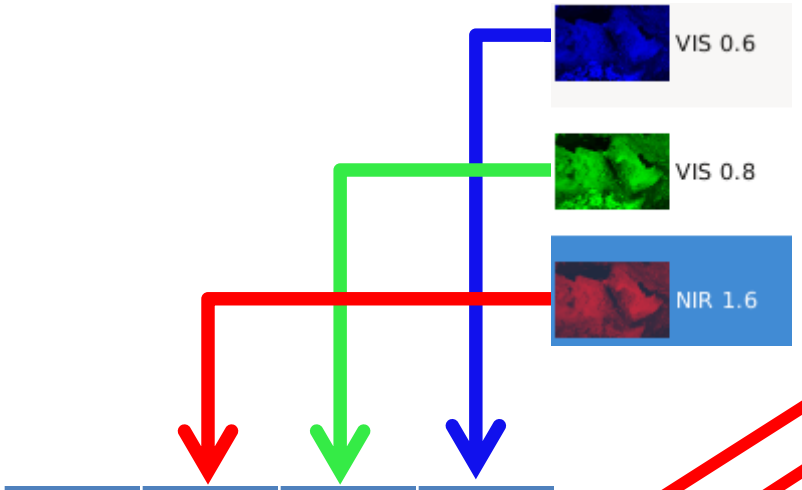




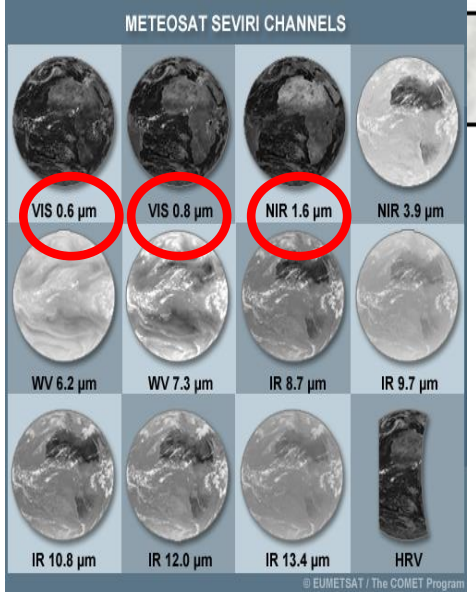






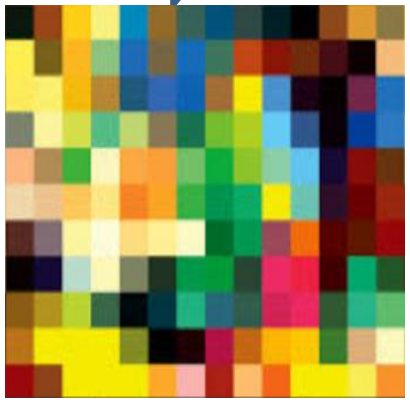


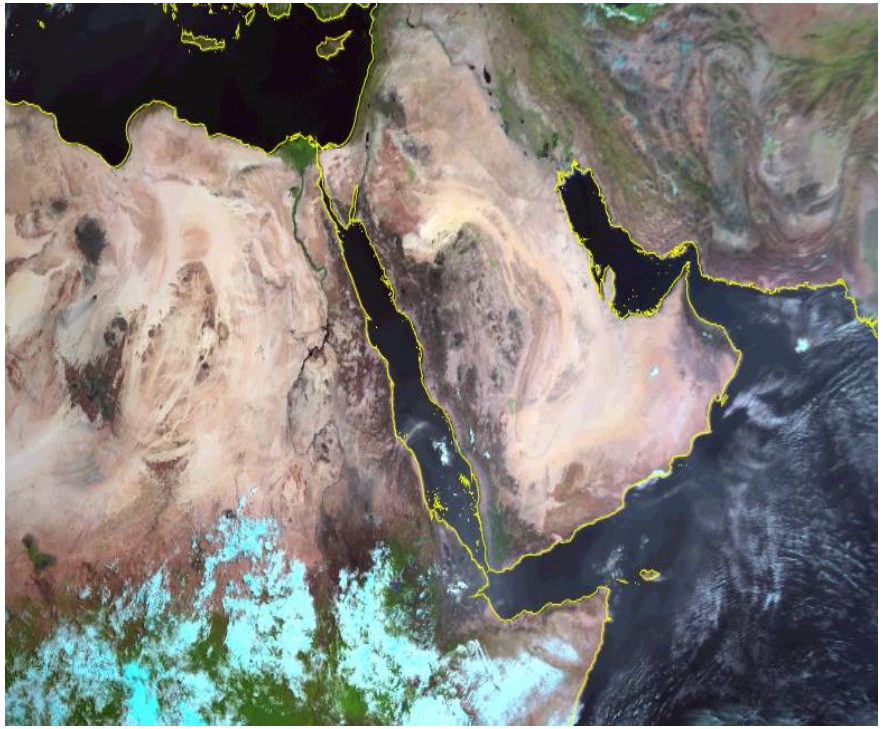
Channel's Intensity



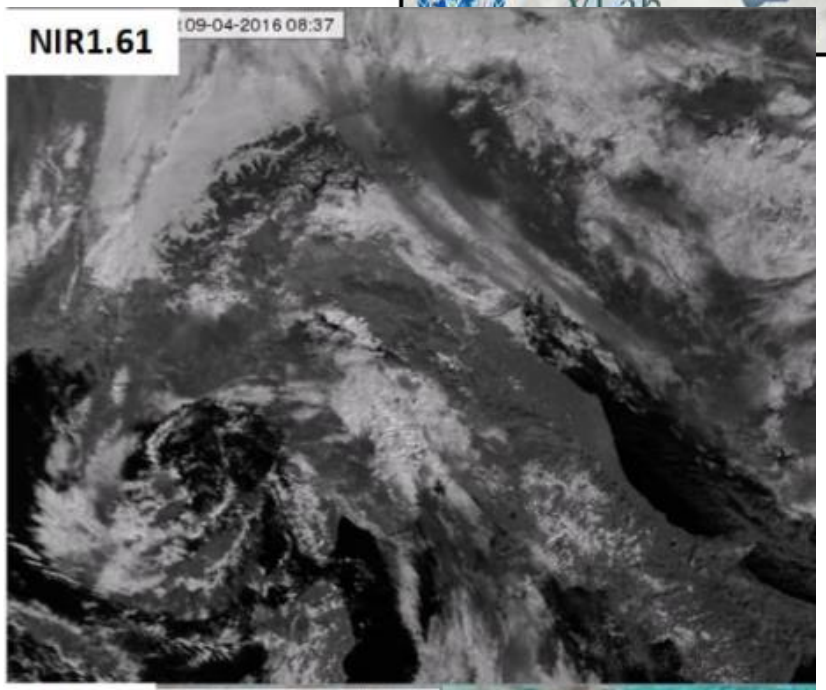
	R	G	B
	255	255	255
	255	255	0
	255	0	255
	0	255	255
	0	0	0
	143	143	143
	255	0	0
	0	255	0
	0	0	255

Natural Color RGB

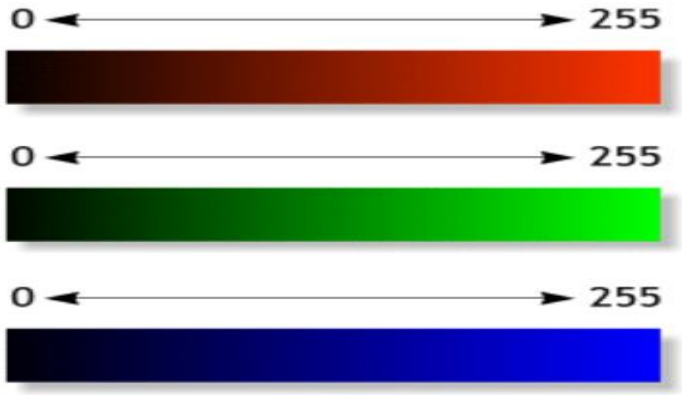


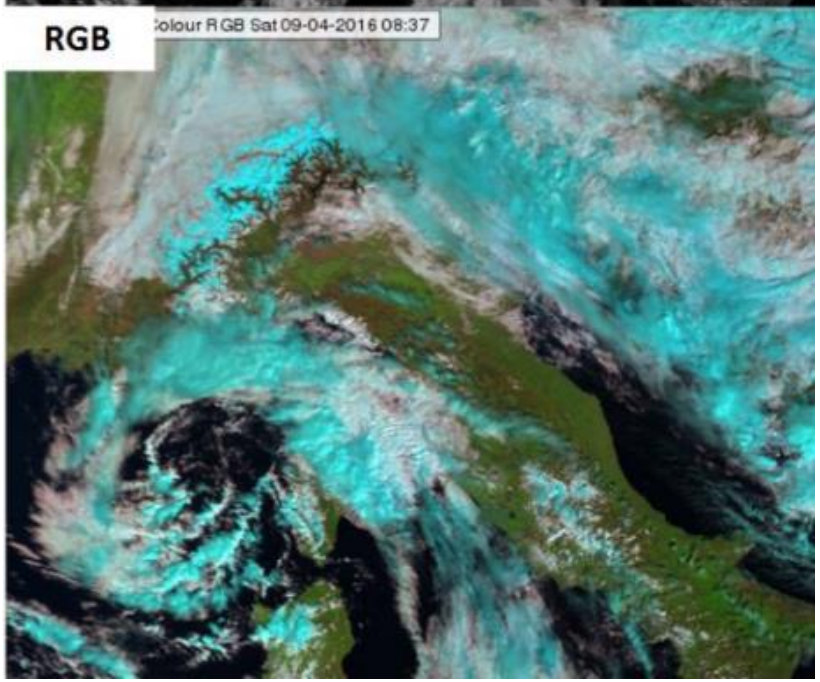


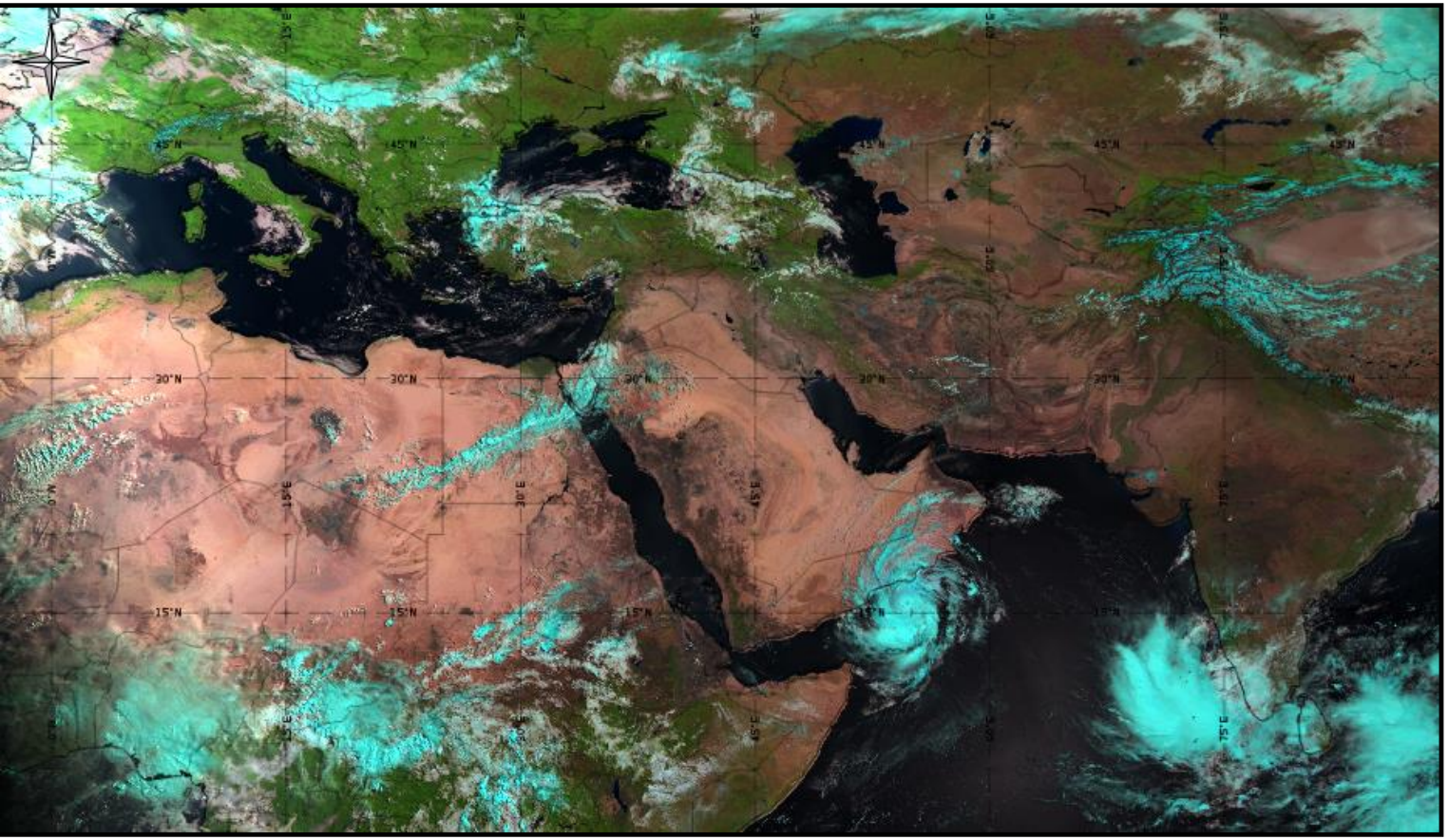
In grayscale Each pixel has 256 possible shades of gray.

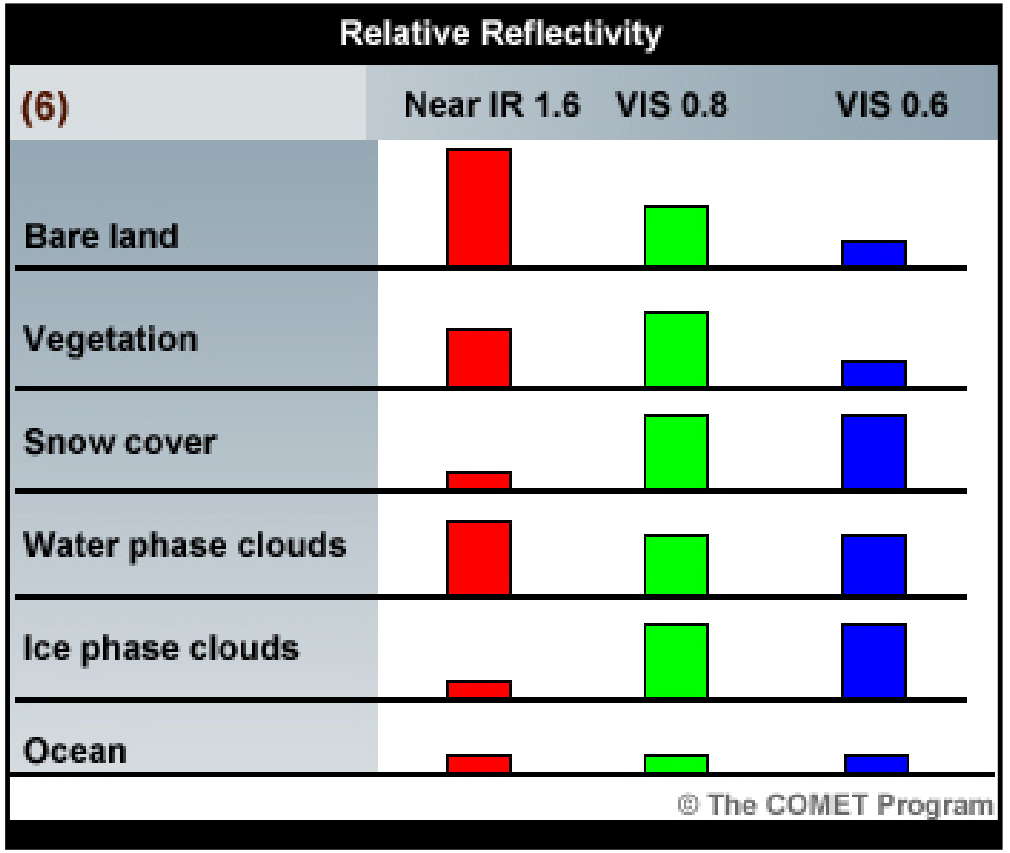


In RGB, each pixel has:
256 × 256 × 256 = **16,777,216** possible color combinations



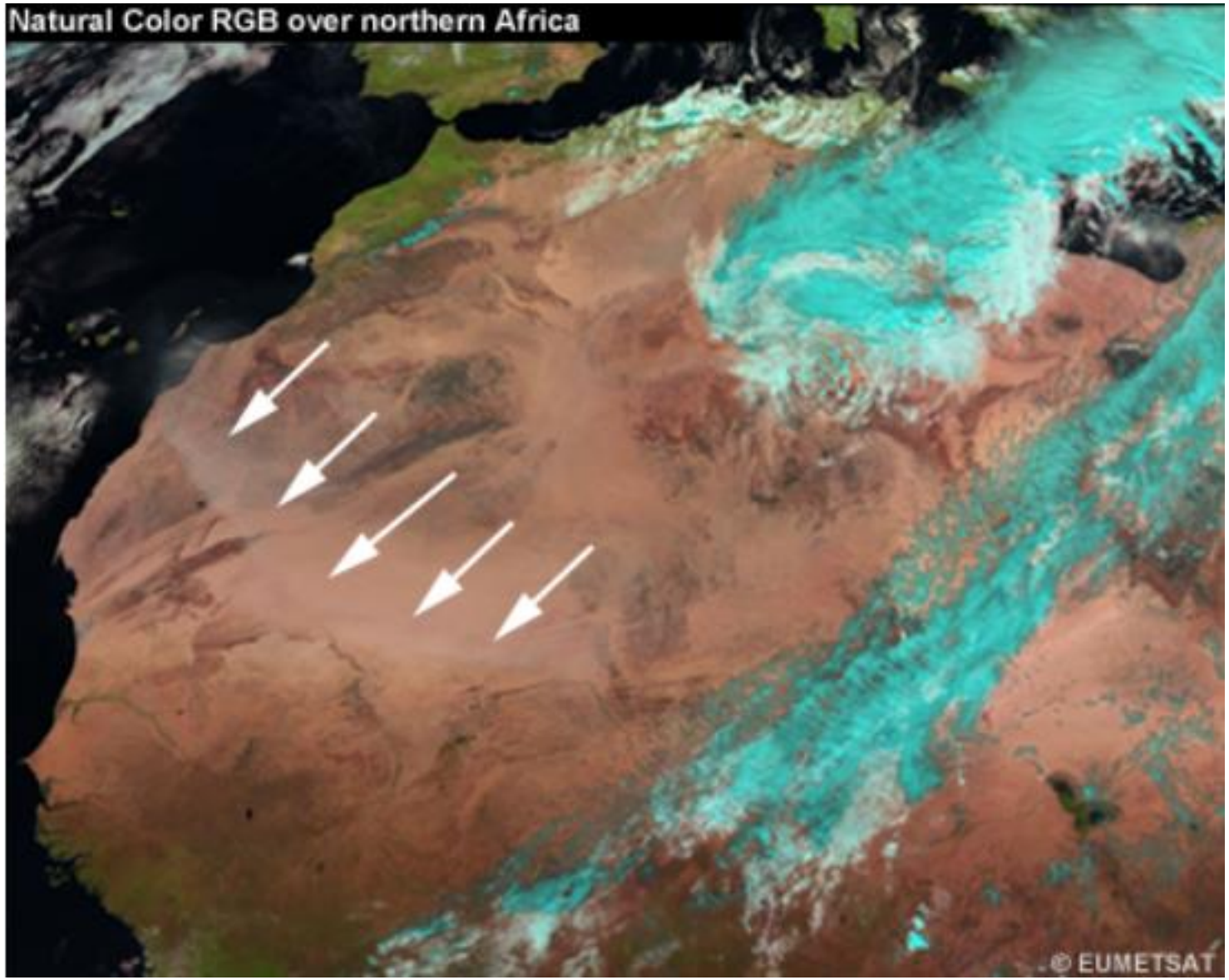





Relative Reflectivity
(6)
Near IR 1.6
VIS 0.8
VIS 0.6
Bare land
Vegetation
Snow cover
Water phase clouds
Ice phase clouds
Ocean
© The COMET Program

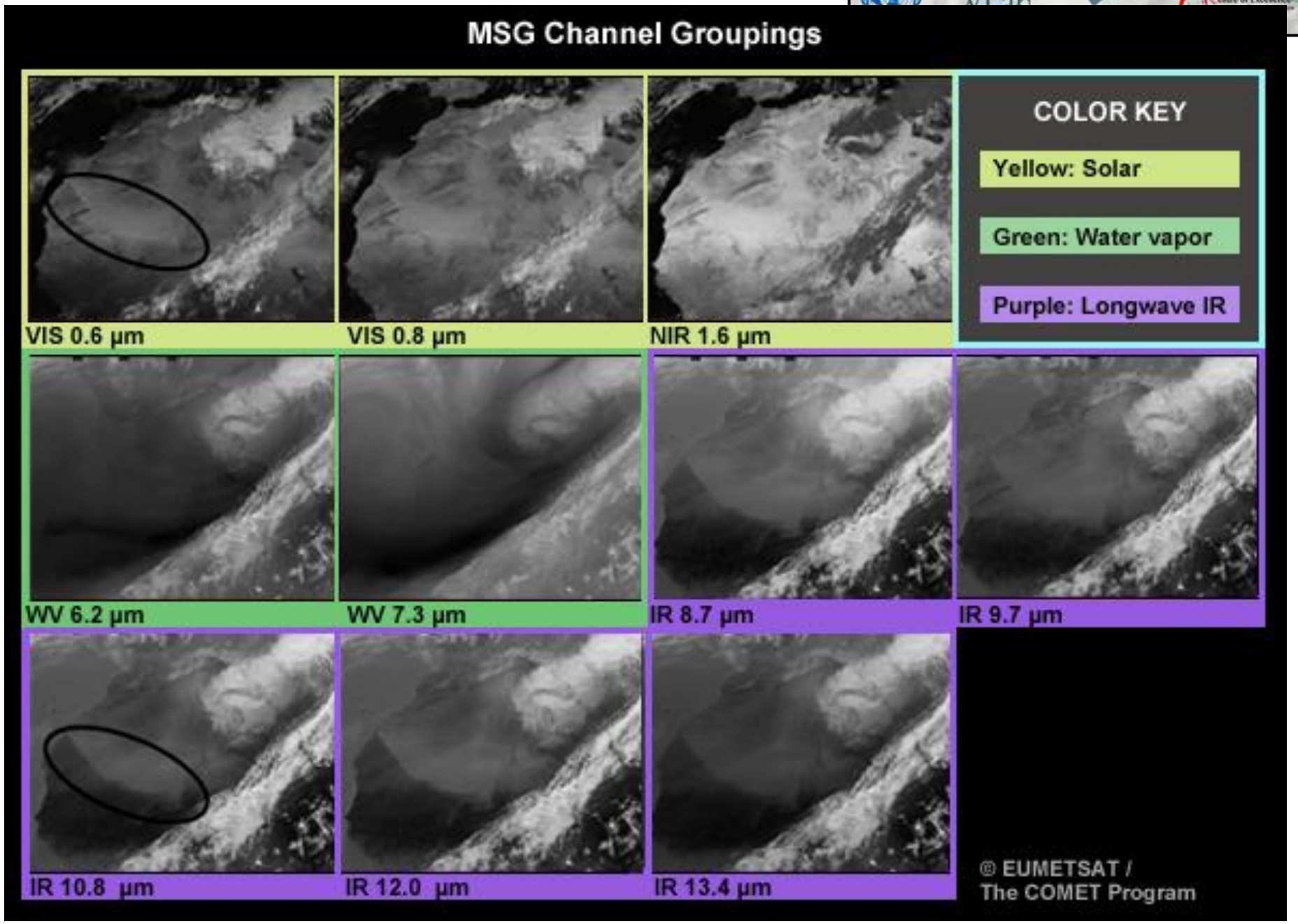

VIS 0.6
VIS 0.8
NIR 1.6
Red: 144
Green: 137
Blue: 124
VIS 0.6
VIS 0.8
NIR 1.6
Red: 141
Green: 141
Blue: 127
VIS 0.6
VIS 0.8
NIR 1.6
Red: 69
Green: 199
Blue: 131
VIS 0.6
VIS 0.8
NIR 1.6
Red: 138
Green: 125
Blue: 143

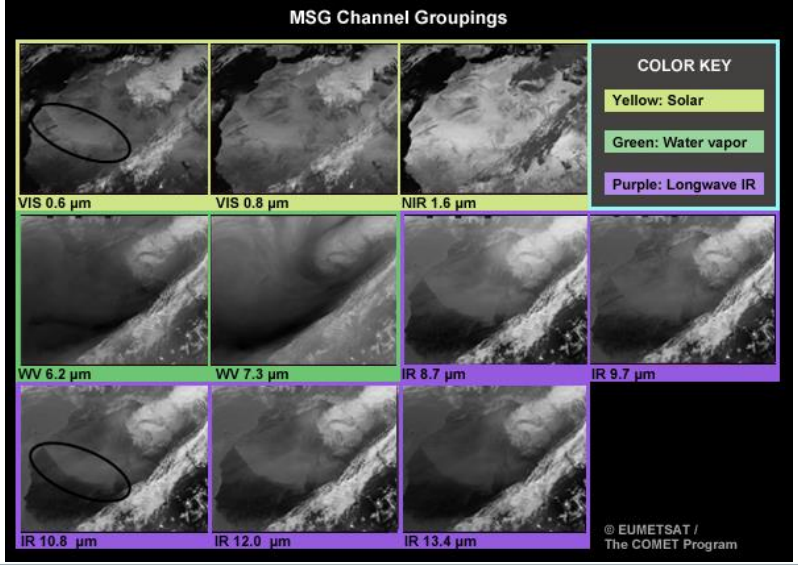
How About Dust

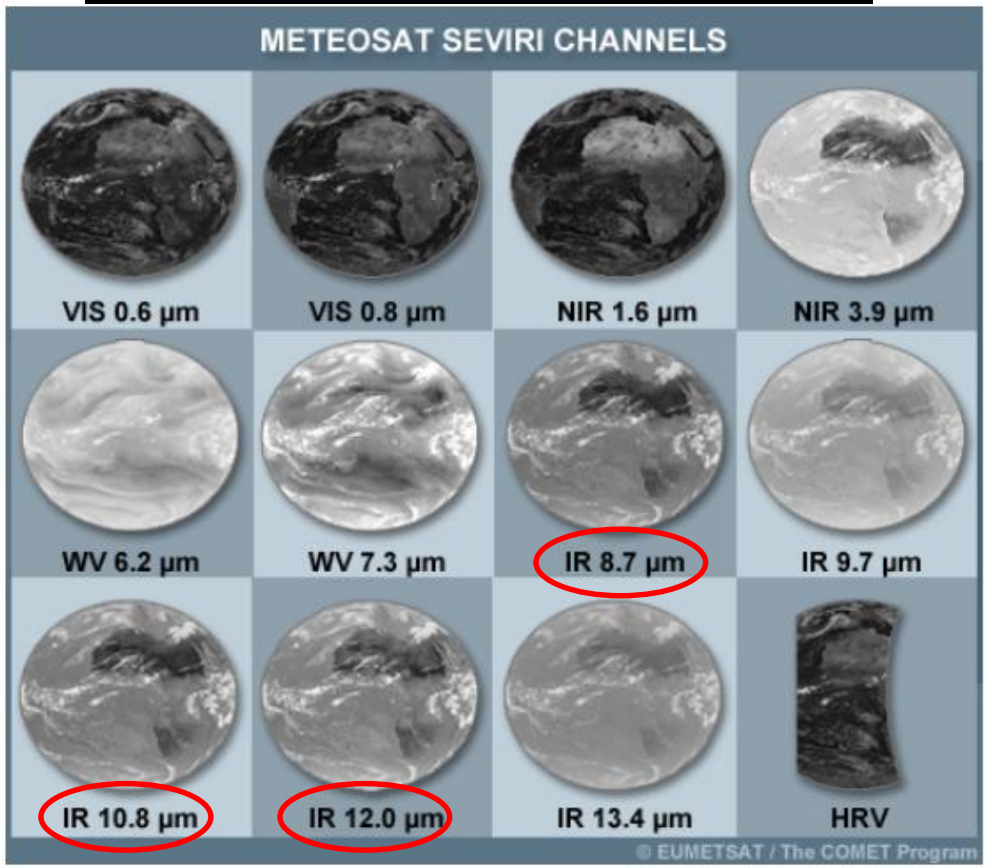


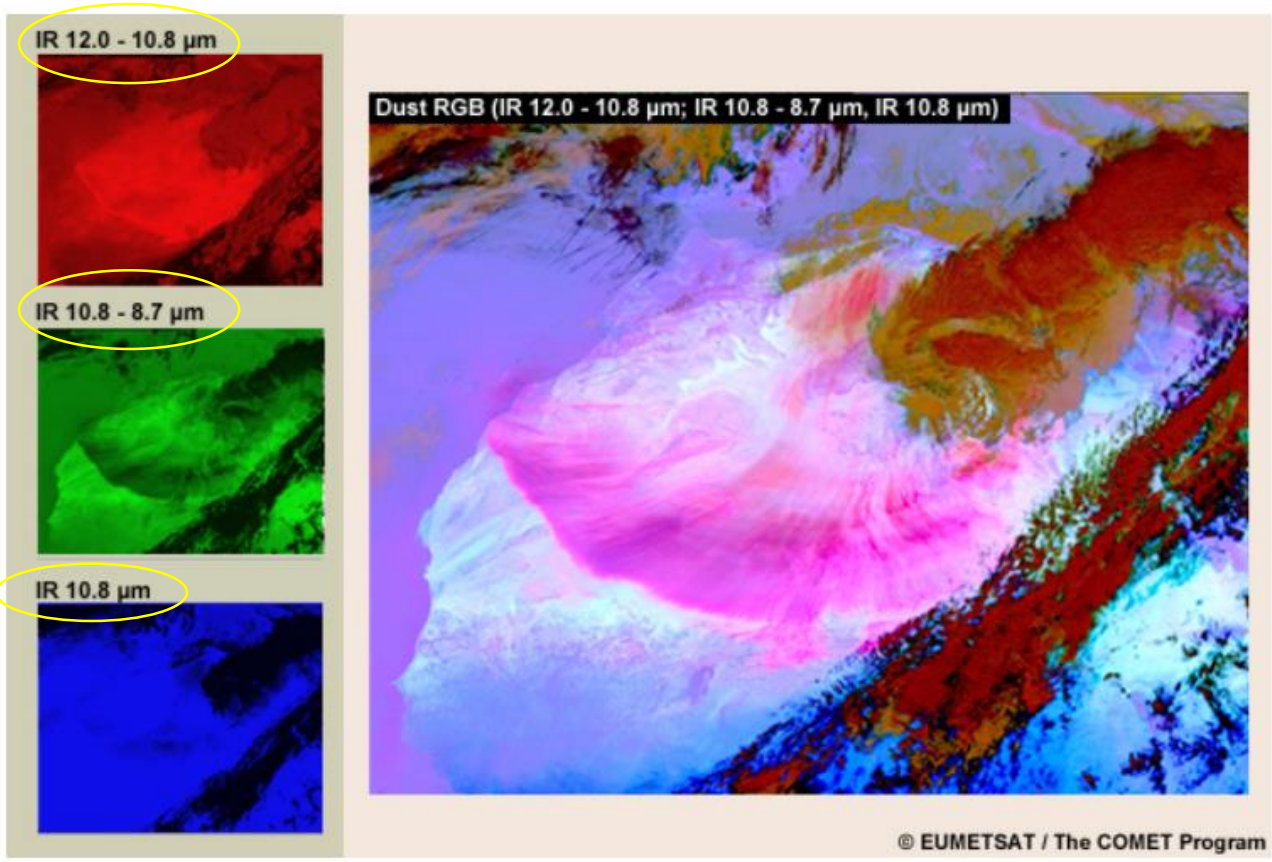
Dust in different channels

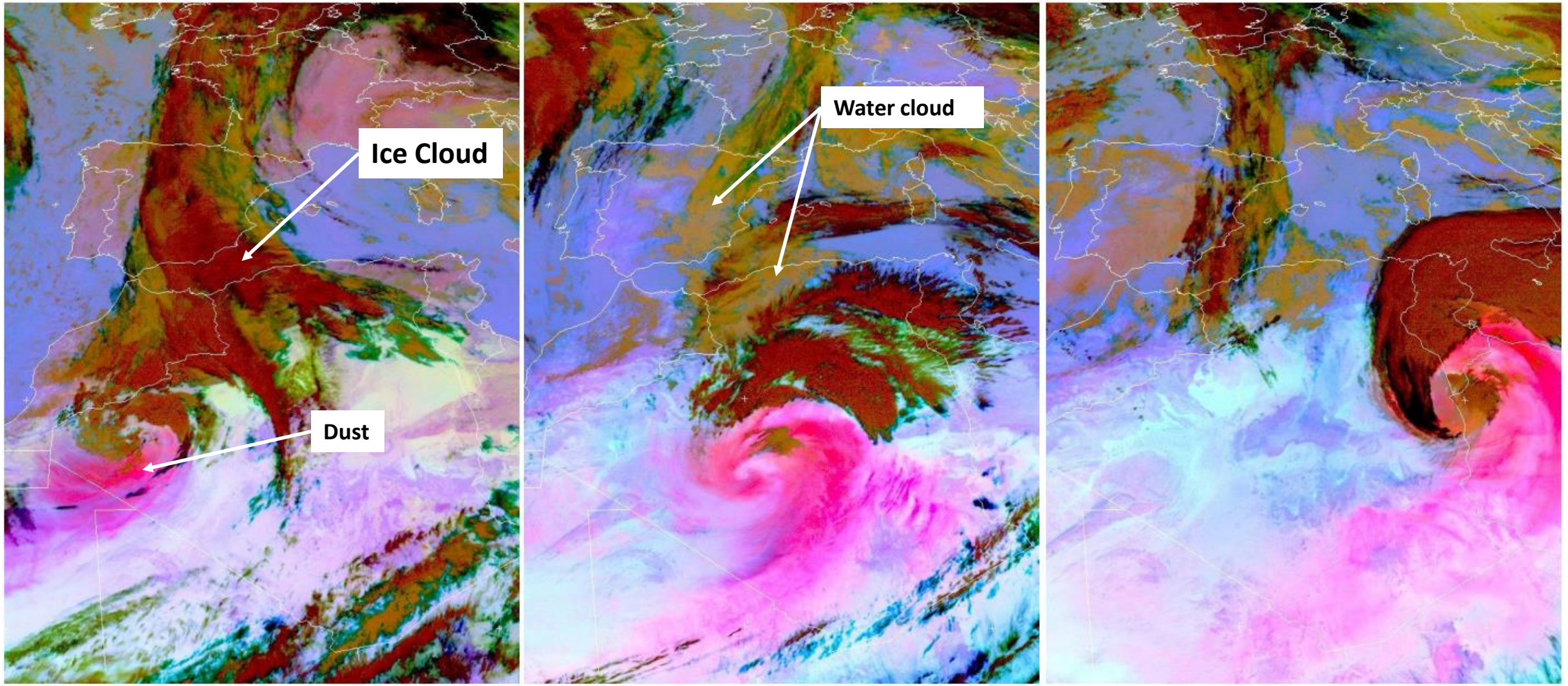
Let us do the magic !



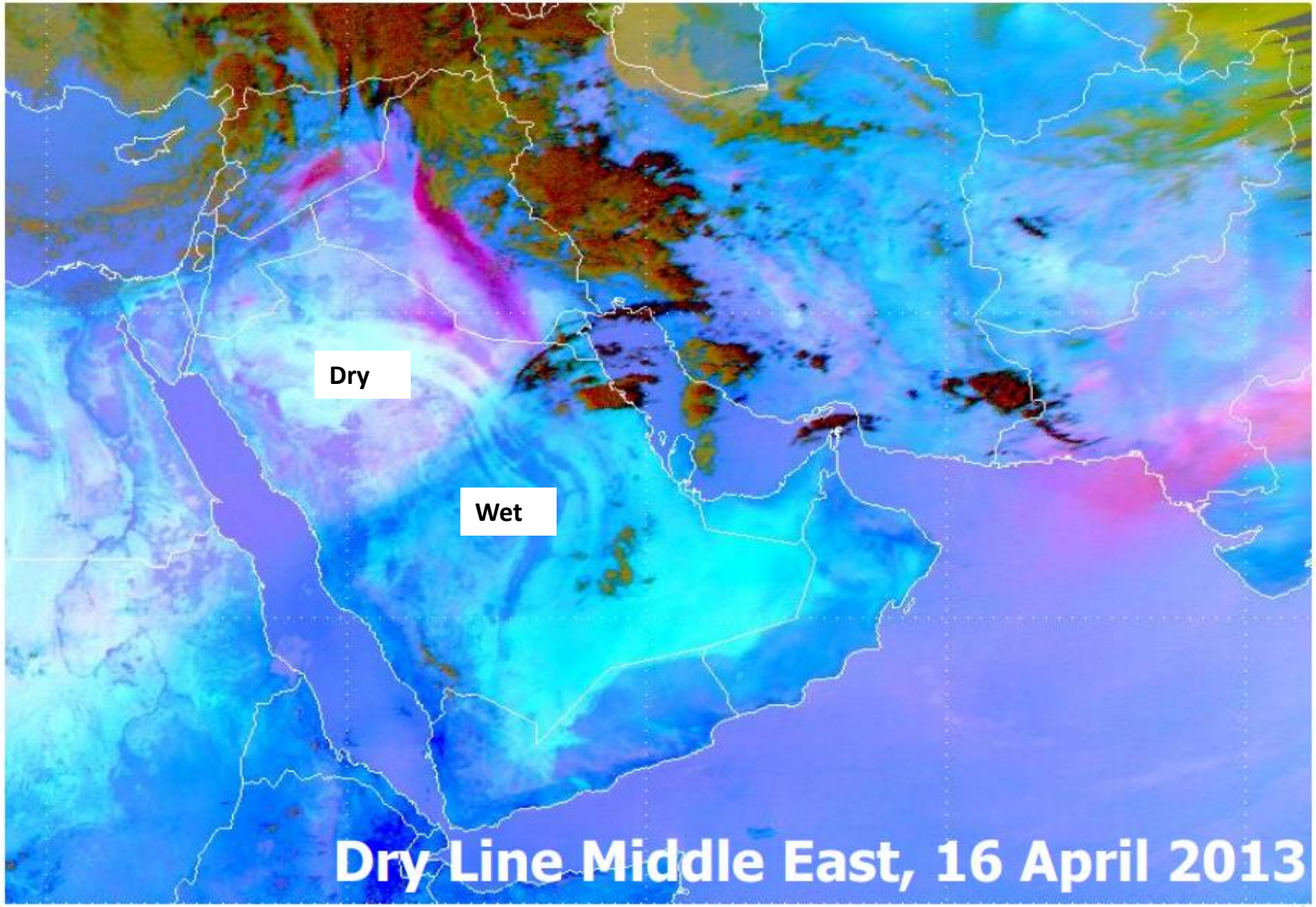

MSG Channel Groupings
COLOR KEY
Yellow: Solar
Green: Water vapor
Purple: Longwave IR
VIS 0.6 µm
VIS 0.8 µm
NIR 1.6 µm
WV 6.2 µm
WV 7.3 µm
IR 8.7 µm
IR 9.7 µm
IR 10.8 µm
IR 12.0 µm
IR 13.4 µm
© EUMETSAT / The COMET Program


METEOSAT SEVIRI CHANNELS
VIS 0.6 µm
VIS 0.8 µm
NIR 1.6 µm
NIR 3.9 µm
WV 6.2 µm
WV 7.3 µm
IR 8.7 µm
IR 9.7 µm
IR 10.8 µm
IR 12.0 µm
IR 13.4 µm
HRV
© EUMETSAT / The COMET Program

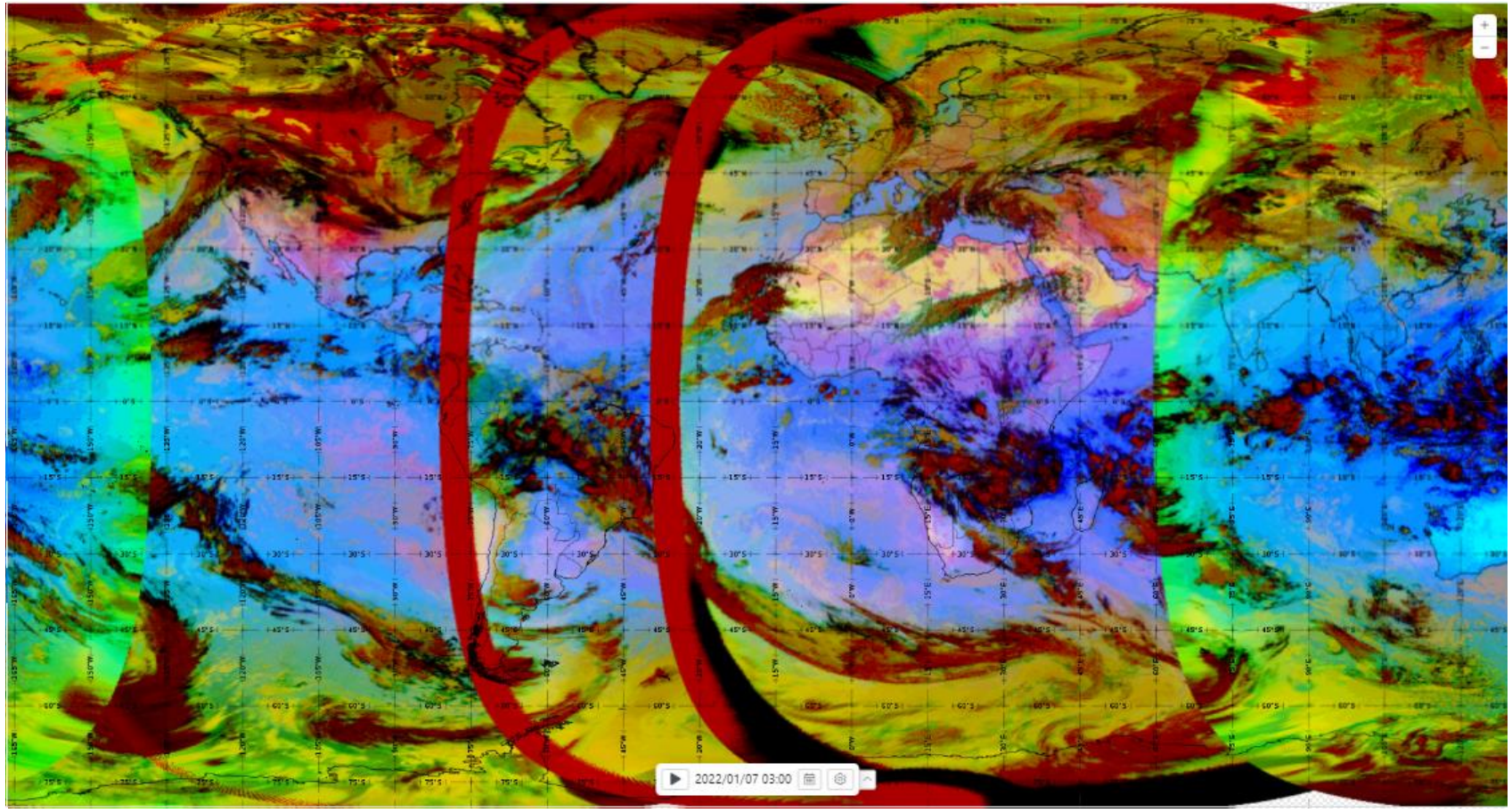

IR 12.0 - 10.8 µm
IR 10.8 - 8.7 µm
IR 10.8 µm
Dust RGB (IR 12.0 - 10.8 µm; IR 10.8 - 8.7 µm, IR 10.8 µm)
© EUMETSAT / The COMET Program

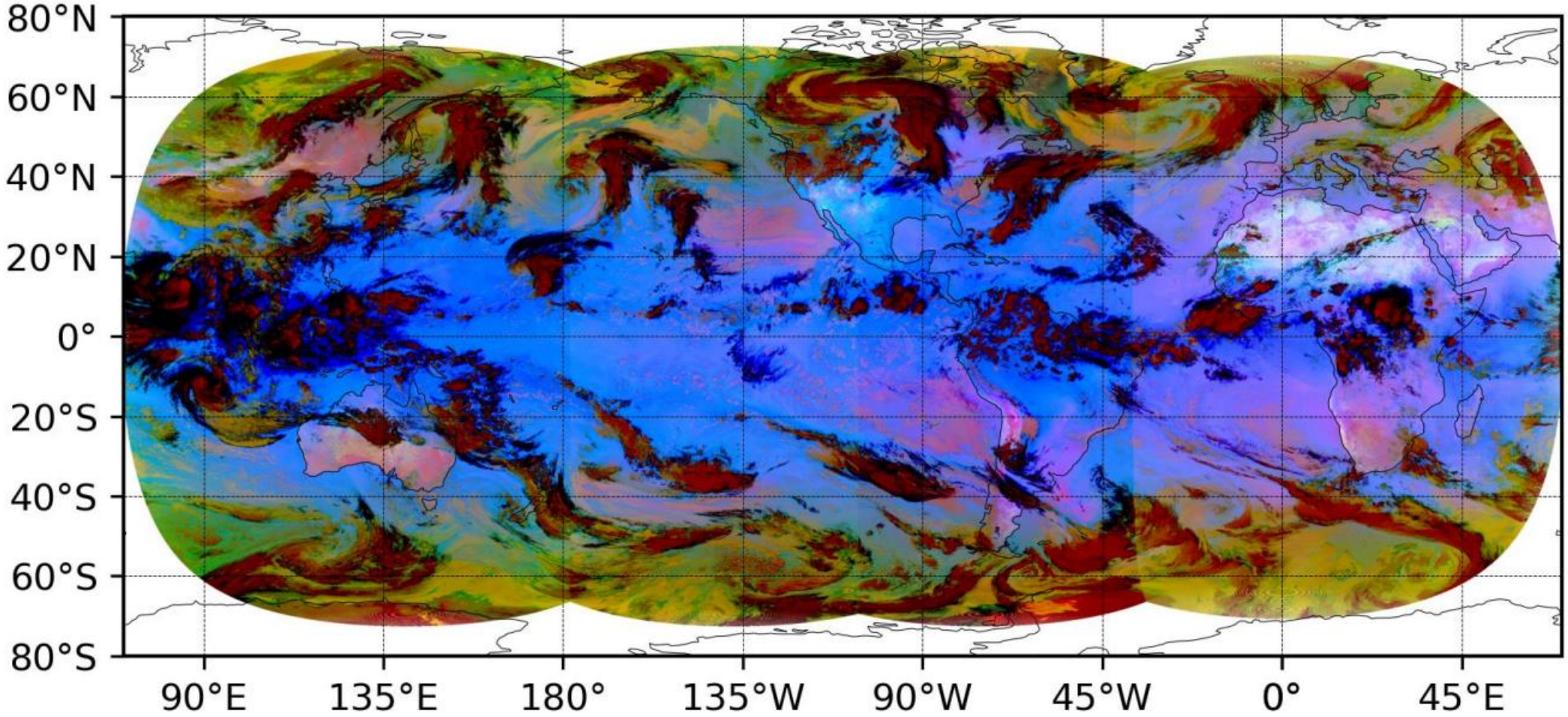

Ice Cloud
Dust
Water cloud

Moisture in lower layers, moisture boundaries



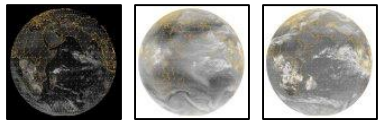
Covering the Whole Earth



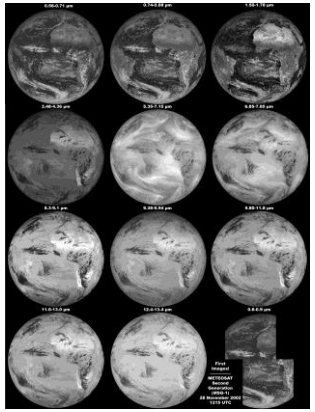

80°N
60°N
40°N
20°N
0°
20°S
40°S
60°S
80°S
90°E
135°E
180°
135°W
90°W
45°W
0°
45°E

THANKS TO EUMETSAT!!

IODC Satellite : **Indian Ocean Data Coverage**

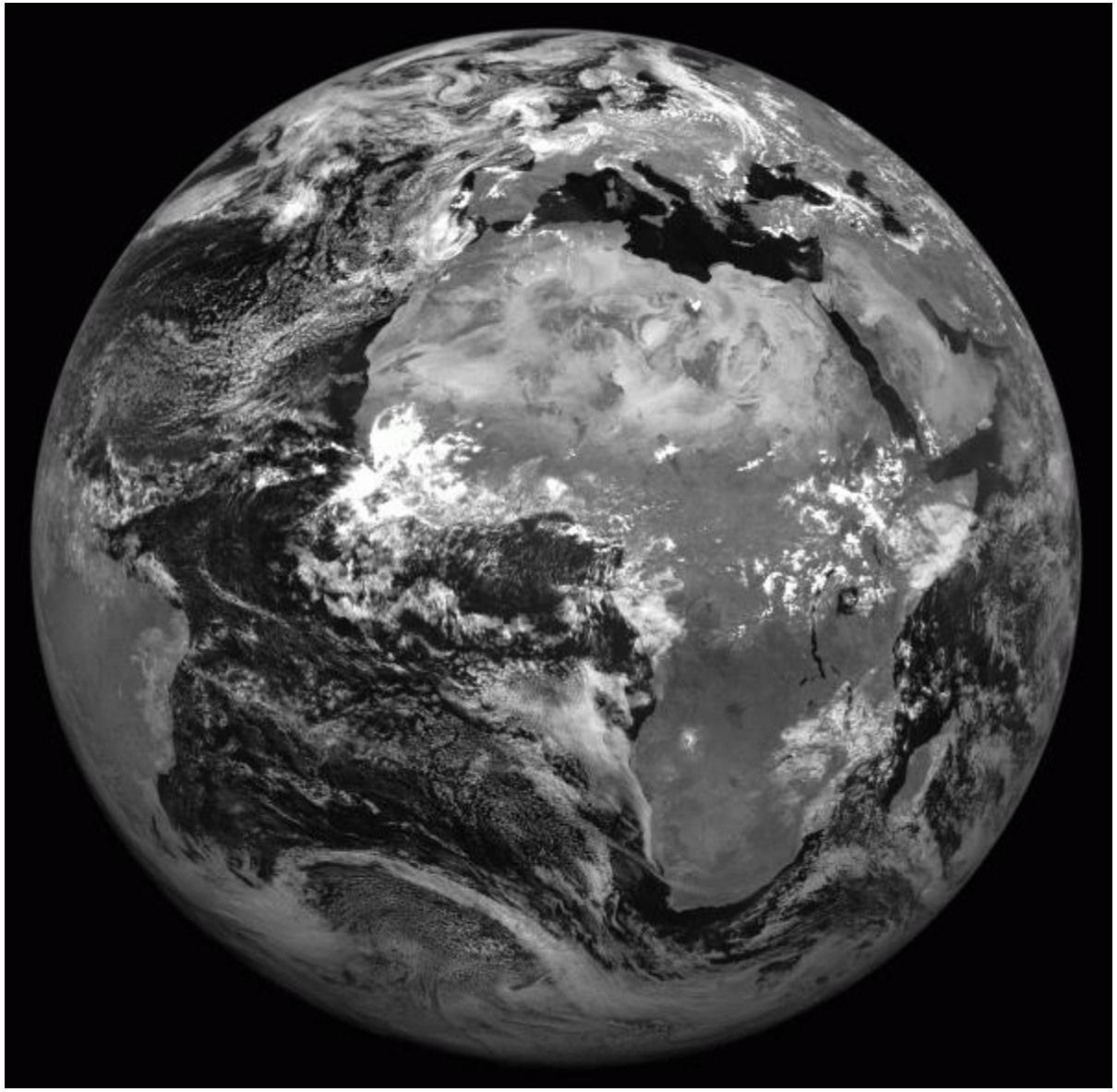


Meteosat 7

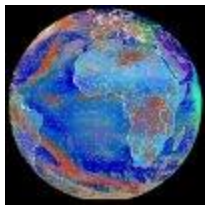


Meteosat 8

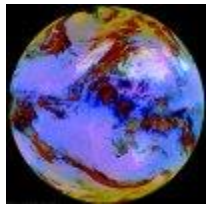
Meteosat 9



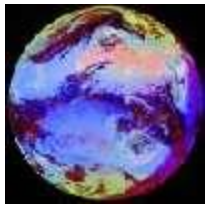
Composite Image (RGB)



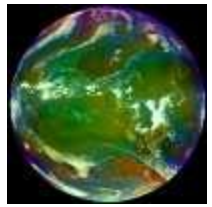
Day Microphysics RGB



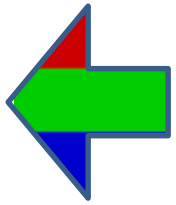
Dust RGB

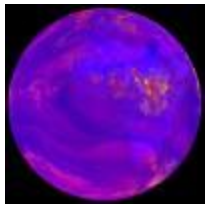


Fog / Low Clouds RGB



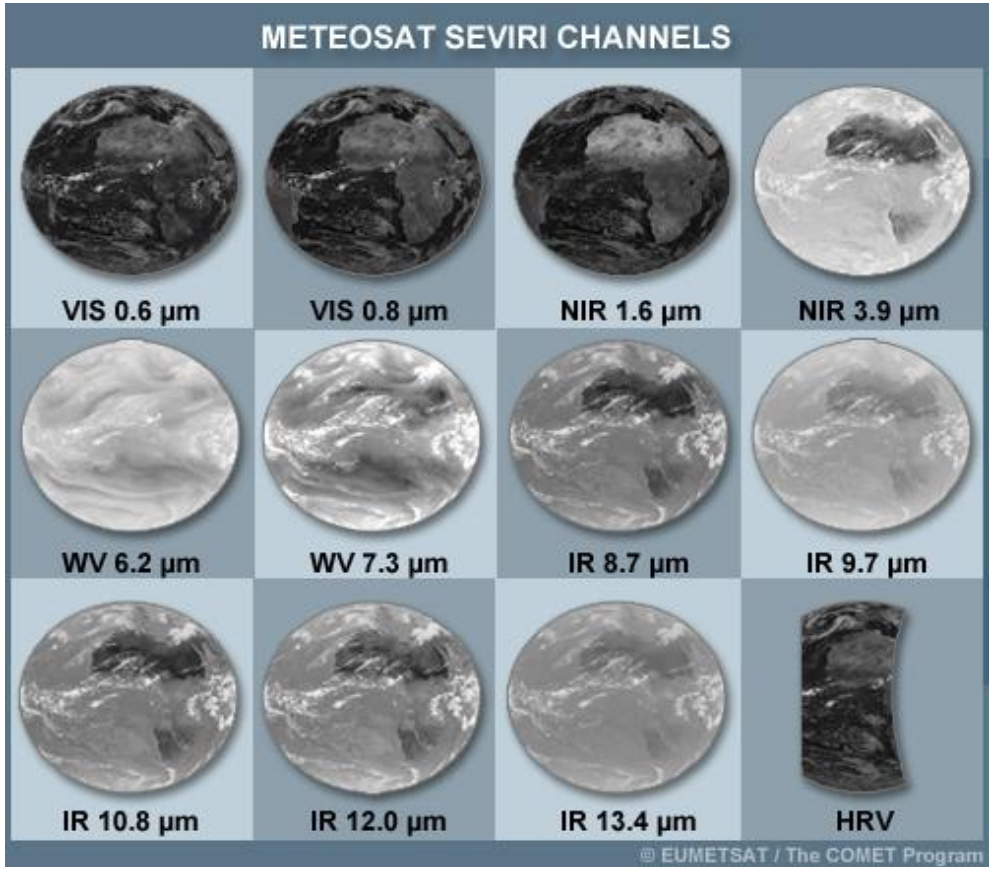
Airmass RGB



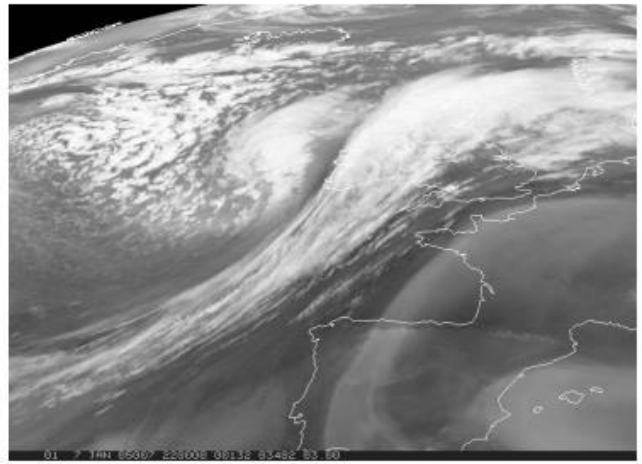


Convection RGB

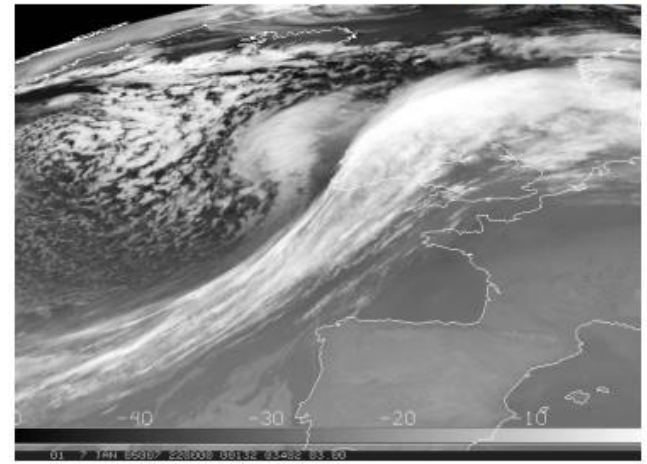
Natural Color RGB



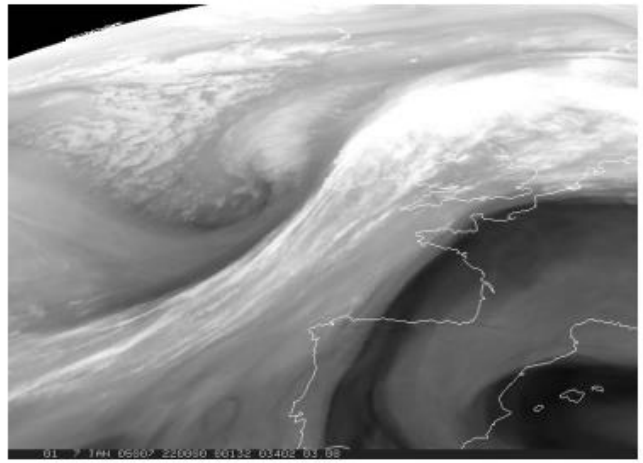
R = BTD WV6.2 - WV7.3
G = BTD IR9.7 - IR10.8
B = WV6.2



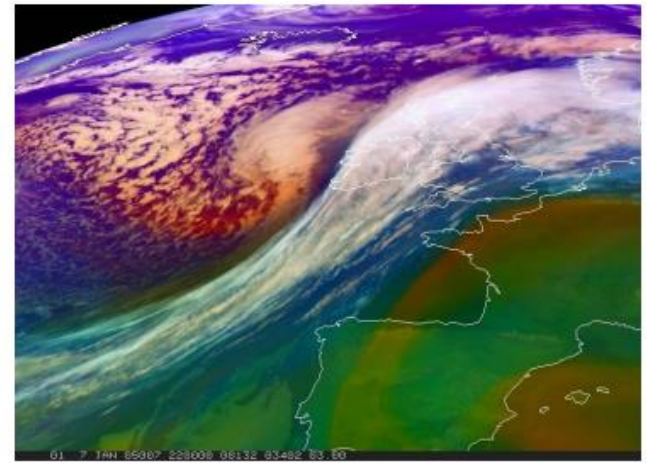
Red = WV6.2 - WV7.3



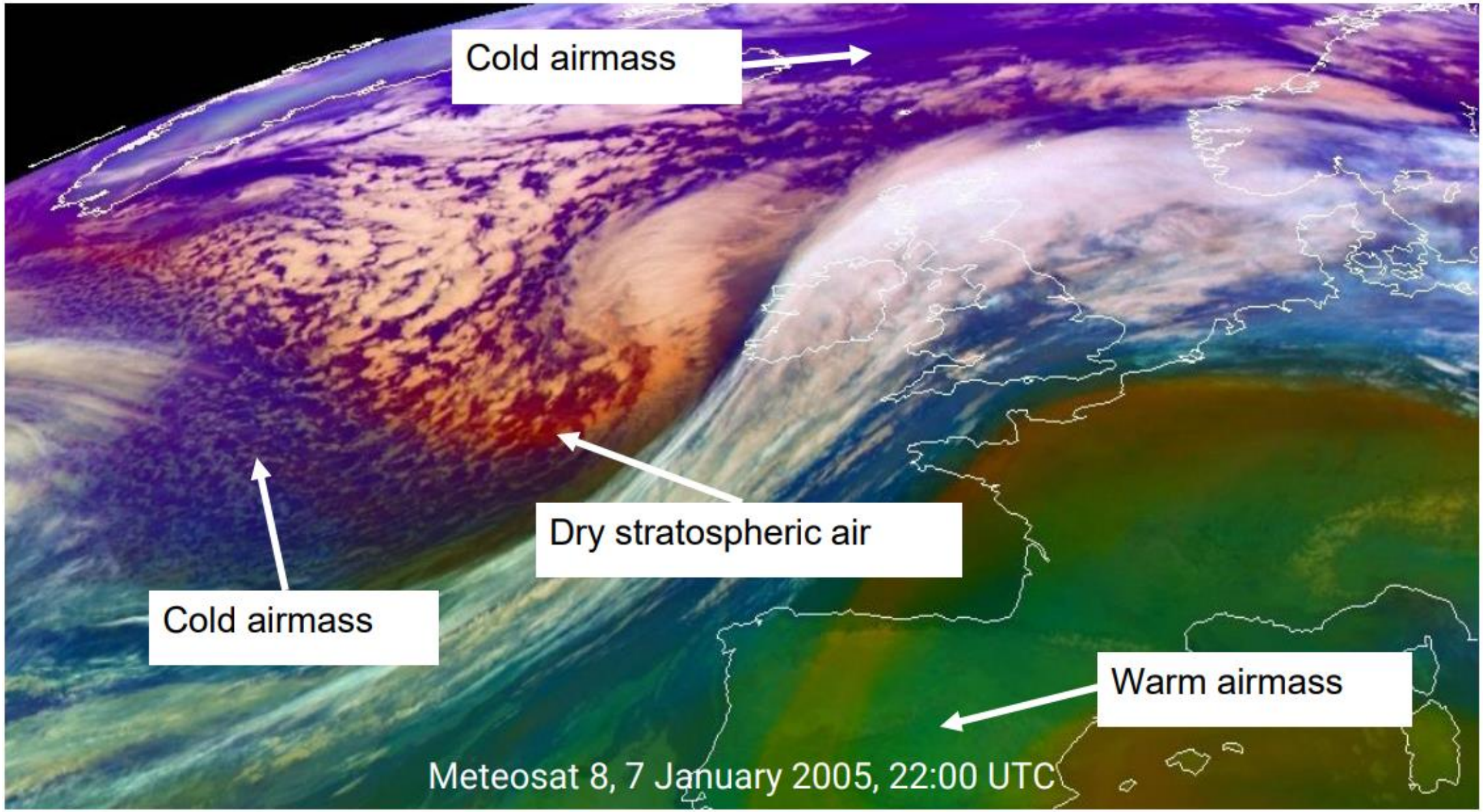
Green = IR9.7 - IR10.8

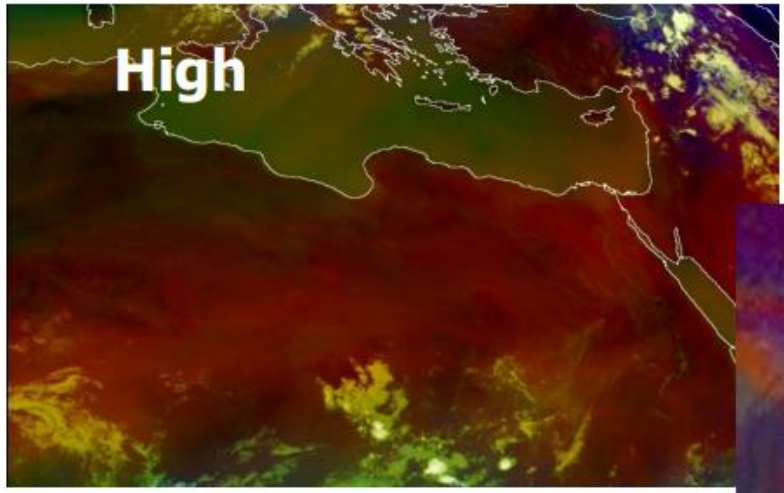


Blue = WV6.2i

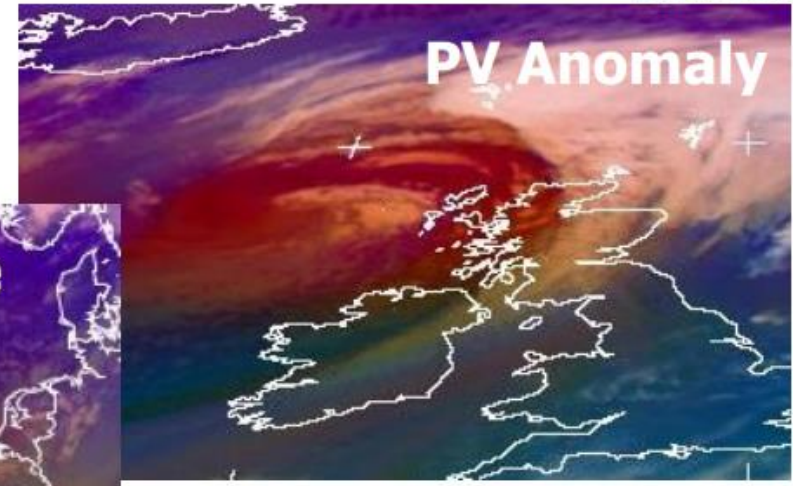


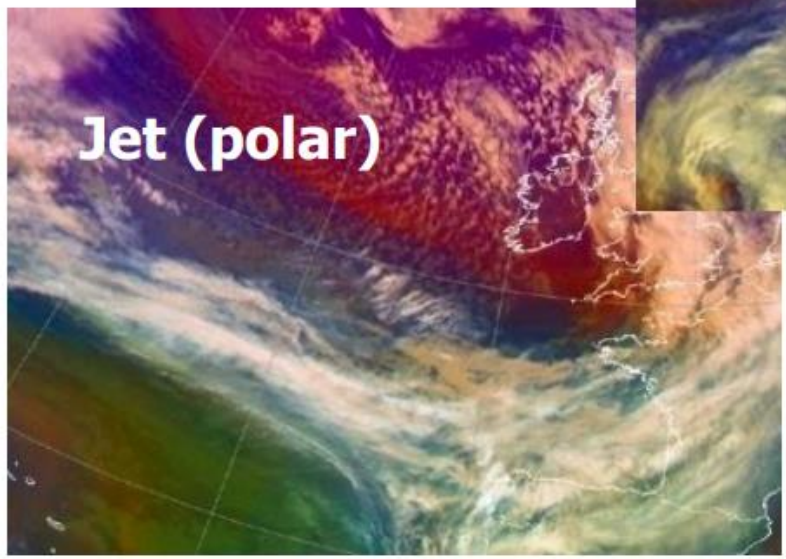
RGB

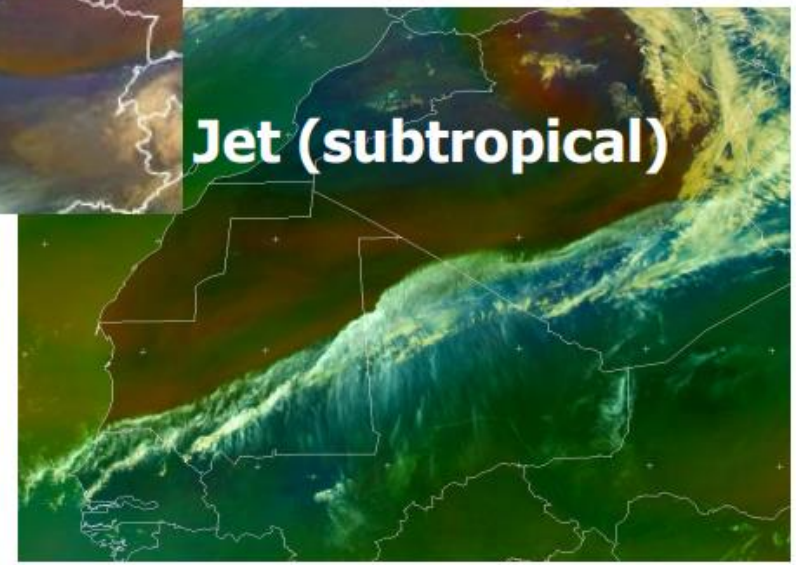

Cold airmass
Dry stratospheric air
Cold airmass
Warm airmass
Meteosat 8, 7 January 2005, 22:00 UTC

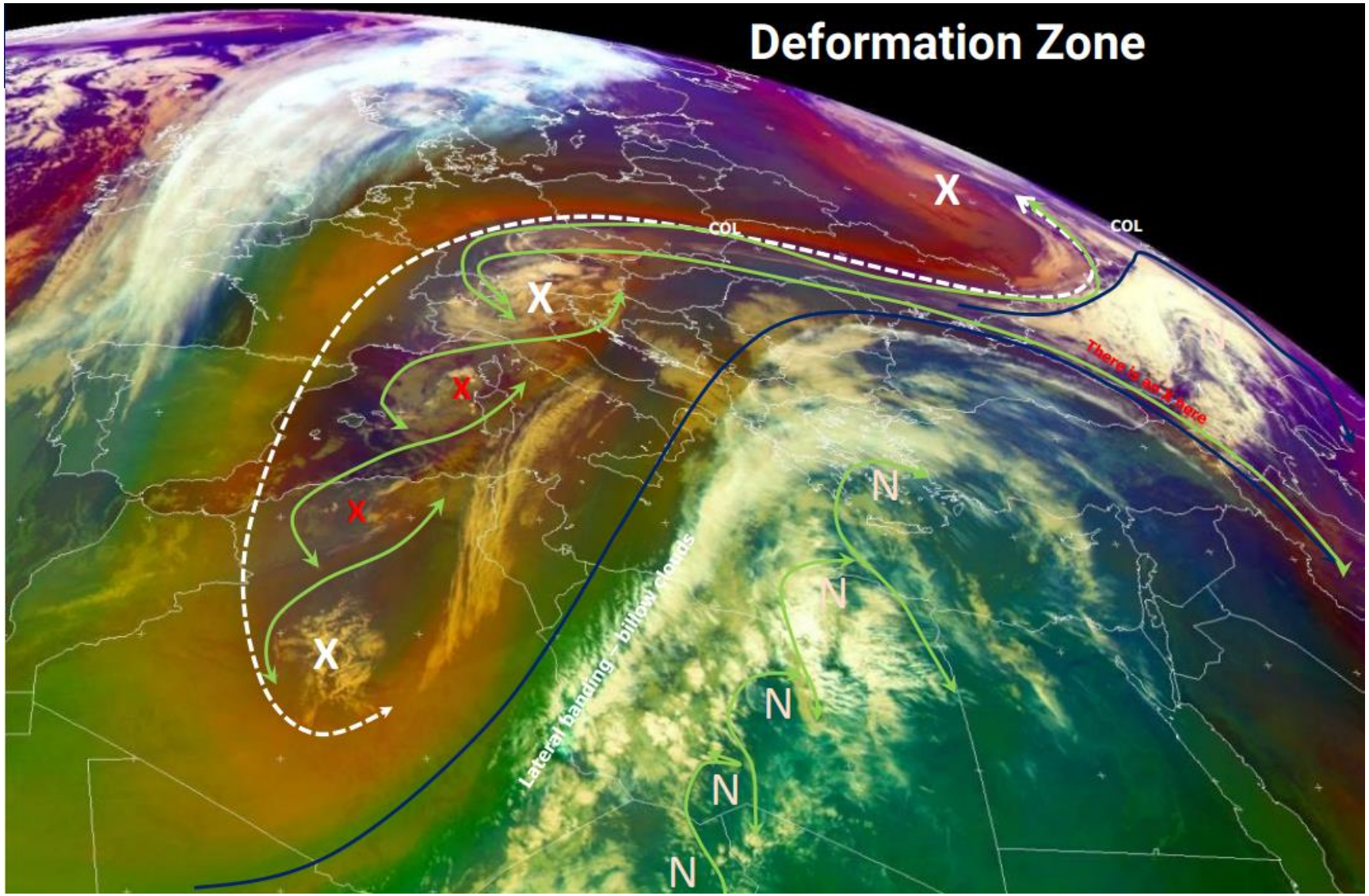

High

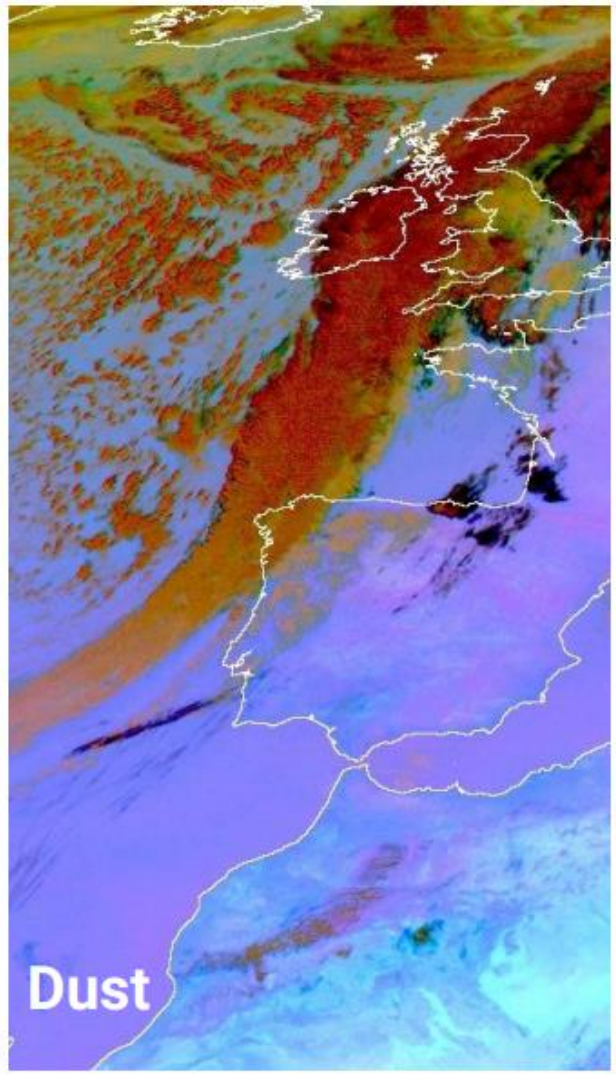

Deformation Zone

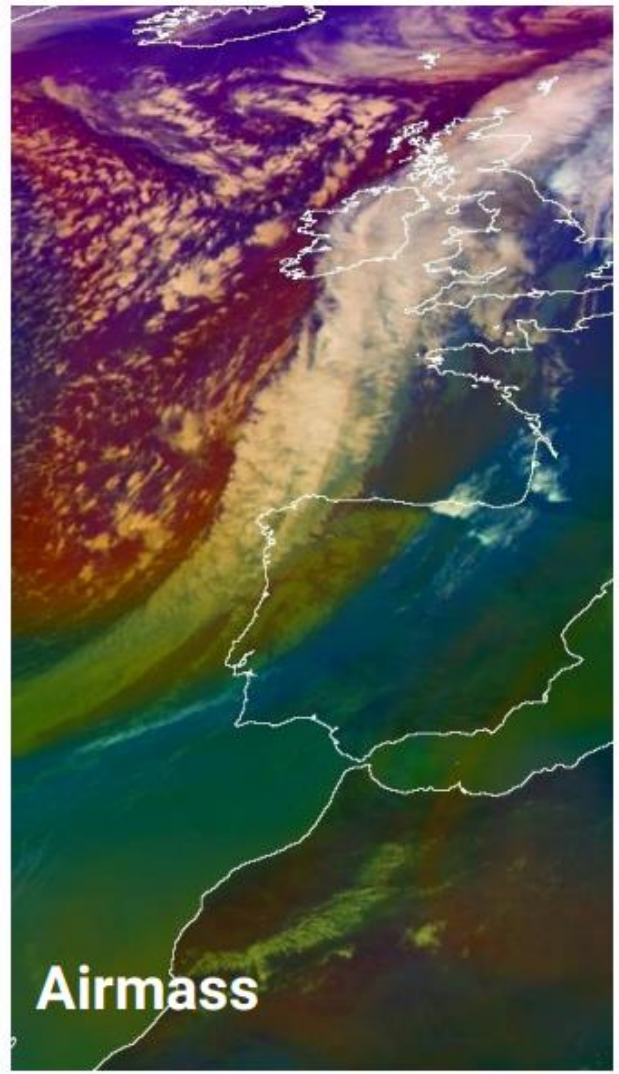

PV Anomaly

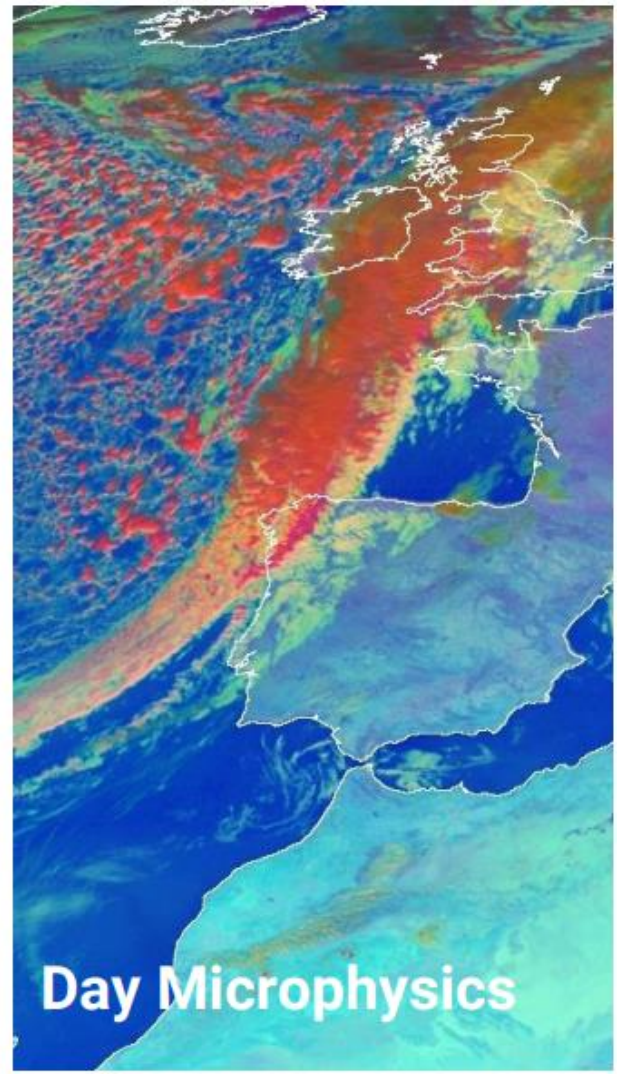

Jet (polar)


Jet (subtropical)

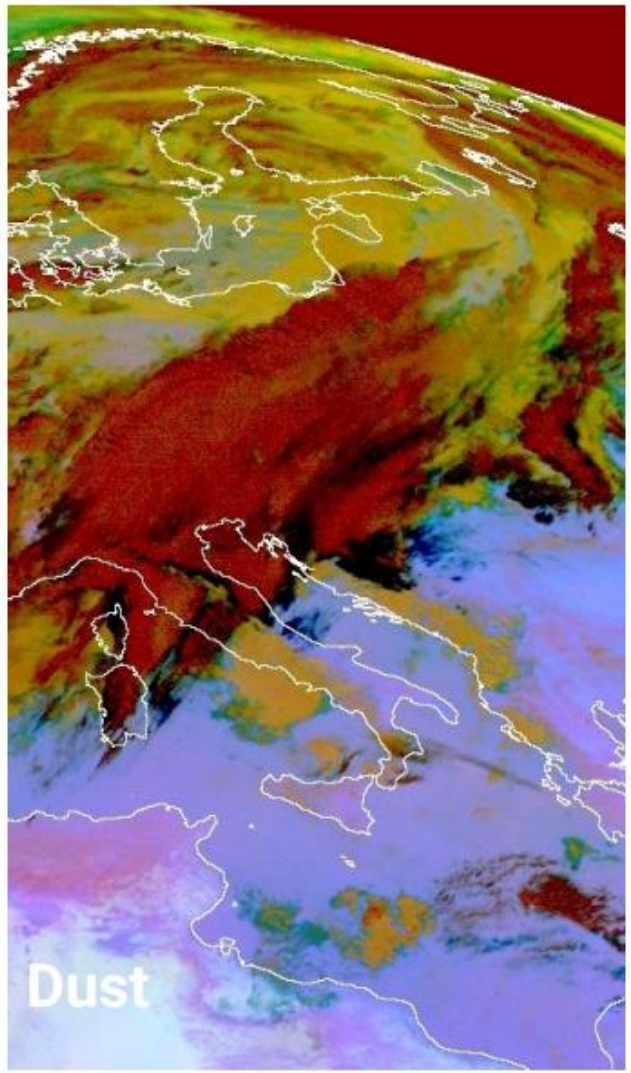

Deformation Zone
X
COL
COL
X
X
X
X
There is an X here
N
N
N
N
N
Lateral banding - billow clouds

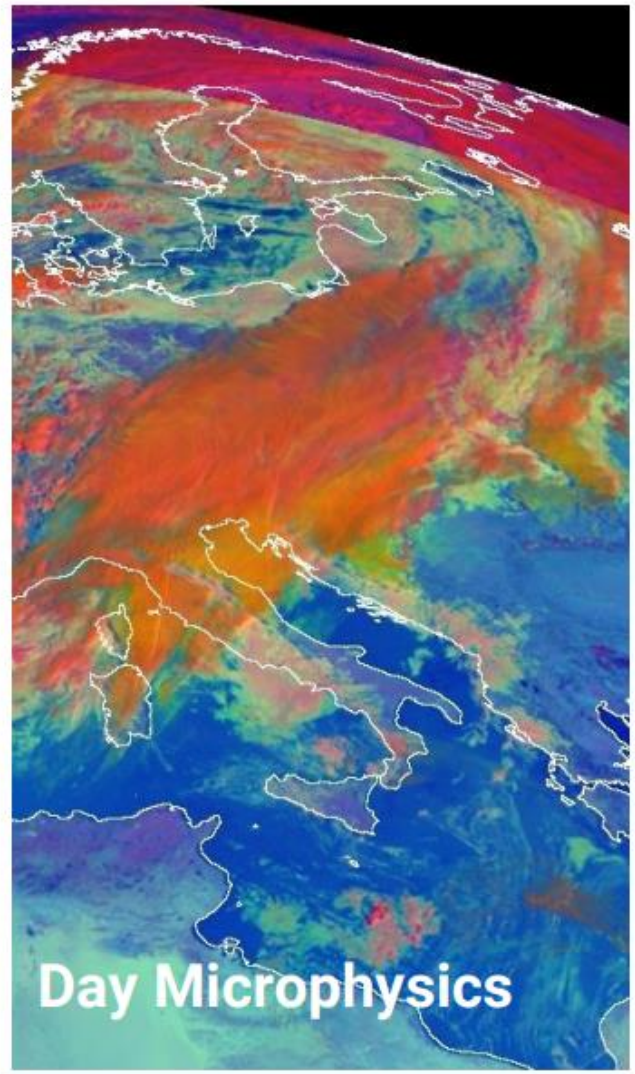


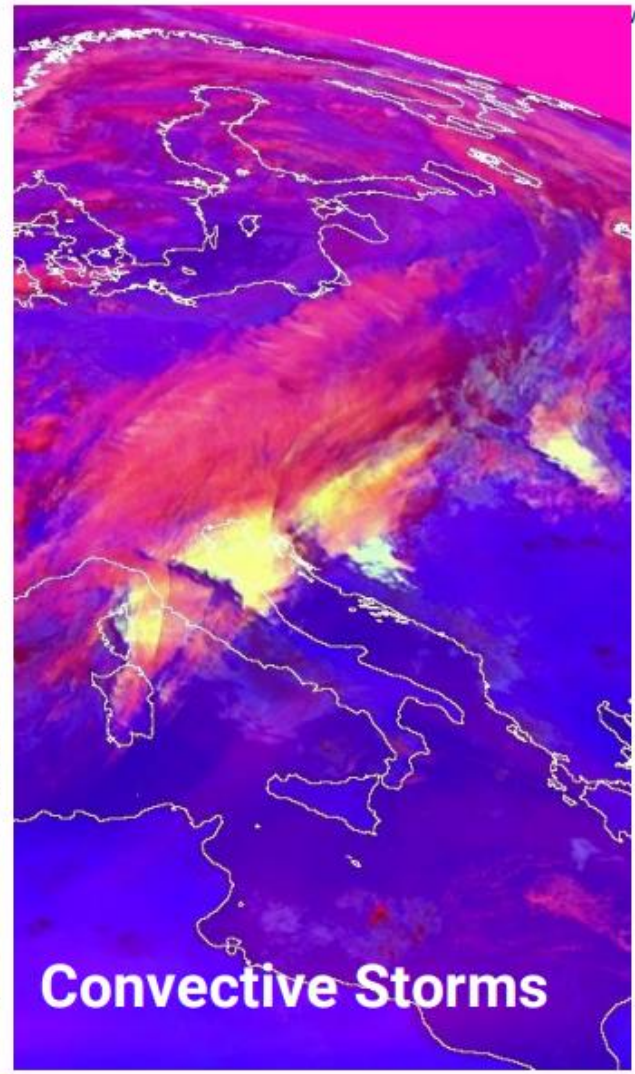




08 November 2005, 12:00 UTC

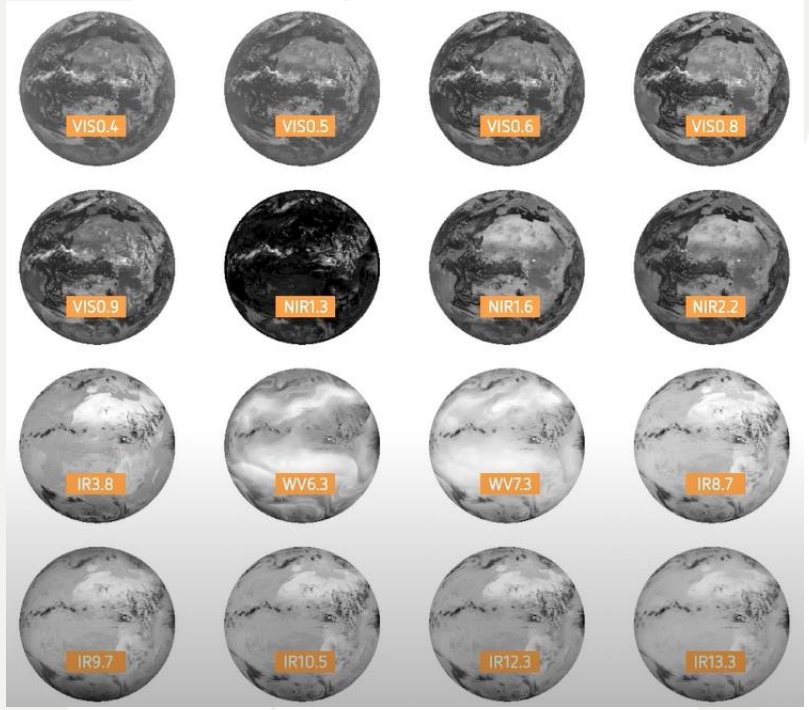


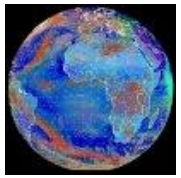




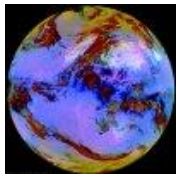
19 March 2007, 08:00 UTC

More Bands more Composite Images (RGB)

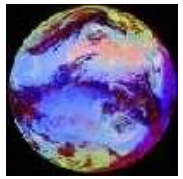




Day Microphysics RGB

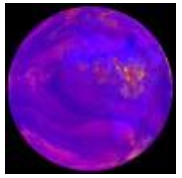


Dust RGB



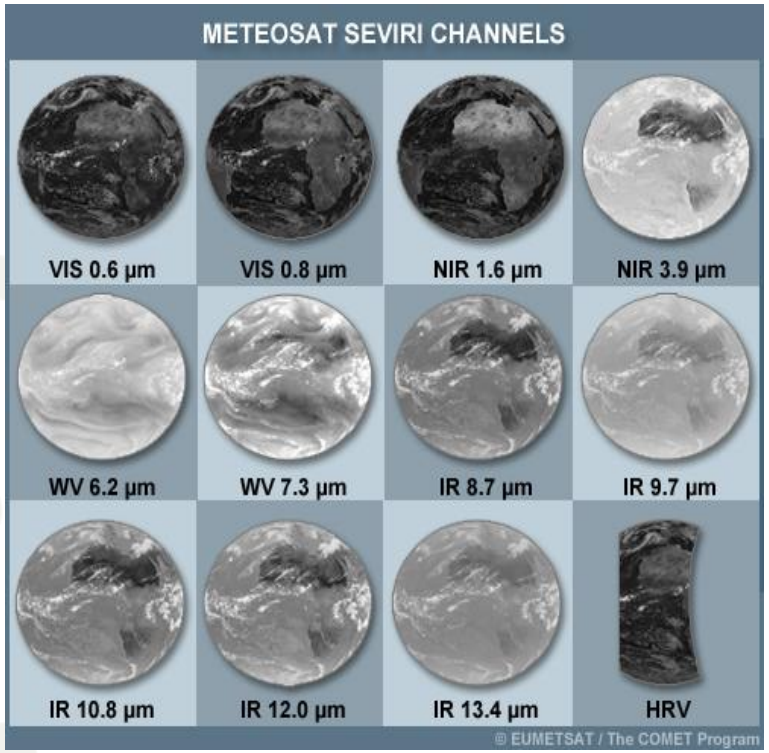
Fog / Low Clouds RGB

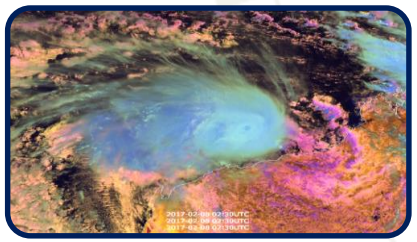
Airmass RGB

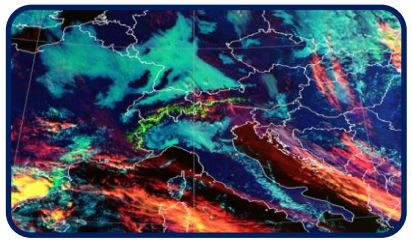


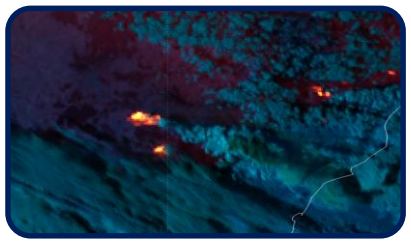
Convection RGB

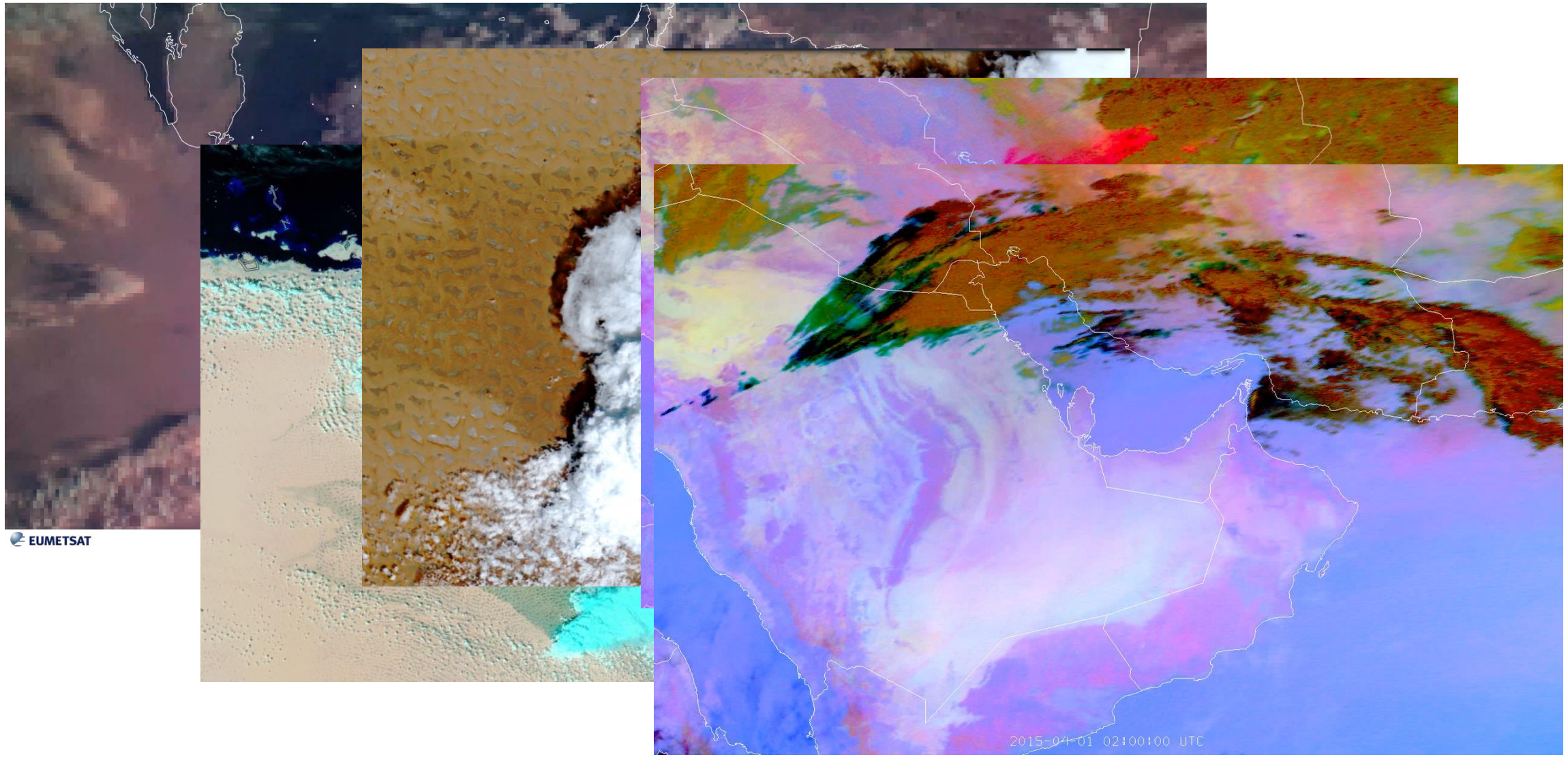
Natural Color RGB










EUMETSAT
2015-04-01 02:00:00 UTC

EUMETRAIN

International training project sponsored by EUMETSAT
to support and increase the use of meteorological satellite data

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https://resources.eumetrain.org/rgb_quick_guides/index.html

شكرا جزيلا

Thank You