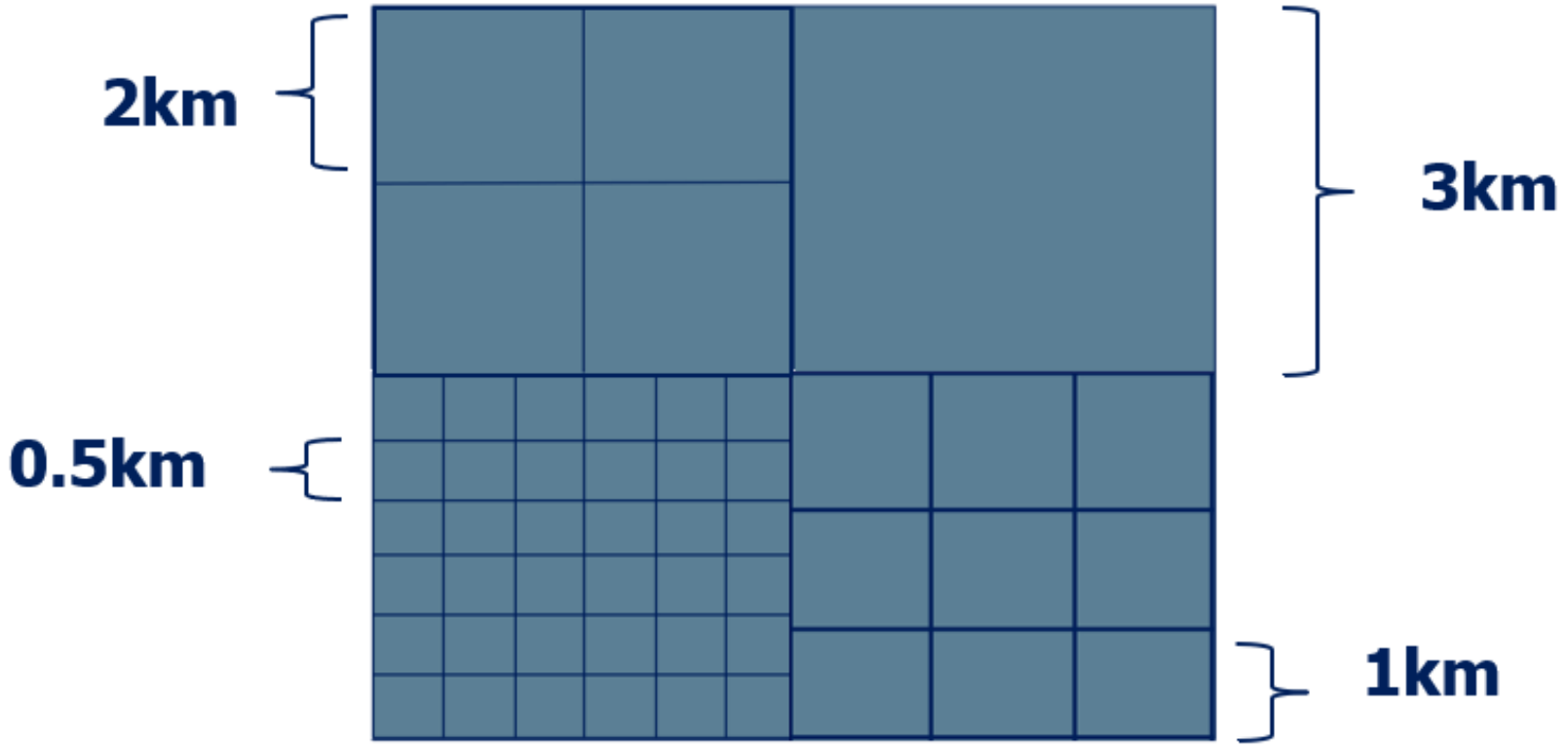
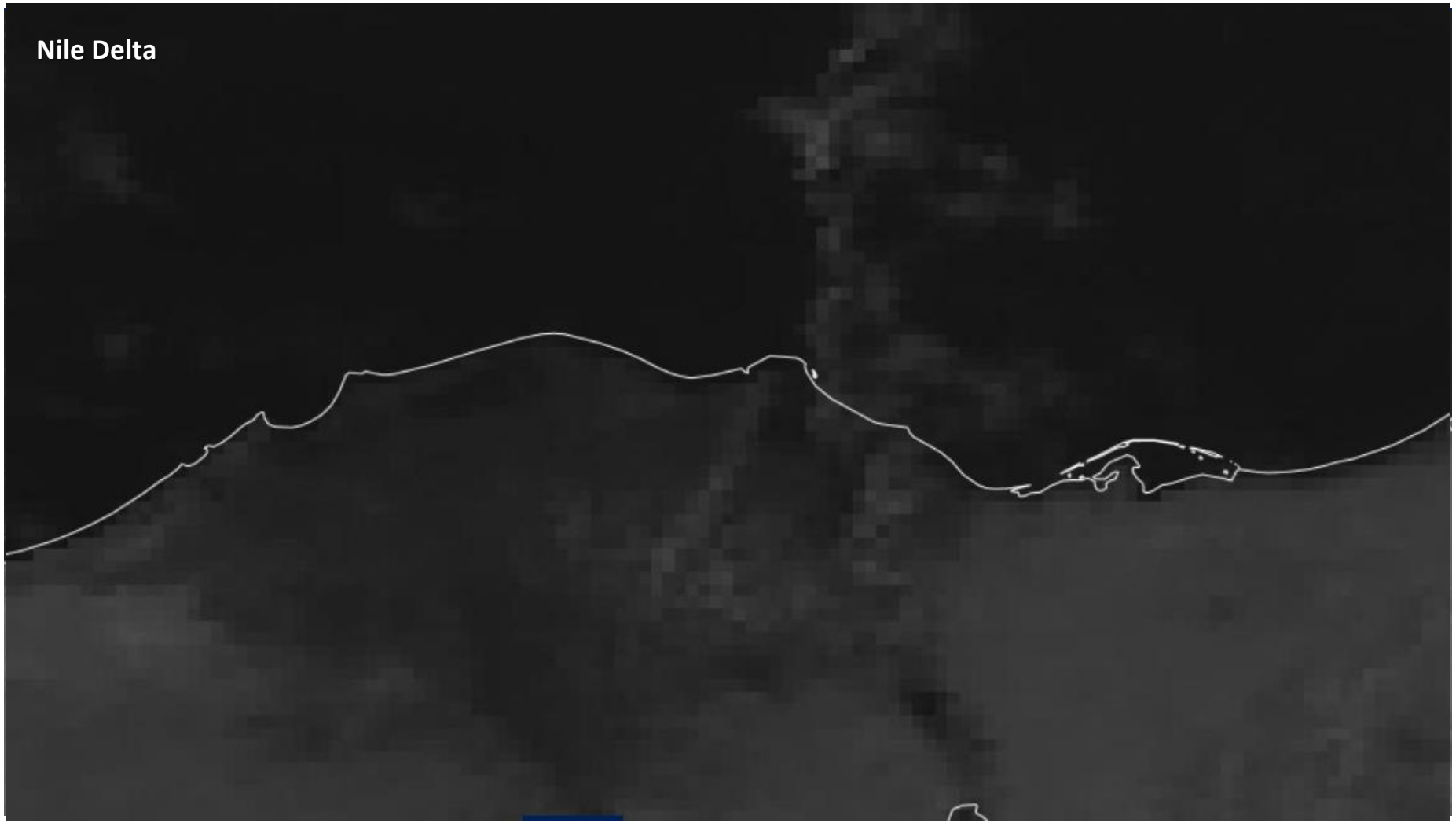
Part 2 : FCI applications

Spatial Resolution

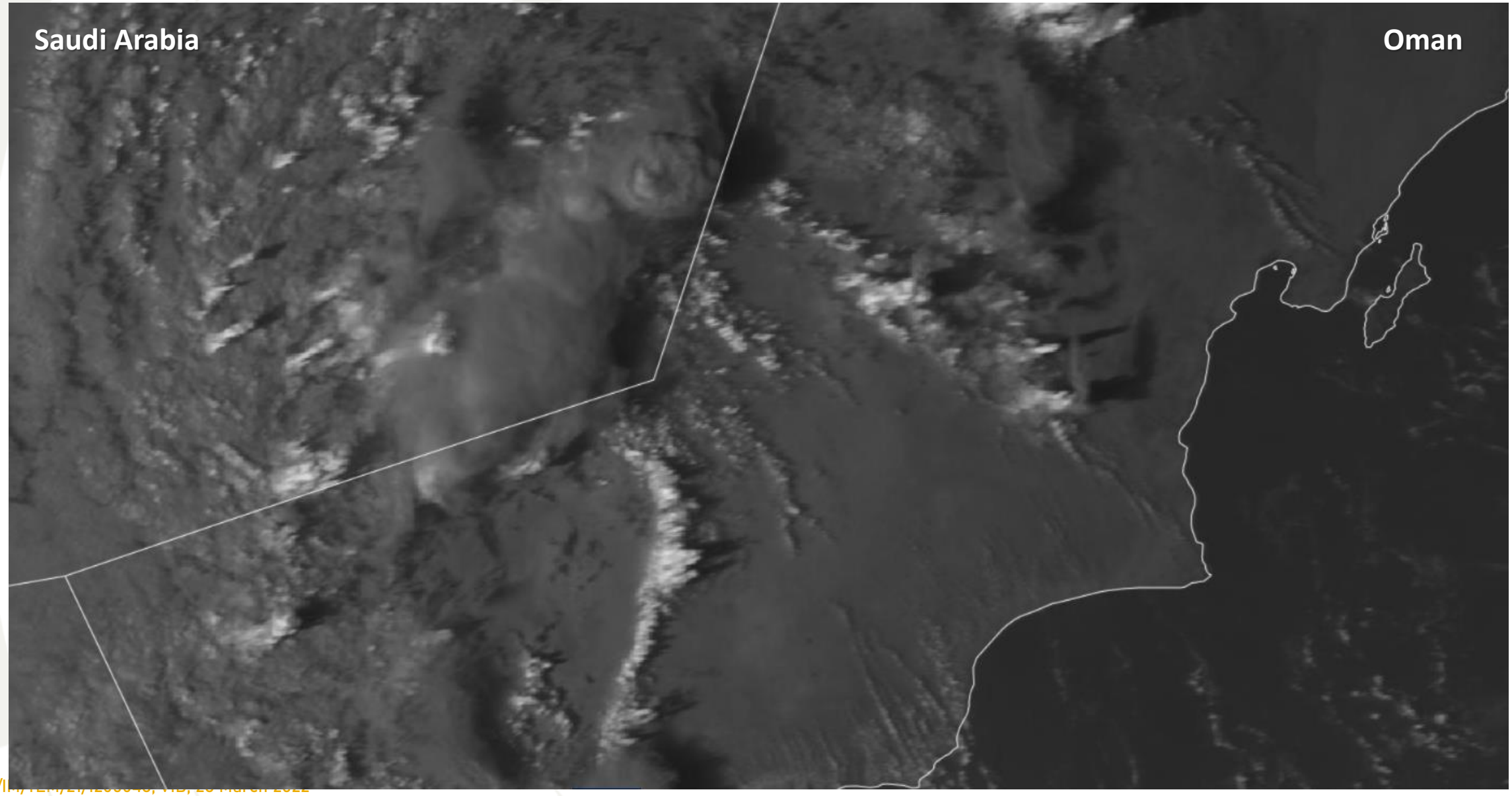


MTG vs MSG (FCI vs SEVIRI)

- **0.6 um from 3x3km to 0.5x0.5km**

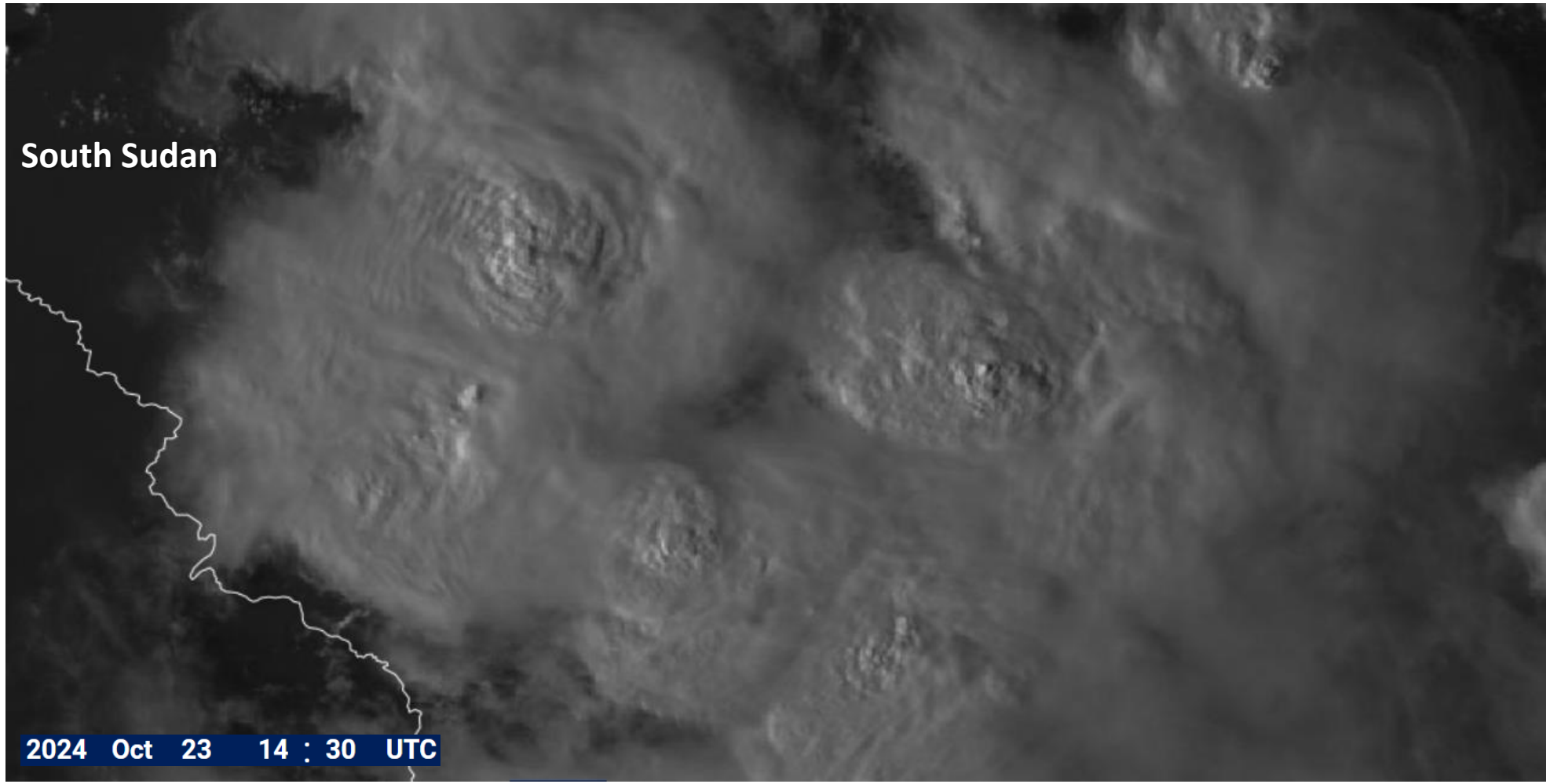


0.6 um from 3x3km to 0.5x0.5km



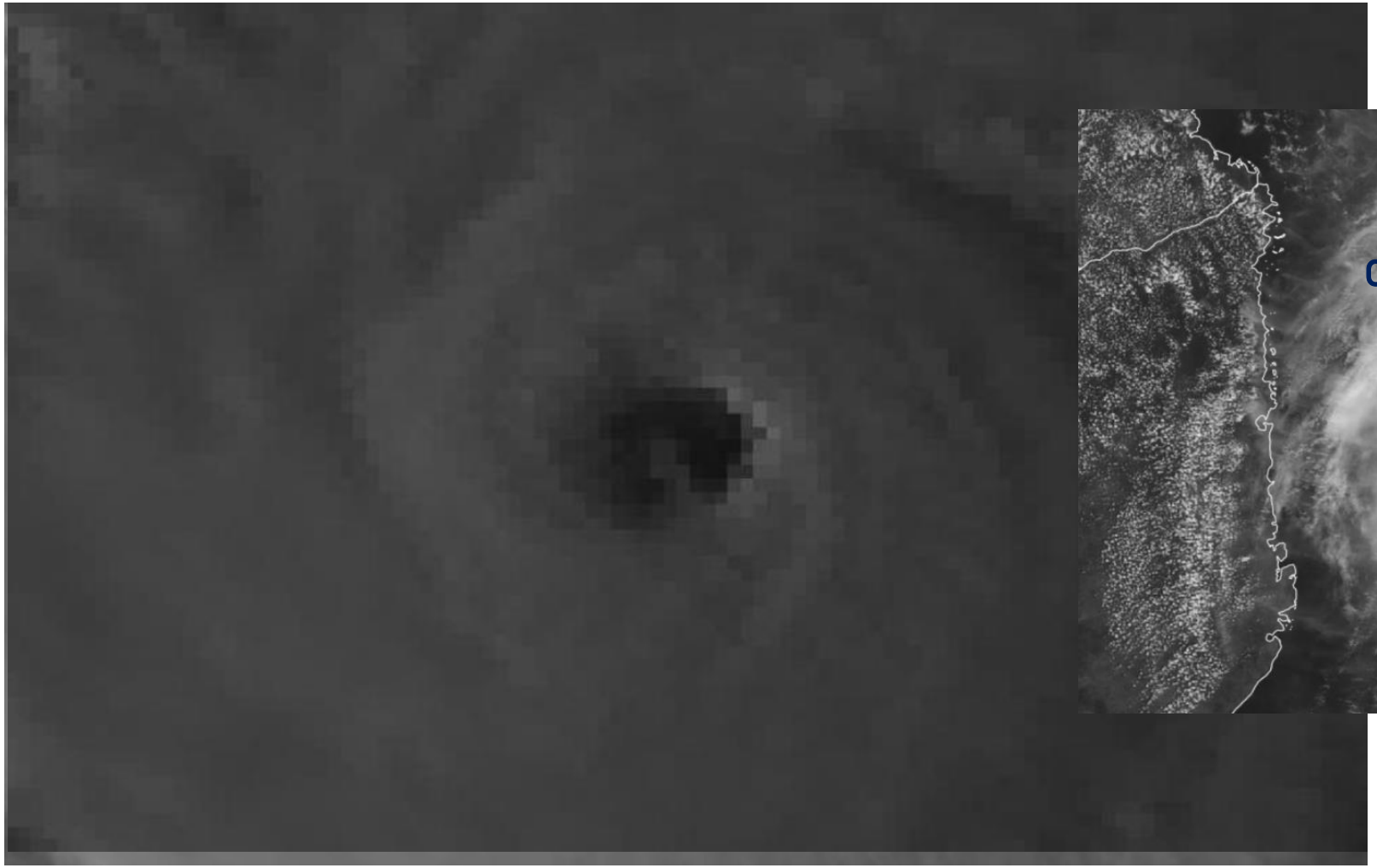
MTG vs MSG (FCI vs SEVIRI)

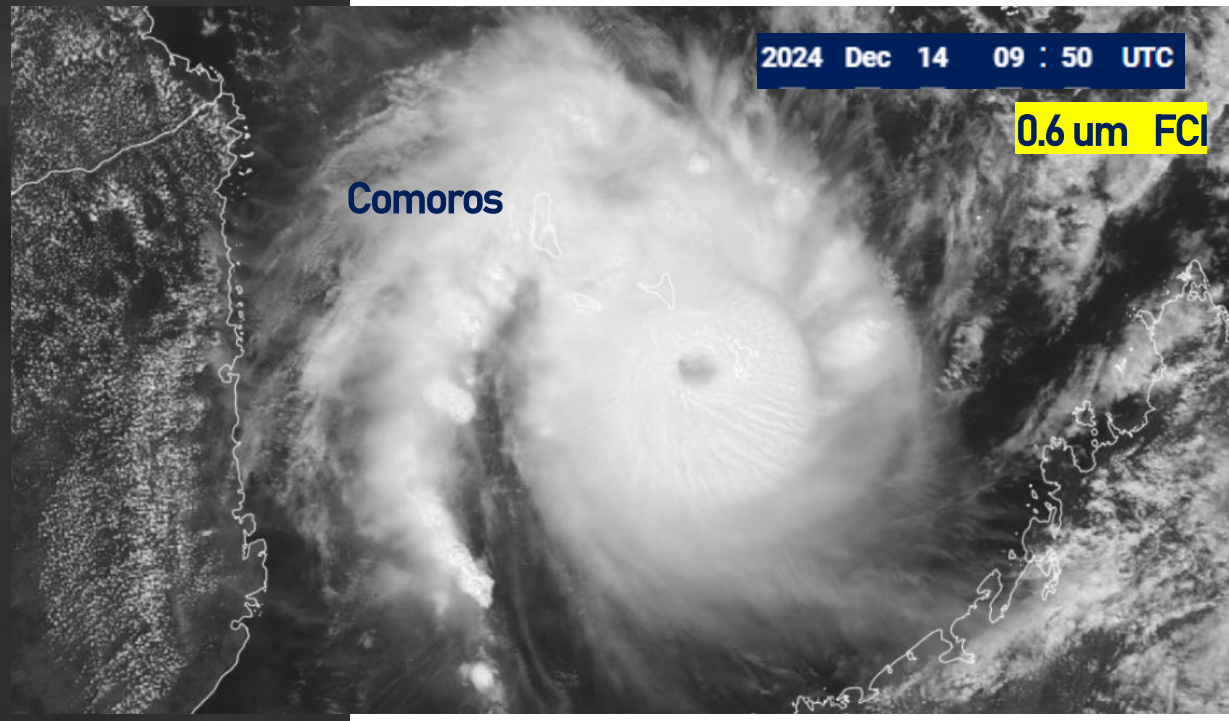
- **What's new? – RESOLUTION: 0.6 um from 3x3km to 0.5x0.5km**



MTG vs MSG (FCI vs SEVIRI)

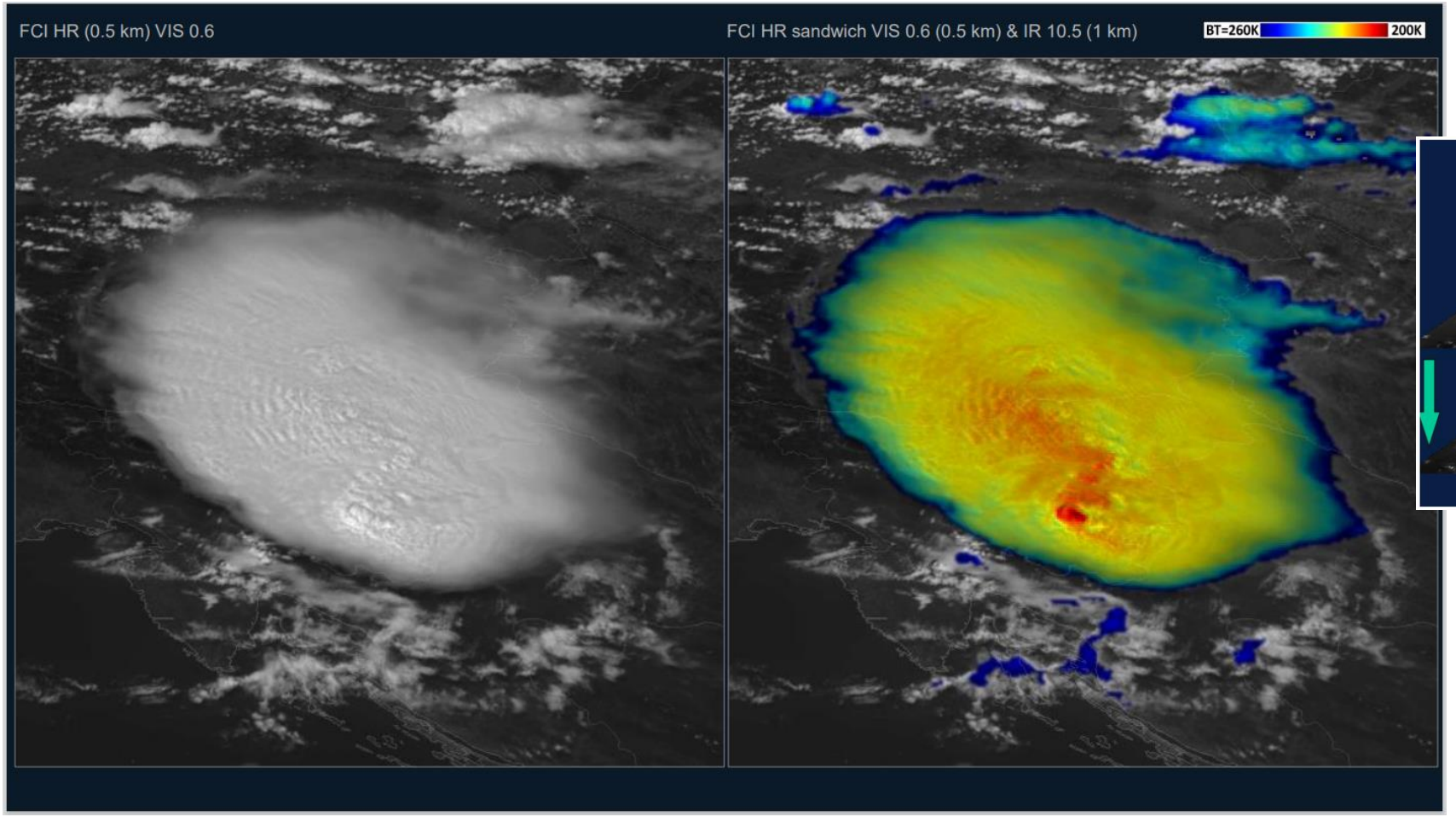
- What's new? – RESOLUTION: 0.6 um from 3x3km to 0.5x0.5km

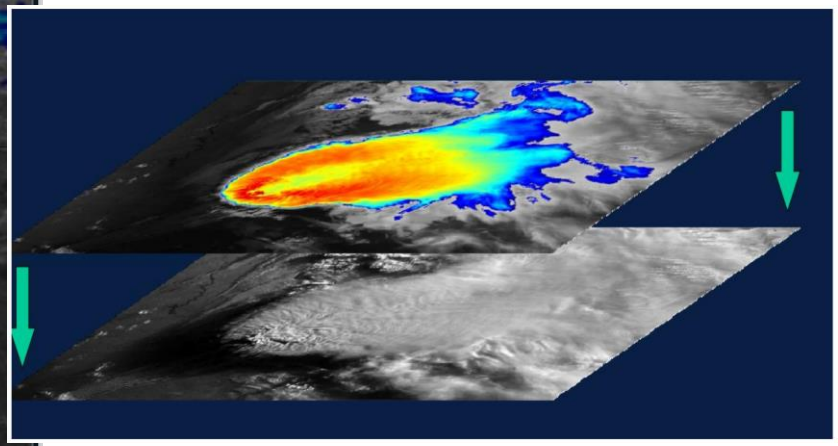




MTG vs MSG (FCI vs SEVIRI)

- **What's new? – RESOLUTION: 0.6 um (0.5km) and 10.5 (1 km)**





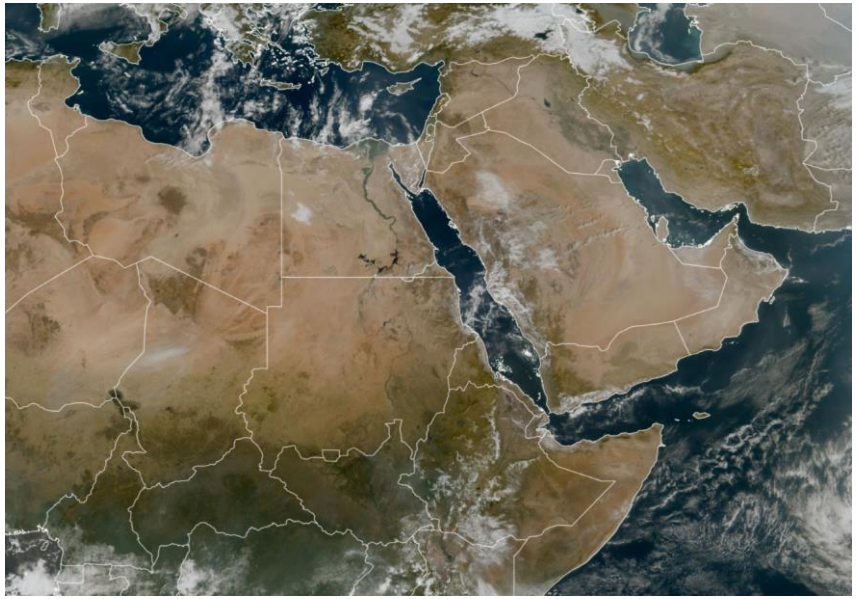
Credit : EUMETSAT

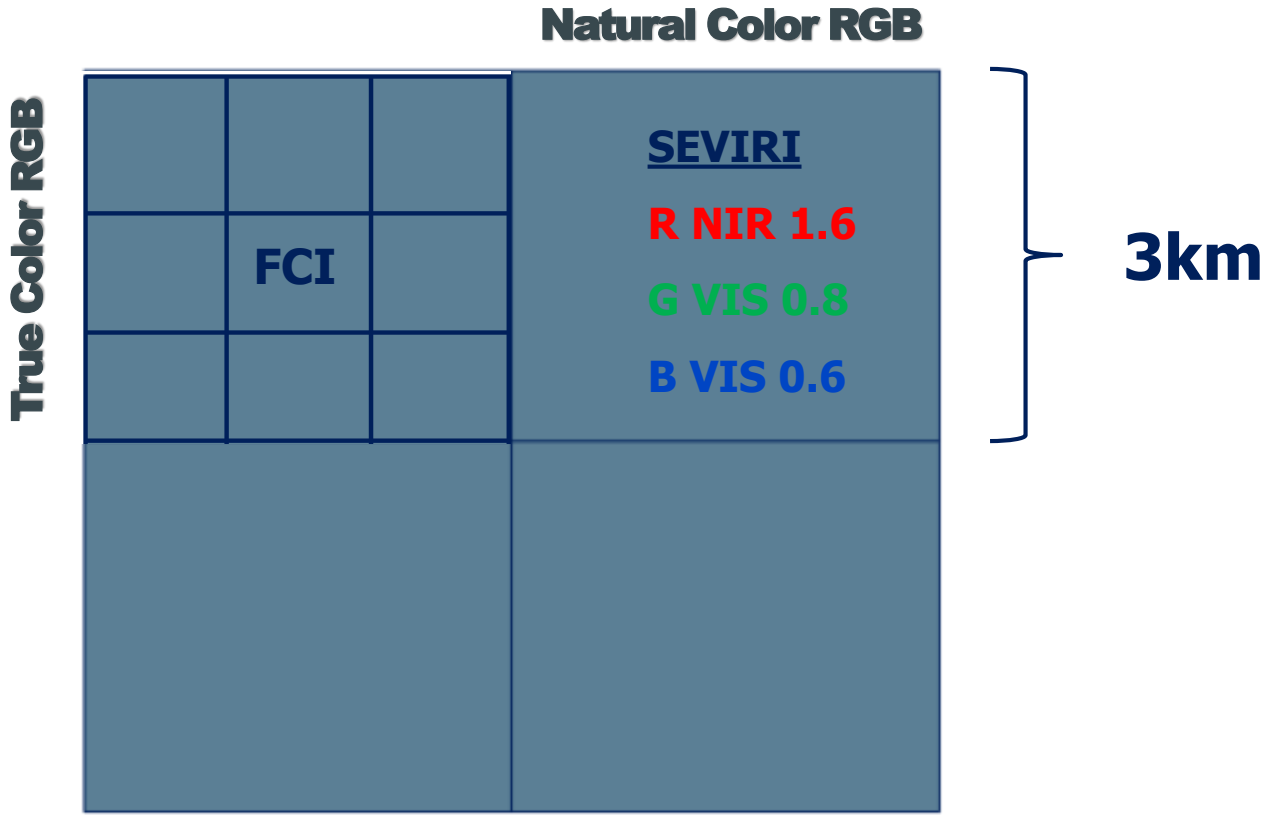
MTG vs MSG (FCI vs SEVIRI)

What's new? True Colour RGB

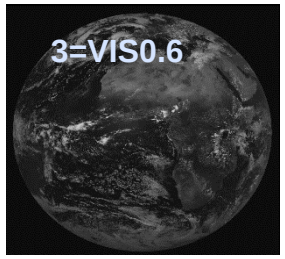
from 3km to 1 km (9 times more pixels!!)

FCI True Colour RGB R VIS0.6 G VIS0.5 B VIS0.4





FCI applications - **True Colour RGB**



2=VIS0.5

> AEROSOL

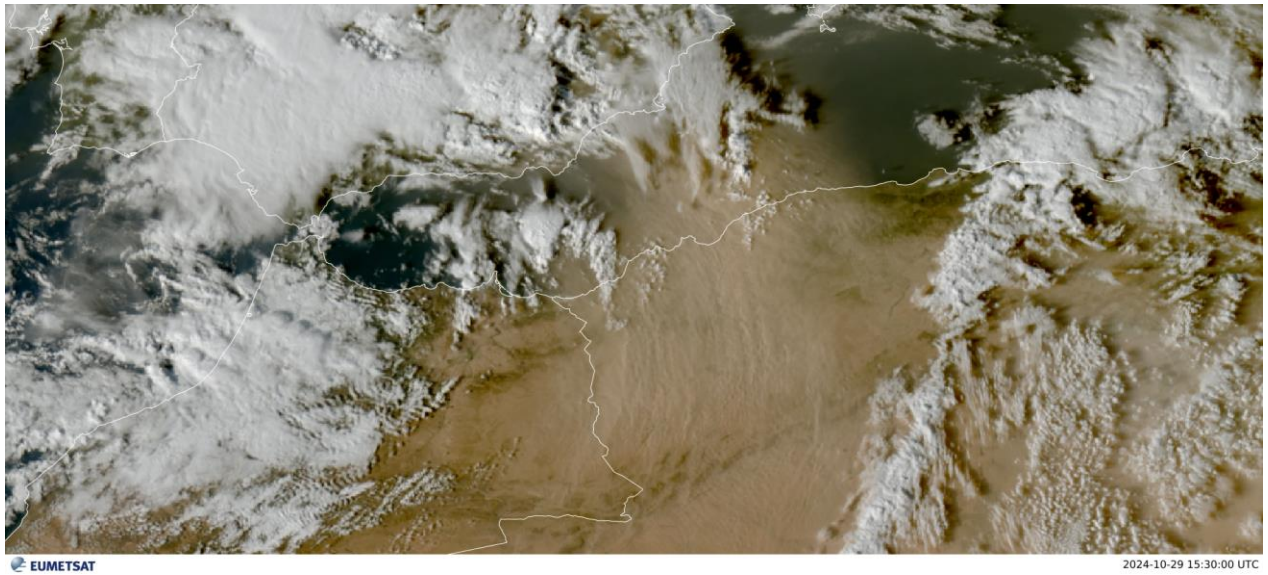
> VEGETATION

1=VIS0.4

> AEROSOL

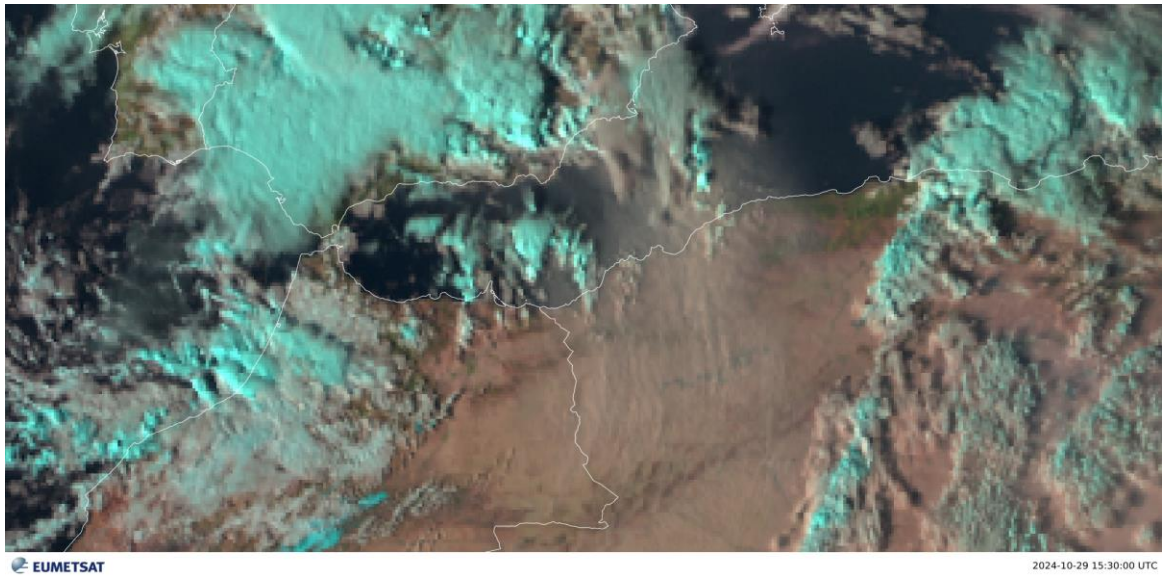
> SURFACE

- **Aerosols (dust, ash, smoke, smog)**
- **Vegetation**
- **Ocean Colour**
- **Ice/snow**
- **(Clouds)**



FCI

R VIS0.6 G VIS0.5 B VIS0.4



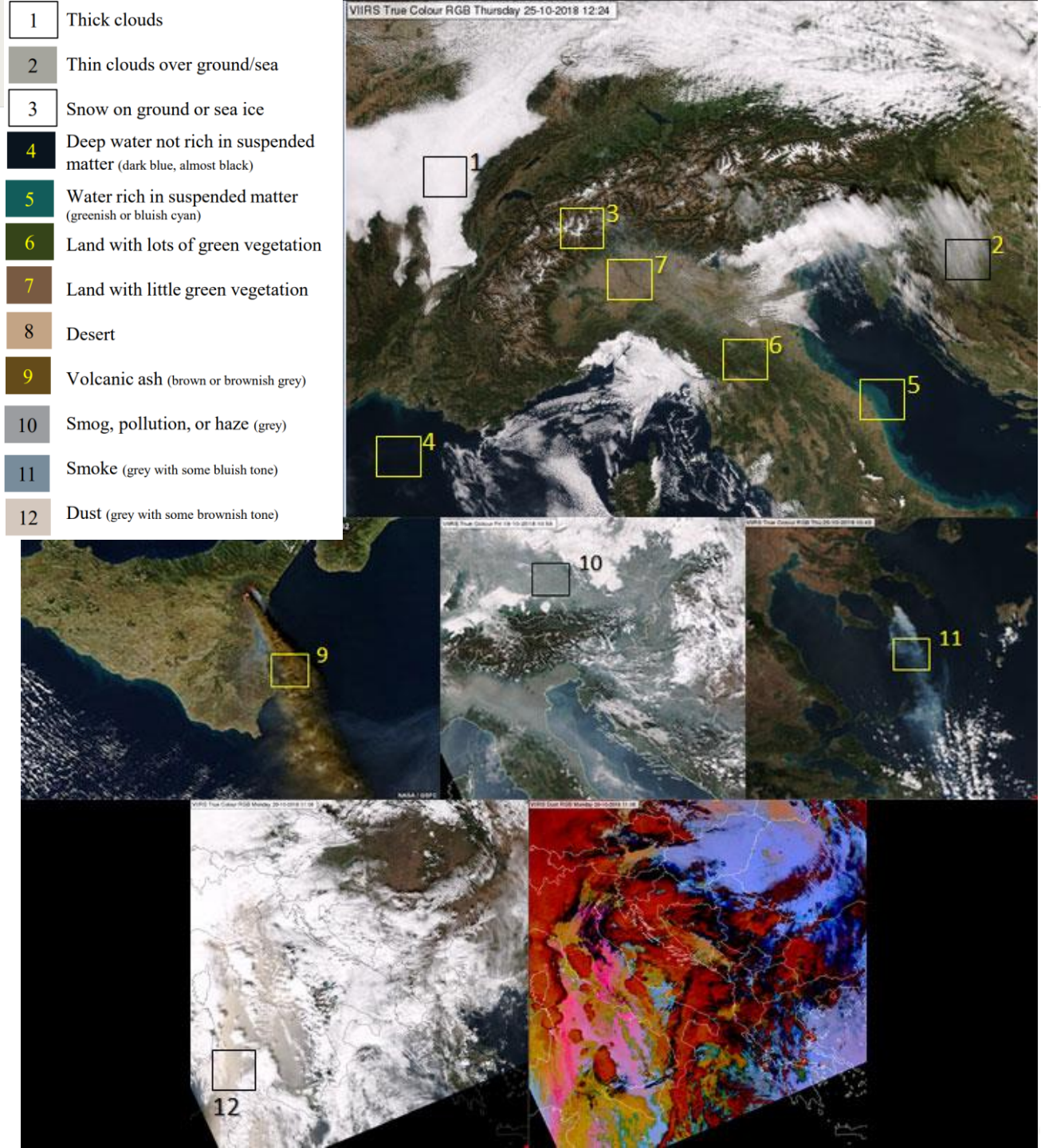
SEVIRI

R NIR 1.6 G VIS 0.8 B VIS 0.6

True Color RGB

R VIS0.6 G VIS0.5 B VIS0.4

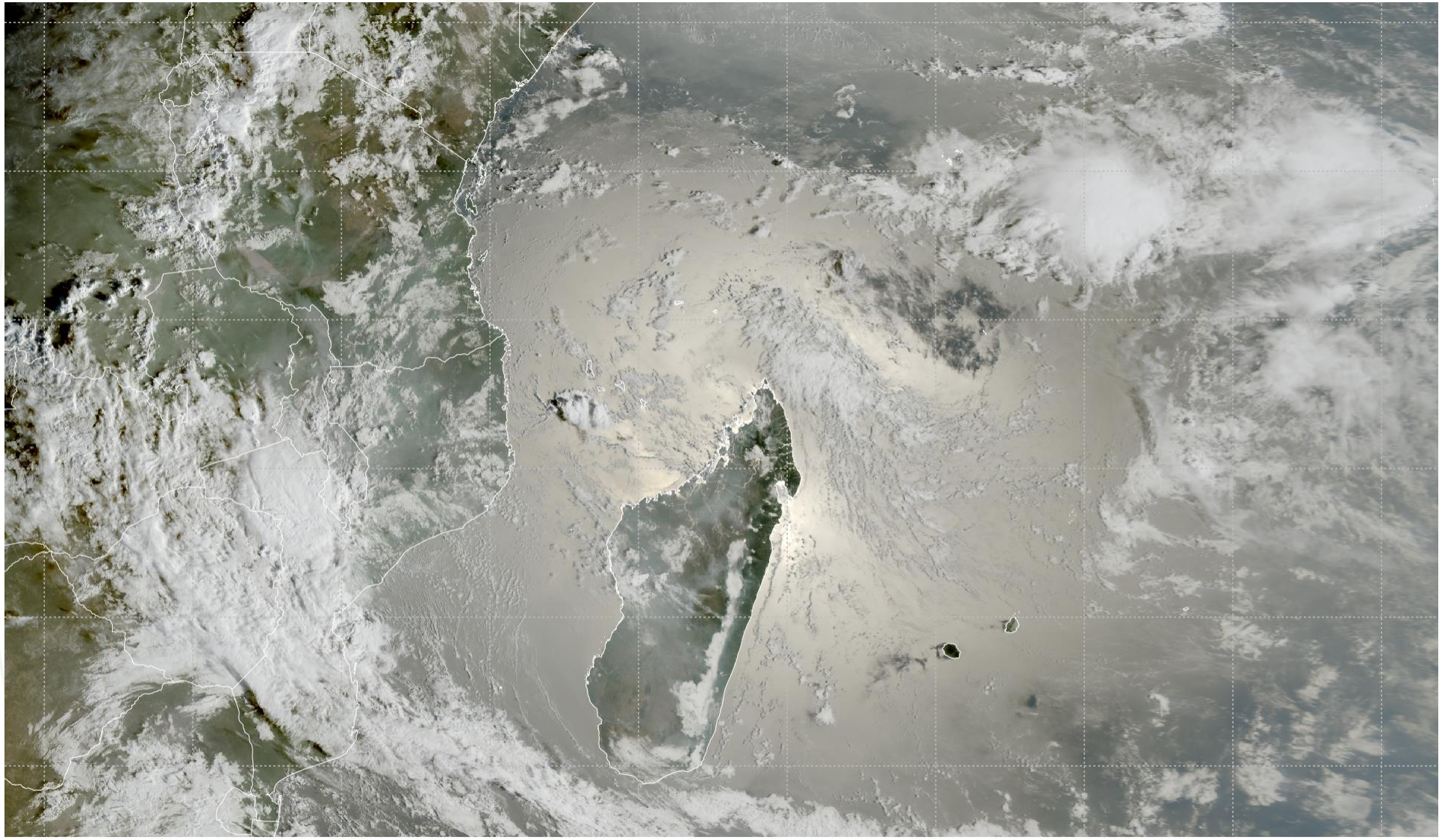
Colour	Channel [micron]	Physically relates to	Smaller contribution to the signal of	Larger contribution to the signal of
Red	VIS0.67	Cloud optical thickness, vegetation, aerosols	Thin clouds	Thick clouds
Green	VIS0.56	Cloud optical thickness, vegetation, aerosols	Thin clouds Dry vegetation	Thick clouds Green vegetation
Blue	VIS0.49	Cloud optical thickness, vegetation, aerosols	Thin clouds	Thick clouds



Limitations

- Works only during the day.
- No separation between clouds and snow.
- No separation of cloud types.
- No temperature information.
- No cloud height information.
- No microphysical information for clouds.
- Strong sunglint.

Strong Sun glint.



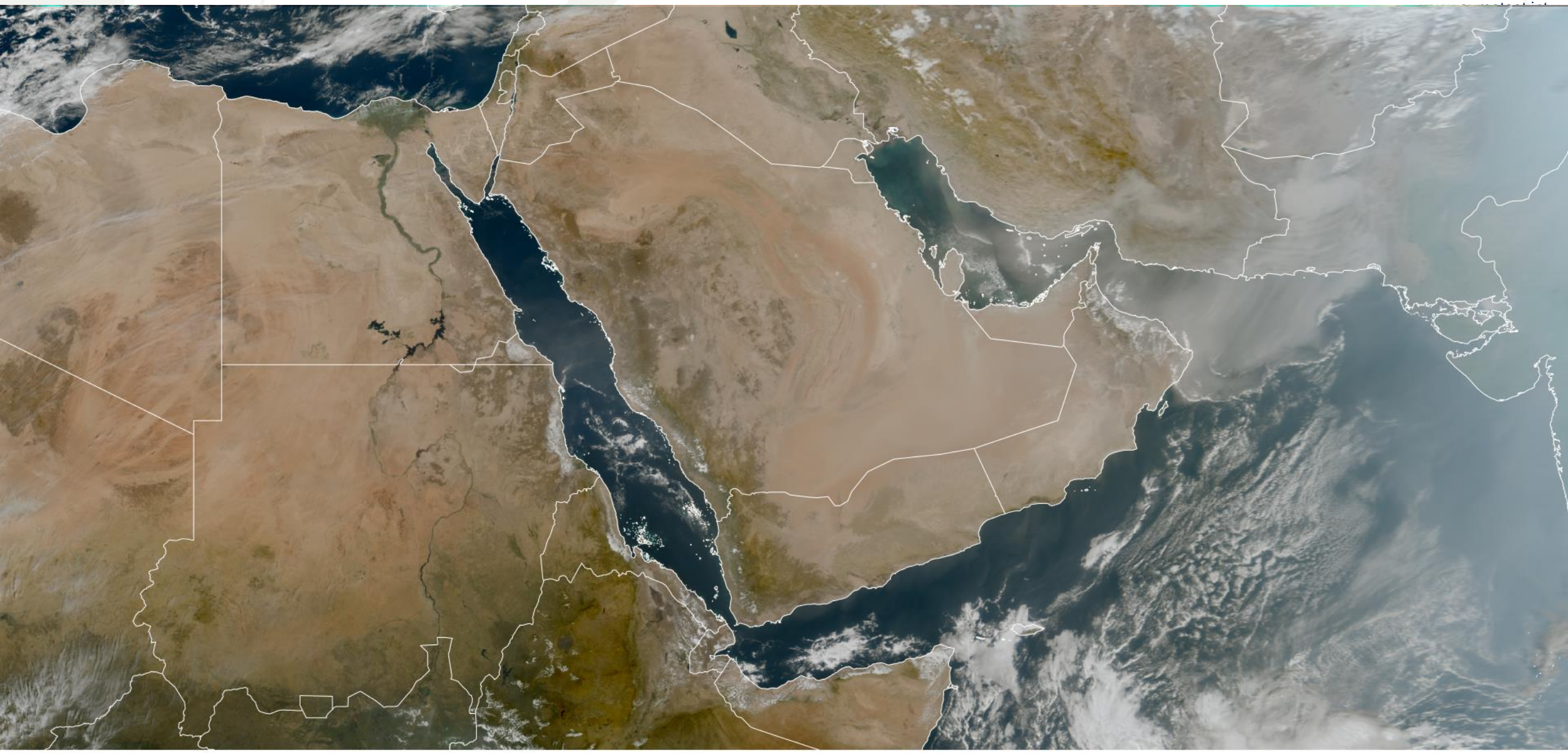
2024-11-14 04:20:00 UTC

FCI

R VIS0.6 G VIS0.5 B VIS0.4

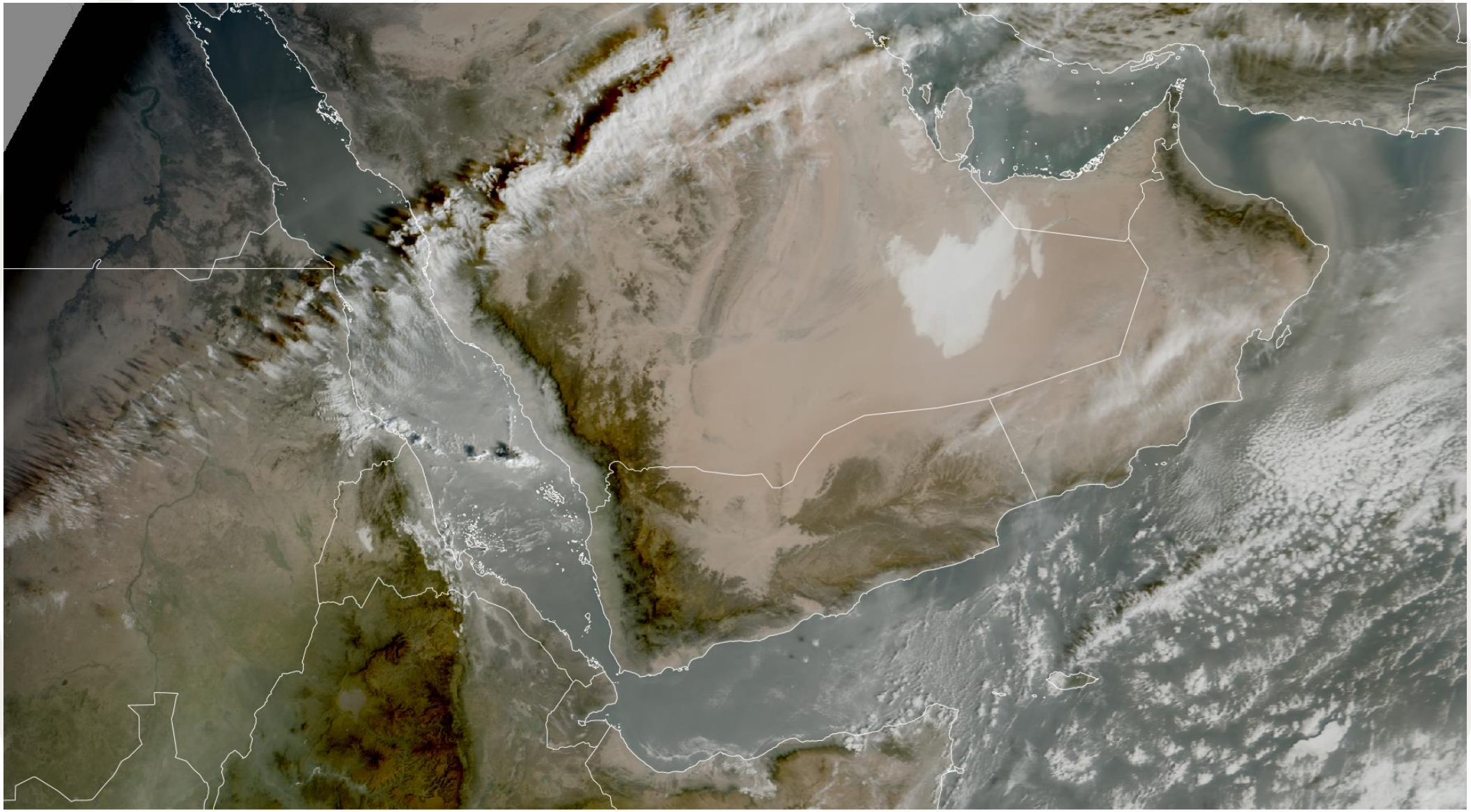
SEVIRI

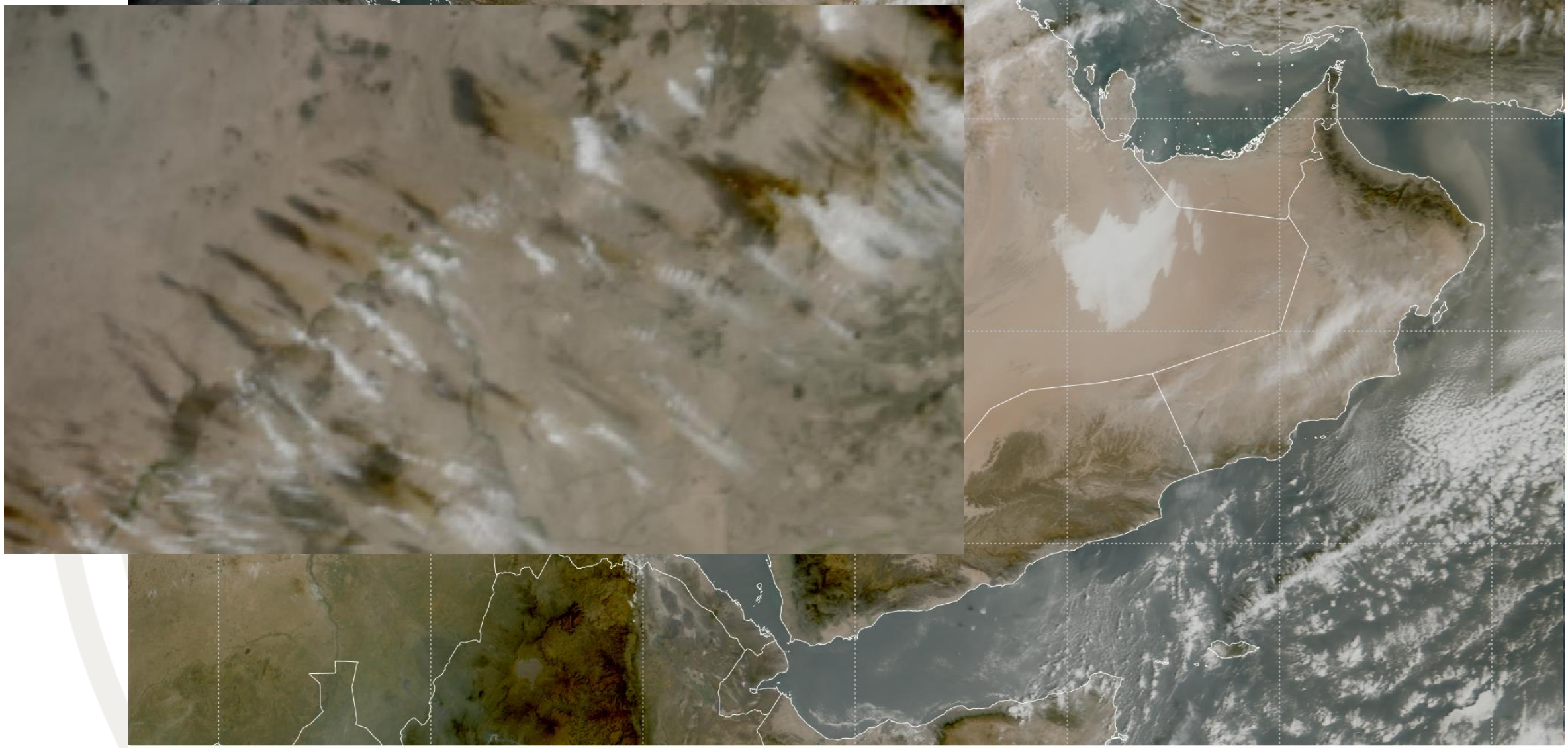
R NIR 1.6 G VIS 0.8 B VIS 0.6



EUMETSAT

2024-12-16 10:30:00 UTC


EUMETSAT
2024-12-09 04:40:00 UTC



EUMETSAT

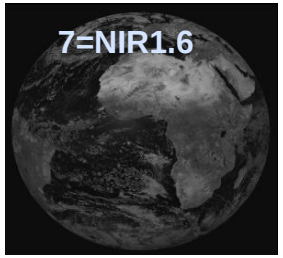
2024-12-09 05:00:00 UTC

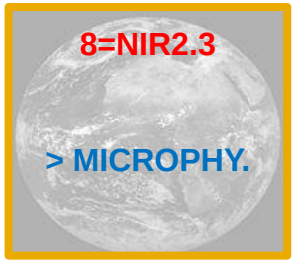
FCI applications – **Cloud Phase RGB**

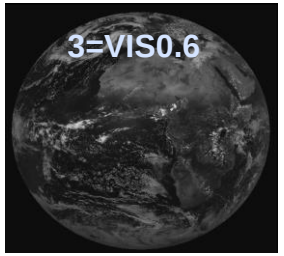
R NIR1.6

G NIR2.3

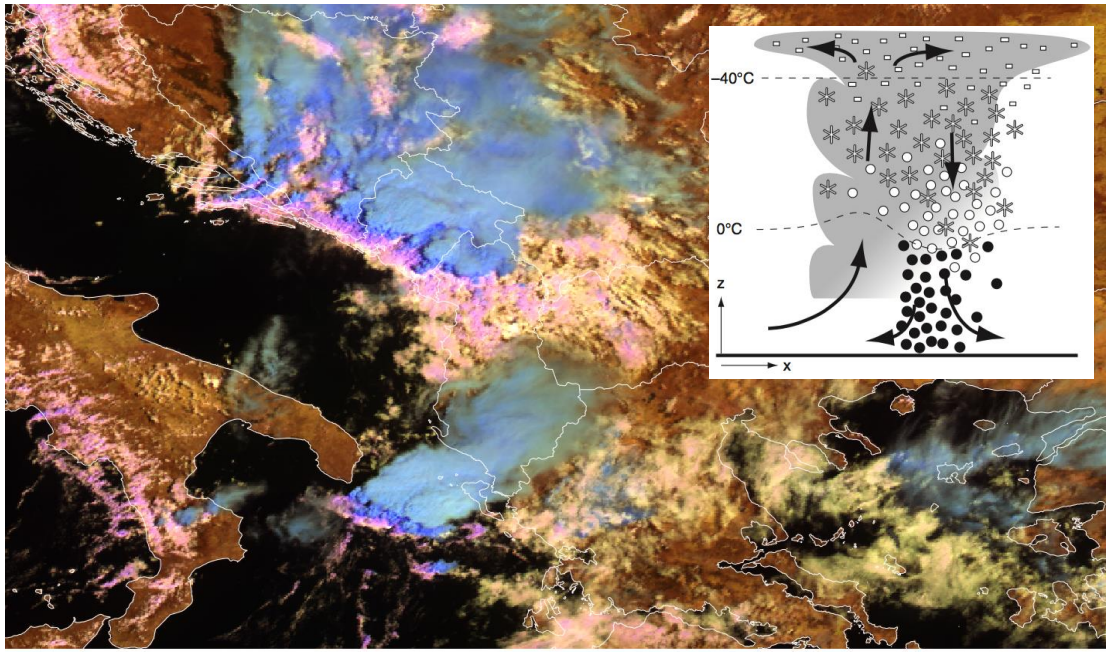
B VIS0.6



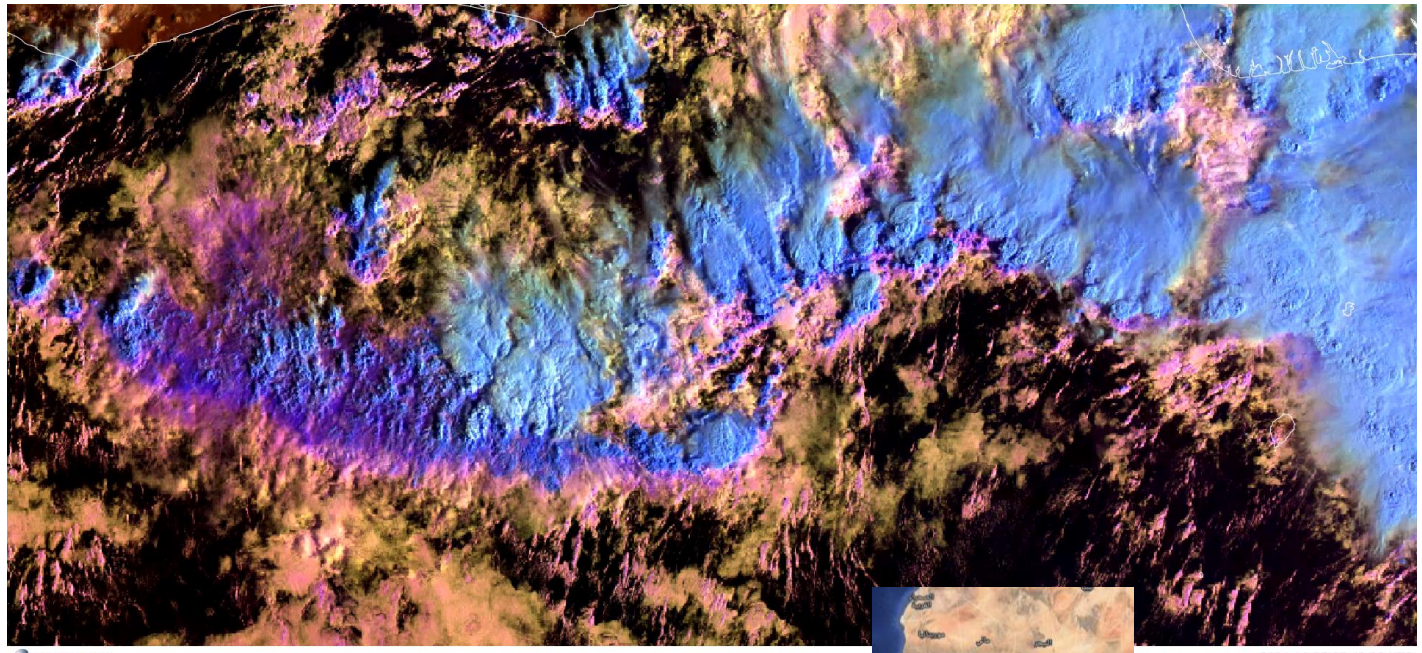




- **Cloud phase**
- **Particle size**
- **Snow/ice**
- **(Aerosols)**
- **(Vegetation)**
- **(Hot fires)**



2024-09-24 09:30:00 UTC



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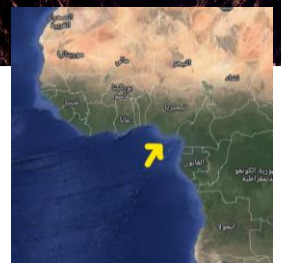
2024-11-07 07:40:00 UTC



Cloud Phase RGB

R NIR1.6

G NIR2.3

B VIS0.6

Colour	Channel [micron]	Physically relates to	Smaller contribution to the signal of	Larger contribution to the signal of
Red	NIR1.6	Cloud Phase (and cloud top particle size)	Thick ice clouds	Thick water clouds
Green	NIR2.25	Cloud top particle size (and phase)	Thick clouds with large particles	Thick clouds with small particles
Blue	VIS0.6	Cloud optical thickness	Thin clouds	Thick clouds

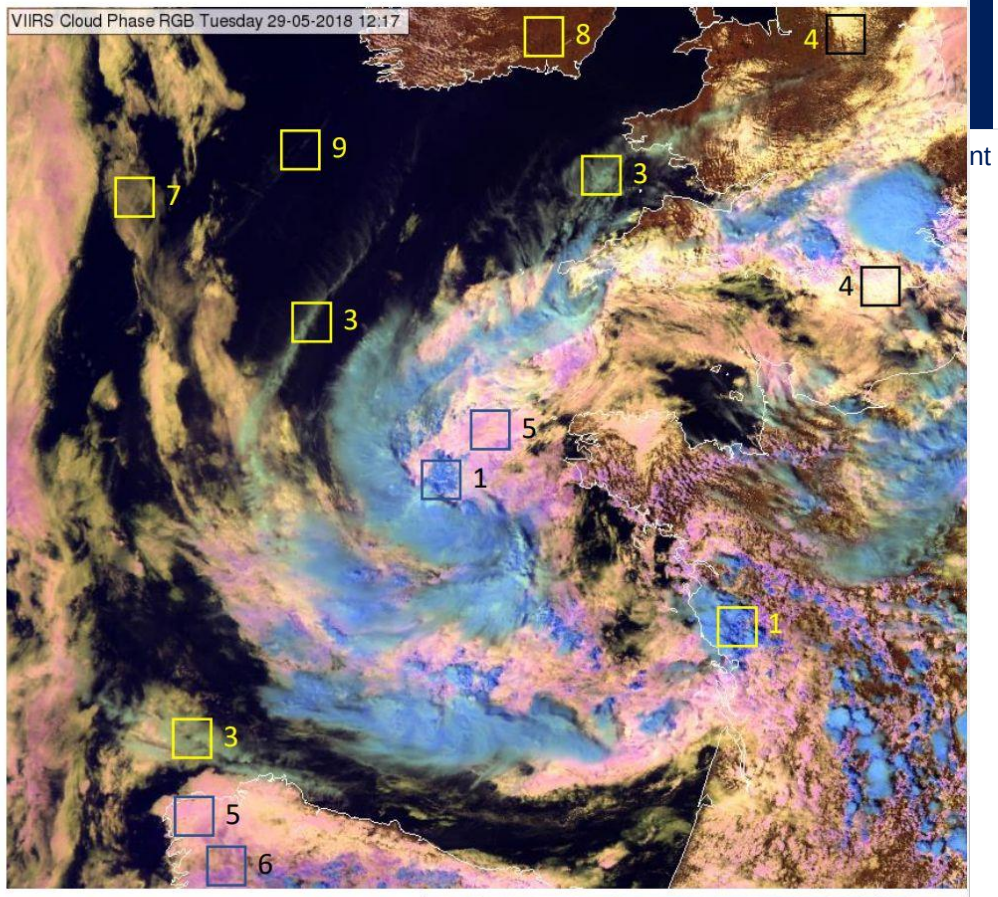
Limitations

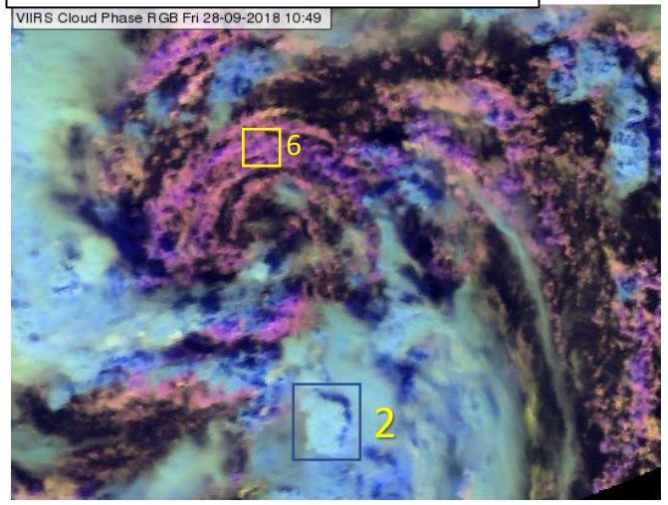
- Limited to daytime applications.
- Separation of very thin water and ice clouds is problematic in some cases.
- It does not contain temperature information.
- The snow-covered surface and the ice clouds covered by large particles have similar colours (dark and medium blue).
- The colour of thin clouds depends on the cloud properties, its transparency, type of the underlying surface, satellite and viewing angles.

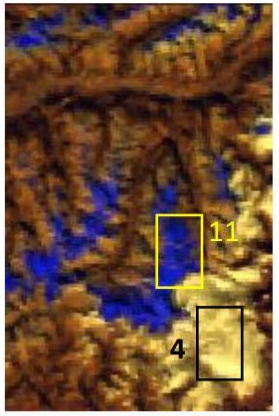
Interpretation

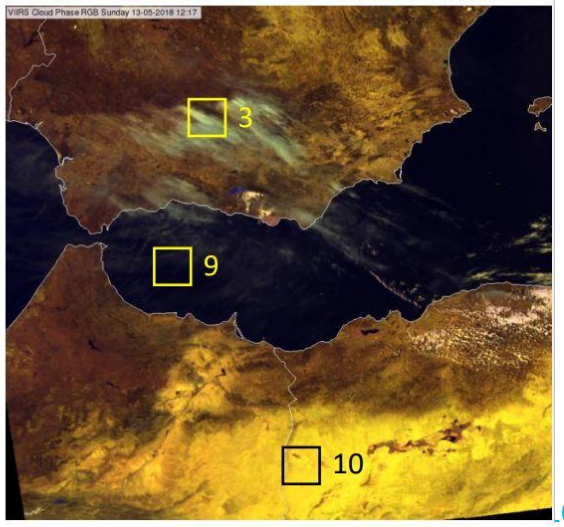
1	Thick ice clouds, large particles
2	Thick ice clouds, small particles
3	Thin ice clouds
4	Thick water clouds, small droplets
5	Thick water clouds, larger droplets (larger the droplets are darker pink)
6	Thick water clouds, extreme large droplets (or thick mixed phase clouds)
7	Thin water clouds over sea
8	Vegetated land (snow free)
9	Sea (ice free)
10	Desert
11	Snow on ground or sea ice

The colour of thin clouds depends on the cloud properties, its transparency, type of the underlying surface, satellite and viewing angles.

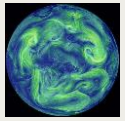








GFS, TPW and Surface Wind



https://earth.nullschool.net/#2024/11/07/1430Z/wind/surface/level/overlay=total_precipitable_water/orthographic=-2.53,-1.03,1146

www.eumetsat.int

1	Thick ice clouds, large particles
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3	Thin ice clouds
4	Thick water clouds, small droplets
5	Thick water clouds, larger droplets (larger the droplets are darker pink)
6	Thick water clouds, extreme large droplets (or thick mixed phase clouds)
7	Thin water clouds over sea
8	Vegetated land (snow free)
9	Sea (ice free)
10	Desert
11	Snow on ground or sea ice

True Color RGB

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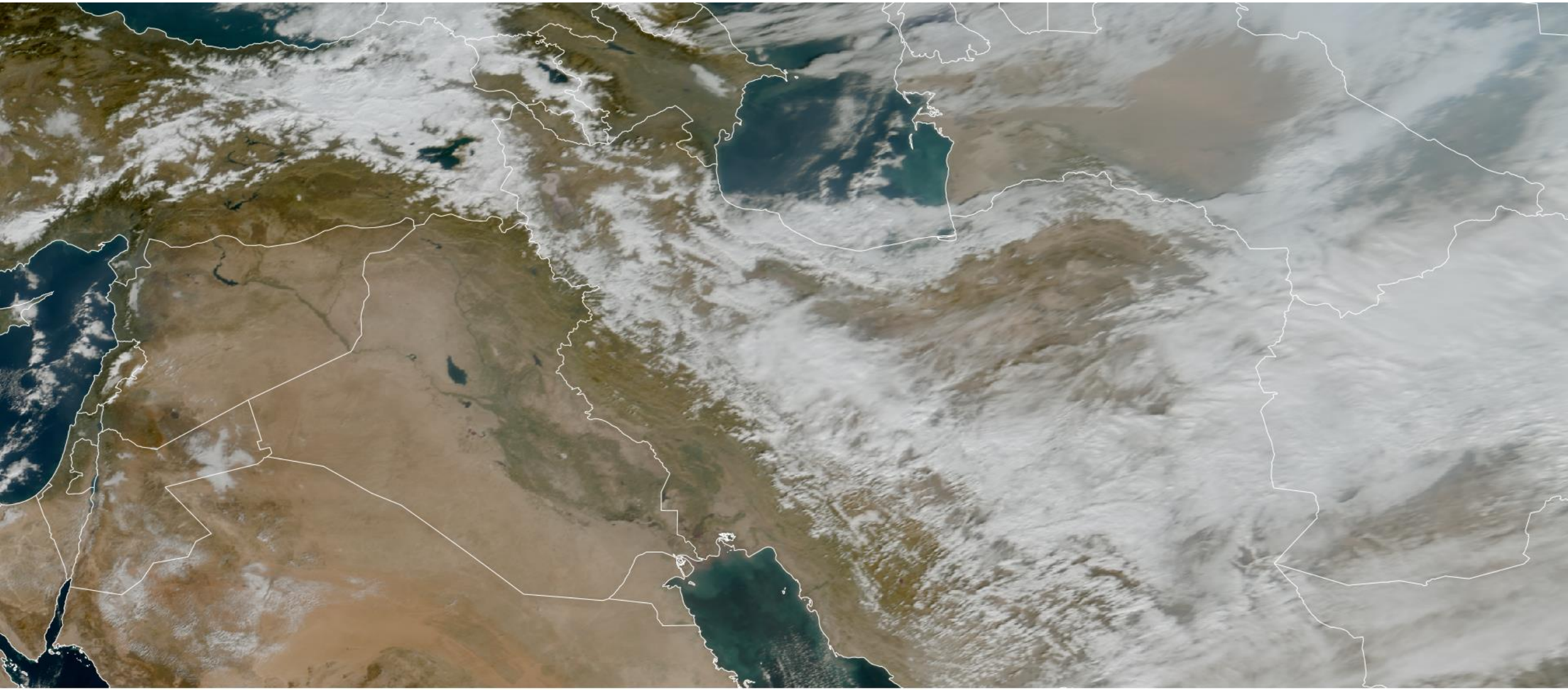

Natural Color RGB

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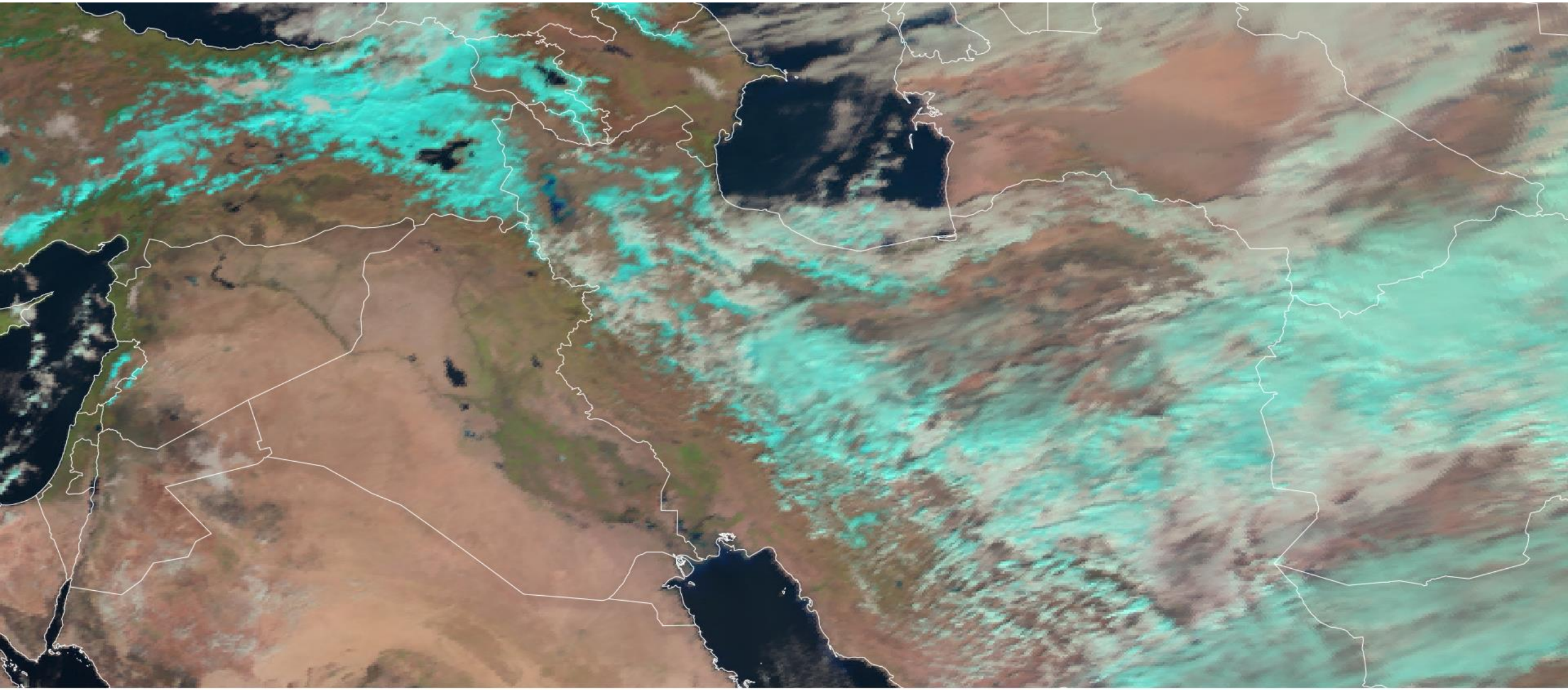

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2025-01-01 08:30:00 UTC

Cloud Phase RGB

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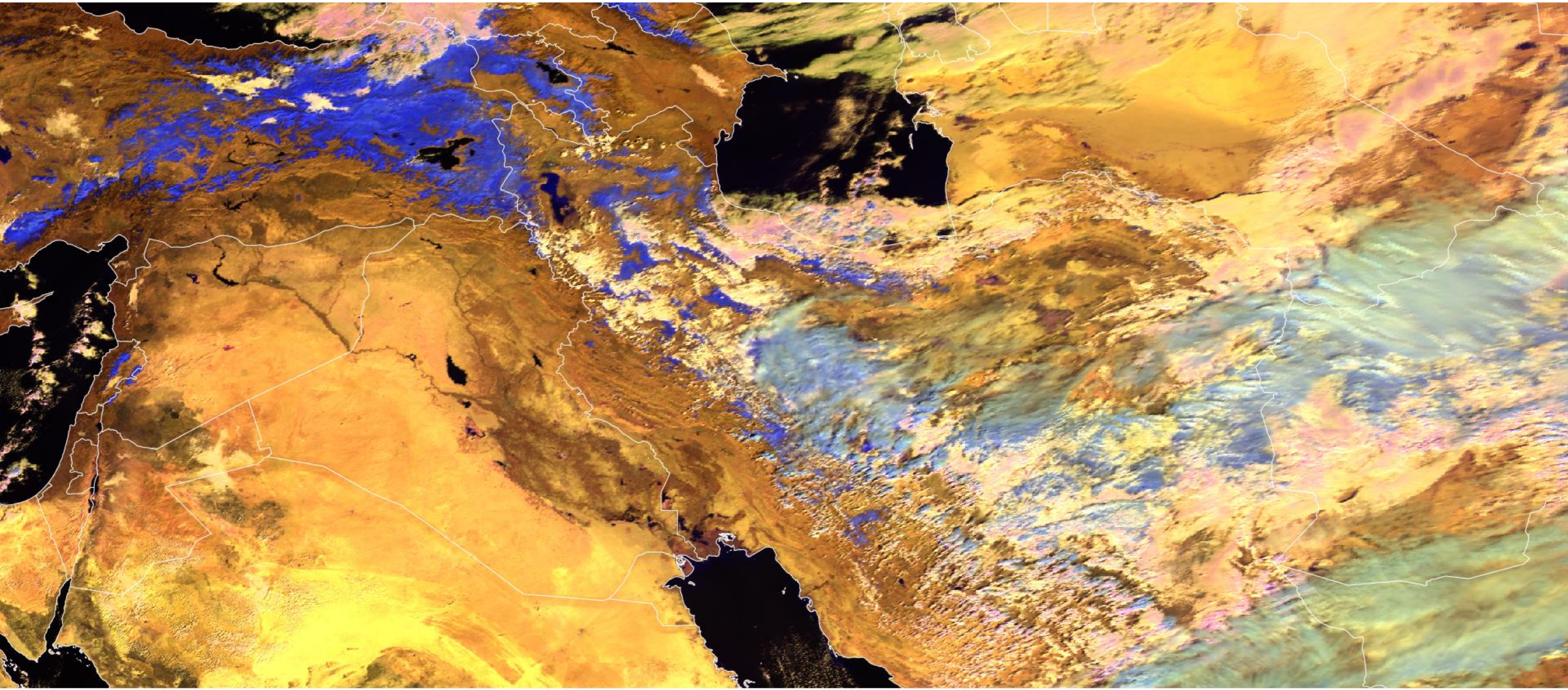
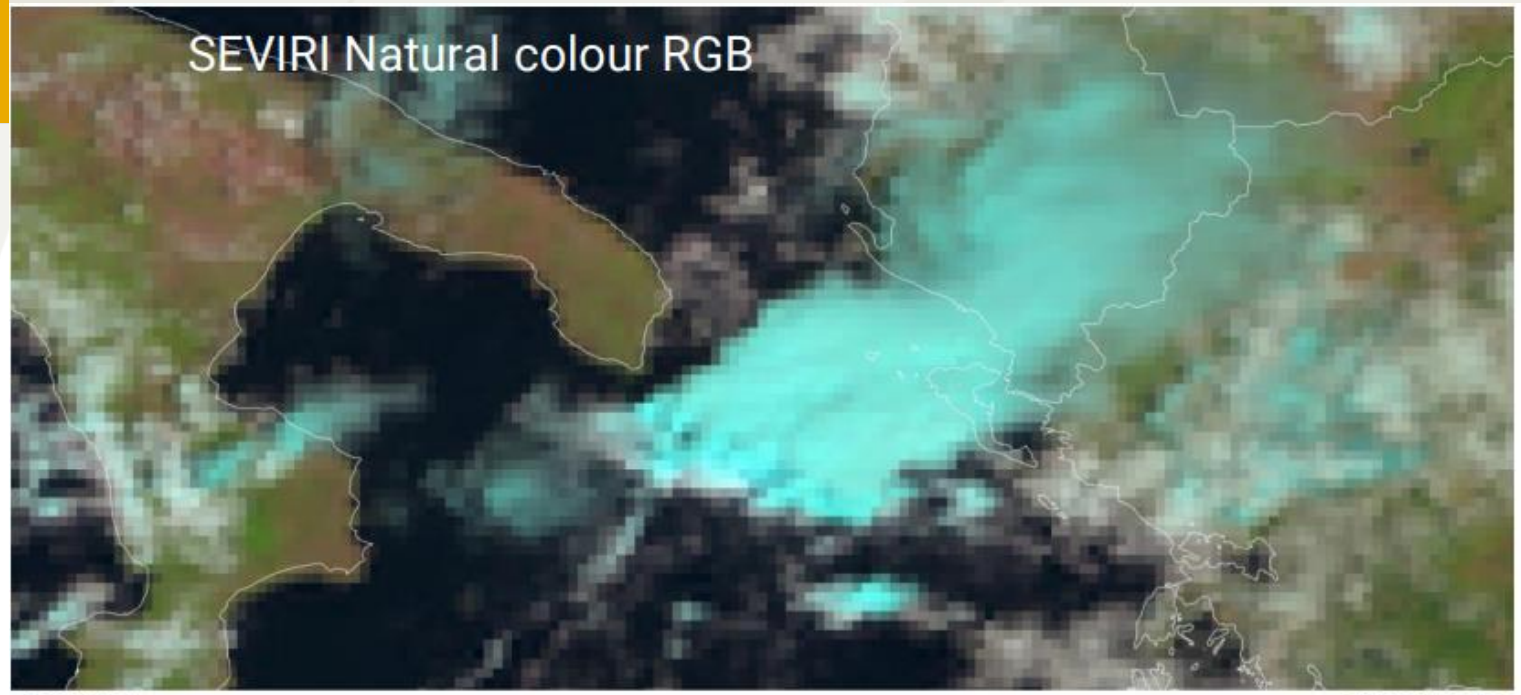
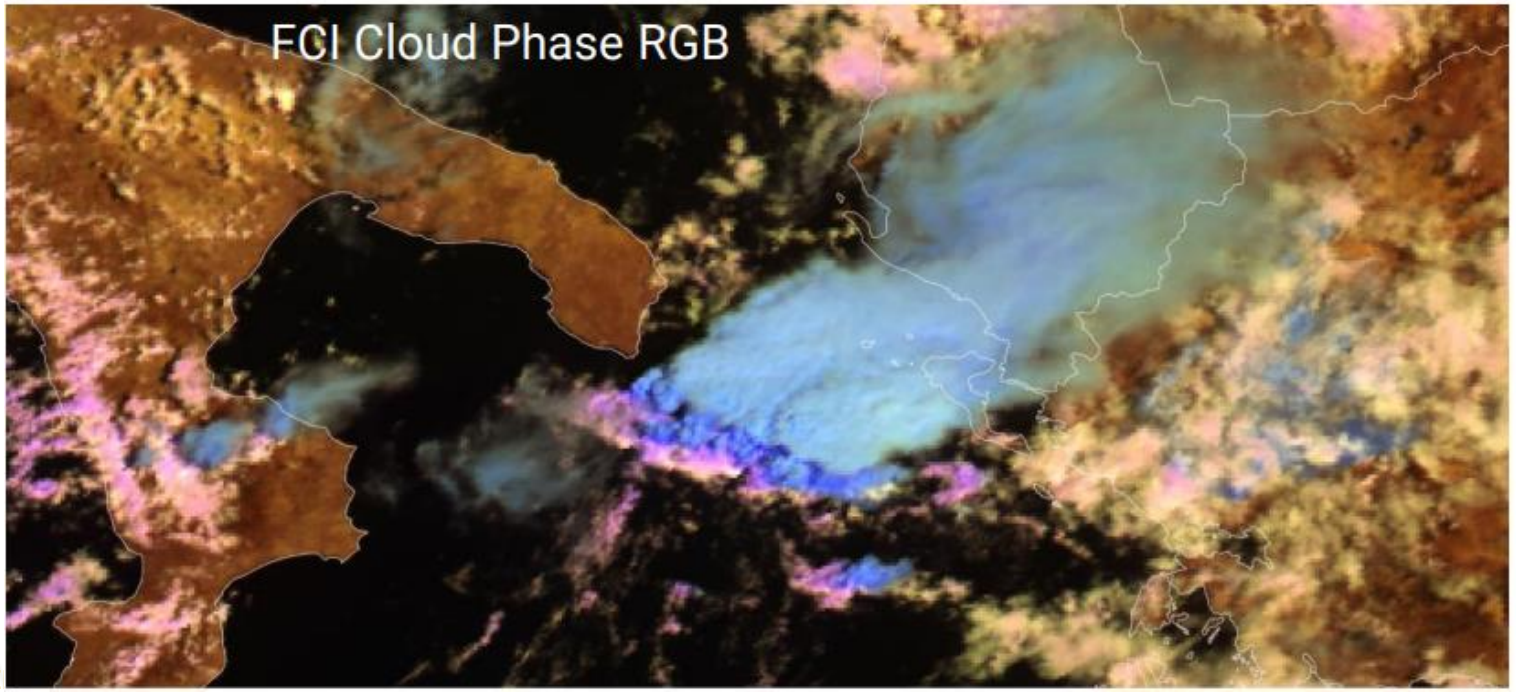
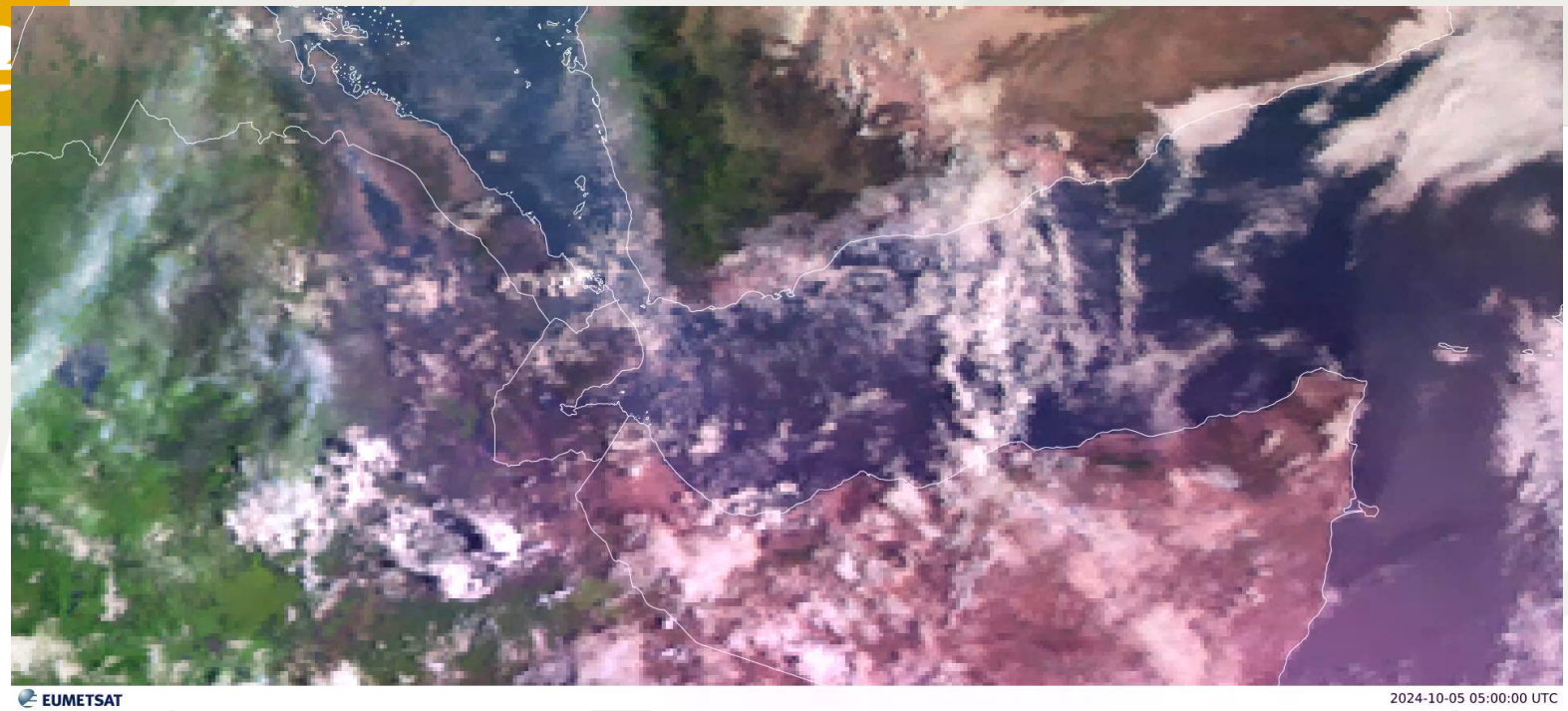



SEVIRI Natural colour RGB
EUMETSAT
2024-09-24 09:30:00 UTC


FCI Cloud Phase RGB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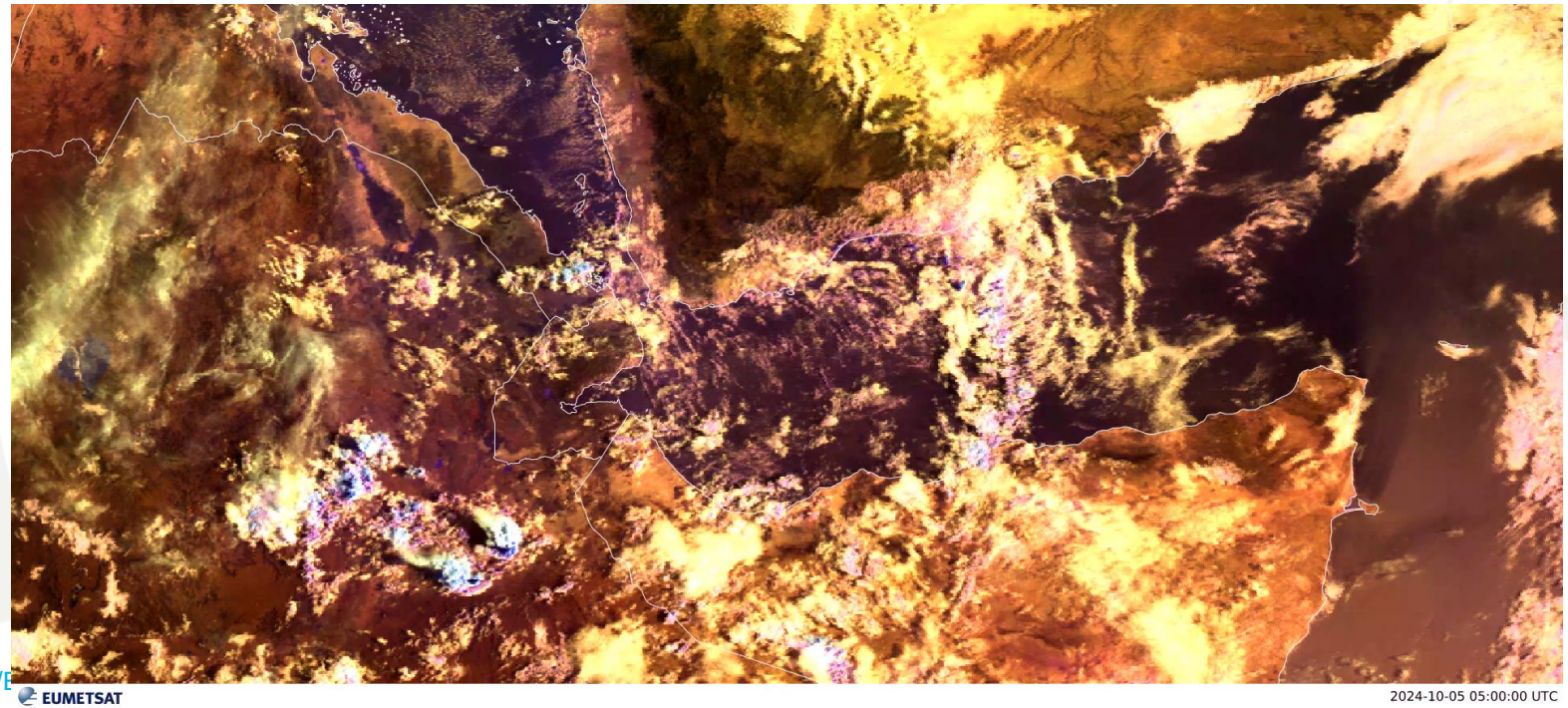
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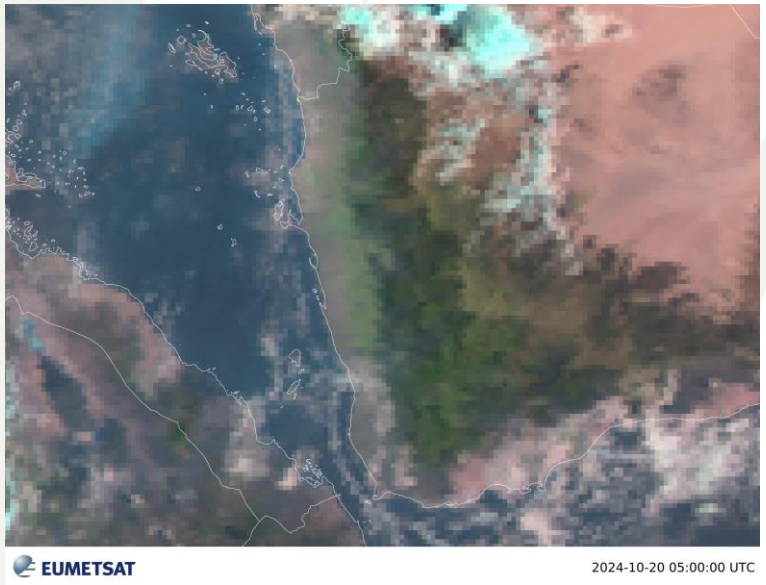
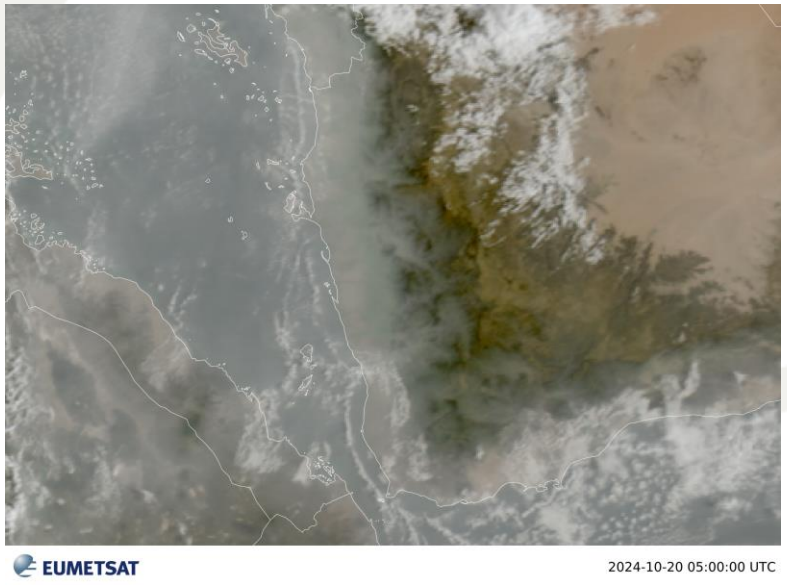
2024-10-05 05:00:00 UTC

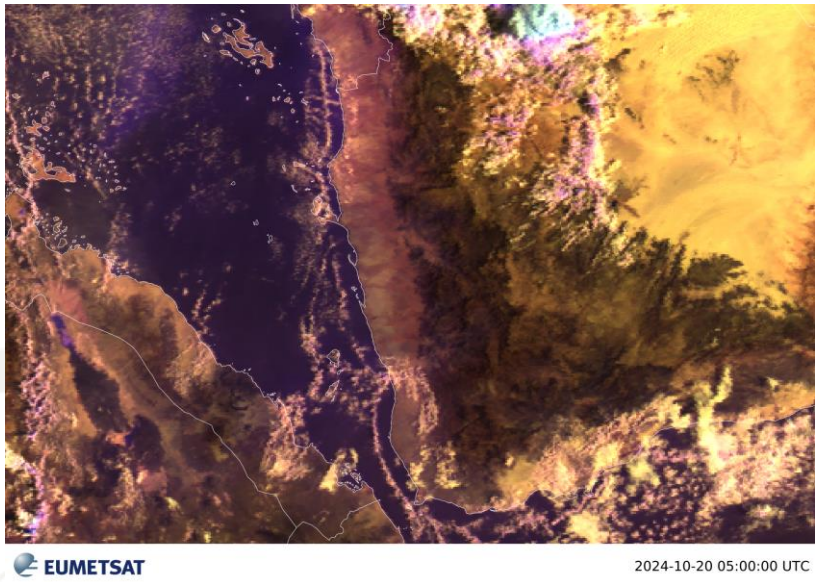
R NIR 1.6 G VIS 0.8 B VIS0.6

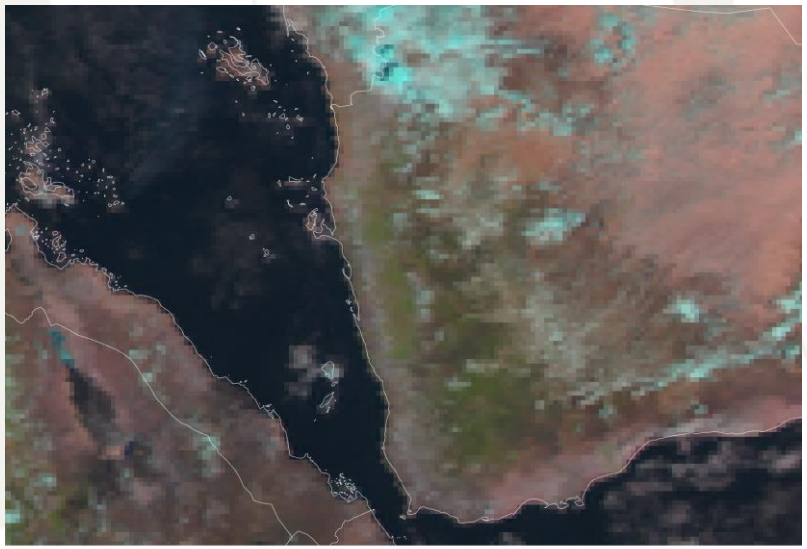


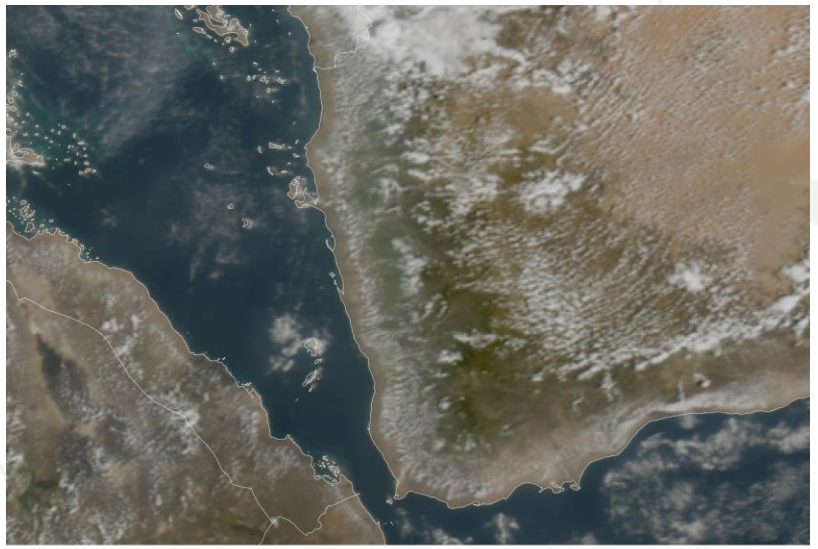
R VIS0.6 G VIS0.5 B VIS0.4

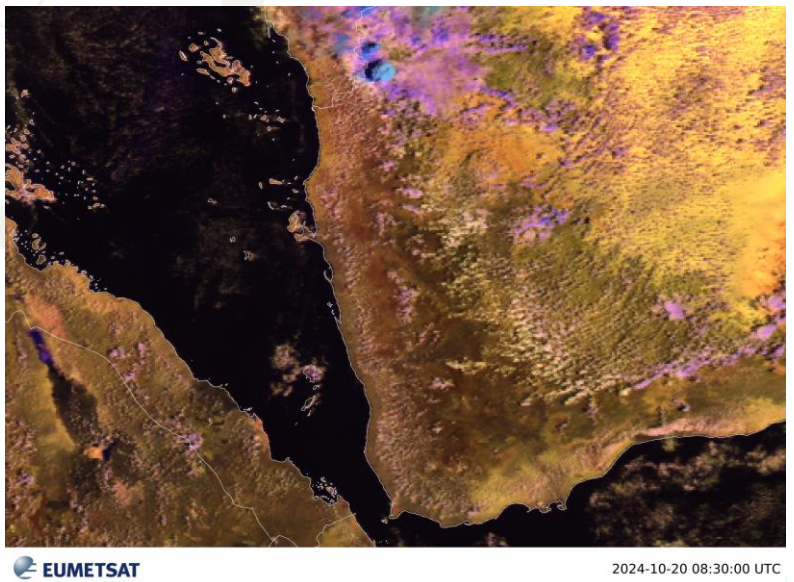


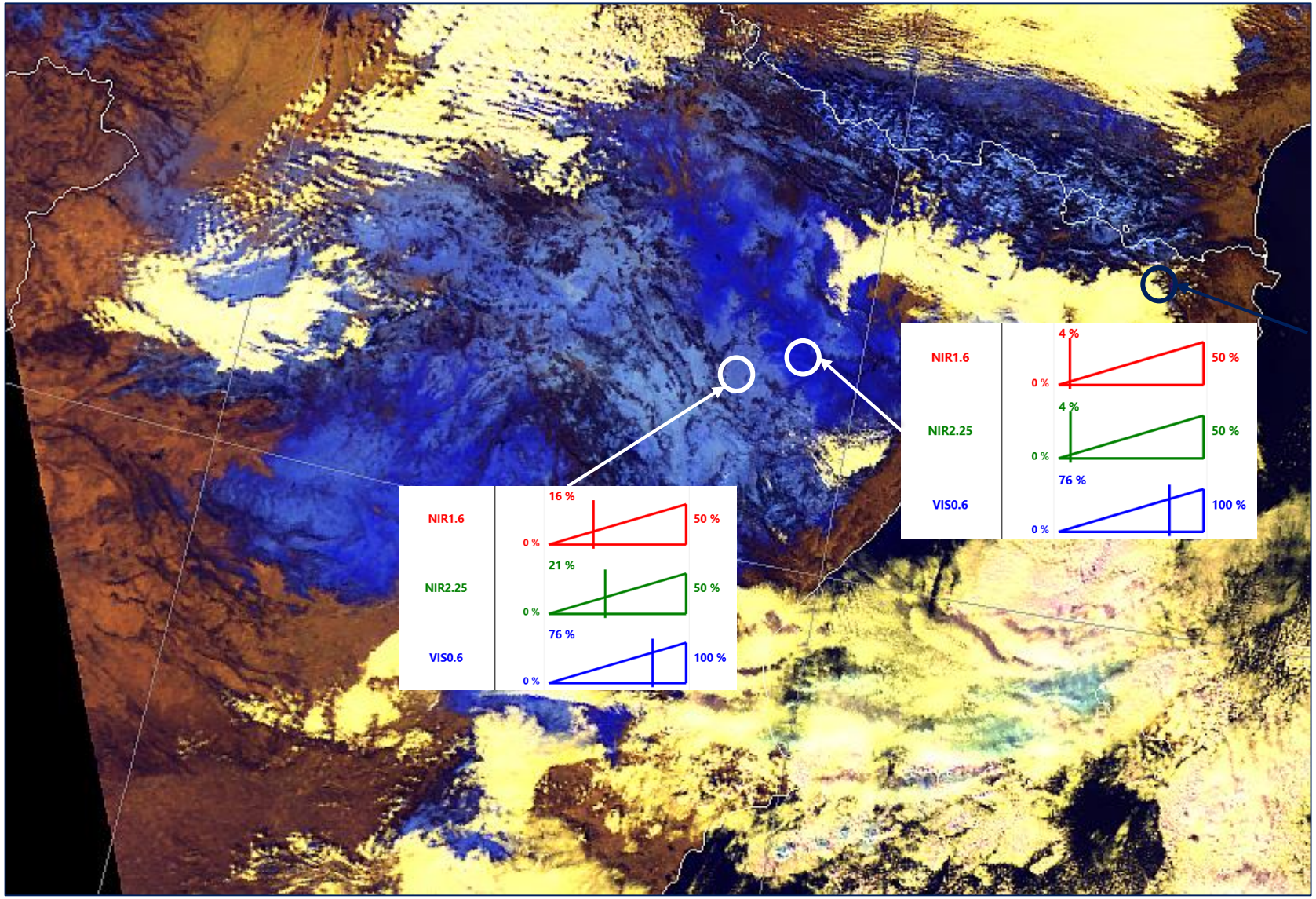
R NIR1.6 G NIR2.3 B VIS0.6



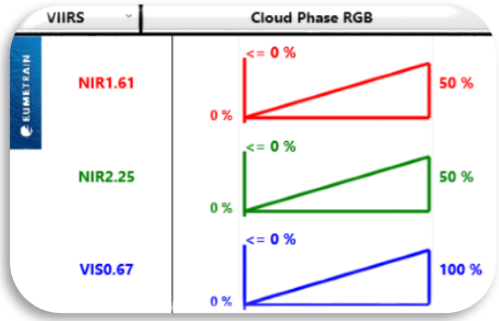




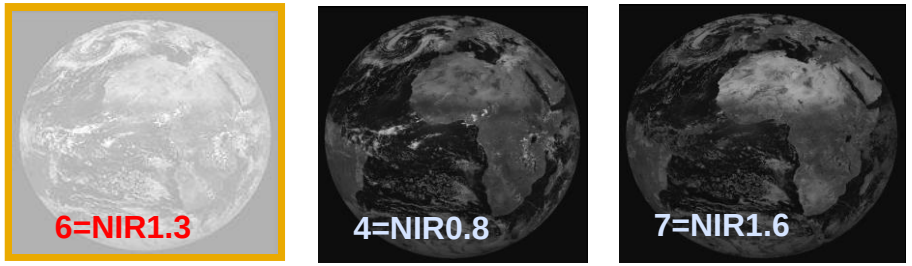




- Clouds
  - Phase
  - Particle size
- Snow/Ice
  - Particle size (fresh, melting, mountain., etc.)



FCI applications – **Cloud Type RGB**

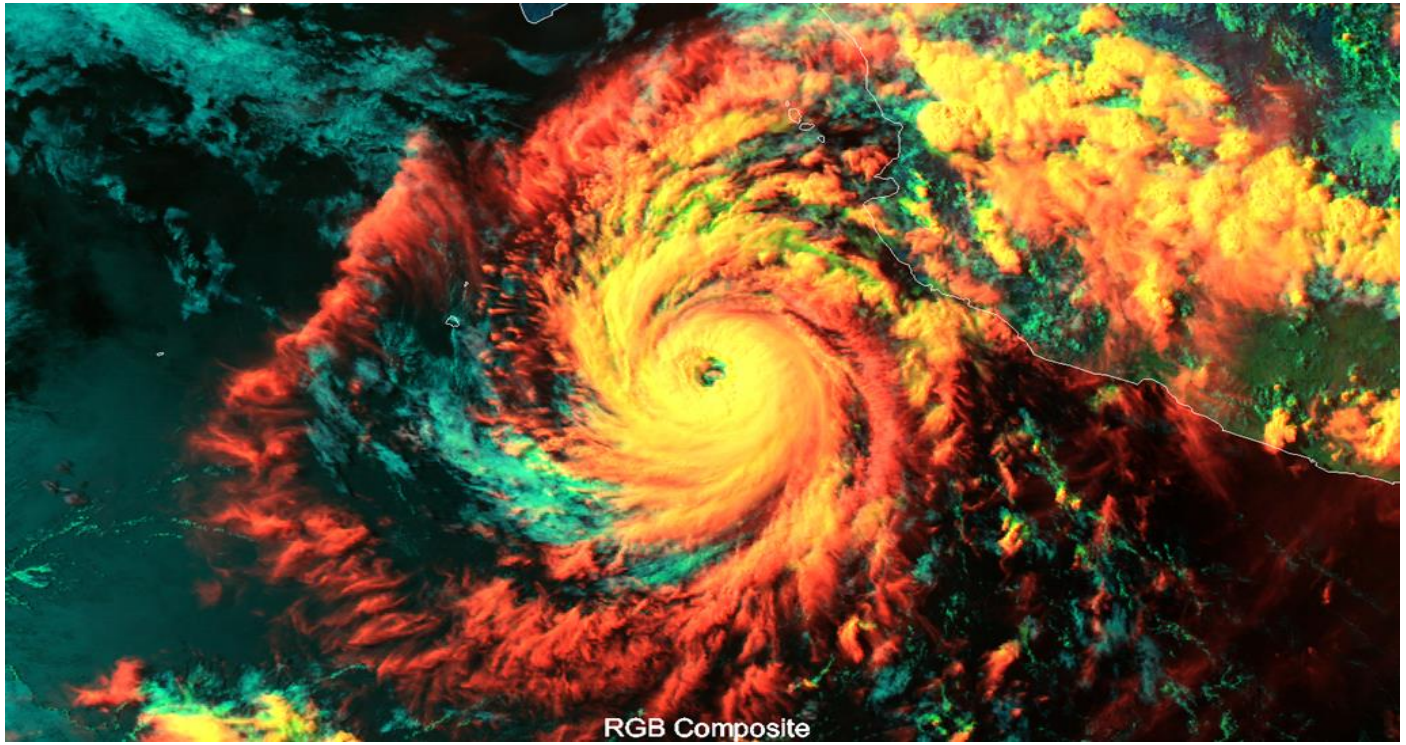


- **Thin cirrus**
- **Cloud height/phase**
- **(Aerosols)**
- **(Vegetation)**
- **(Snow)**

R NIR1.3

G VIS0.8

B NIR1.6

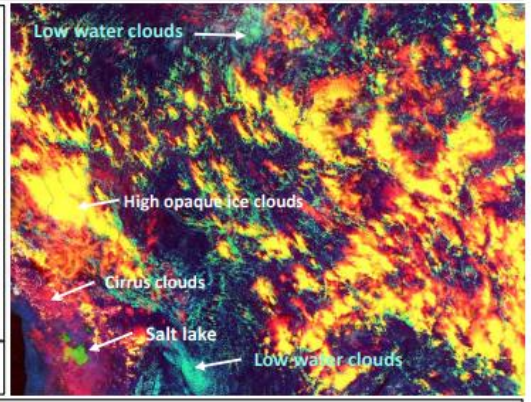


EUMETRAIN

Cloud Type RGB Quick Guide

The **Cloud Type RGB** will be a standard RGB created from the imager data (FCI) on board the future MTG satellites. It will use the 1.38 µm channel, which is new on FCI. In this Quick Guide, however, GOES-16 ABI band 4 (1.37 µm) is used as proxy for FCI. Currently, the VIIRS Cloud Type RGB can be used over Europe.

Primary aim: Cloud type differentiation (low and mid-level clouds, thin and thick high clouds, super-cooled water clouds)
Secondary aim: Thin cirrus detection
Main application period and area: Only during daytime; not usable at high satellite viewing angles or low solar angles.
Guidelines: The Cloud Type RGB combines information on **cloud optical thickness**, **cloud height** and **cloud phase** into one product. Because of the colour assignment chosen and colour enhancements performed, the cloud types appear clearly separated from each other.



Widespread convective activity over central Brazil,
ABI Cloud Type RGB from 5 February 2020 at 18:00 UTC

Background

The table below shows the FCI bands used in the Cloud Type RGB. The red channel (NIR 1.38) provides excellent detection of very thin **cirrus clouds** over land. This channel is located in a spectral region where strong absorption by water vapor occurs, so that low clouds and surface features are not detected in a moist atmosphere. The **optical depth** depends on the amount of water vapor in the upper troposphere. Hence, the signal strength in this channel reflects the **cloud height**. The green channel (VIS 0.64) represents the **optical thickness** of clouds. It also provides information on surface snow and sea ice. The blue channel (NIR 1.61) is a microphysical channel sensitive to the **ice and water phases**. At 1.61 µm, ice clouds usually have a low reflectivity (~ 30%), while water clouds strongly reflect (~ 60 – 70%) the incoming shortwave radiation. Additionally, this channel shows a weak dependence on cloud particle size. Ice clouds with very small ice crystals may be as bright as water clouds, and water clouds with very large droplets may be as dark as ice clouds.

Colour	Channel [µm]	Physically relates to	Small contribution to the signal of	Large contribution to the signal of
Red	NIR 1.38	Cloud height and optical depth	Low-level clouds	High clouds
Green	VIS 0.64	Cloud optical thickness	Thin clouds	Thick clouds Snow covered land Sea ice
Blue	NIR 1.61	Cloud phase	Thick ice clouds Snow covered land	Thick water clouds

Notation: NIR is near-infrared, VIS is visible, and the number is the central wavelength of the channel in micrometres.

Benefits

- It combines cloud height with cloud phase and cloud optical depth information.
- It effectively detects thin cirrus clouds over other clouds and cloud free land/sea.
- Snow and ice on the ground are clearly delimited from high-level (thin) ice clouds.
- It detects supercooled water clouds.
- It provides good colour contrast between cloud types.
- Coastlines and surface features are visible.

Limitations

- Limited to daytime applications.
- The categories "high and low clouds" are rather coarse classifications.
- Less suited for particle size discrimination.
- Unable to detect thin cirrus over opaque high clouds.
- Small colour contrast between mid-level water and ice clouds.
- Snow has similar colour to low- and mid-level (ice) clouds.
- Mid-level thin clouds might not be detected in a moist atmosphere.
- Colour shades depend on atmospheric moisture.

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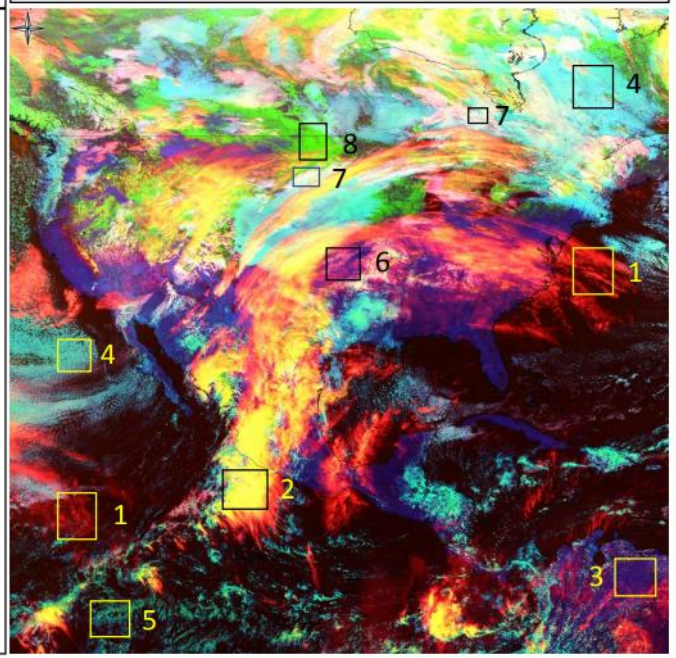
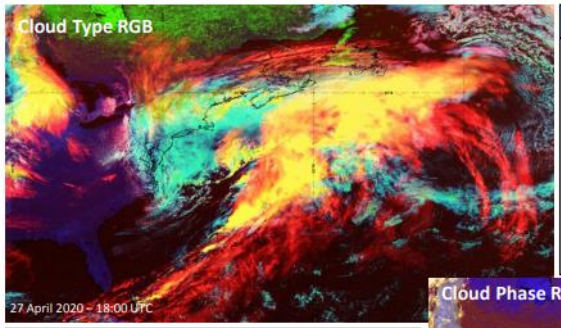
Cloud Type RGB Quick Guide

Interpretation

1. Thin cirrus clouds over land and sea (darker red over the seas)
2. Thick ice clouds (multi-layered clouds with ice on top)
3. Land
4. Low to mid-level water clouds
5. Mixed phase clouds (at low and mid-levels)
6. High and thin water clouds (more orange if ice is present)
7. Super-cooled water clouds
8. Snow and ice on the ground

GOES-16 ABI sensor, North America, February 3, 2020, 18:00 UTC

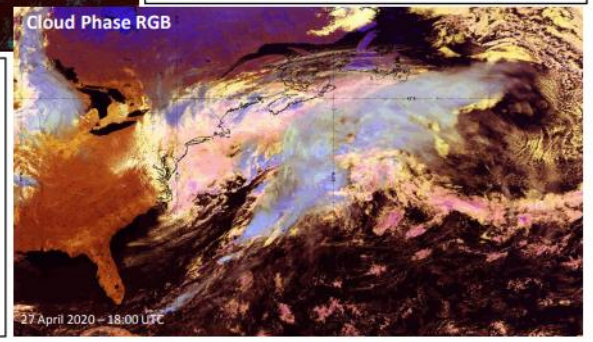




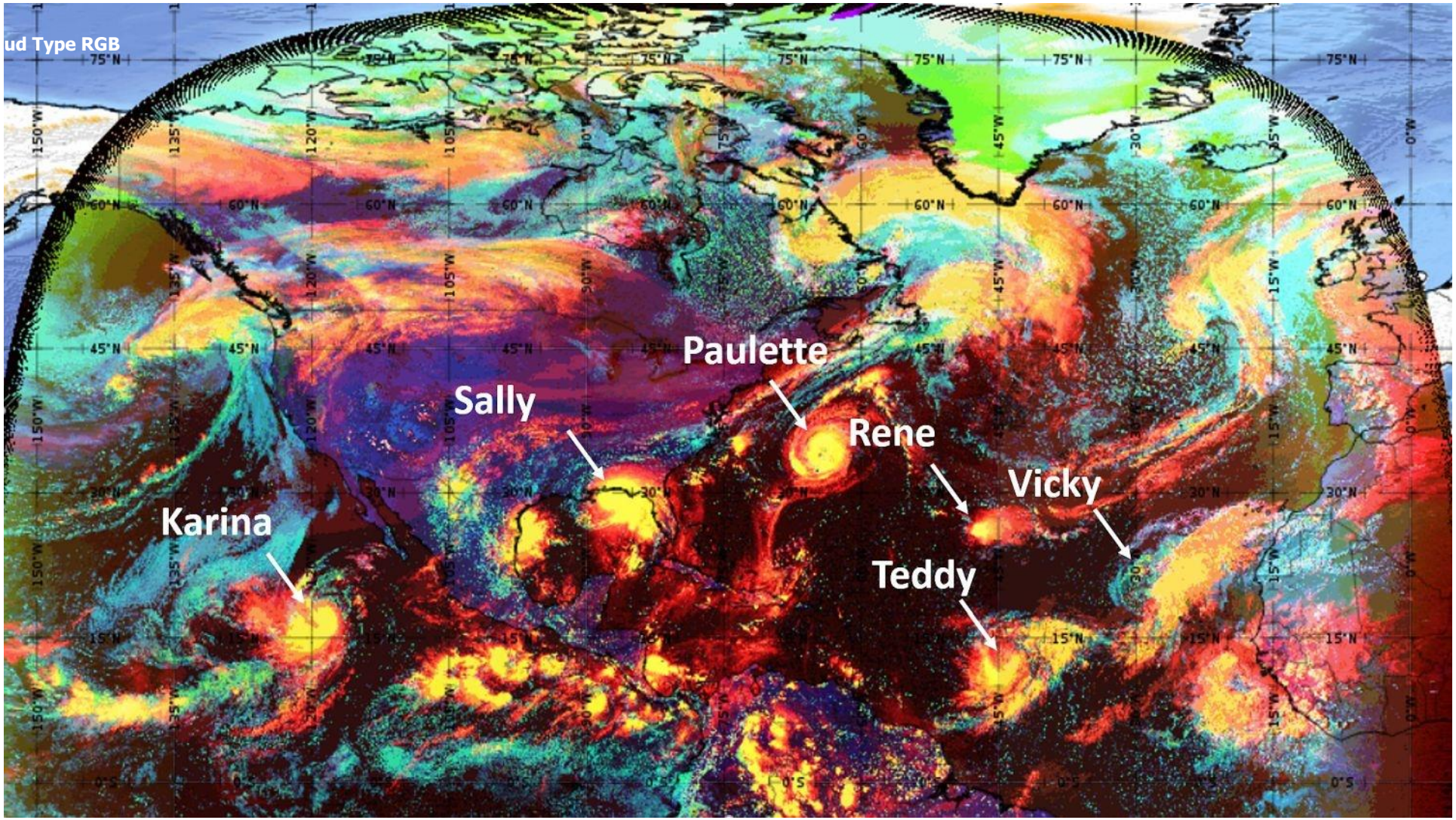
Comparison between Cloud Type and Cloud Phase RGB

The **Cloud Type RGB** detects high and thin ice clouds (reddish colours) much better than the Cloud Phase RGB, due to the use of the 1.38 µm WV absorption channel.
The **Cloud Phase RGB** is better at differentiating water and ice phases (blue against pinkish/white) and cloud particle sizes (shades of blue) due to the combined use of two microphysical channels, 2.25µm and 1.61µm.

In the case of deep moist convection, the **Cloud Type RGB** offers the possibility to discriminate between the thick (towering cell) and the thinner (anvil) parts of the convective cloud (see the image on the reverse).
The **Cloud Type RGB** can be used in combination with the **Convection RGB,** which provides cloud microphysics information (particle size) to provide a more complete image of the convective cells.

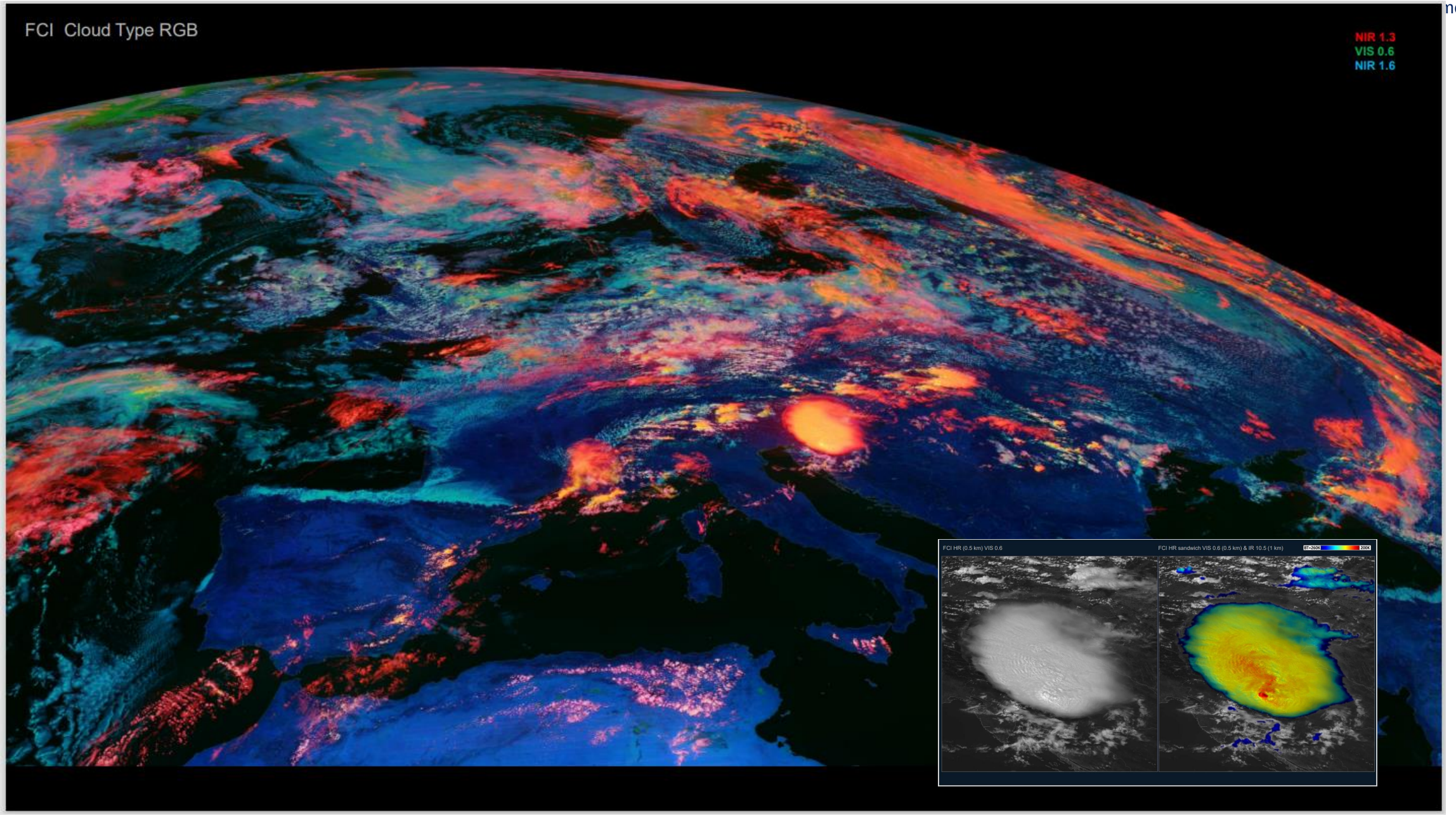


- Busy 2020 tropical cyclone season 14/09/2021

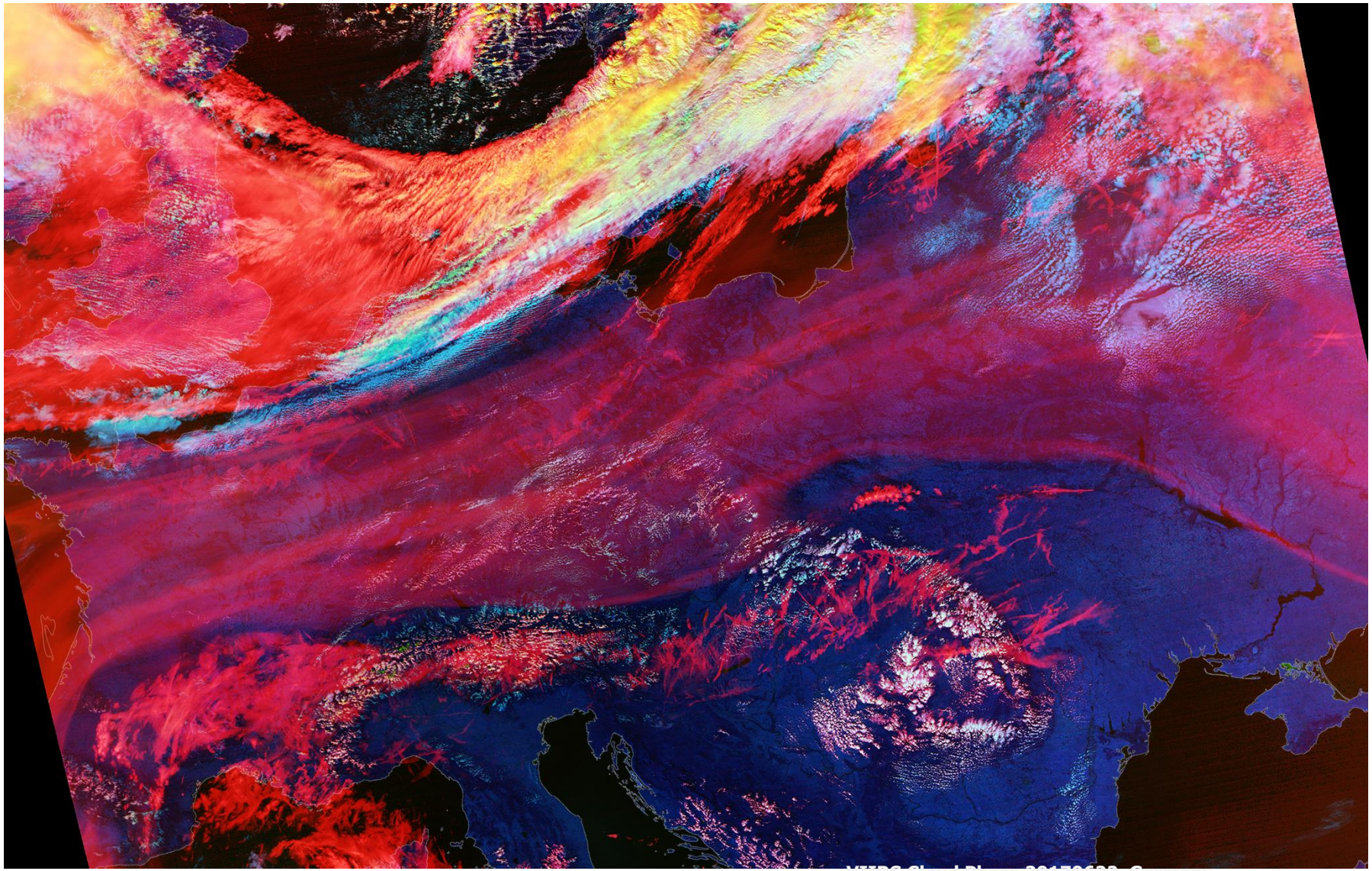


FCI applications – **Cloud Type RGB**

netsat.int

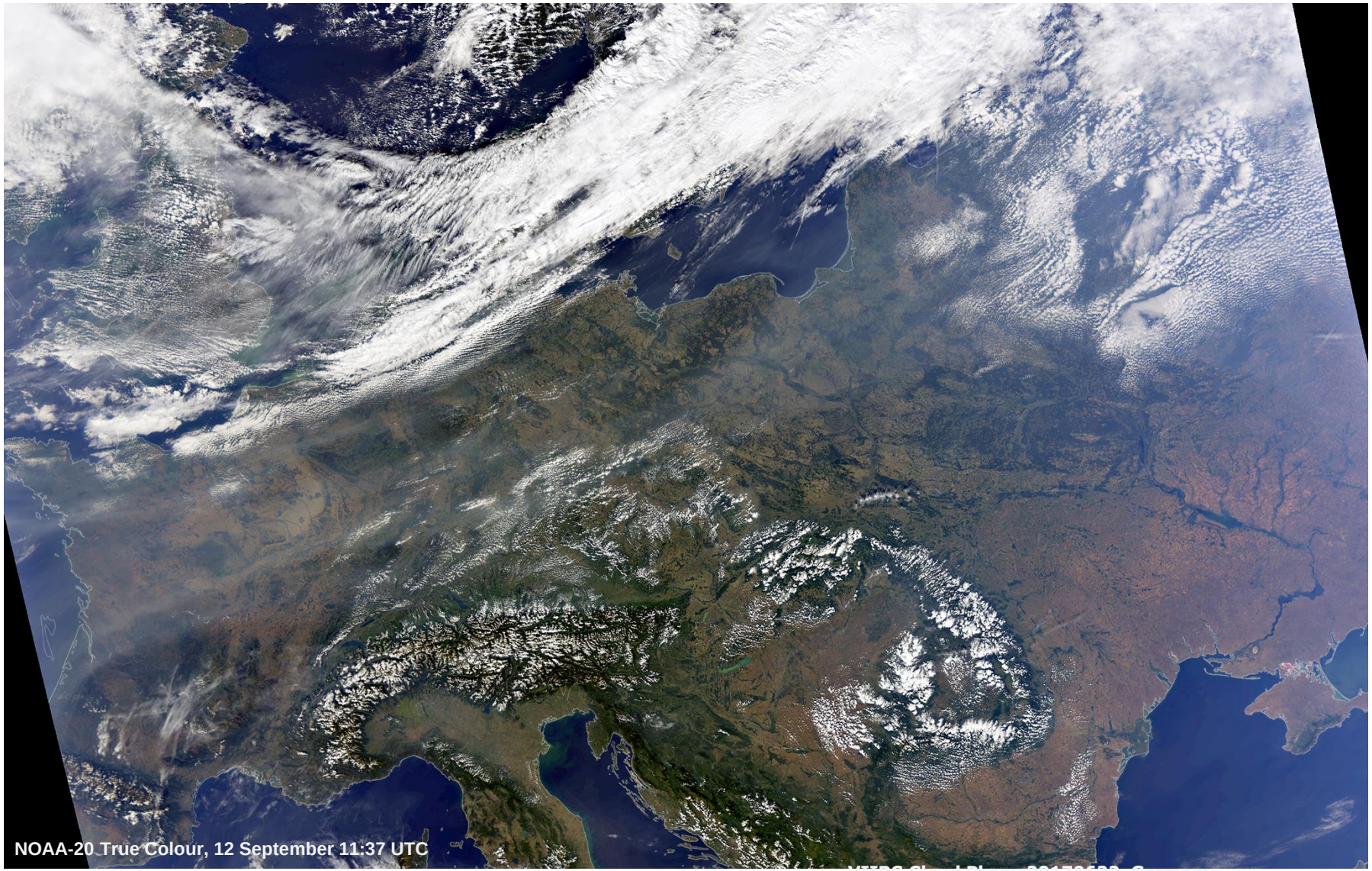


Aerosol detection – angle dependency (Solar)



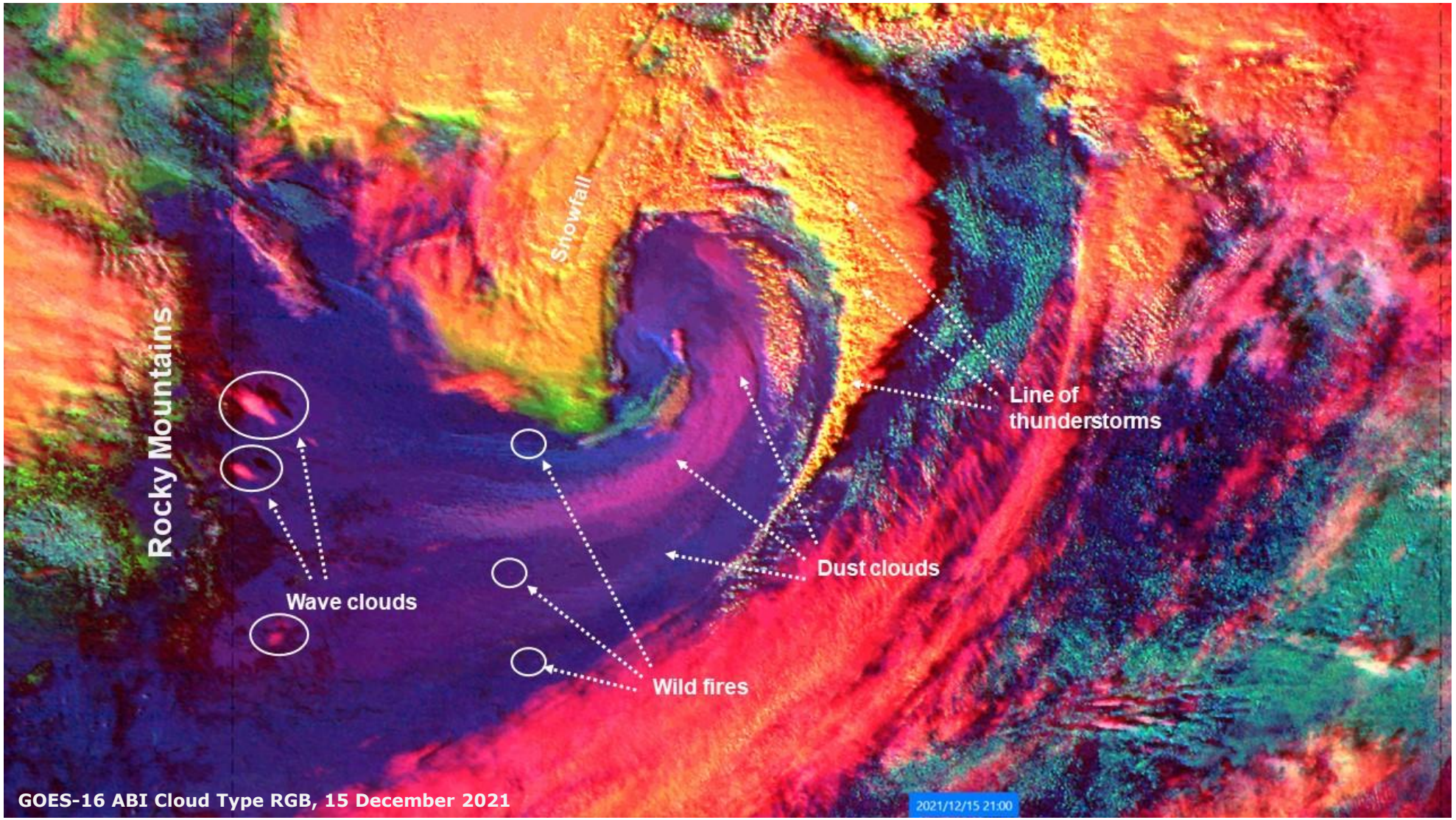
- Aerosols
  - High thin smoke

Aerosol detection – angle dependency (Solar)



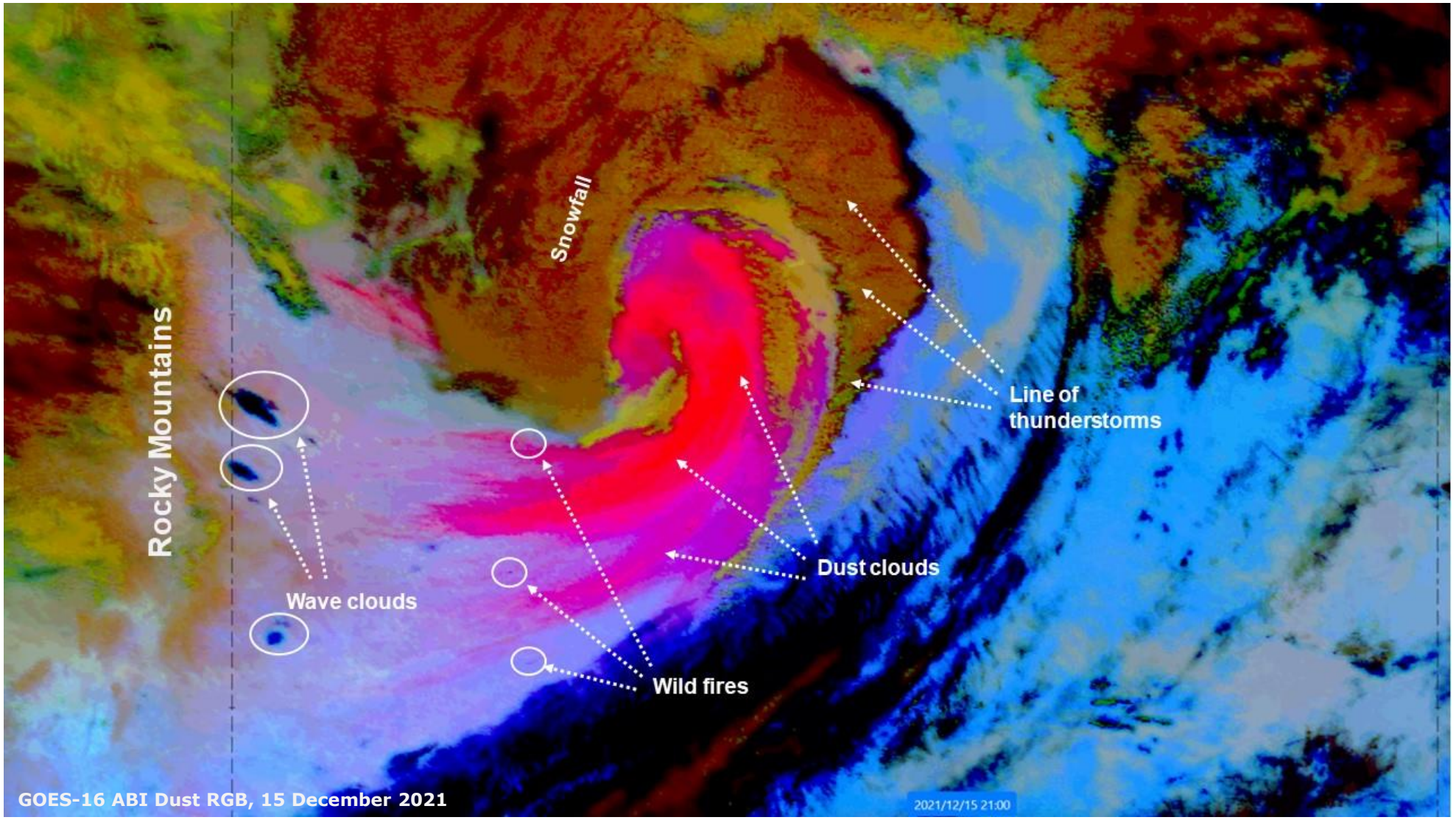
- Aerosols
  - High thin smoke
  - True Colour RGB shows weak signal

Cloud Type RGB / MTG expected ‘novel’ RGBs

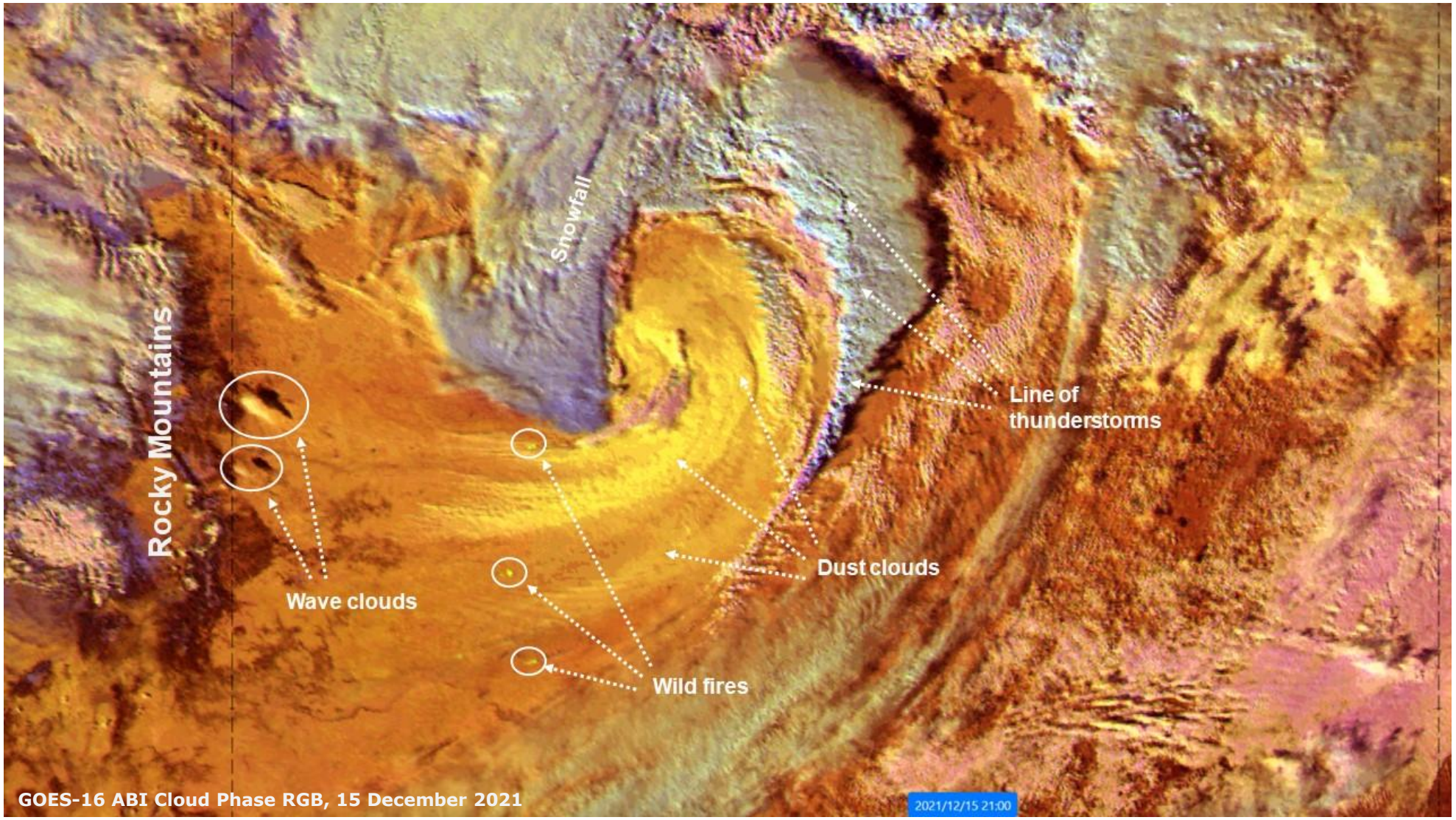


- Aerosols
  - Dust
    - Height
    - Thickness

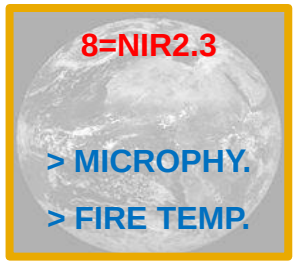
Cloud Type RGB / MTG expected ‘novel’ RGBs

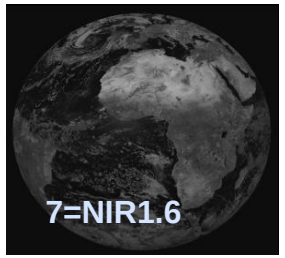


Cloud Type RGB / MTG expected ‘novel’ RGBs



FCI applications – **Fire Temperature RGB**



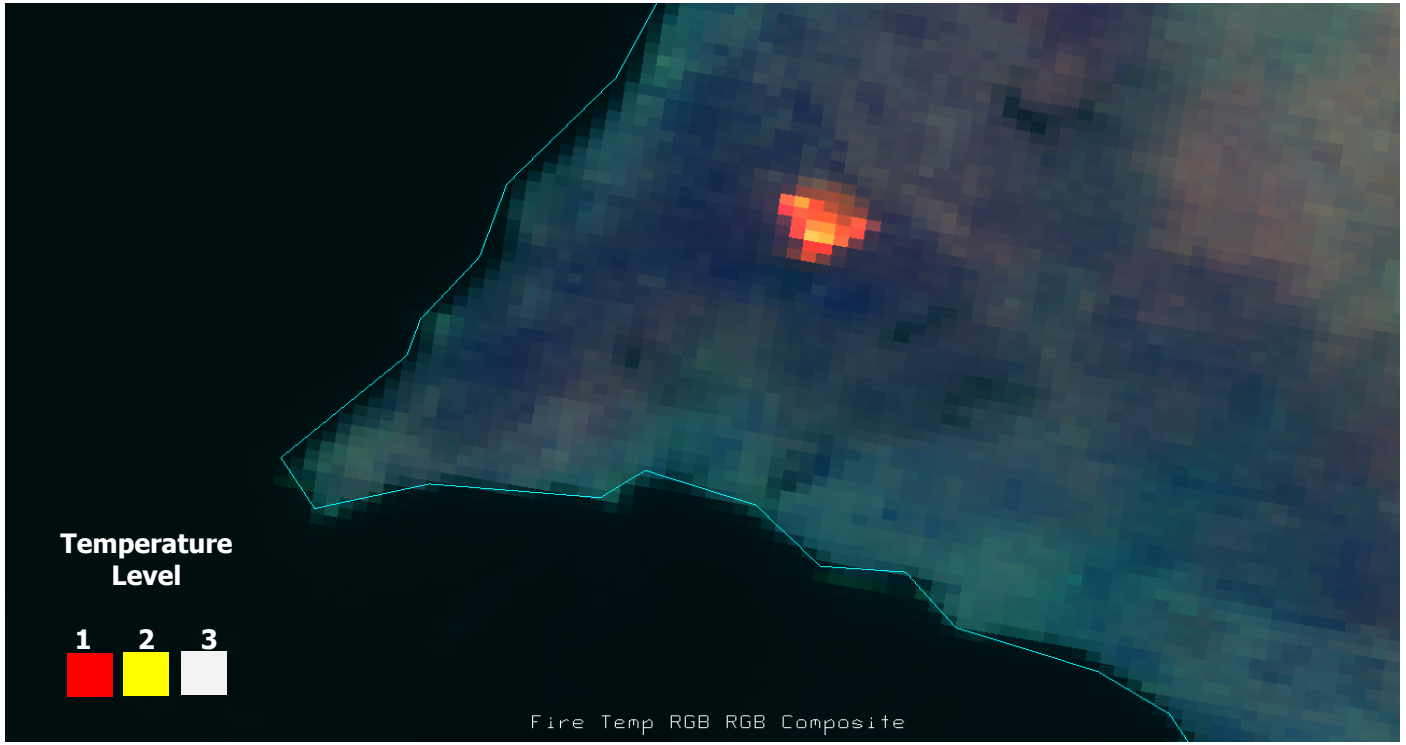


- Fire intensity
- Burn scars
- (Aerosols)
- (Clouds)
- (Vegetation)

R IR3.8

G NIR2.3

B NIR1.6



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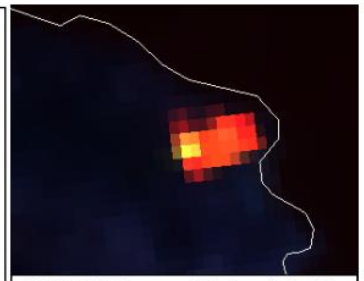
Fire Temperature RGB Quick Guide

The Fire Temperature RGB is a candidate to become a standard RGB, to be created using the imager (FCI) on future Meteosat Third Generation satellites. It uses the 2.25 µm channel, which will be new with FCI. The FCI IR3.8 channel is not new, but has been redesigned (extended dynamical range, slight shift) especially to improve fire detection. In this Quick Guide, VIIRS images are used as proxy data for the FCI. Currently, the VIIRS Fire Temperature RGB can be used for the Meteosat region.

Aim: Detection and monitoring of fires.
Main application area and time period:
Full disk, day and night.
Applications and guidelines: This RGB is useful for ***fire detection*** and provides a qualitative estimation of ***fire temperature***.
The smoke of the fire is usually not seen in this RGB.
During the night, fires are seen against dark background, while clouds are not seen. Colour contrast is high between the fire and the background. During the day, some surface features, water and ice clouds can be identified. (However, other RGBs are better for analysing clouds.) The colour contrast is sometimes low, particularly with hot land not covered with much green vegetation.



NPP VIIRS Fire Temperature RGB, fire on the cloud-free Peninsula Sithonia, Greece, 25 October 2018, 10:43 UTC

Background

The table below shows which channels are used in the Fire Temperature RGB. These channels are all sensitive to fires. At shorter wavelengths, signals become stronger as the fire temperature increases. The 3.7 µm channel is sensitive even to fires that are much smaller than the pixel size. Small/"cool" fires show up only at 3.7 µm and appear red. Moderately intense/large fires are detected at both 3.7 µm and 2.25 µm and appear orange to yellow. Very intense fires are detected by all three bands and appear white.
The appearance outside the fire is different during the day from during the night. During the night the background is mostly dark, whereas during the day one can differentiate sea, land, water and ice clouds.
The **bold** text in the table below applies to both day and night images, and the *italic* text to day imagery only.

Colour	Channel [µm]	Physically relates to	Smaller contribution to the signal	Larger contribution to the signal
Red	IR3.7	**(Fire) temperature** *Cloud top microphysics*	**Cold land surfaces** *water, snow/ice, cold clouds*	**Low fire temperature, hot spots** *Warm land surfaces*
Green	NIR2.25	**Fire temperature** *Land type, cloud top particle size*	*Green vegetation, water, snow/ ice, large cloud particles*	**Medium fire temperature,** *Dry grass, bare ground, small cloud particles*
Blue	NIR1.6	**Fire temperature** *Land type, cloud top phase*	*Green vegetation, water, snow/ice, ice clouds*	**High fire temperature** *Dry vegetation, bare ground, water clouds*

Notation: IR: infrared; NIR: near-infrared; number: central wavelength of the channel in µm (for VIIRS).

Benefits

- Useful for fire monitoring during both the day and the night. It detects even those fires that are much smaller than the pixel size.
- It provides information on fire intensity. The pixel colour is related to fire temperature: 'cooler' fires appear more red, hotter fires appear yellow to white.
- During the day ice and water clouds are seen in the image in different colours.

Limitations

- Fires are seen only in cloud-free areas.
- Smoke is usually not detectable in this RGB.
- Clouds are not seen at night.
- The colour of the surface during the day strongly depends on temperature and land type. Arid, dry regions and hot land surfaces may both appear reddish, making fire detection more difficult.
- If the red component saturates at a relatively 'low' temperature, false alarms can appear as red colours without fire at the surface.

Remark: With FCI, fewer false alarms are expected due to the extended dynamic range of the IR3.8 channel.

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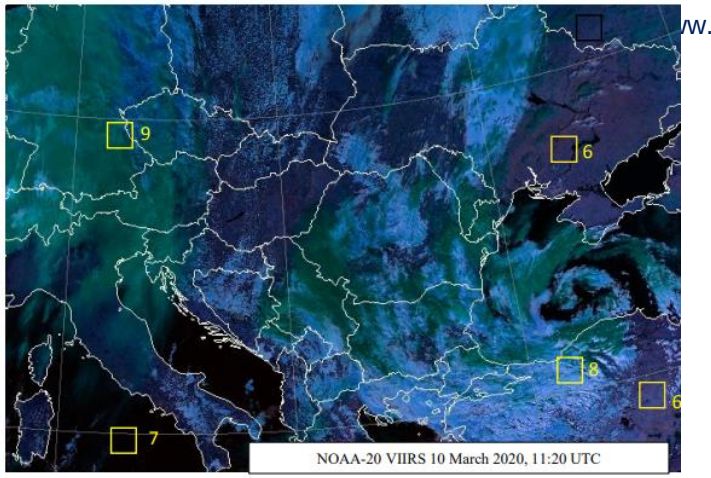
Fire Temperature RGB Quick Guide

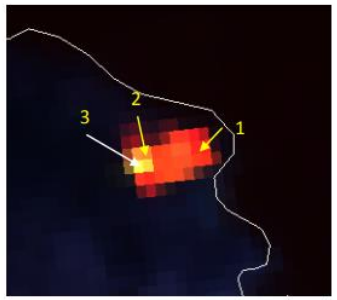
Interpretation

1	warm fire, hot spot
2	very warm fire
3	hot fire
4	extreme intense fire
5	burn scars (day)
6 6	land surface (day)
7	water, snow, ice, night-time
8	water cloud (day)
9	ice cloud (day)

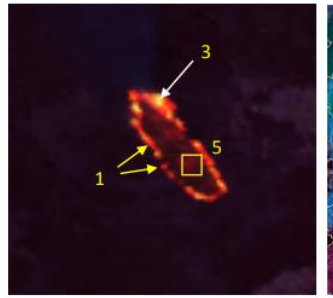


NOAA-20 VIIRS 10 March 2020, 11:20 UTC

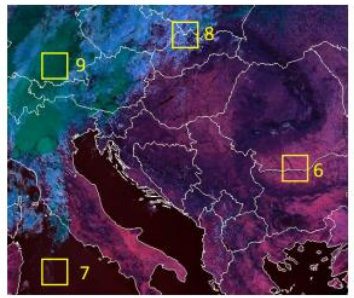
The colours may vary diurnally, seasonally and latitudinally. During the night the fires are seen over a dark background. During the day water/ice clouds and land/sea surfaces can be identified. The colour of the surface strongly depends on surface type and temperature: compare the March and August images (above and below right).



NPP VIIRS Fire Temperature RGB, Sithonia Peninsula, Greece, 25 October 2018, 10:44 UTC



NOAA-20 VIIRS Fire Temperature RGB, Alberta, Canada, 19 May 2019, 19:01 UTC



NPP VIIRS Fire Temperature RGB, 29 August 2020, 11:46 UTC

NPP VIIRS Fire Temperature RGB (left) and True Colour RGB (right), Zakynthos, Greece, 15 September 2019, 10:48 UTC

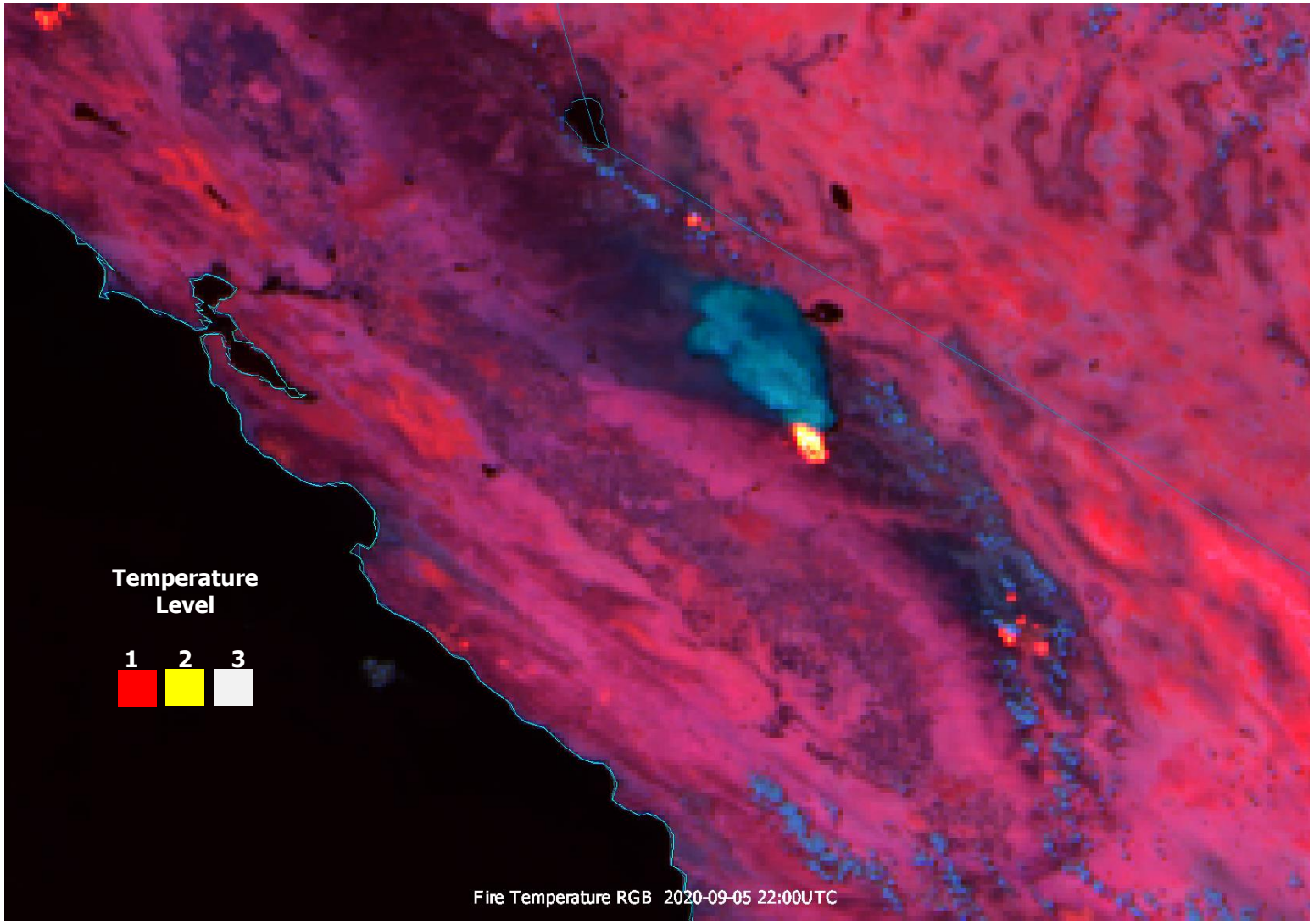
Comparison to True Colour RGB

Both images on the left show the Greek island Zakynthos. The Fire Temperature RGB image (left) shows a fire in red and yellow, while the True Colour RGB (right) shows the corresponding smoke.
Note that during the night the fire can still be identified in the Fire Temperature RGB, but the smoke is not seen in the True Colour RGB.

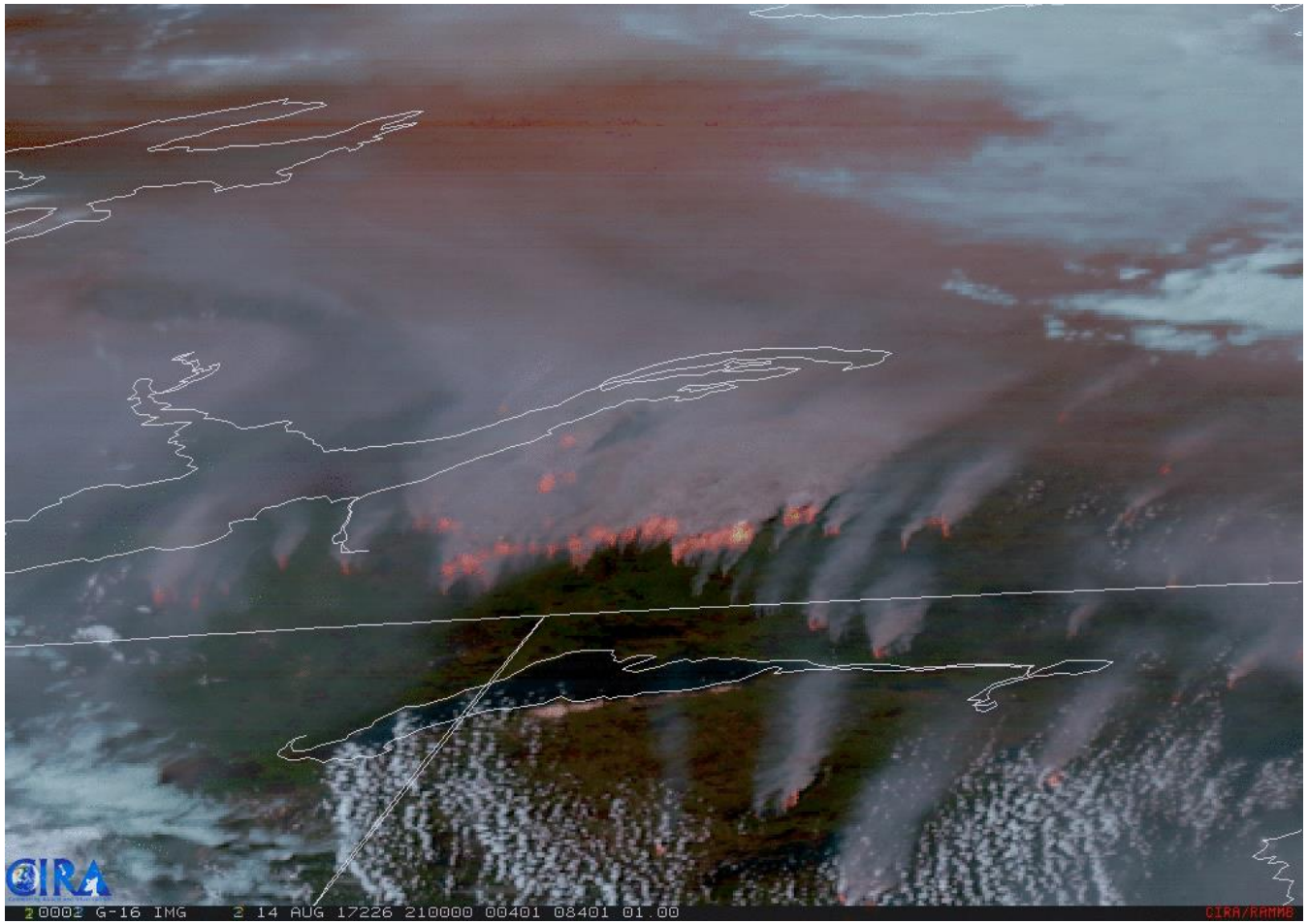
More about RGBs at EUMeTrain.org
Contact: info@eumetrain.org;

FCI applications – **Fire Temperature RGB**

- Fires over California 05/09/2020



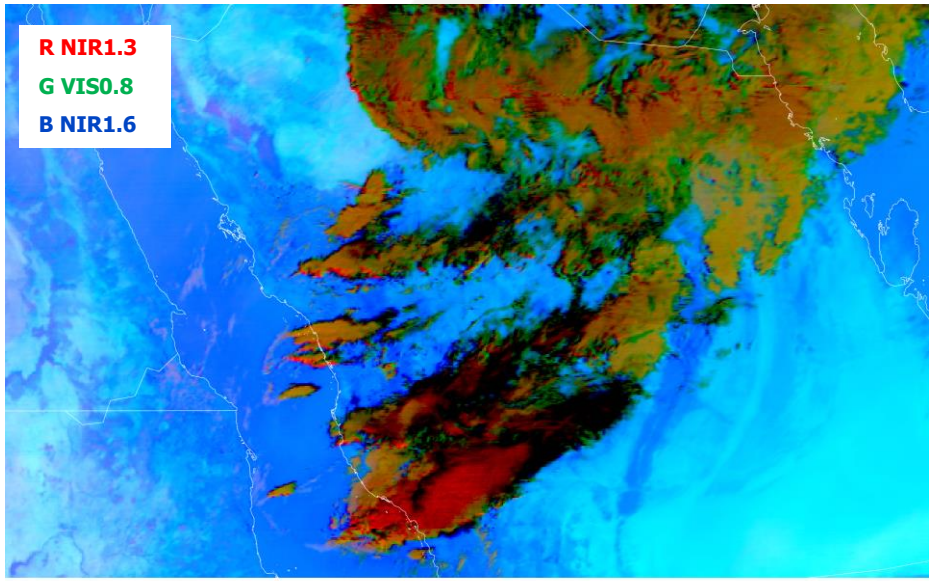
GOES-16, Fire Temperature RGB (with NIR1.6 and NIR2.25 Bands)

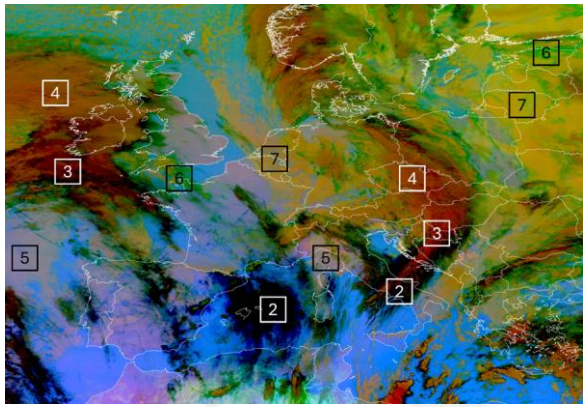


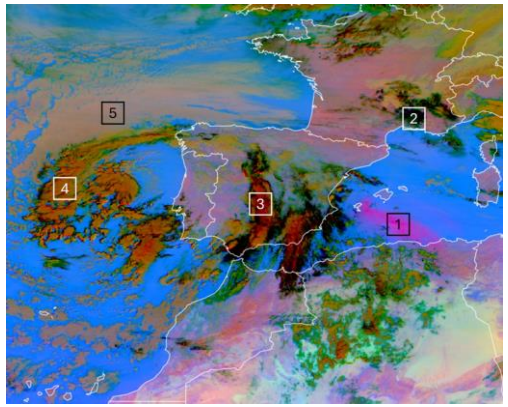
Canada
Northwest Territories
14 Aug. 2017

FCI

1. Dust cloud. The colour can vary from pink to violet
2. Thin cirrus clouds with no underlaying clouds. The colour can vary from black to dark blue or green
3. Thick, high, cold ice clouds
4. Possibly different ice particles
5. Low level water cloud
6. Semi-transparent cloud
7. Mid-level water clouds





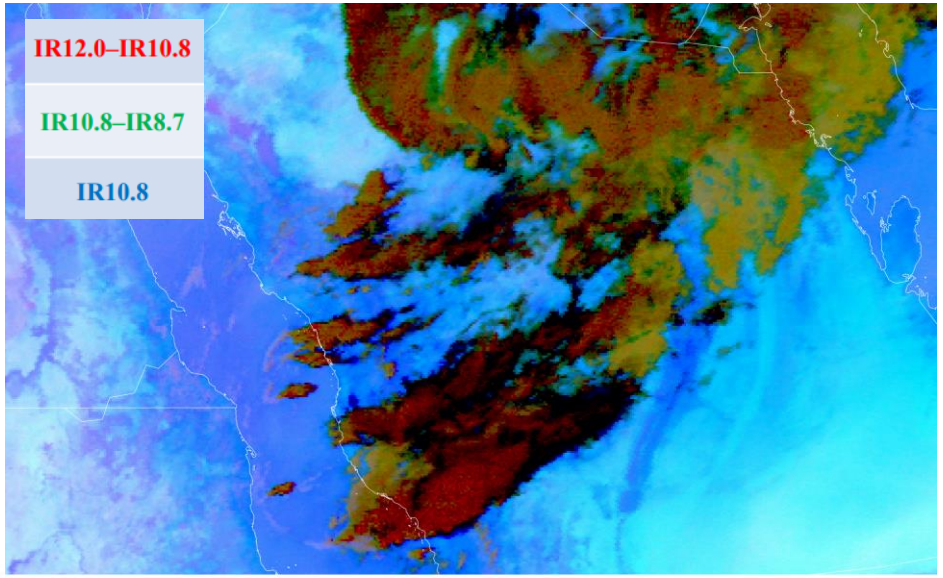


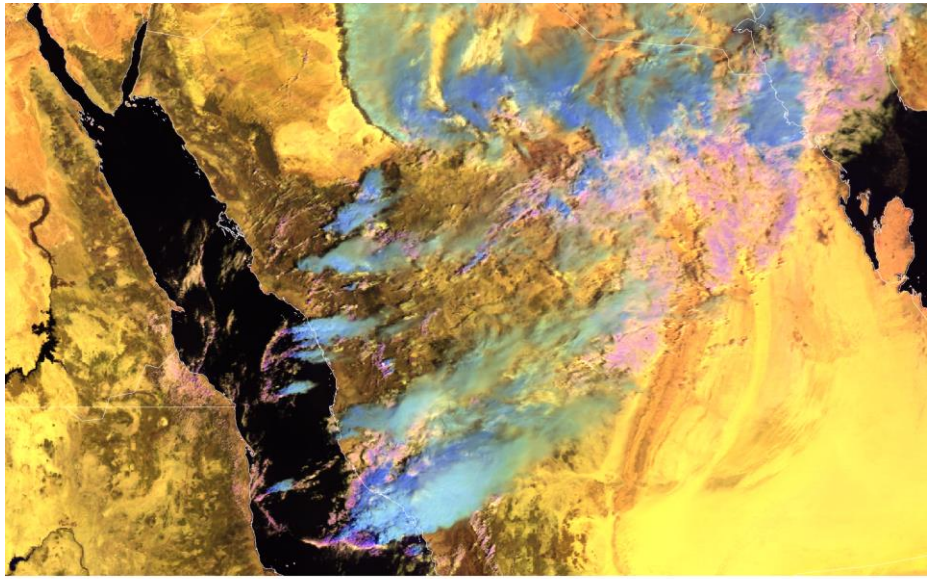
SEVIRI

1. Dust or ash clouds. The colour of dust clouds varies from pink to violet, ash clouds are more reddish.
2. Cirrus clouds with no clouds below are black or dark blue.
3. Thick, high and cold ice clouds.
4. Thick mid-level clouds. Thin mid-level clouds appear green (black arrow).
5. Thin cirrus clouds over deserts appear green.
6. Hot sandy deserts, dry air mass.*
7. Humid air in lower levels.* (~ 700 hPa)
8. Dry air in lower levels.*

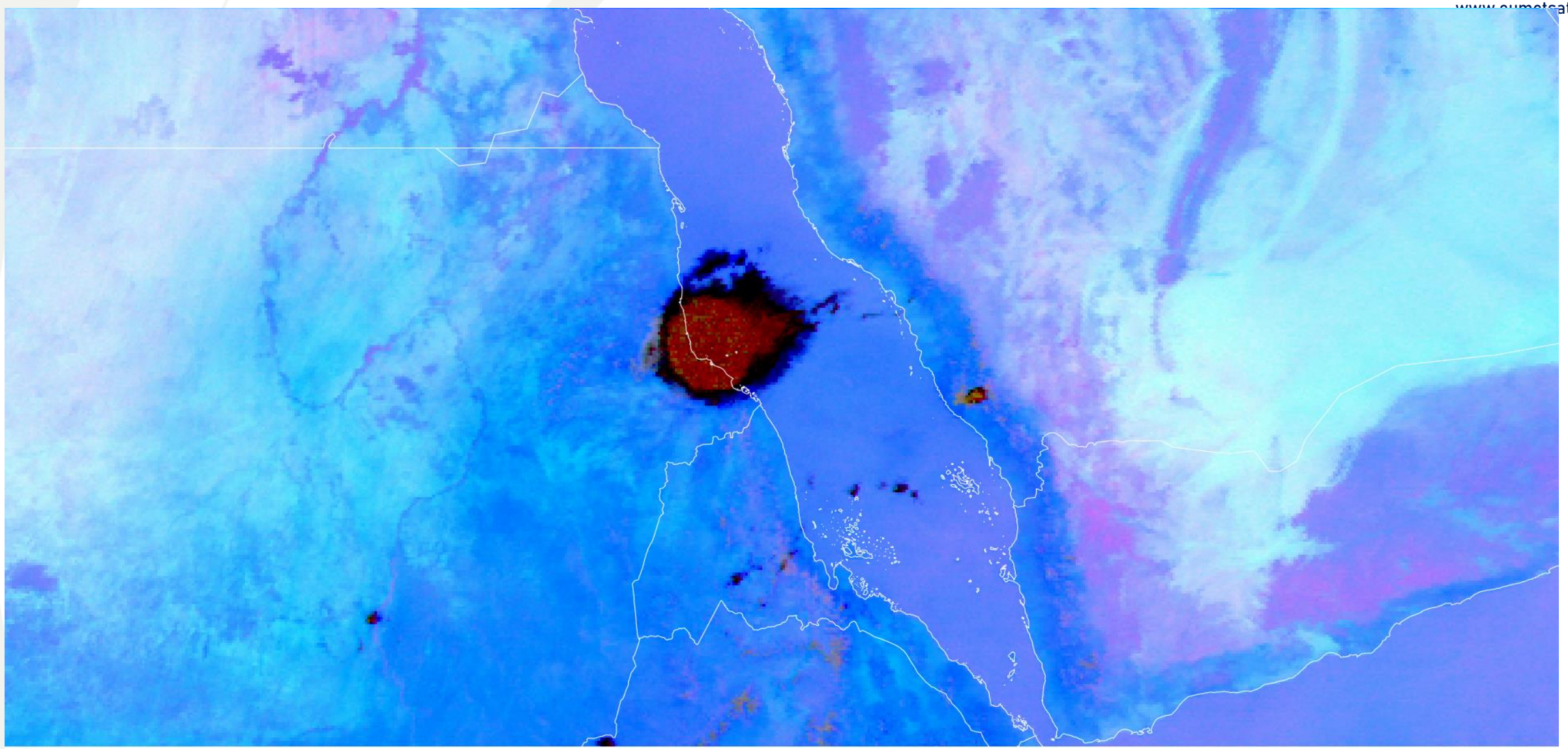
* *Colours can vary considerably depending on surface temperature.*

Dust RGB image, 29 May 2017, 18:00 UTC

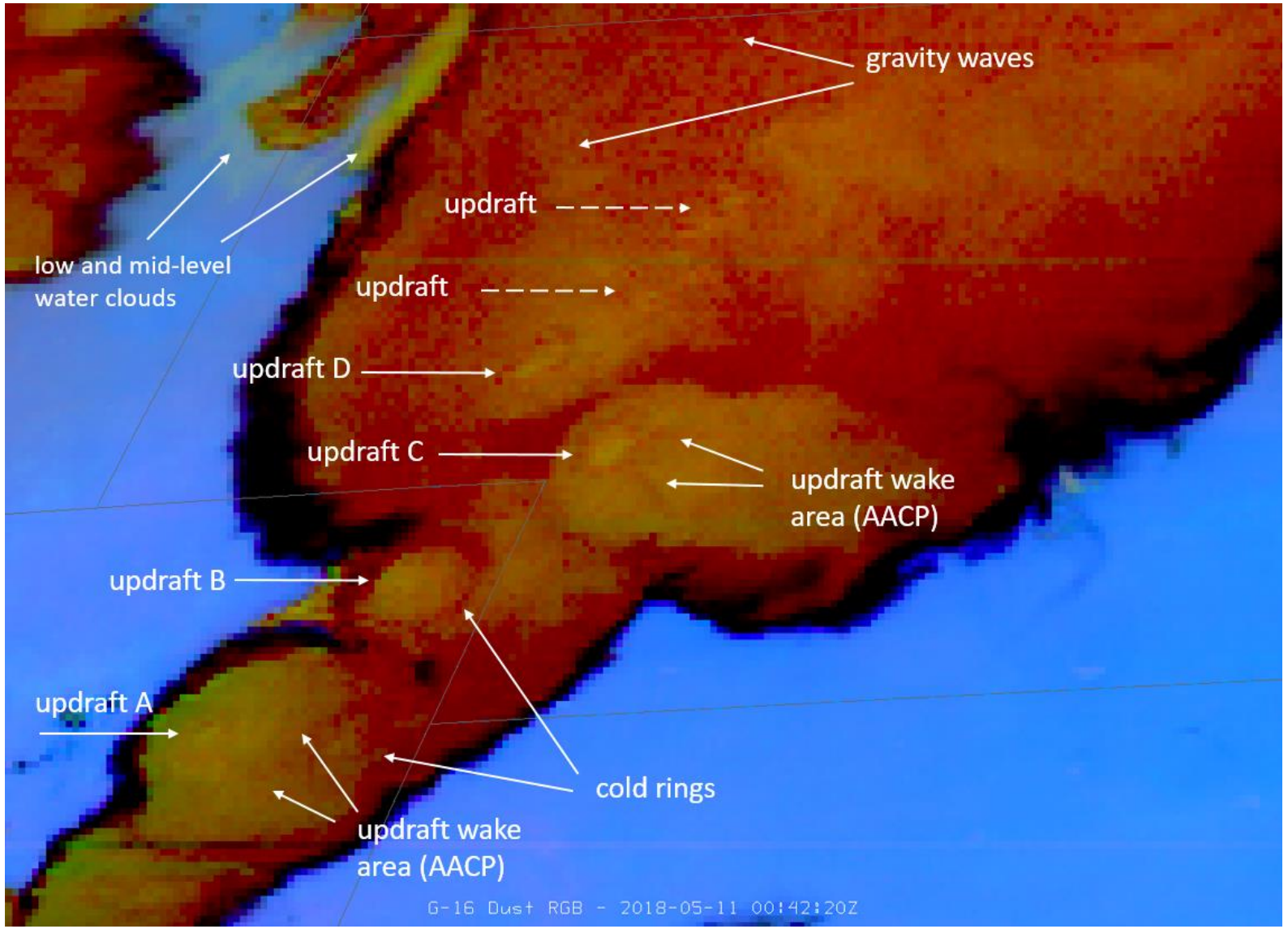




Low Level Moisture



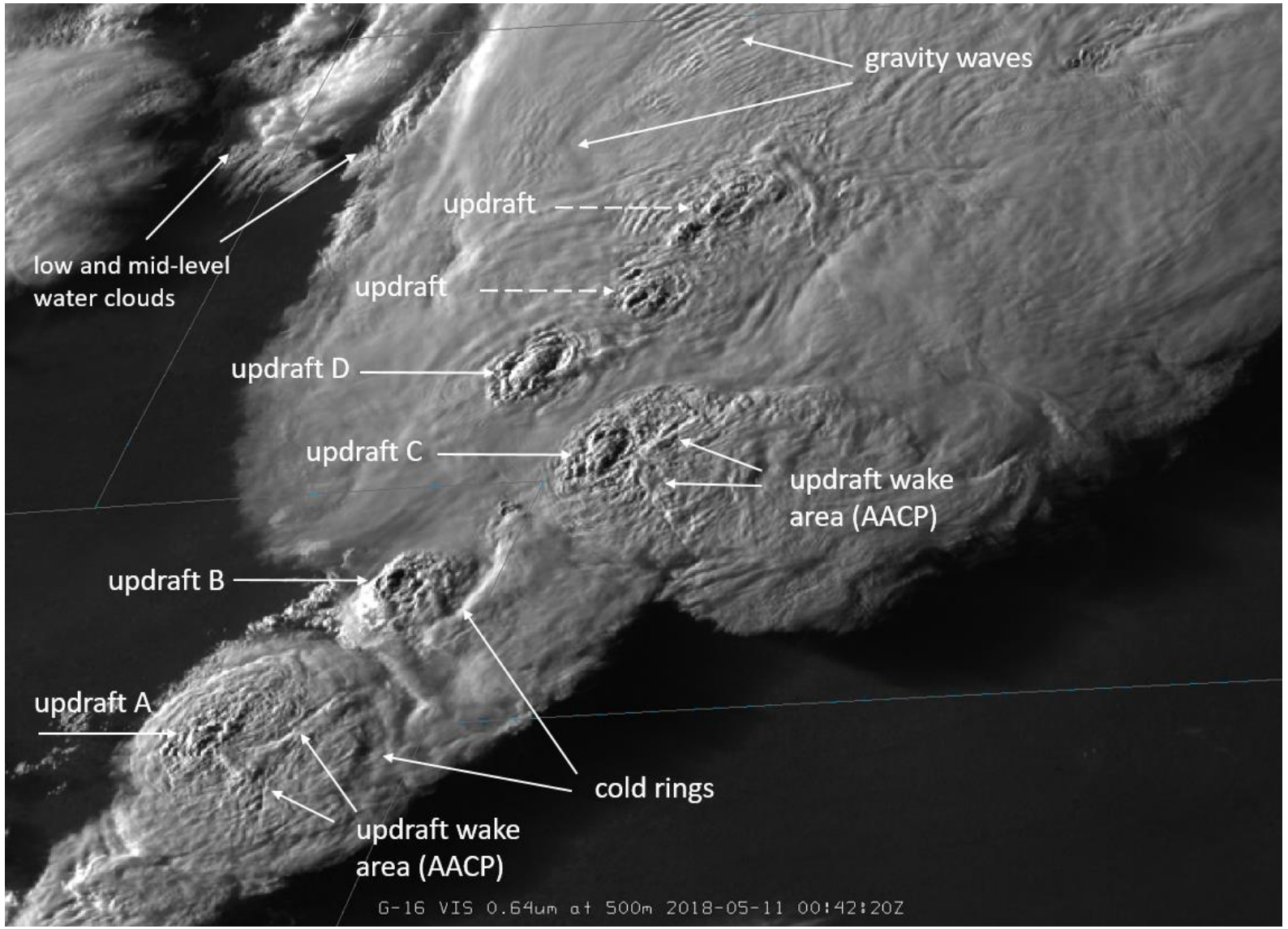
Dust RGB / New within ‘oldies’



- **Dust RGB**
  - High cloud top features during night time!

https://www.eumetsat.int/cloud-top-features-over-mcs-seen-through-dust-rgb-product

Dust RGB / New within ‘oldies’



- **Dust RGB**
  - High cloud top features during night time!

End of Part 2

شكرا جزيلاً