

A detailed illustration of a satellite in space, showing its complex structure with multiple solar panel arrays and instruments. The background is a deep black space with a faint star field. The satellite is positioned diagonally across the frame.

An overview of EUMETSAT next (present) generation GEO mission

Ivan Smiljanić

Satellite applications and training expert

04 November 2024 , ToT PUMA / MTG Applications Training





Applications – what are you interested in?

www.eumetsat.int



Skopje flight, 17 Sep 2023



Applications – what are you interested in?

etsat.int



Ohrid, 18 Sep 2023



Meteosat Third Generation (MTG)

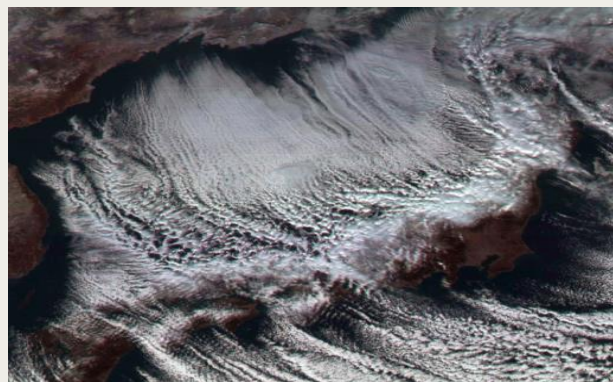
- MTG mission





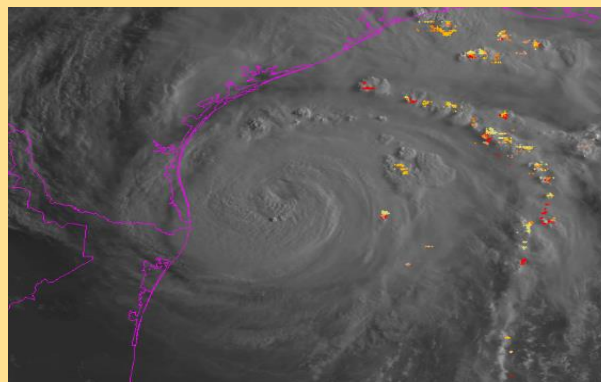
IMAGERY

18 December 2014
(Japan snowstorm)



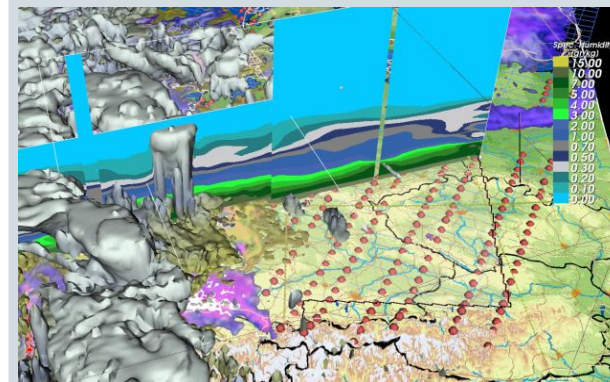
LIGHTNING

12 August 2017
(Hurricane Harvey)

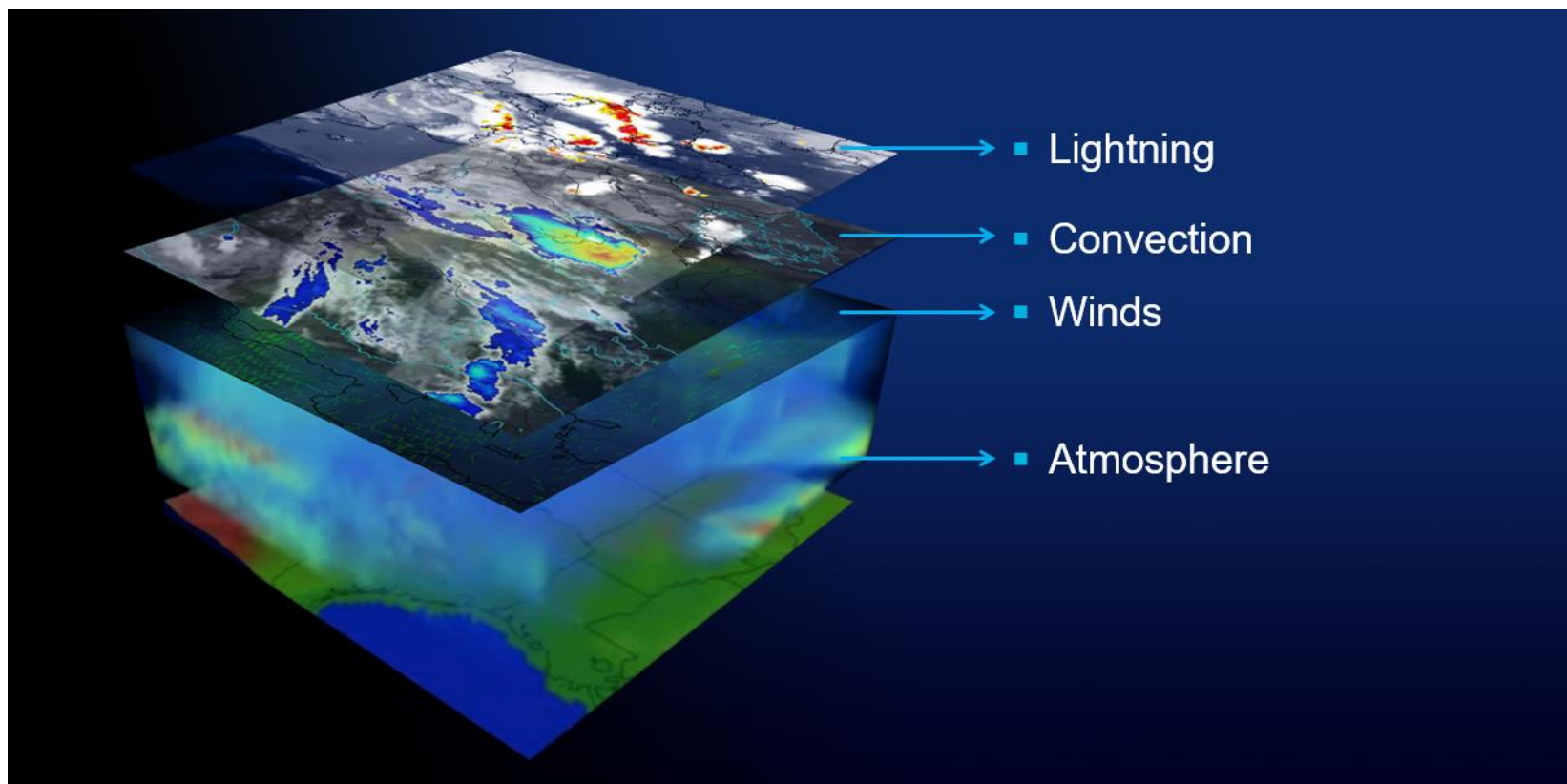


SOUNDINGS

20 June 2013
(IASI vs Harmonie)

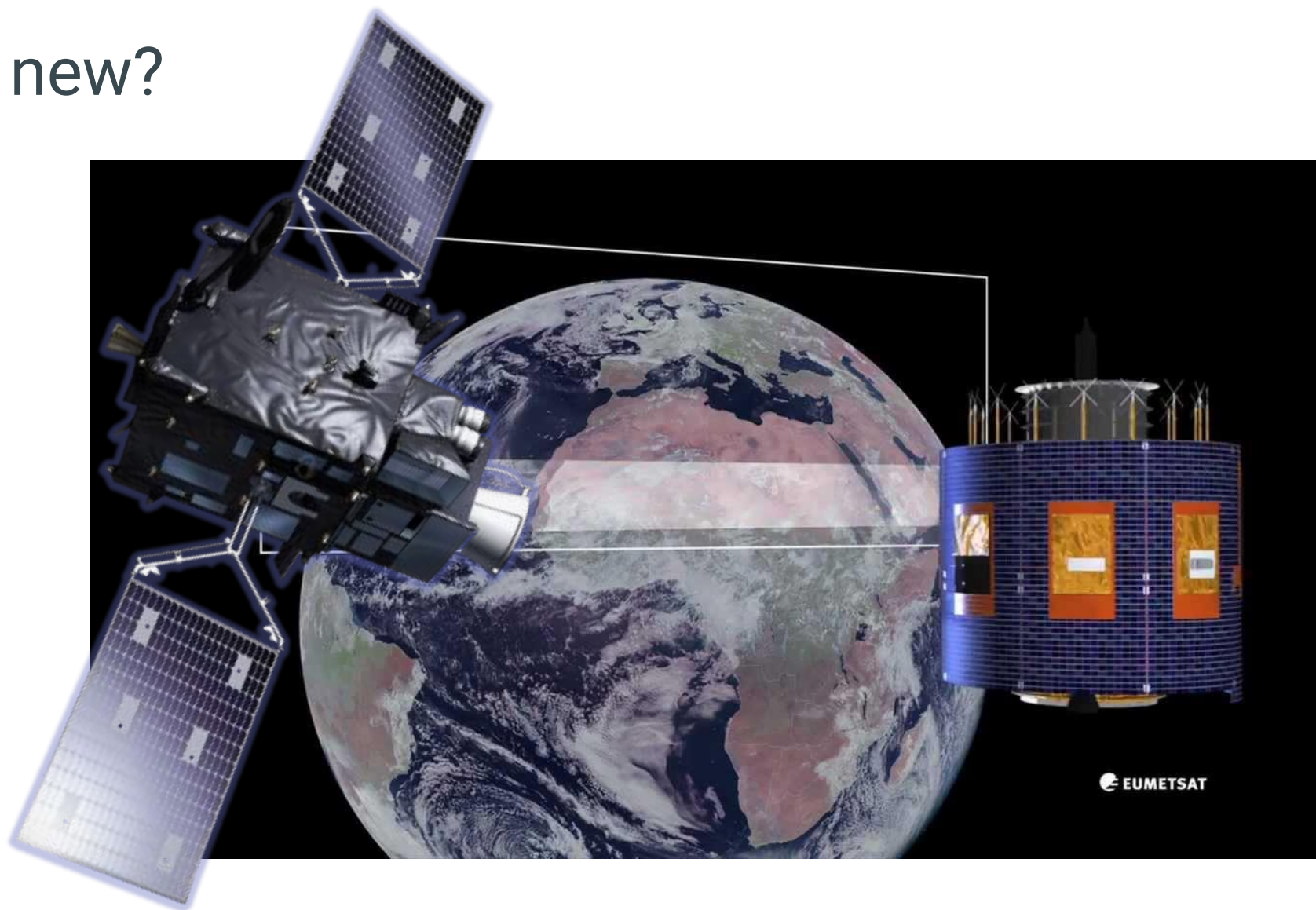


- 4D weather cube



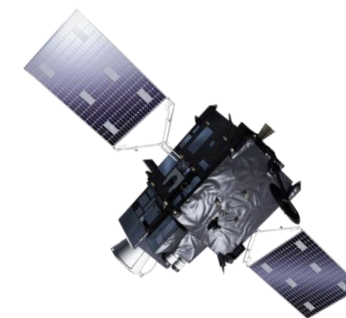


- What's new?





- What's new? - EVOLUTION





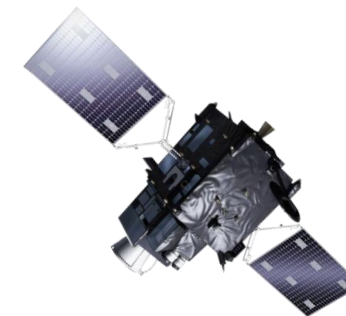
- What's new? – RESOLUTION:

Spatial

Temporal

Spectral

Radiometric





- What's new? – RESOLUTION:

Spatial*

3 km (1 km)

>

2/1 km (1/0.5 km)

Temporal*

15 min (5 min)

>

10 min (2.5 min)

Spectral

12 channels

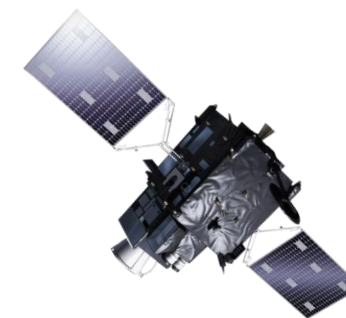
>

16 channels

Radiometric

>

Lower SNR and NEdT

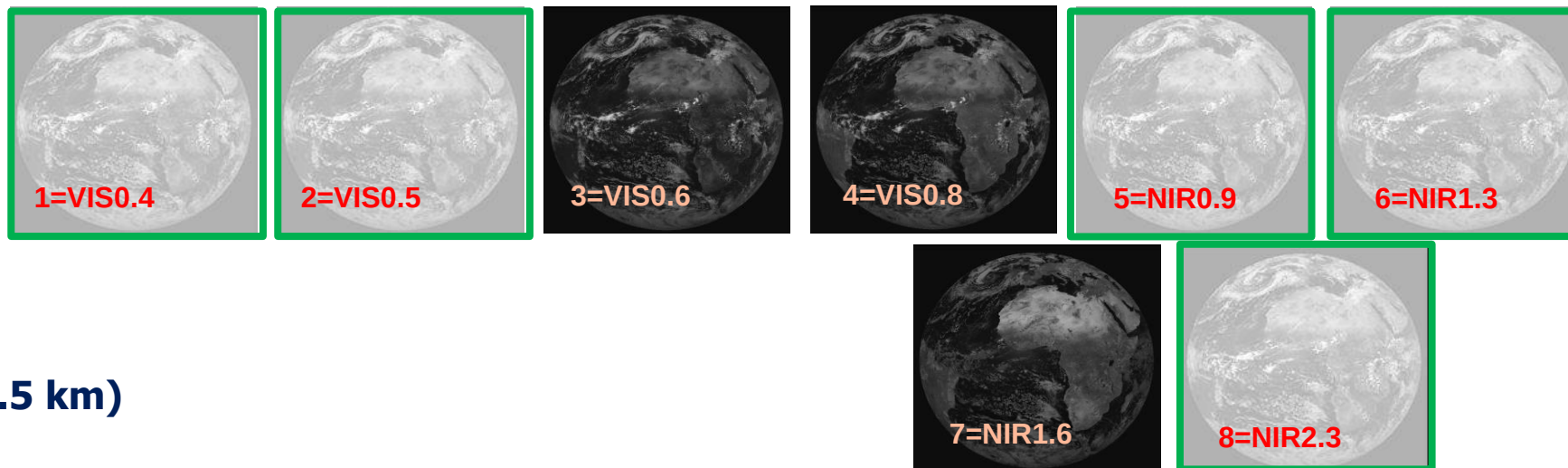


* limited dissemination for Africa

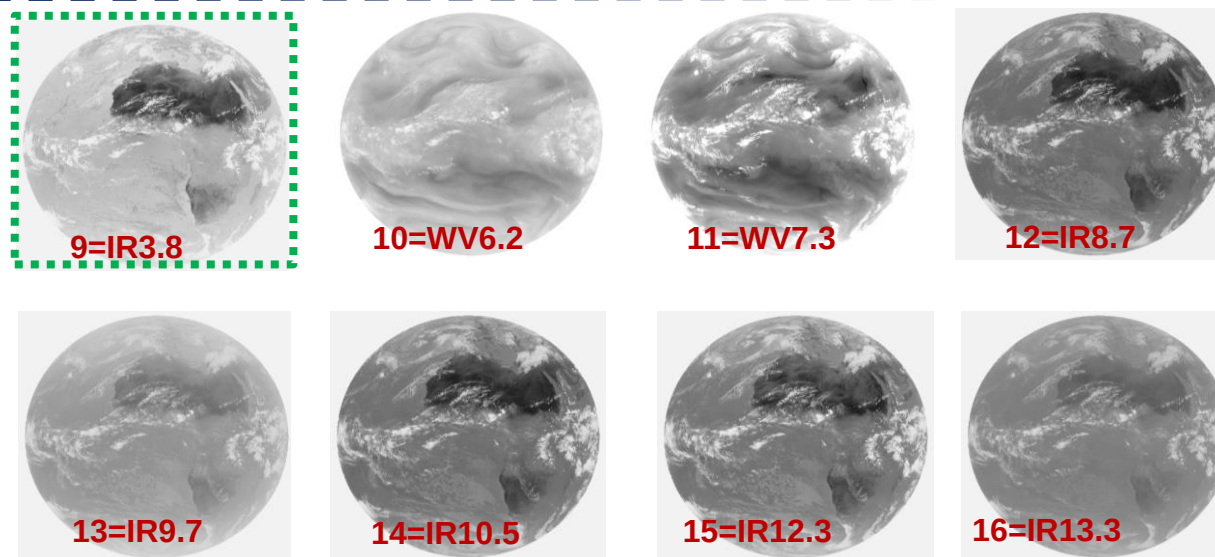


MTG vs MSG (FCI vs SEVIRI)

www.eumetsat.int



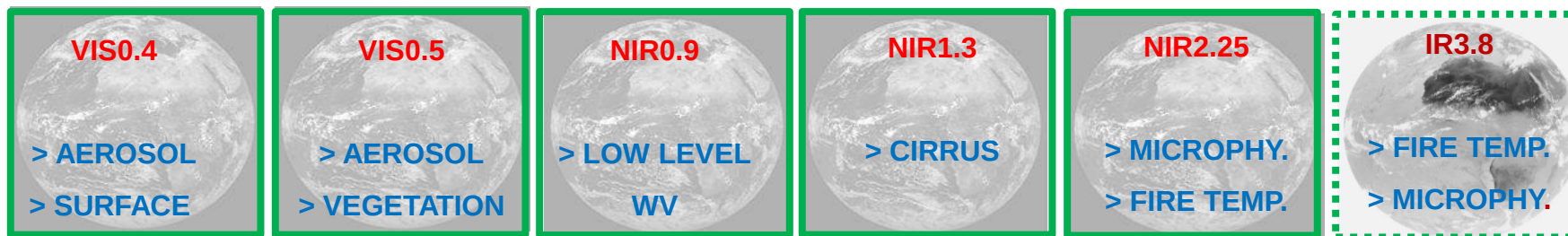
Thermal
2.0 km (1.0 km)





MTG vs MSG (FCI vs SEVIRI)

www.eumetsat.int



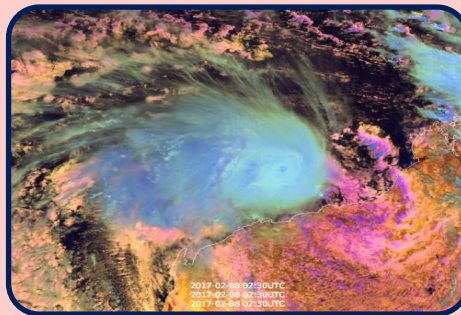
True Colour RGB

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



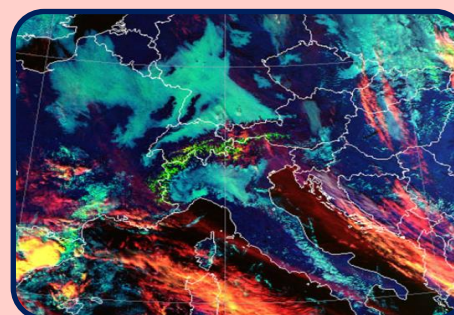
Cloud Phase RGB

R NIR1.6
G NIR2.3
B VIS0.5/VIS0.6



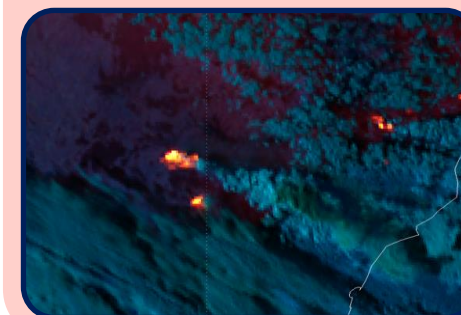
Cloud Type RGB

R NIR1.3
G VIS0.8
B VIS1.6



Fire Temp. RGB

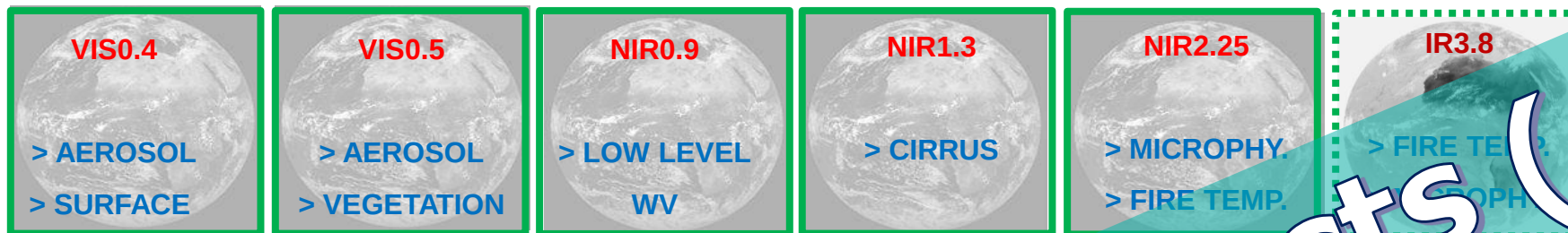
R IR3.9
G NIR2.3
B NIR1.6





MTG vs MSG (FCI vs SEVIRI)

www.eumetsat.int



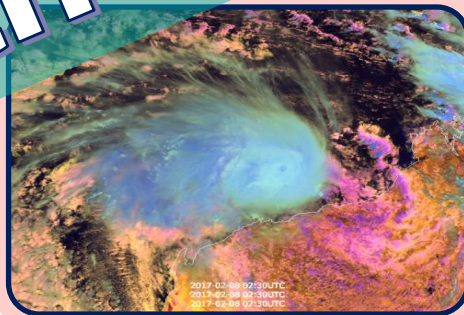
True Colour RGB

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



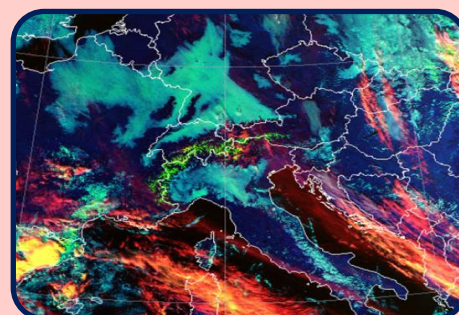
Cloud Phase RGB

R NIR1.6
G NIR2.25
B VIS0.5/VIS0.6



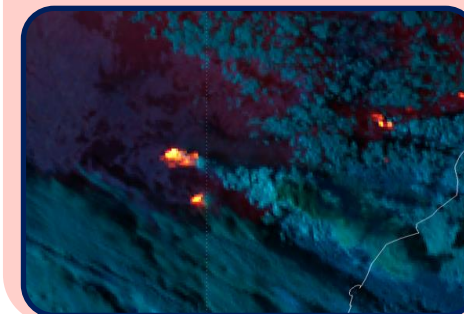
Cloud Type RGB

R NIR1.3
G VIS0.8
B VIS1.6



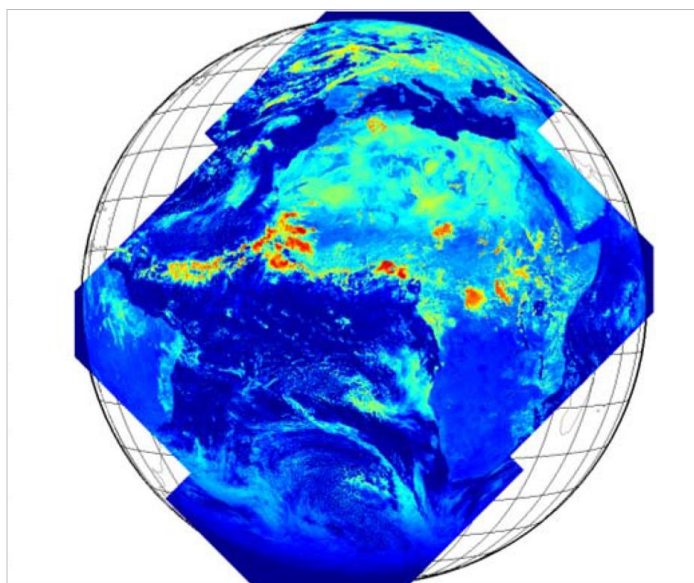
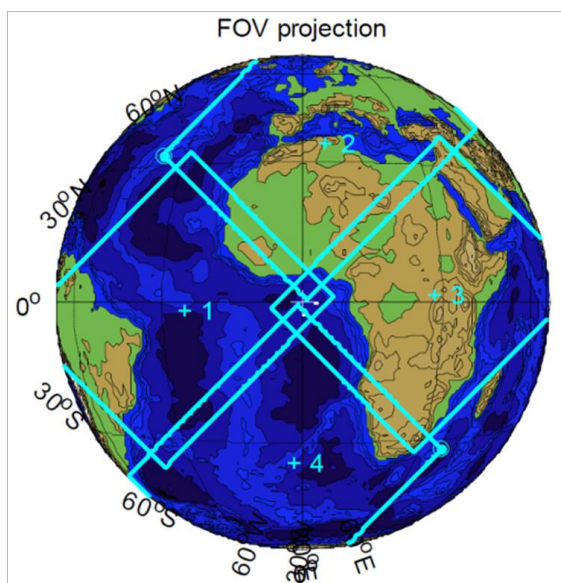
Fire Temp. RGB

R IR3.9
G NIR2.3
B NIR1.6



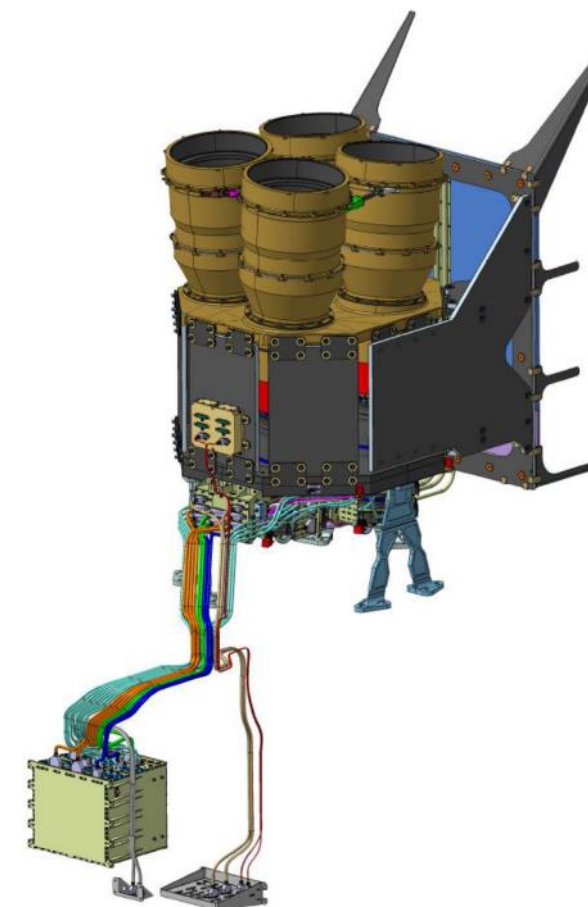


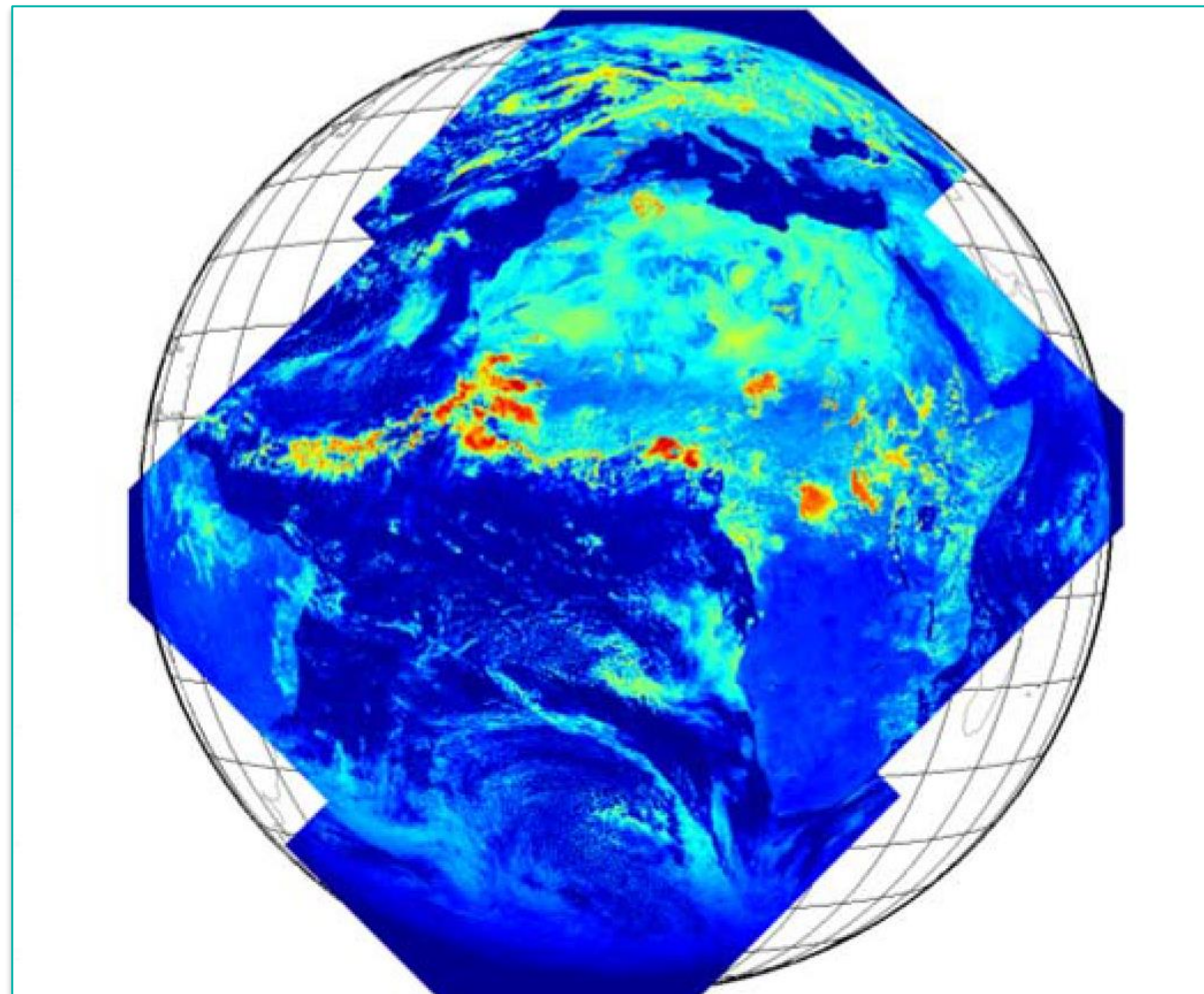
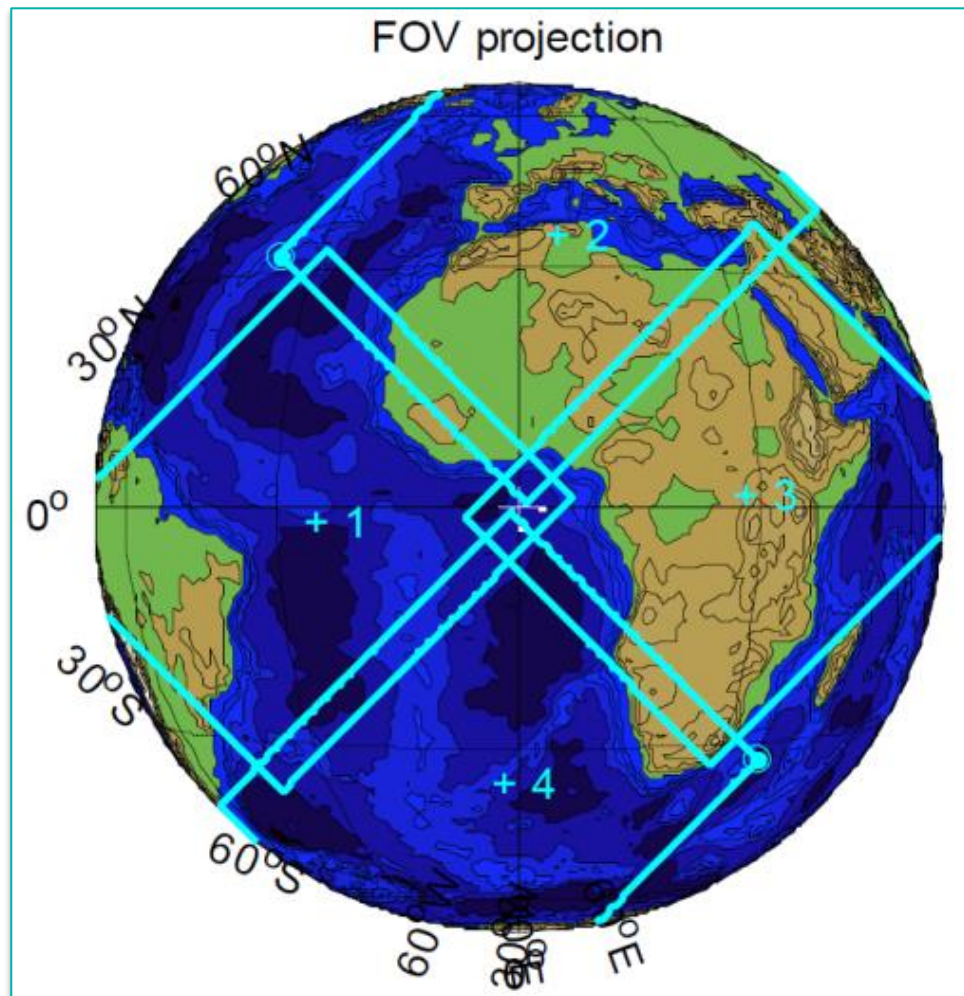
- Lightning is a precursor of severe weather, with a lead time of tens of minutes
- Most ground-based lightning location systems are mainly sensitive to cloud-to-ground lightning (CG)
- Often, no increase in CG due to “weather intensification” observable → Total lightning is the parameter of interest
- Total lightning
= cloud-to-ground + intra- cloud lightning
- MTG LI will measure total lightning



LI in a nutshell

Spatial Resolution at Nadir	4.5 km (variable throughout the Field of View, FOV)
Spectral band	777.4 nm and 1.9 nm narrow band
Detector(s)	1000 x 1170 pixel (x 4) CMOS
Frame rate	1 ms (1 kHz acquisition frequency)
On-board processing	• Background evaluation and subtraction • Lightning detection • On-board filtering
Bandwidth	30 Mbps
Manufacturer	<i>Leonardo</i> (Italy) under the industrial prime contractor <i>Thales Alenia Space</i> (France)



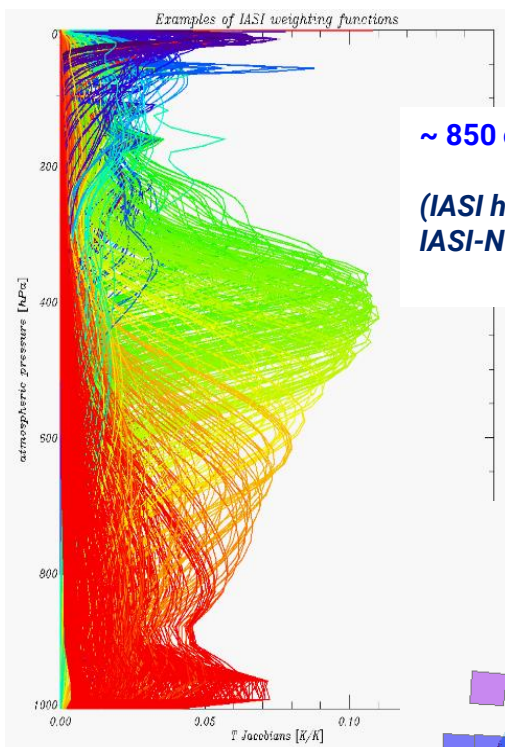




2023-06-02 00:00

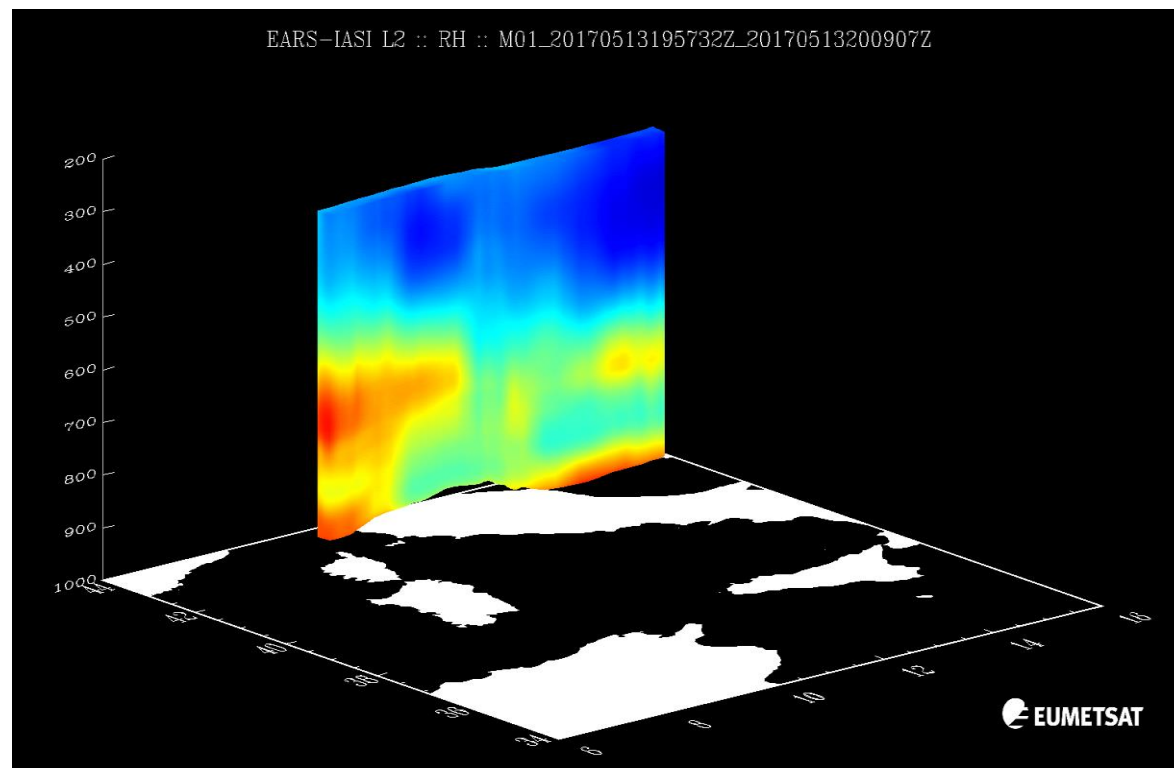
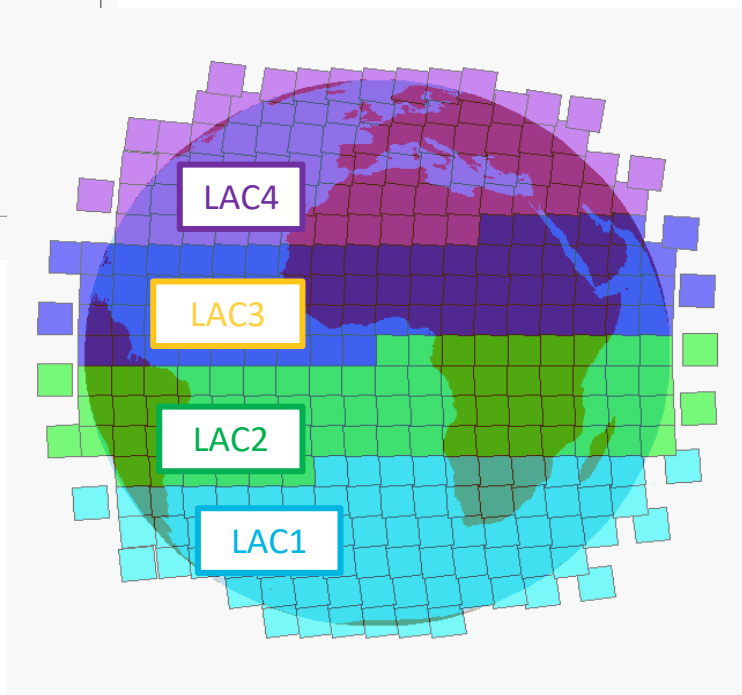
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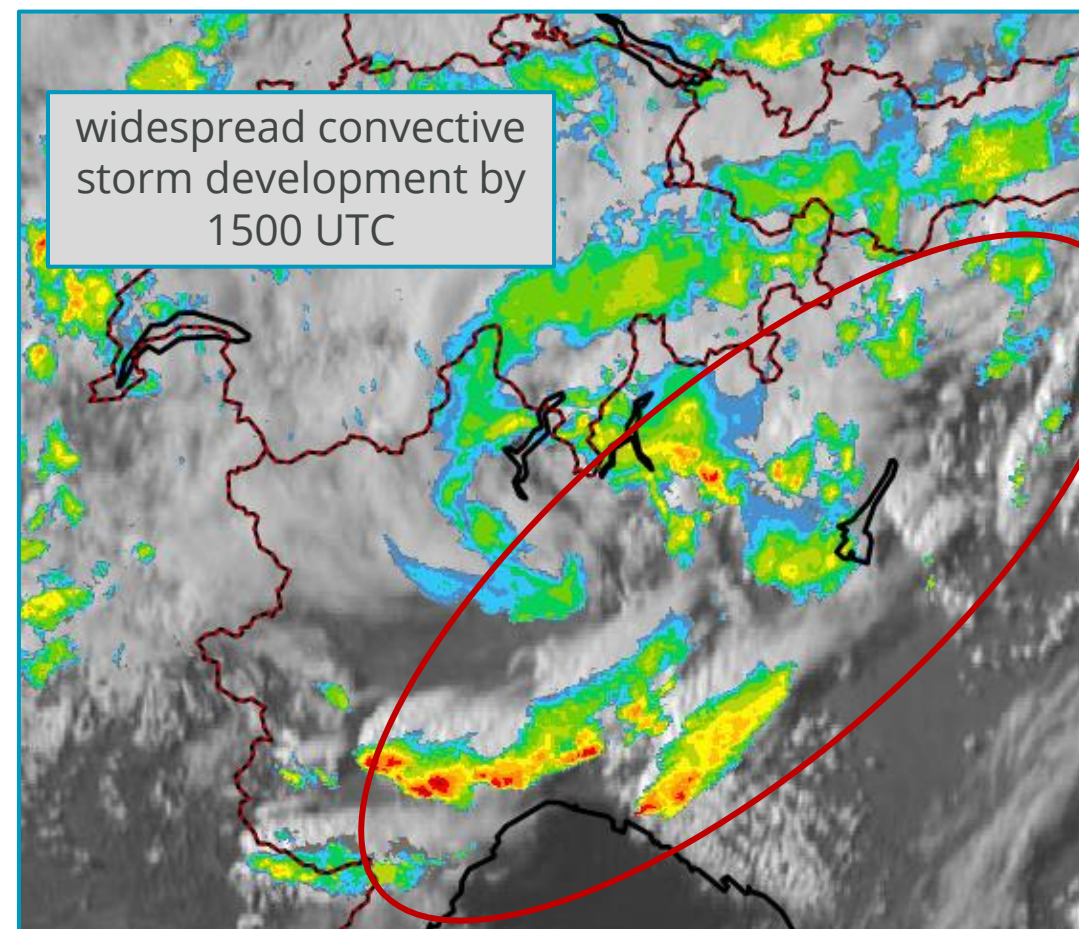
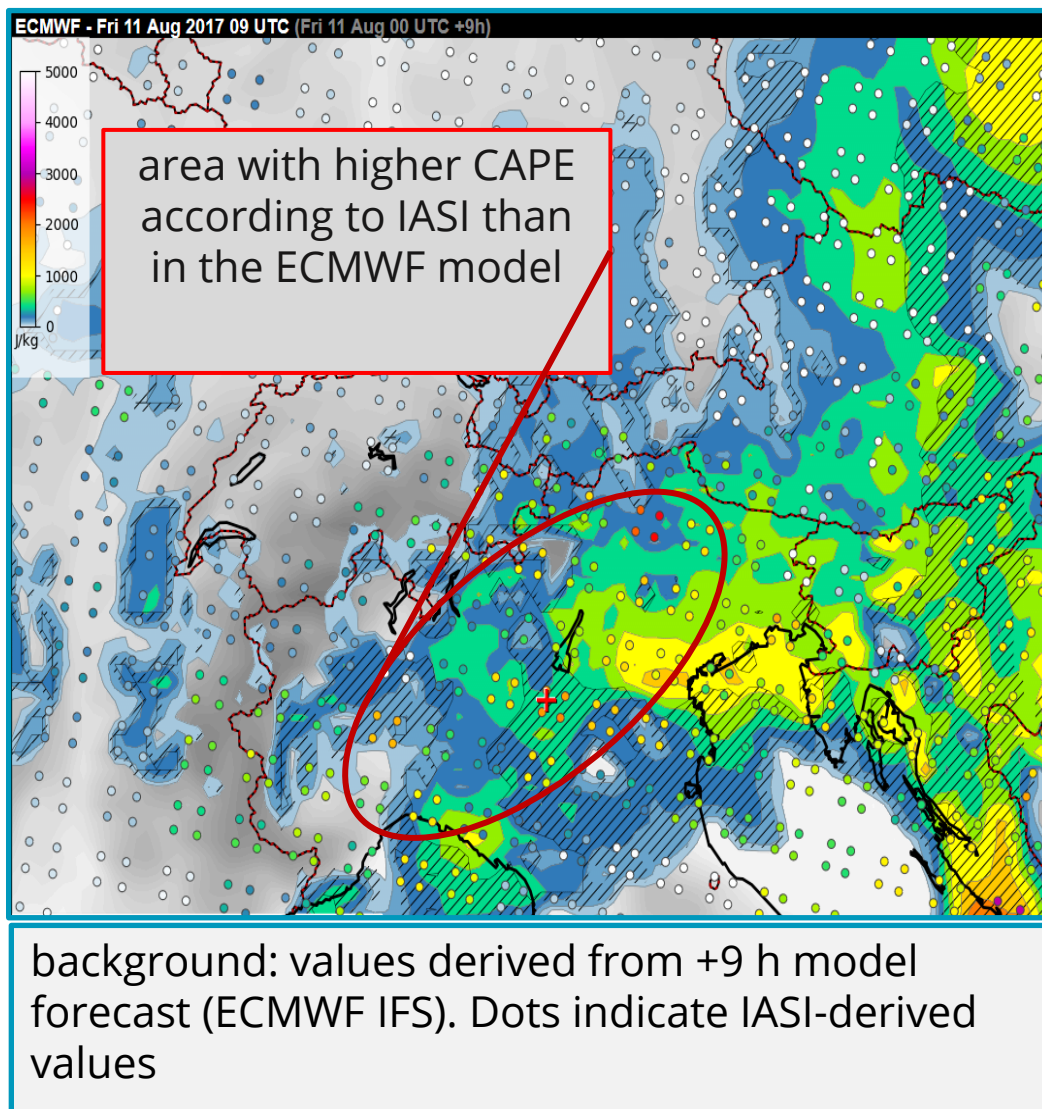
~ 850 channels

(IASI has 8461,
IASI-NG 16921)



Operational spectro-imagery at high spectral, spatial & temporal resolution:

Sampling: 0.6cm⁻¹ spectral, 4km at nadir spatial, 30min temporal over Europe and parts of North Africa

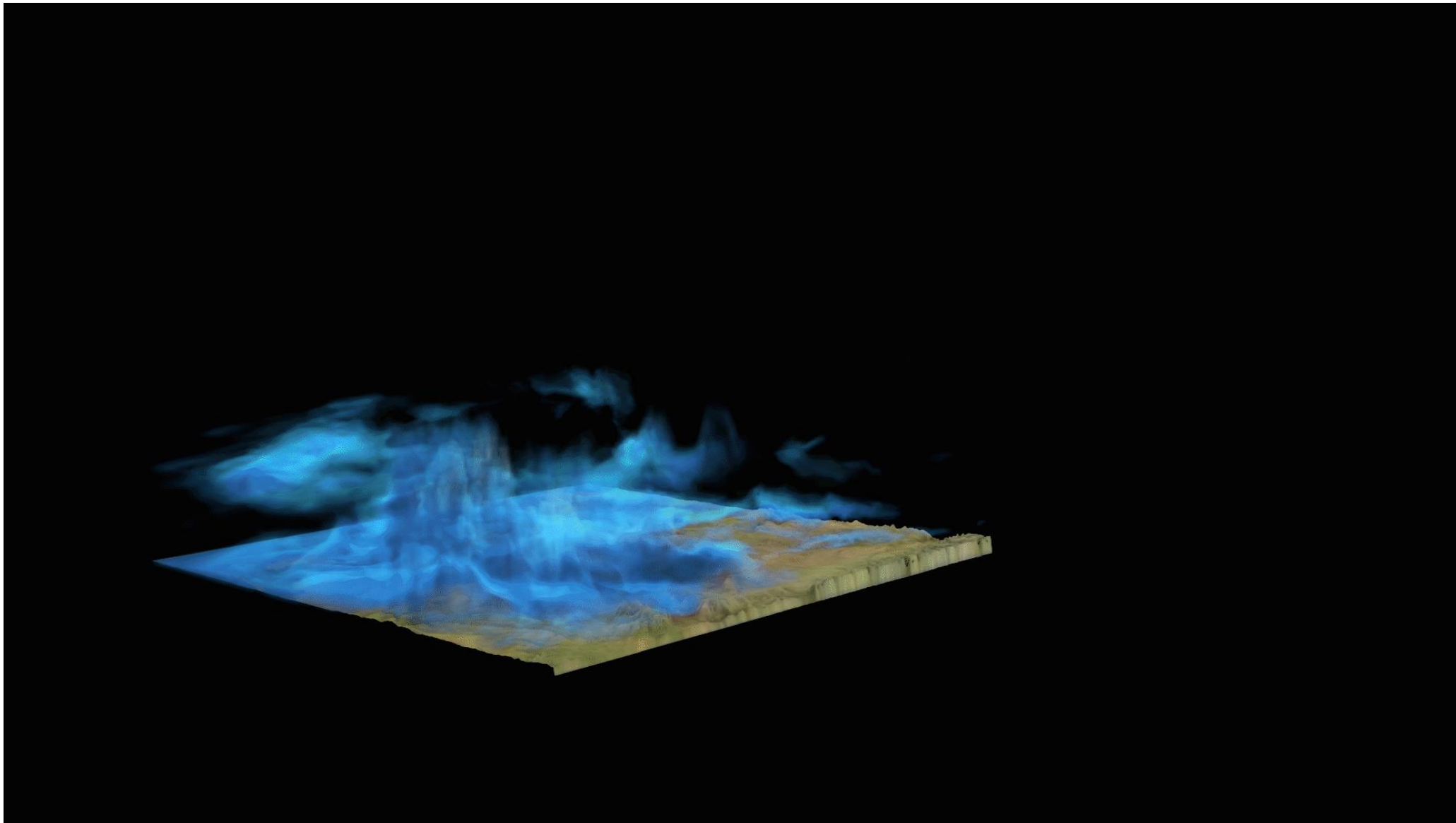


Source: Groenemeijer and Pucik: Hyperspectral sounding for severe storm forecasting; contract EUM/CO/184600002214/TA



4D weather cube with MTG-I and MTG-S

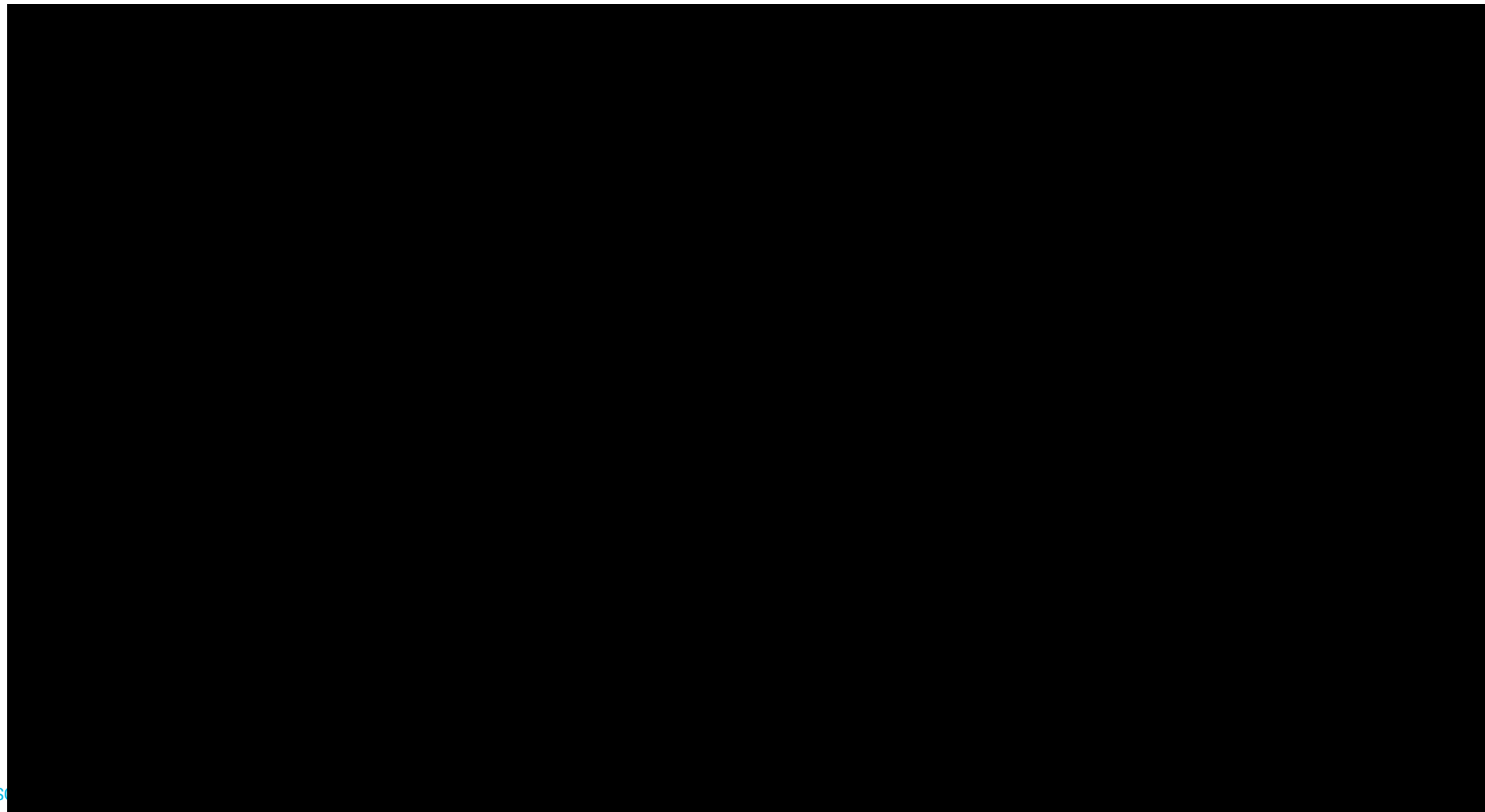
www.eumetsat.int





MTG overview video:

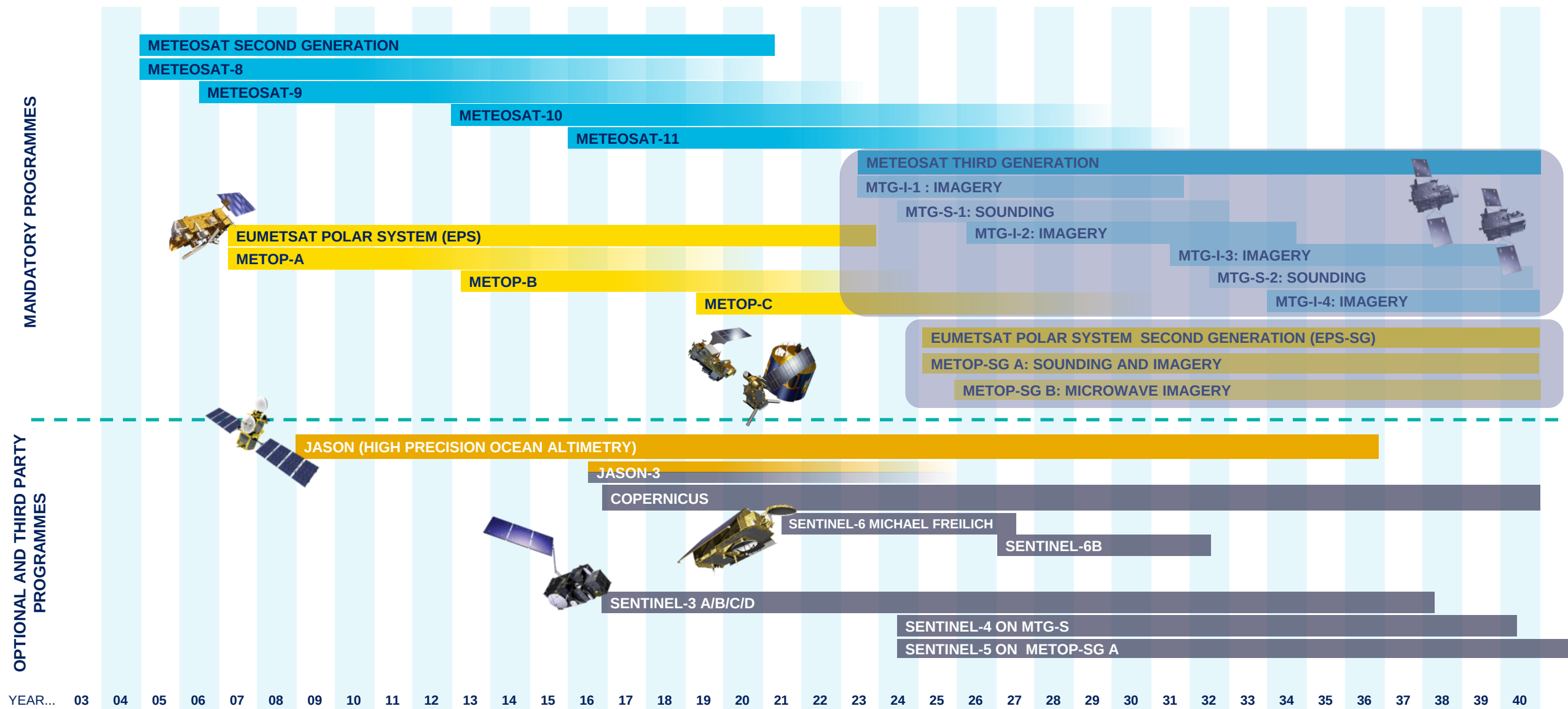
www.eumetsat.int





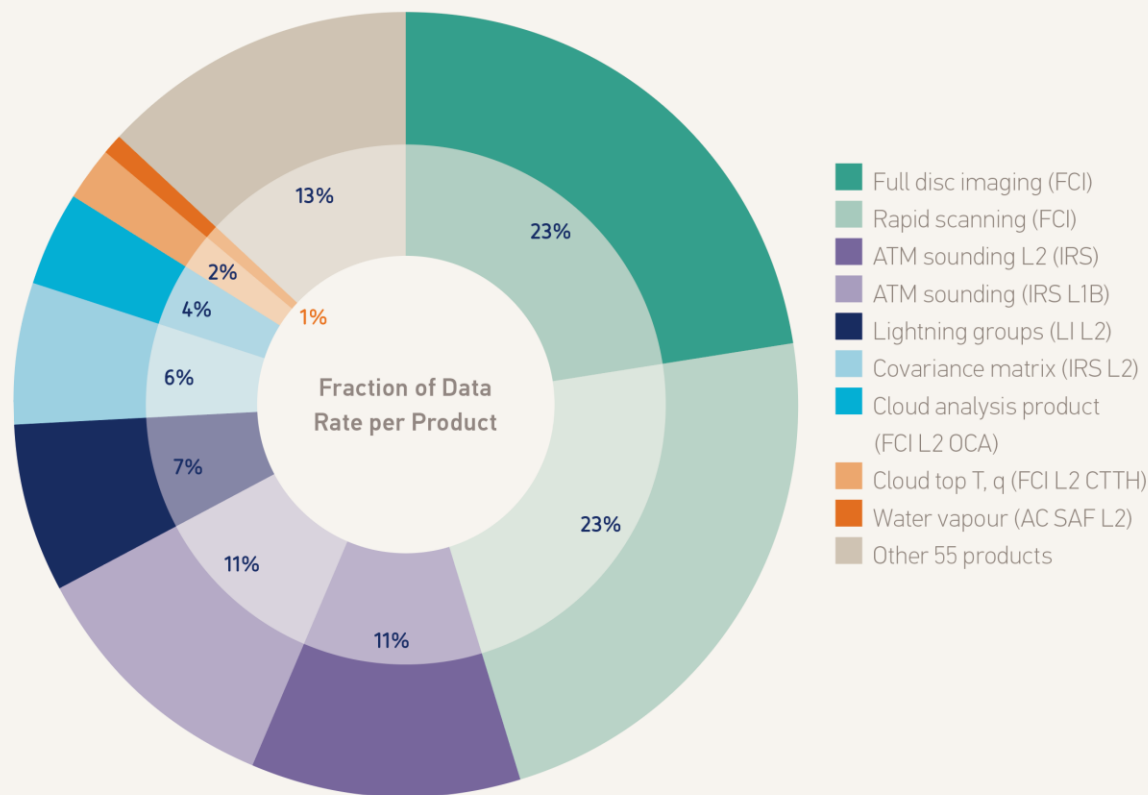
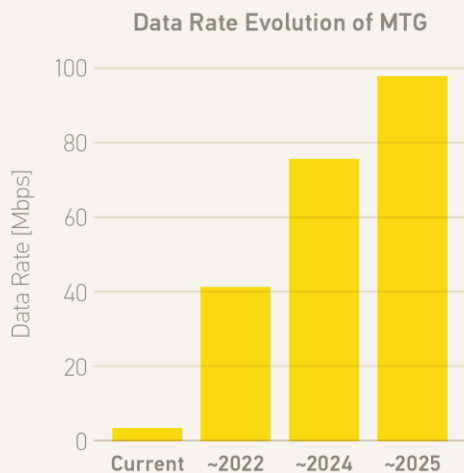
Mission planning

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Evolution of MTG data rates and fraction of data rate used per MTG product class

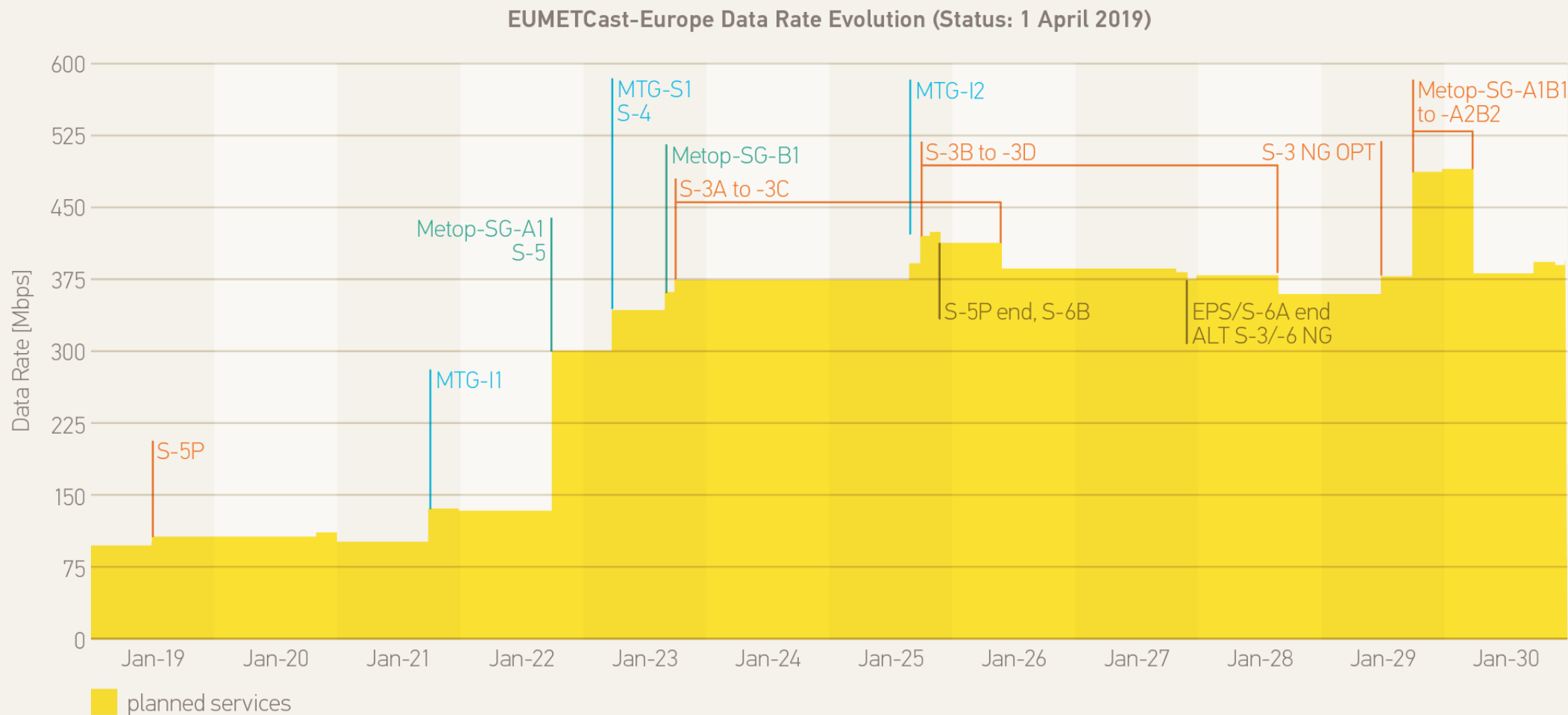


- Full disc imaging (FCI)
- Rapid scanning (FCI)
- ATM sounding L2 (IRS)
- ATM sounding (IRS L1B)
- Lightning groups (LI L2)
- Covariance matrix (IRS L2)
- Cloud analysis product (FCI L2 OCA)
- Cloud top T, q (FCI L2 CTTH)
- Water vapour (AC SAF L2)
- Other 55 products



Mission planning – data volumes

EUMETCast-Europe data rate evolution. The full operational MTG capability is planned to be reached by 2026.



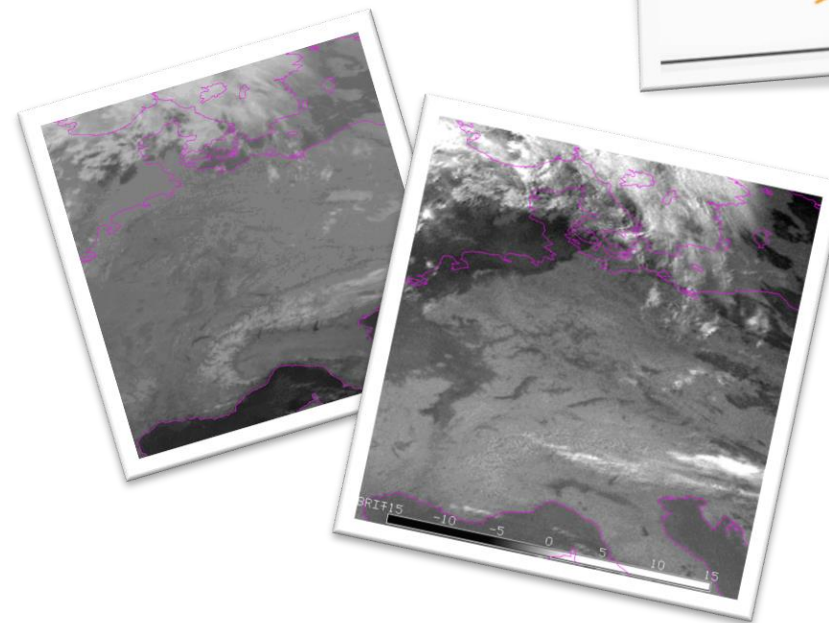


MTG Data and Products



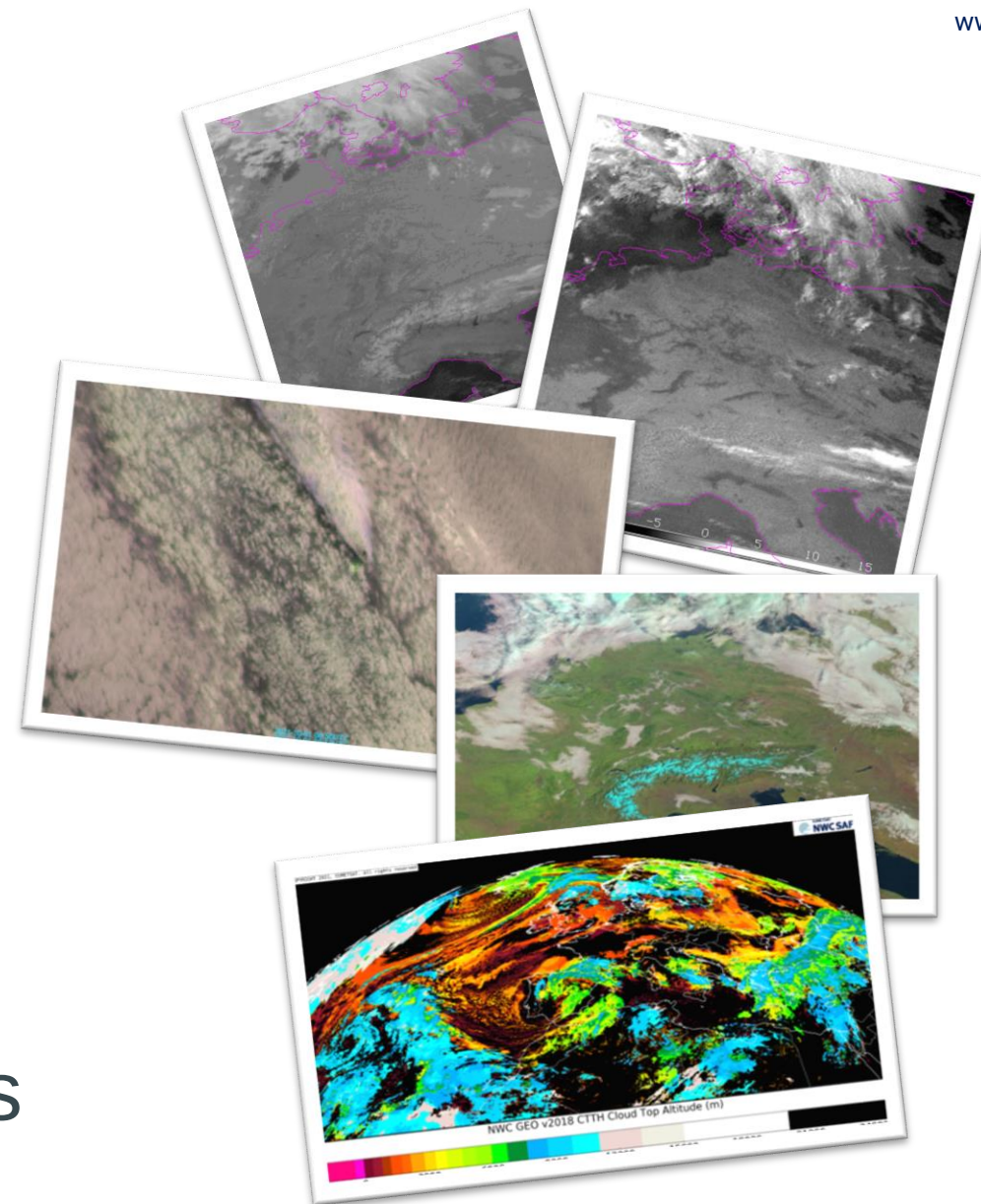
How to use data?

- Single channel??
- ...
- ..?



How to use data?

- Single channel
- Channel difference/ratio
- Sandwich products
- RGB products
- ...
-
- L2(+) / Geophysical products



Why do we need products?

.

What kind of products do we have?

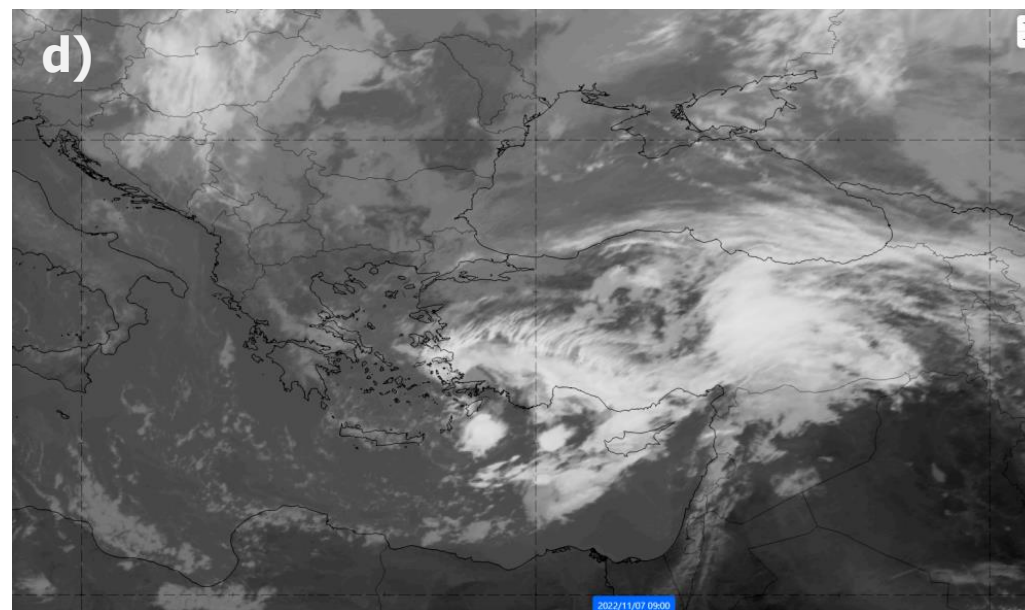
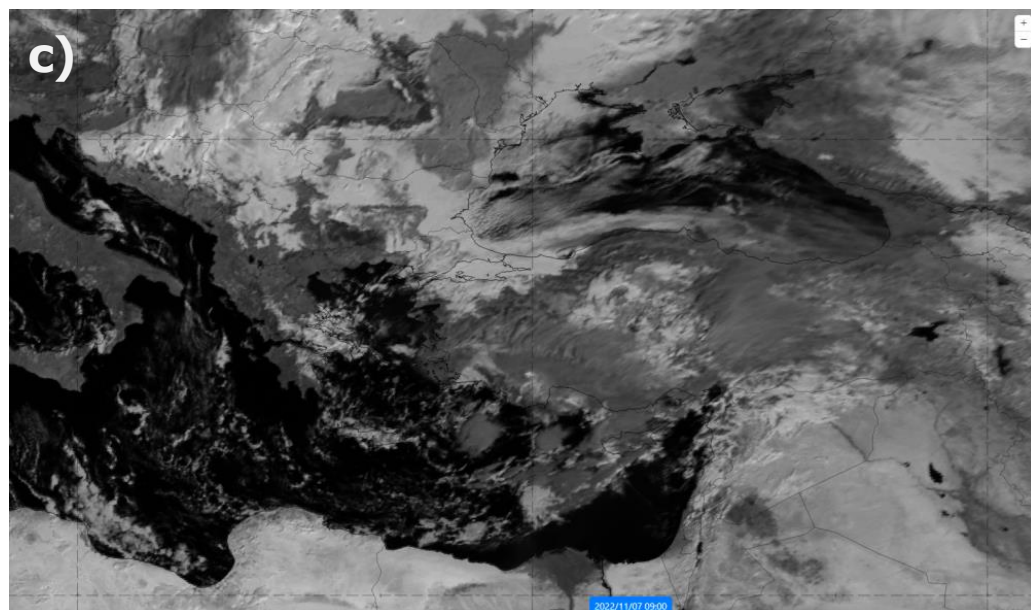
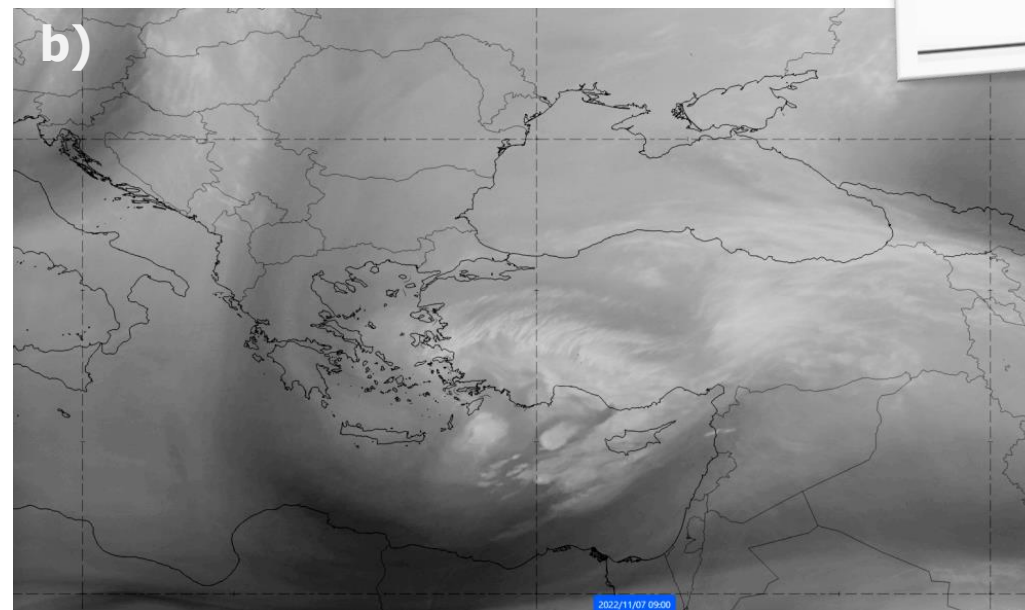
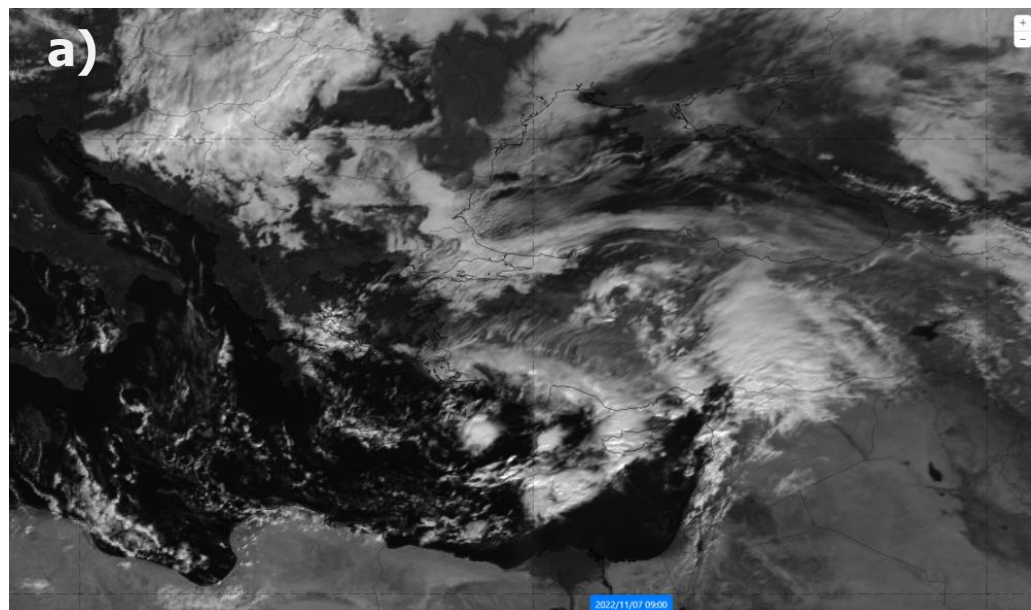




#Single channel(s) – what part of spectra?



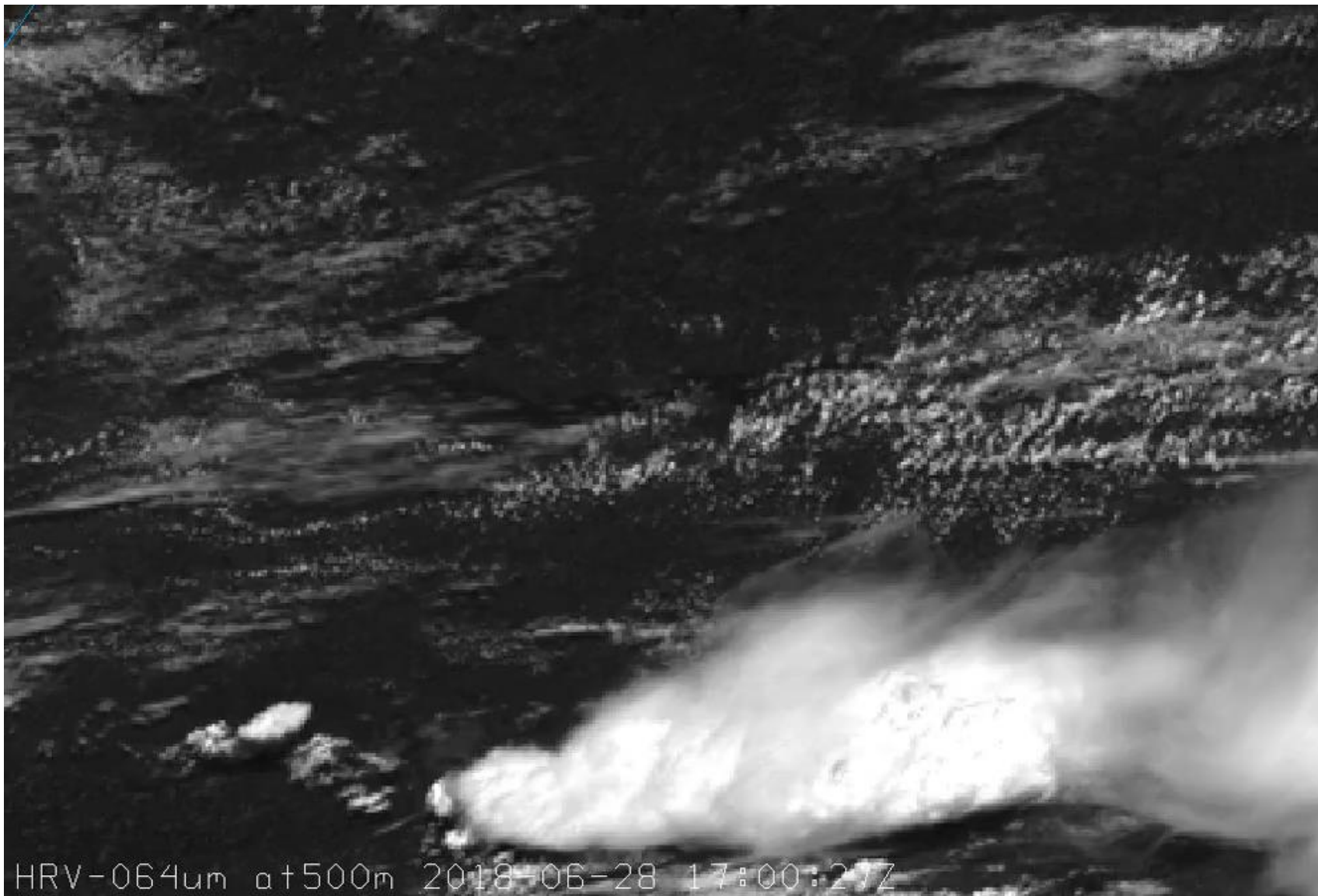
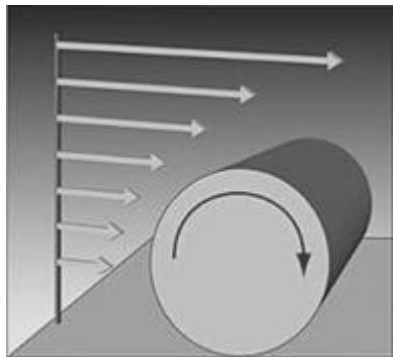
at.int





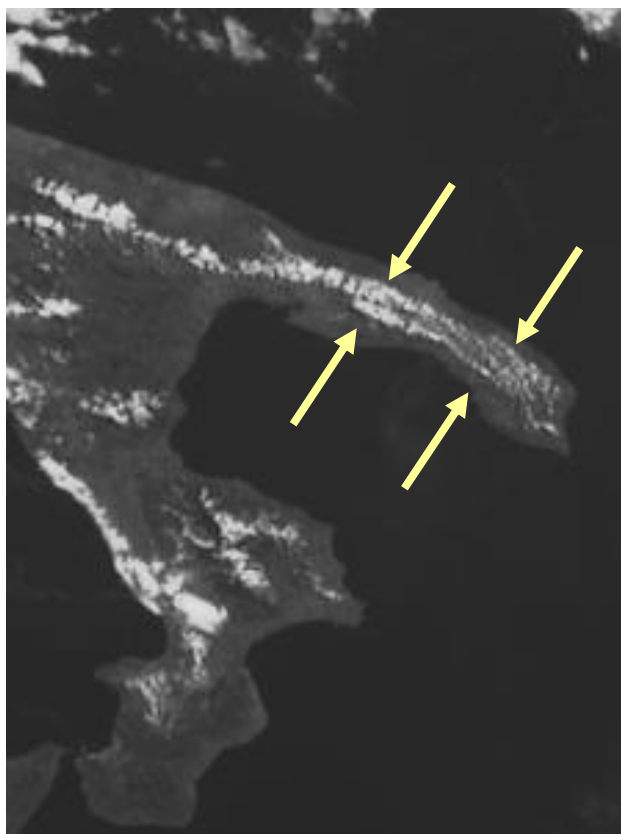
Single channel(s) – wind shear detection, storm dynamics

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Seabreeze Convergence, Southern Italy (Salento)



09:05 UTC

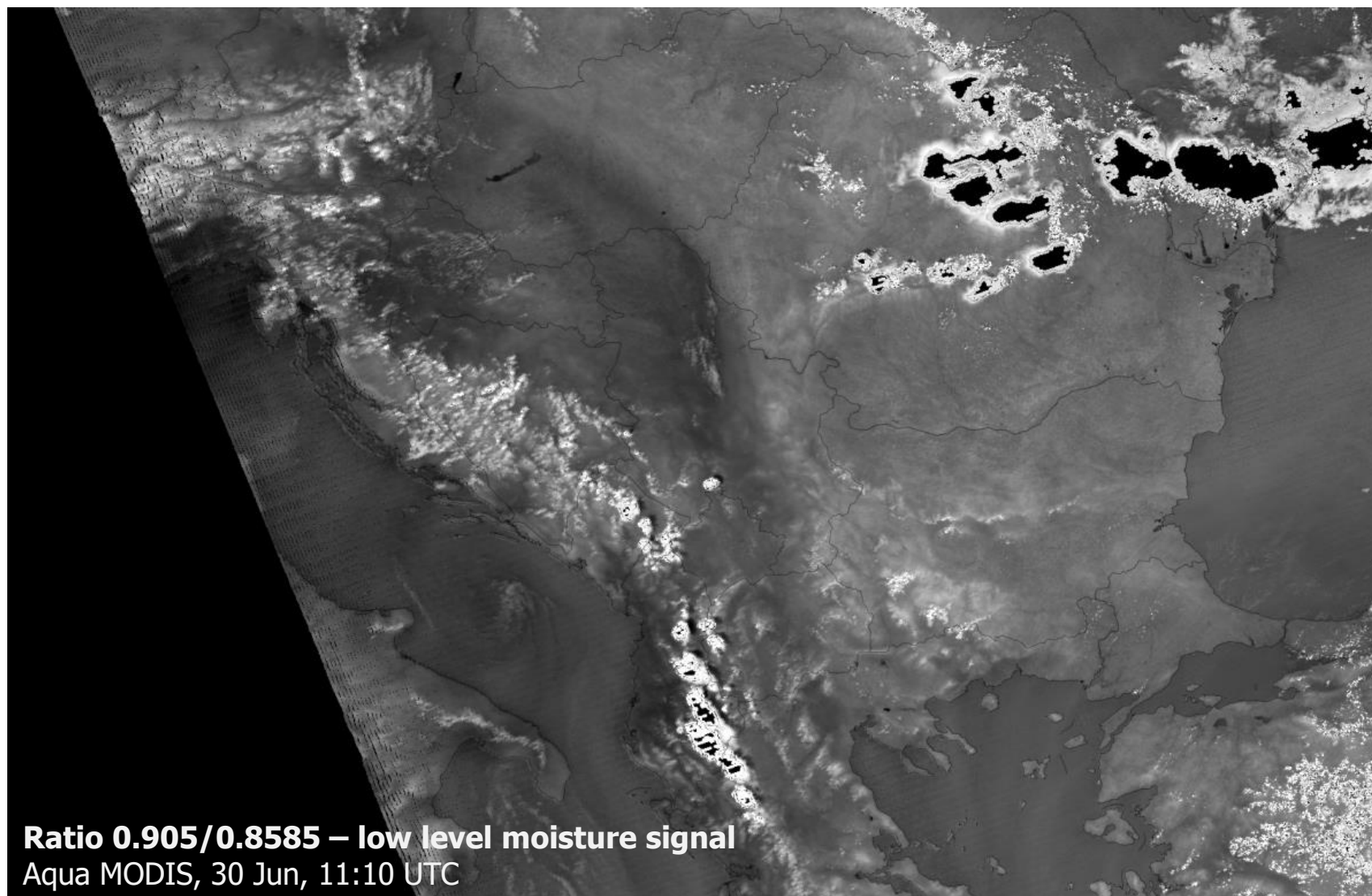


09:40 UTC

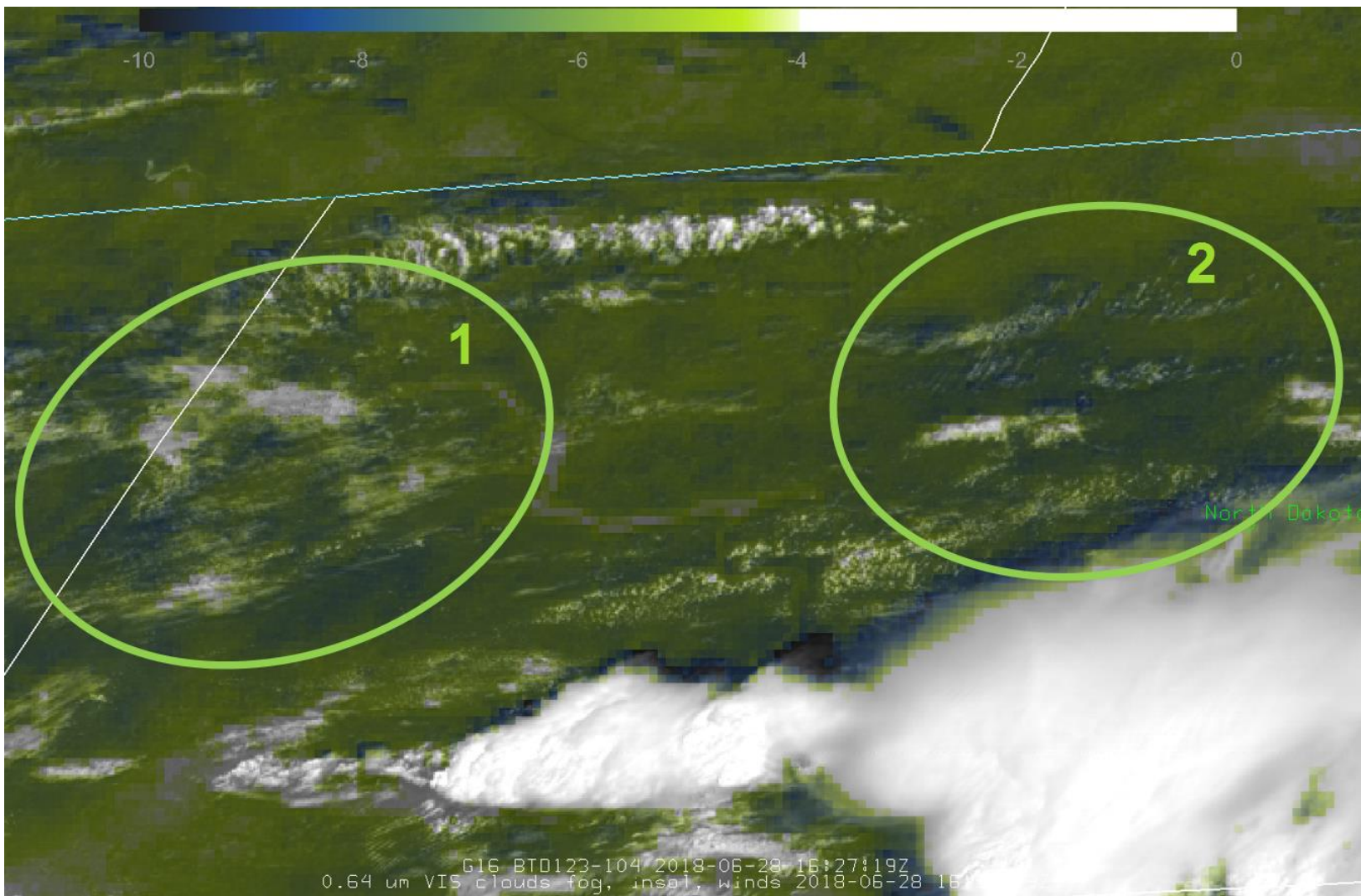


10:55 UTC

12 June 2007, HRV Channel (Met-8 Rapid Scans)



- Enhances the certain signal from single channels



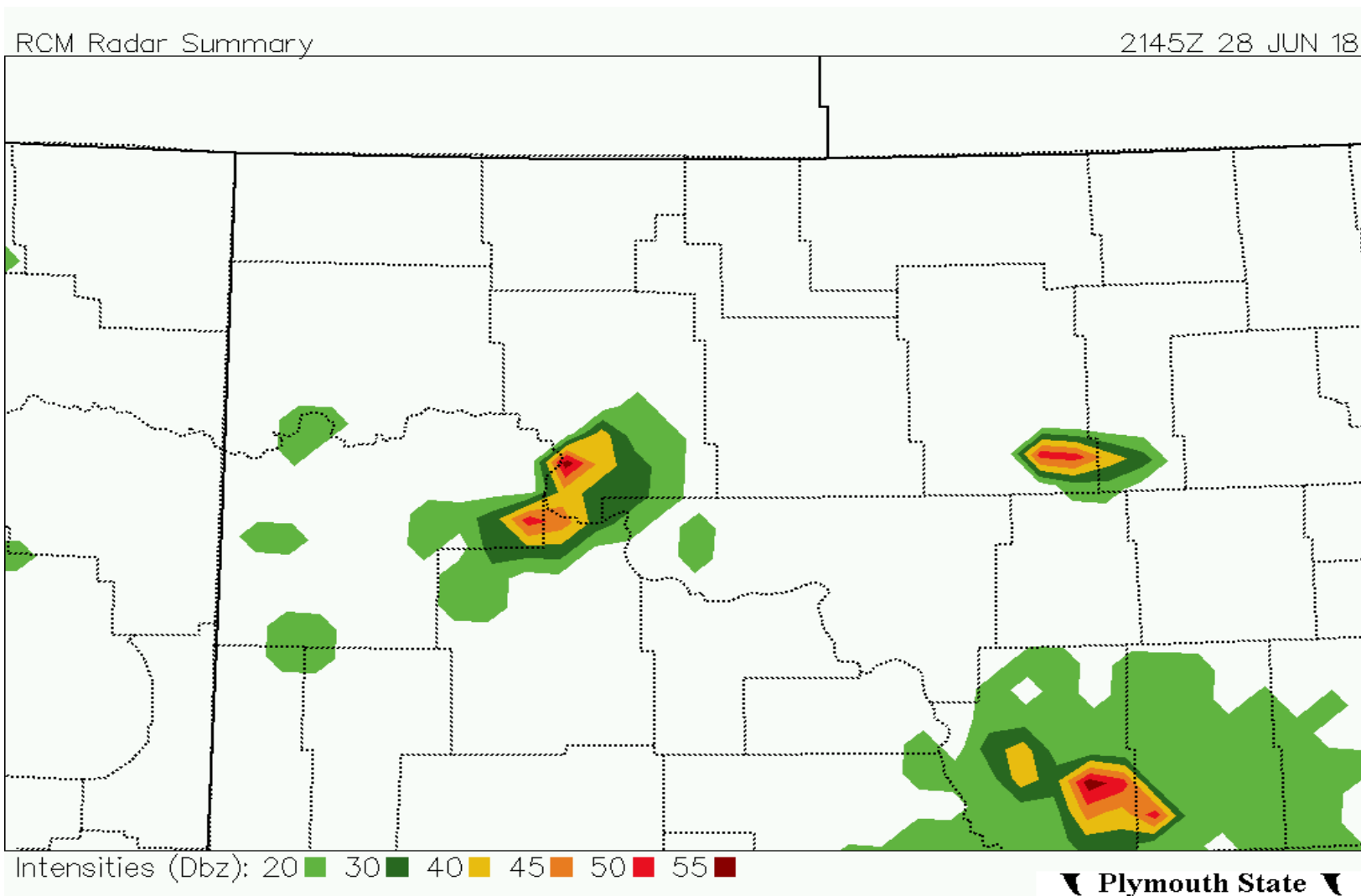
- Enhances the certain signal from single channels

BTD 12.0-10.8

28 June 2018

16:27 UTC

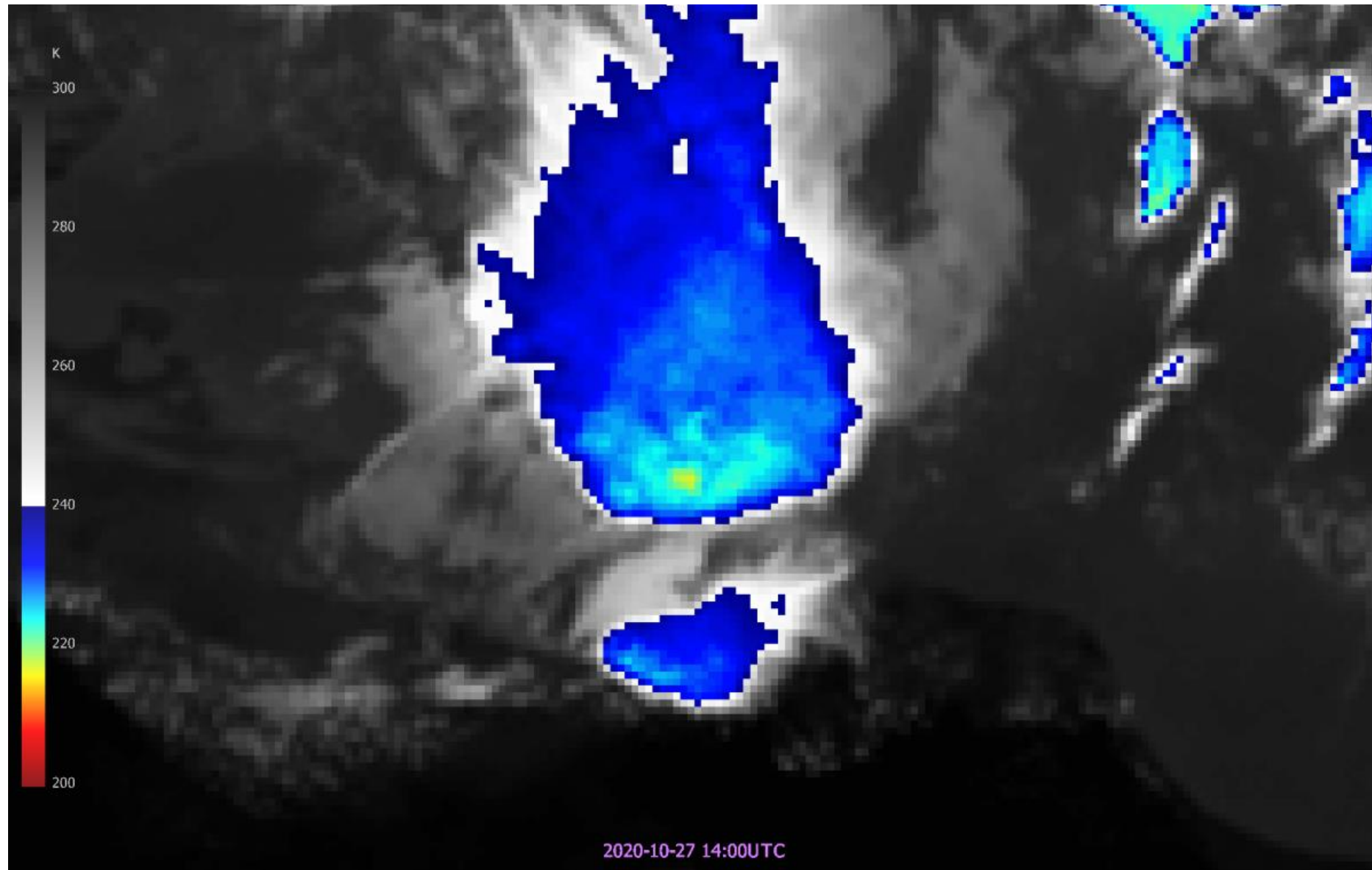
North Dakota



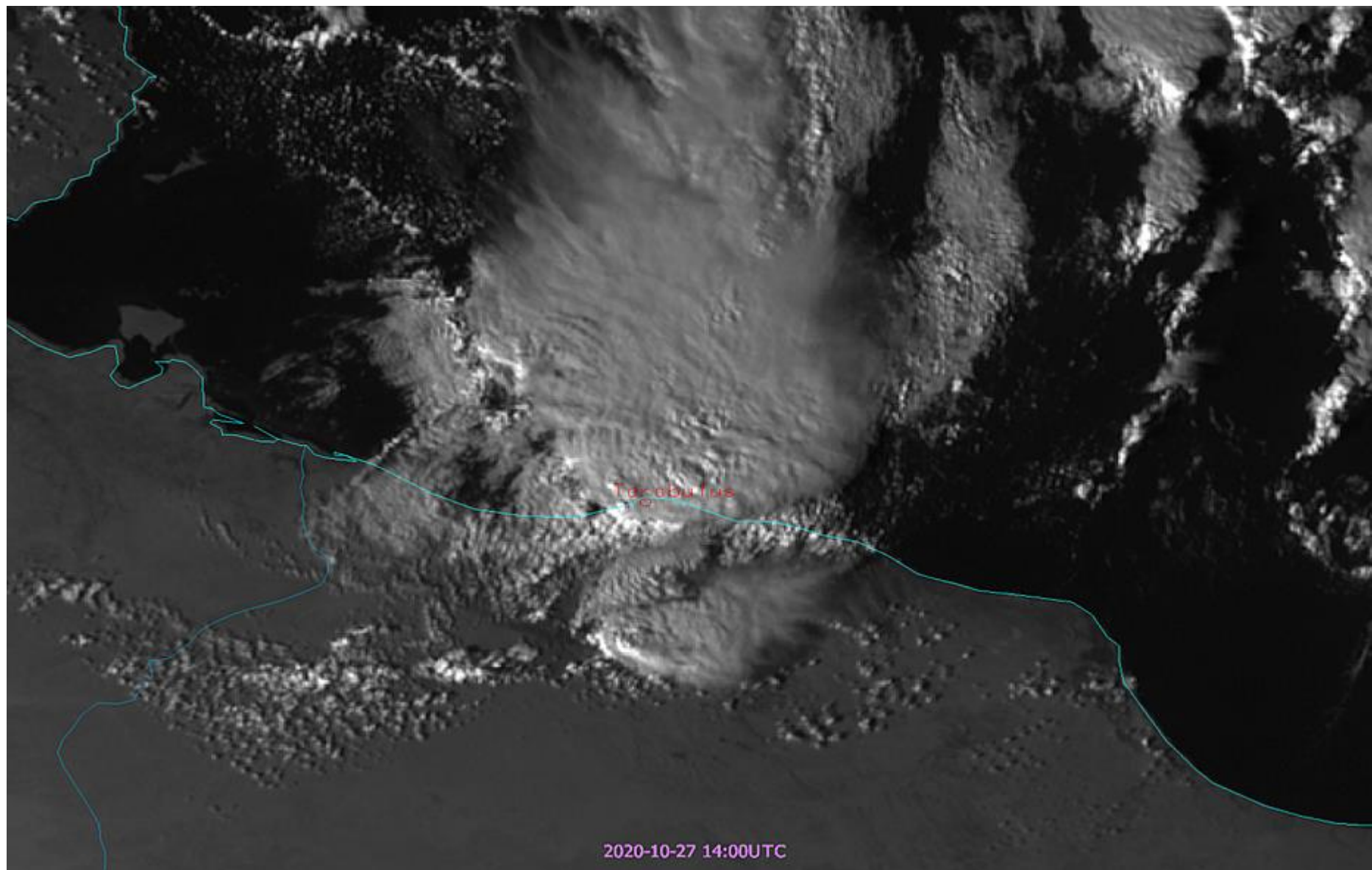
Confirmation ca. 5h
later from
Radar refl.

28 June 2018
21:45 UTC

North Dakota



- **Sandwich:**
IR temperature
+
enhanced
spatial
resolution
through
HRV channel

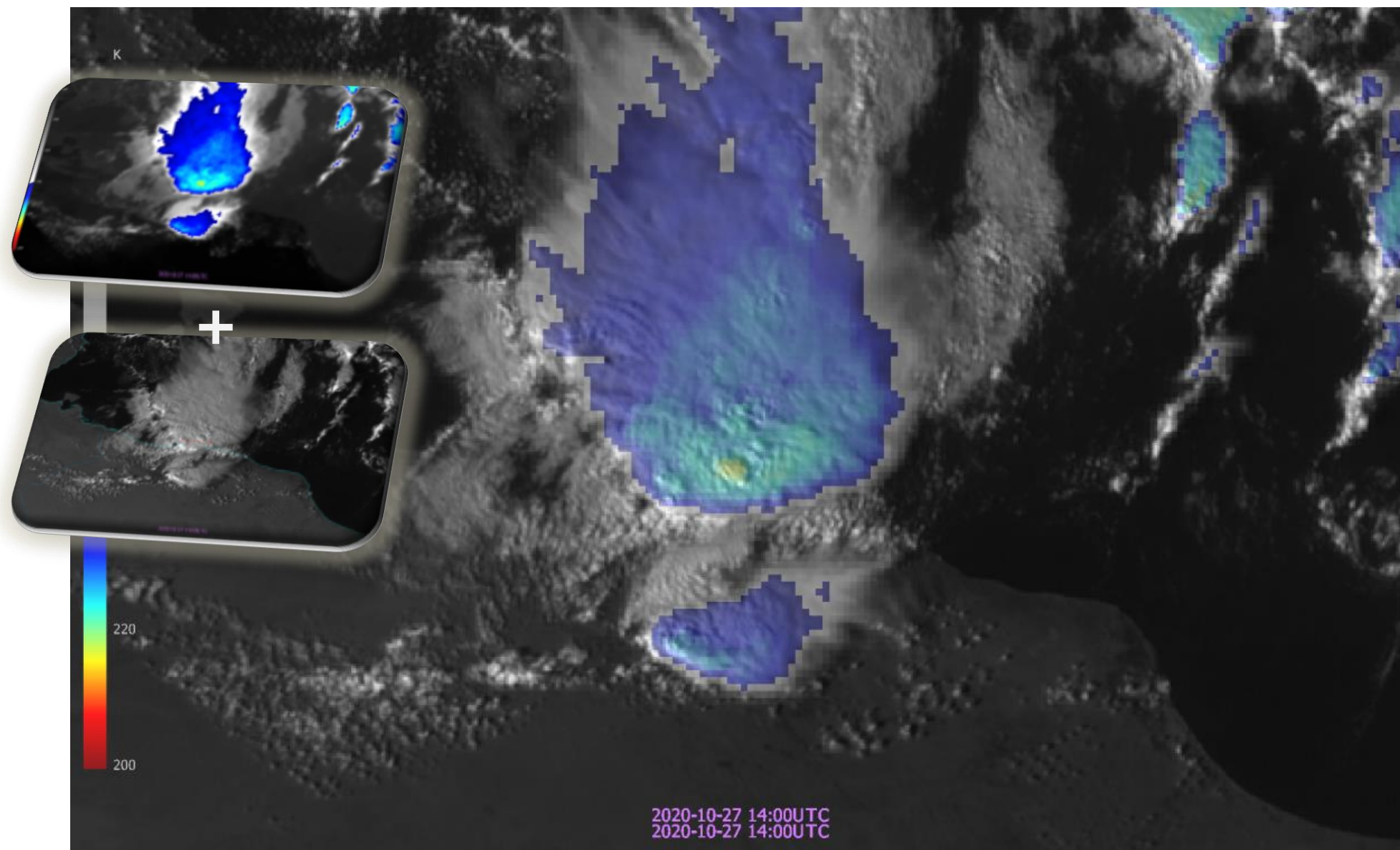


- **Sandwich:**
IR temperature
+
enhanced
spatial
resolution
through
HRV channel

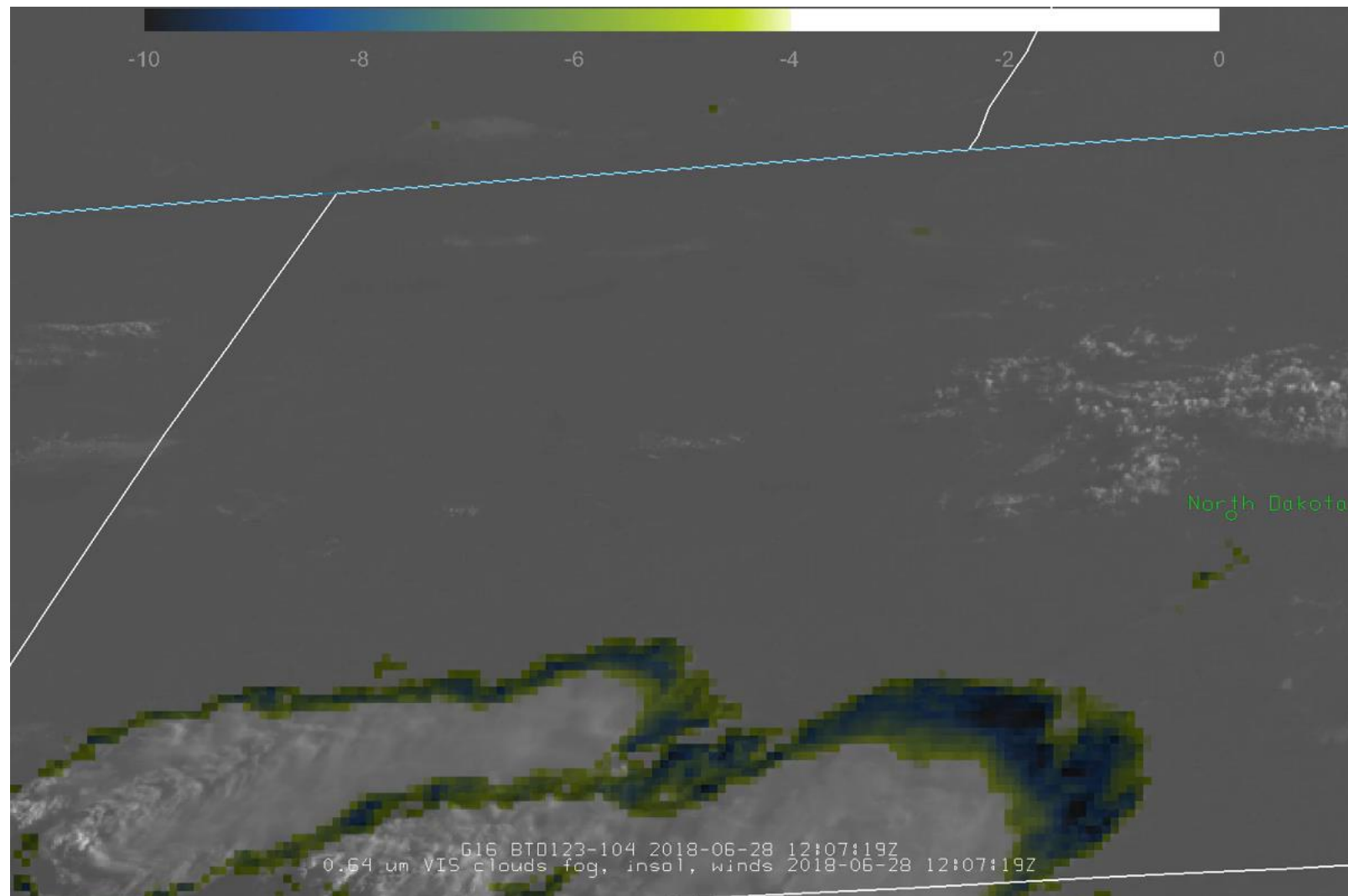


'Sandwich' product

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- **Sandwich:**
IR temperature
+
enhanced
spatial
resolution
through HRV
channel



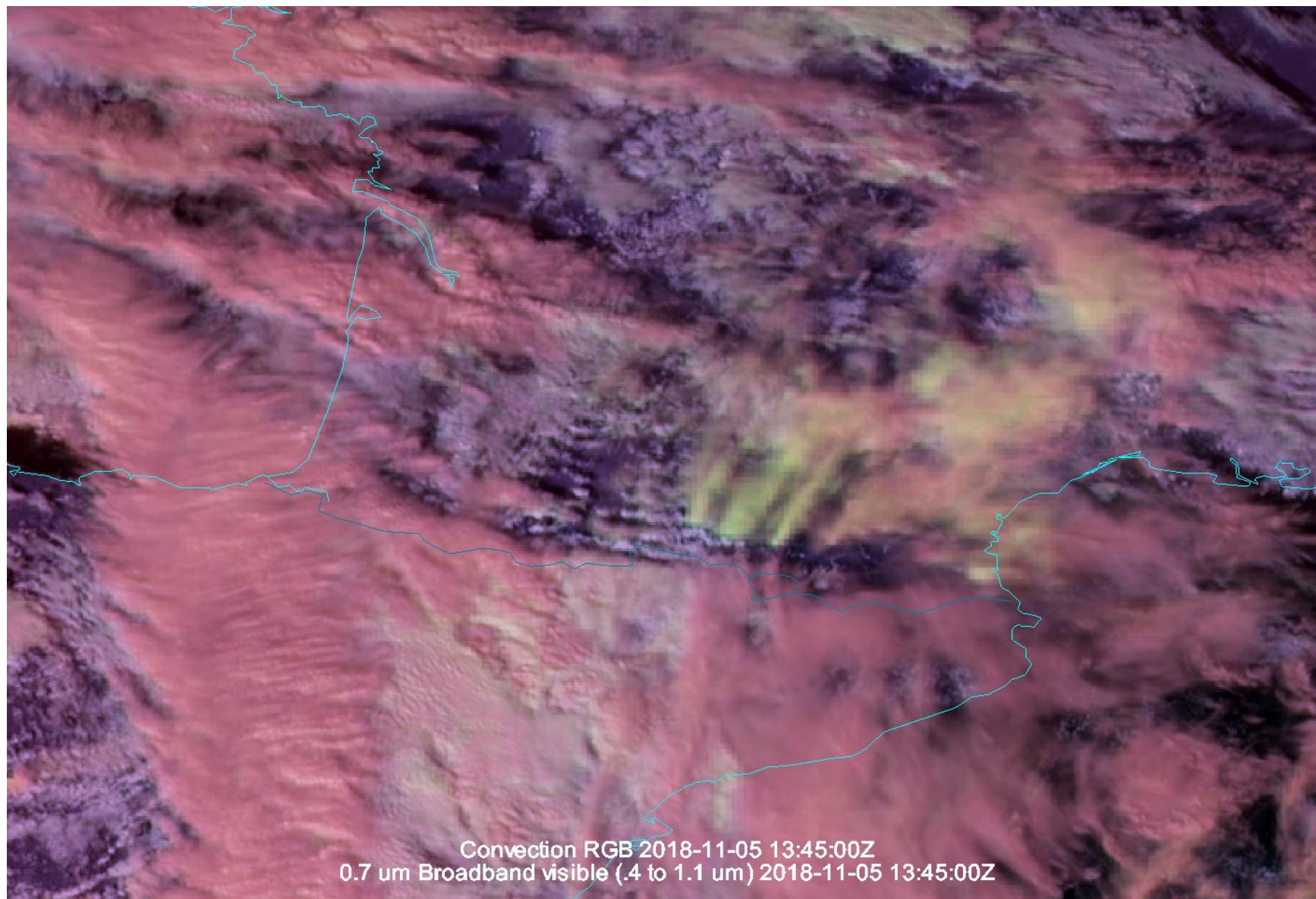
- **Sandwich:**
BT012-10
+
enhanced
spatial
resolution
through **HRV**
channel

28 June 2018
North Dakota



'Sandwich' product

www.eumetsat.int

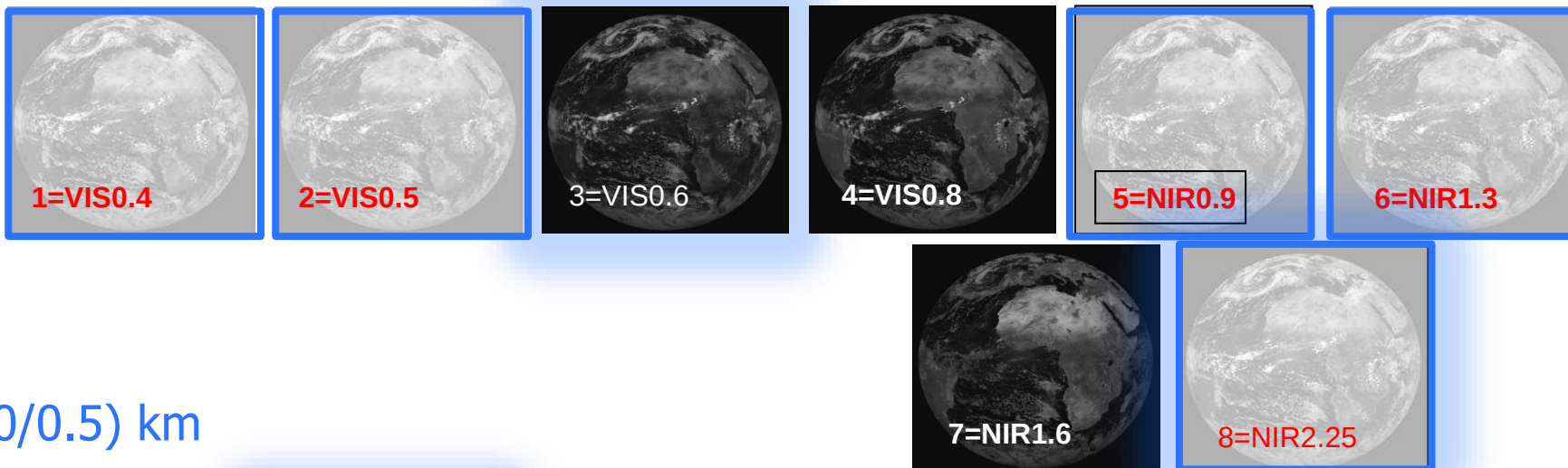


- **Sandwich:**
Convection RGB
+
enhanced spatial
resolution
through HRV
channel
- Wave clouds
over Pyrenees
mountains
(small ice
particles in
yellow)



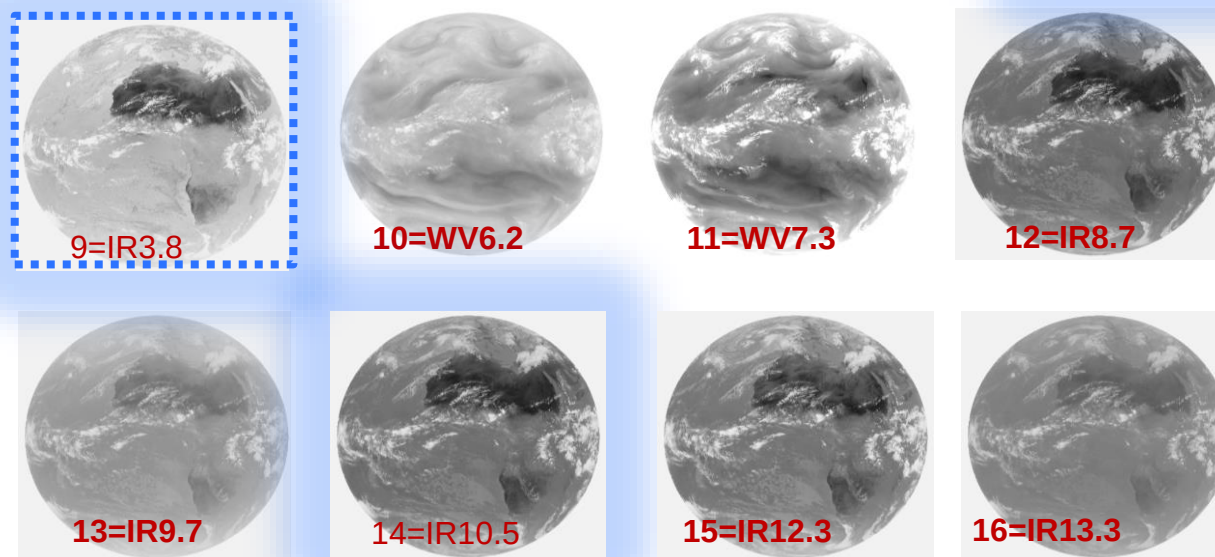
RGBs - Spectral channels

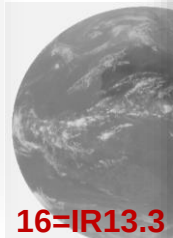
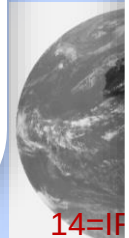
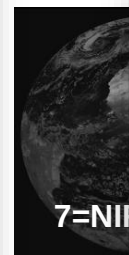
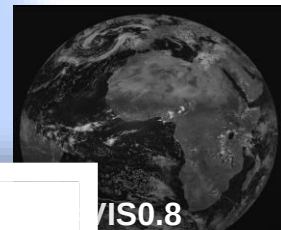
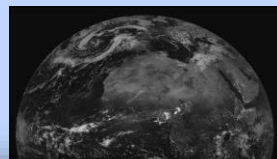
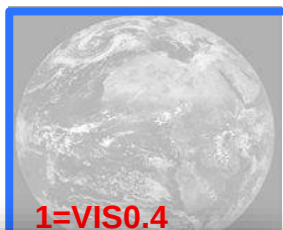
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Solar
3.0 (1.0/0.5) km

Thermal
3.0 (2.0/1.0) km



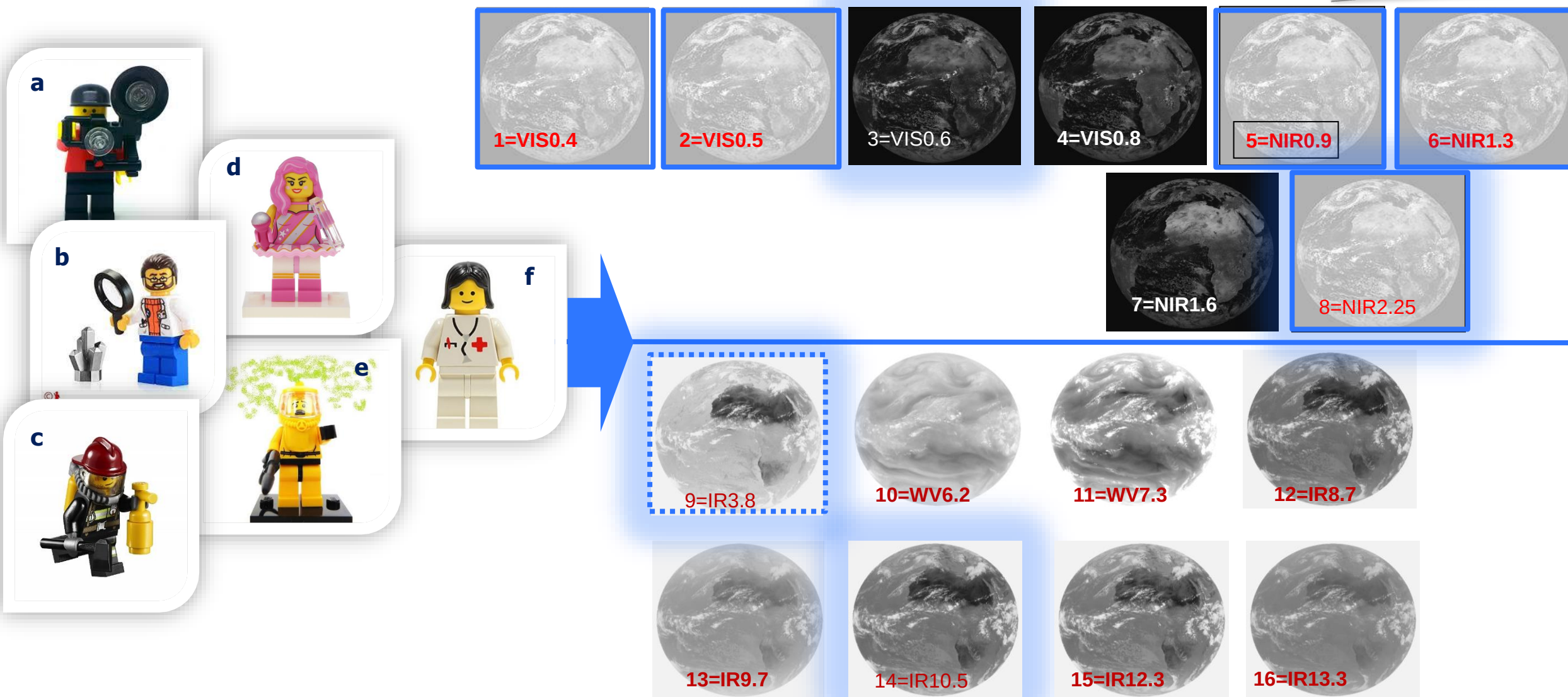


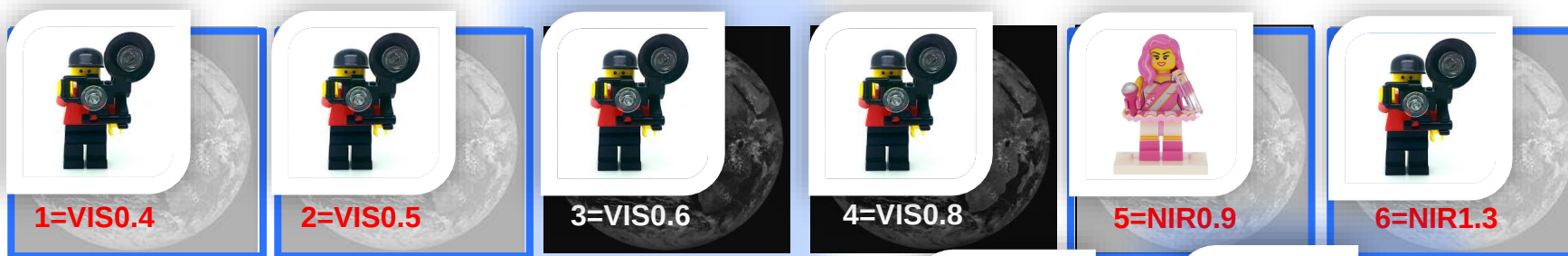


Spectral utility



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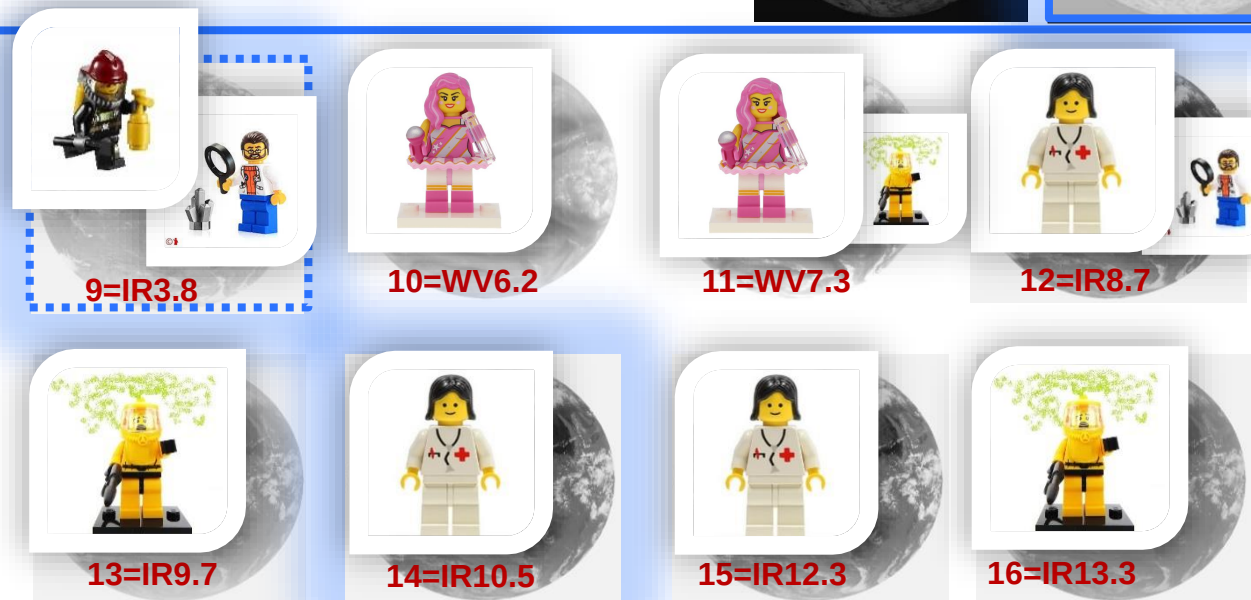




Solar
3.0 (1.0/0.5) km



Thermal
3.0 (2.0/1.0) km



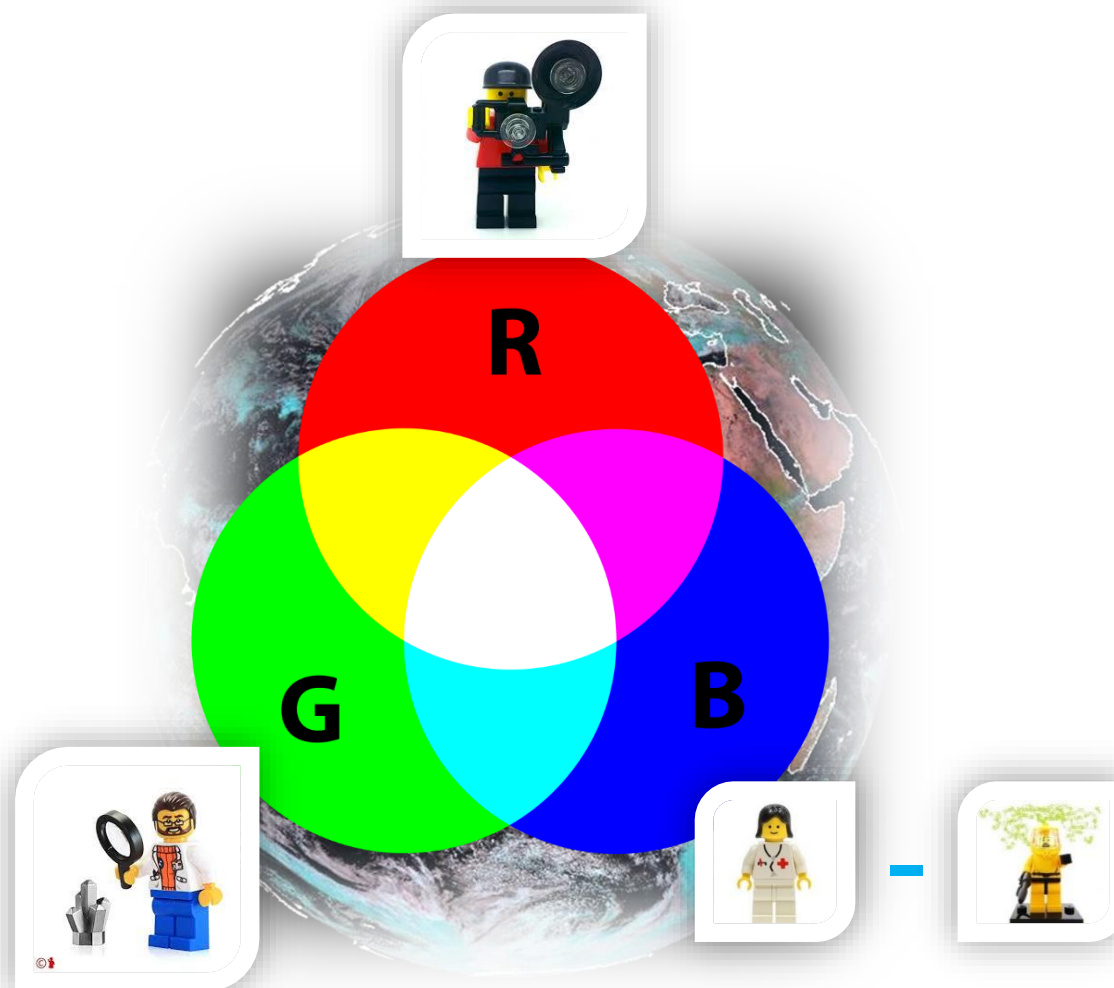


XY RGB

Red: ...

Green: ...

Blue: ...





RGB products – applications – which channels..?



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Solar
3.0 (1.0/0.5) km

Thermal
3.0 (2.0/1.0) km



Convective
storm?

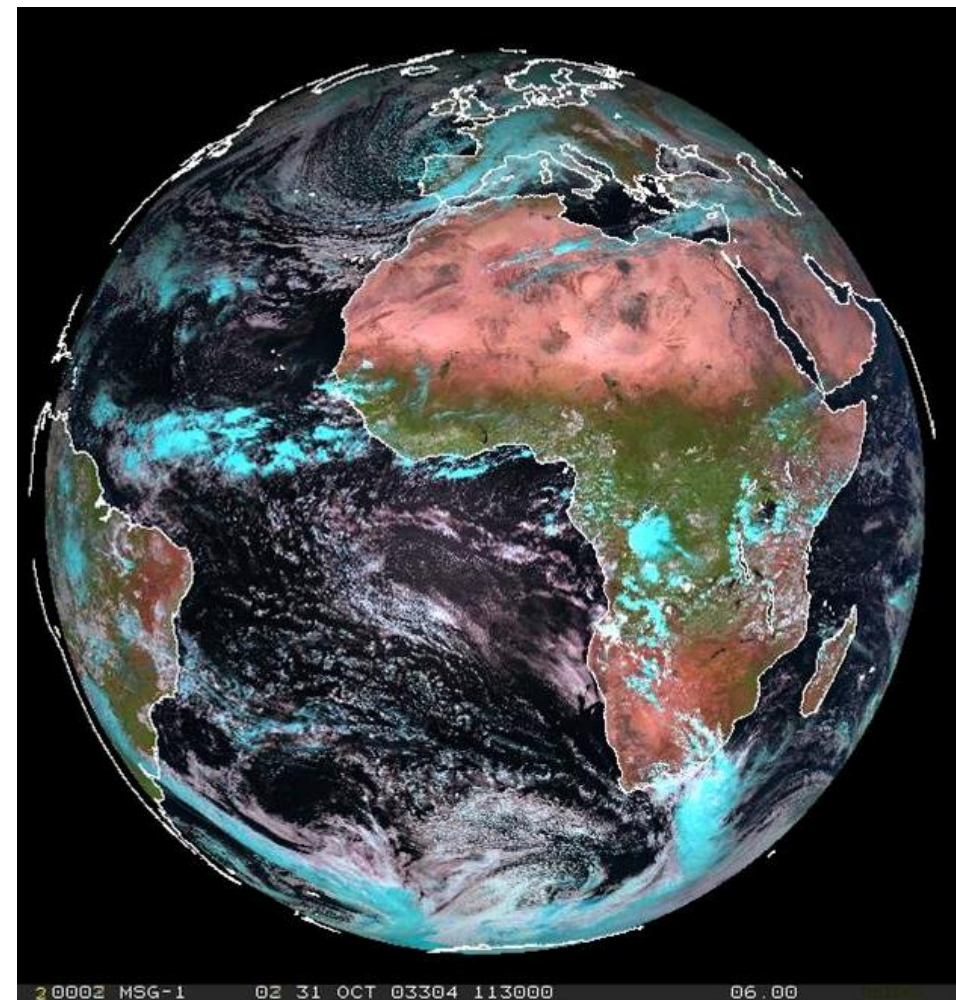
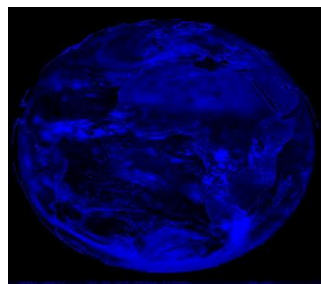
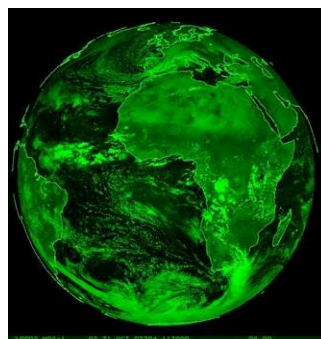
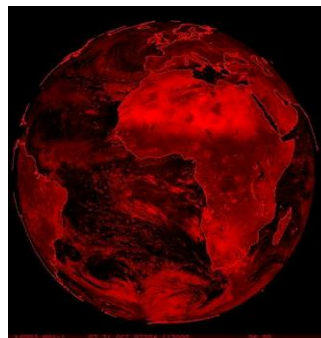
Fire
monitoring?

Natural Colour RGB

Red: NIR 1.6 μm

Green: VIS 0.8 μm

Blue: VIS 0.6 μm





RGB products – components

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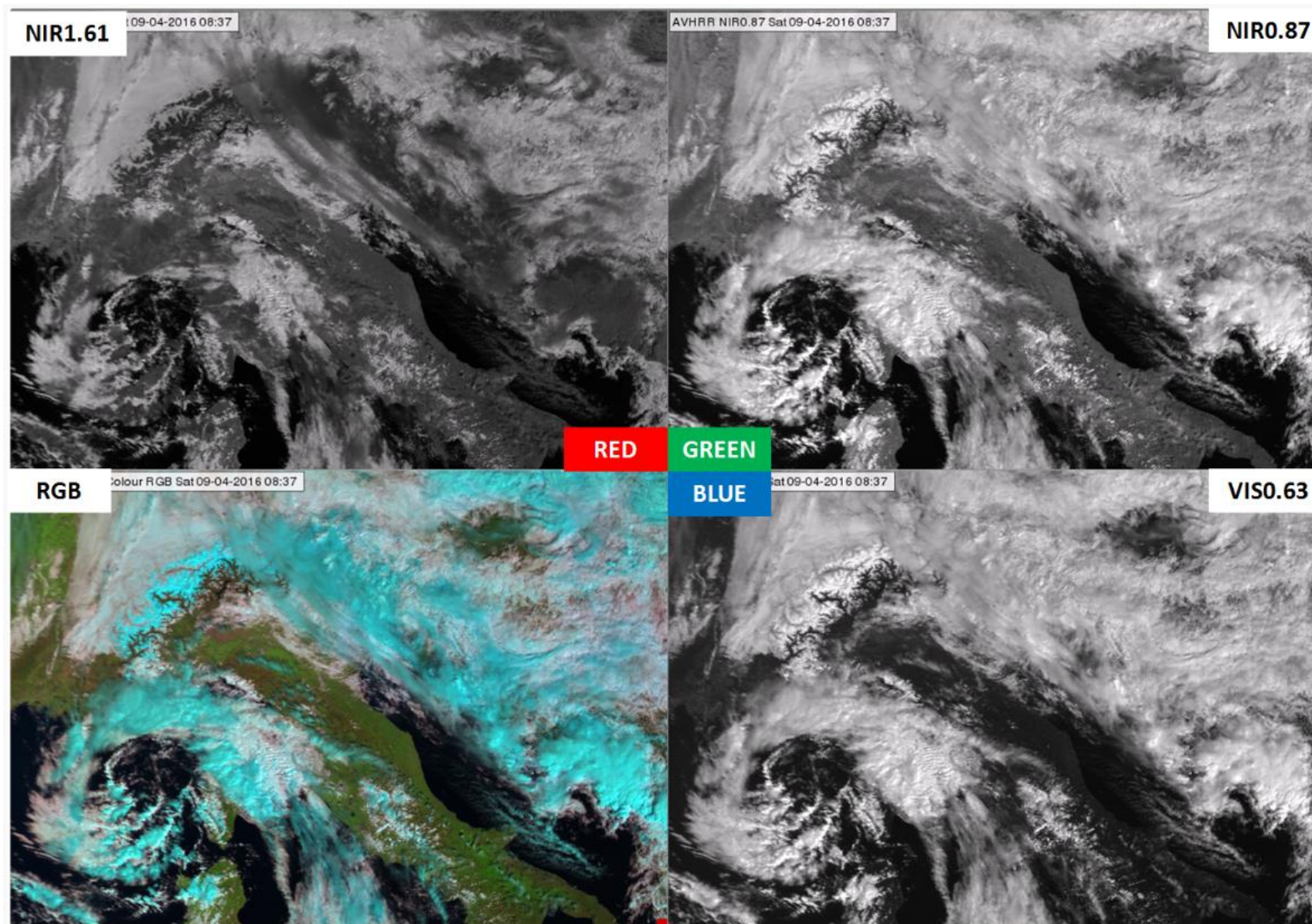
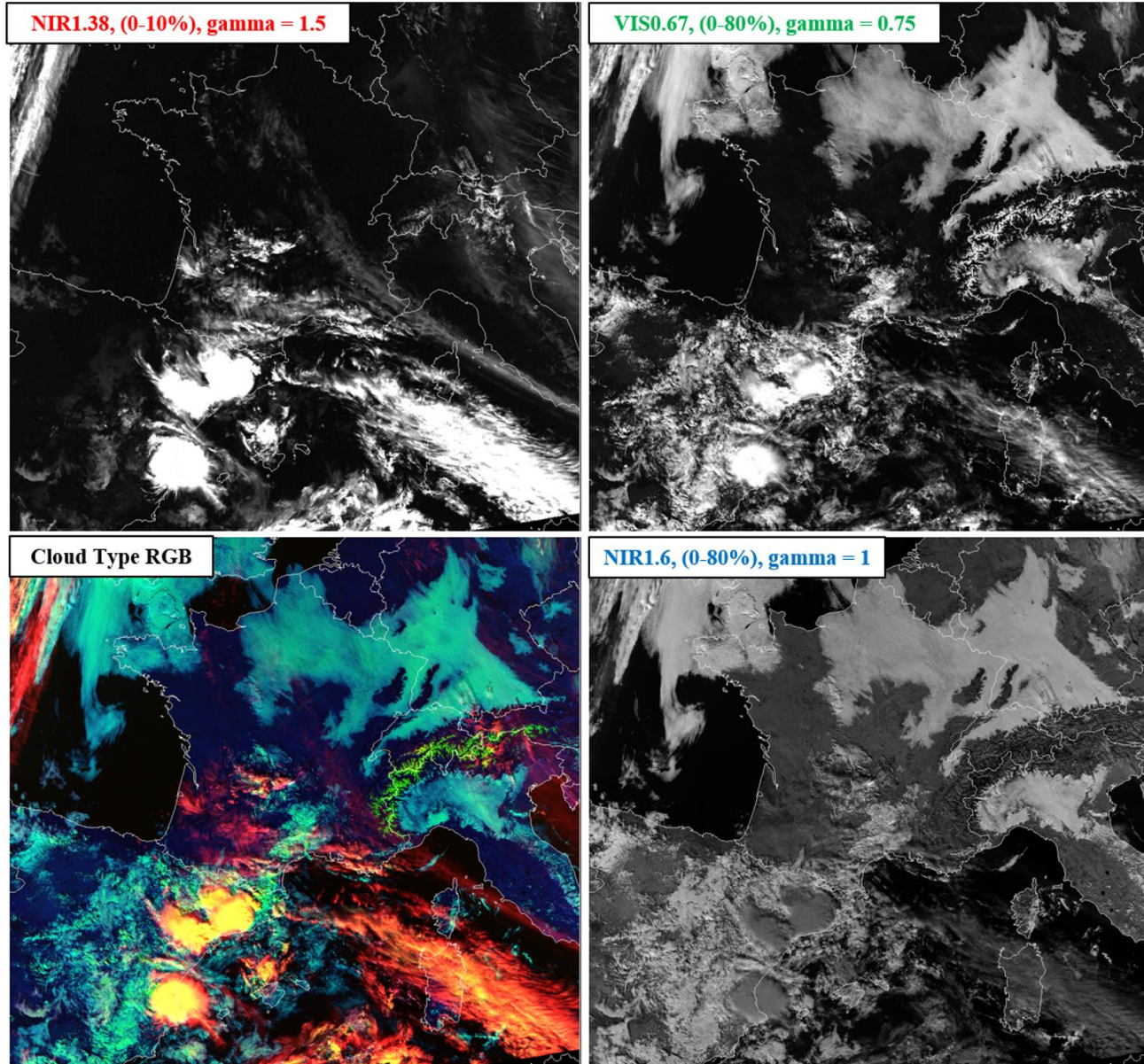


Figure 4a: METOP-A AVHRR NIR1.61 (upper left), NIR0.87 (upper right), Natural Colour RGB (bottom left) and VIS0.63 (bottom right) images of Italy and the Alps on 9 April 2016 at 08:37 UTC



RGB products – components (Cloud Type)

www.eumetsat.int



VIIRS Cloud Type RGB and its components, 15 November 2018, 12:31 UTC. (Credit to NOAA)

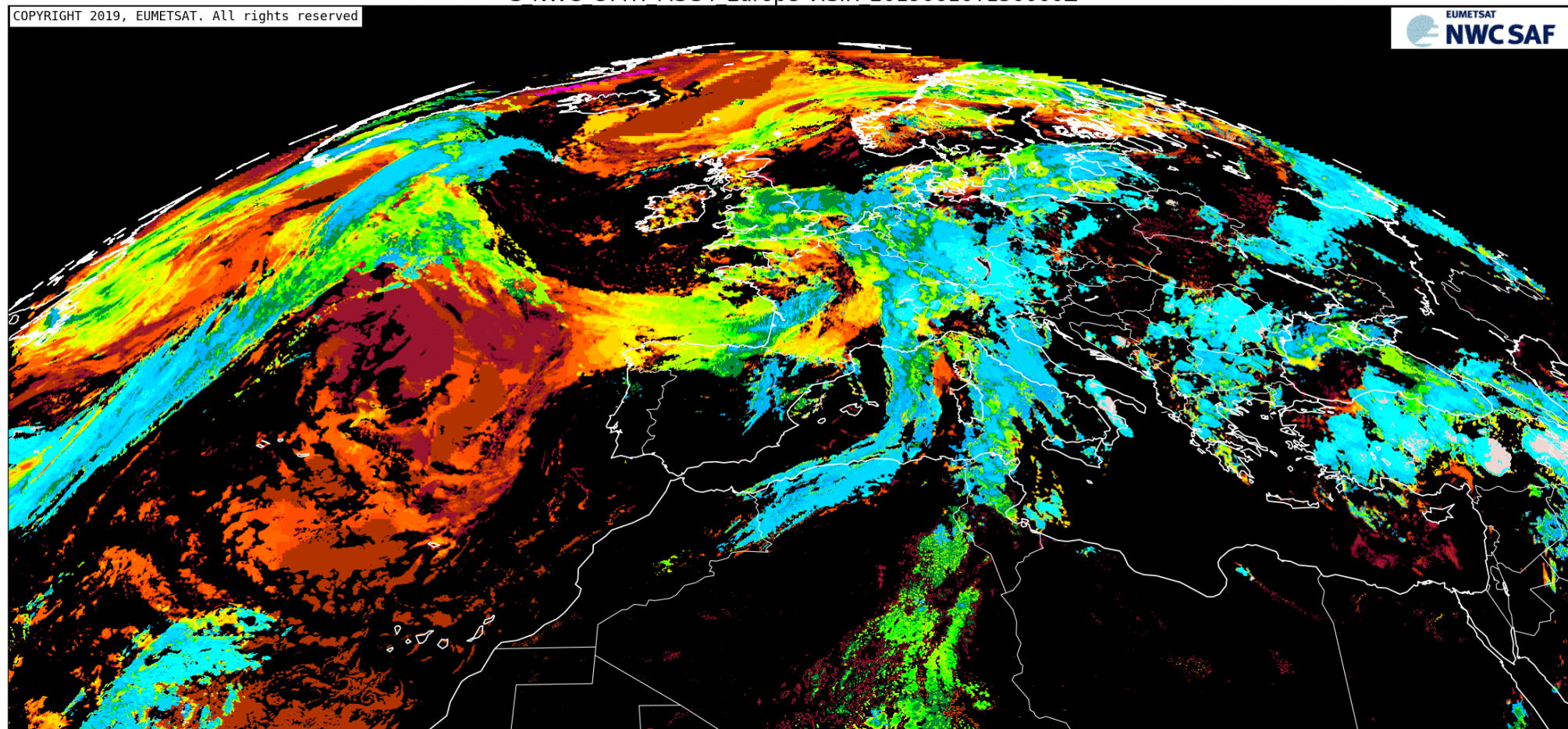


- Quantitative values derived from satellite data (height, temperature, pressure, humidity, chlorophyll, wind vector, etc.)
- Includes multiple inputs (aside from the original satellite data):
 - Auxiliary satellite data
 - NWP variables
 - Look-up tables
 - Climatology
 - Background maps
 - Parametrization parameters
 - Corrections
 - ...



S NWC CTTH MSG4 Europe-VISIR 20190610T150000Z

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NWC GEO v2018 CTTH Cloud Top Pressure (Pa)

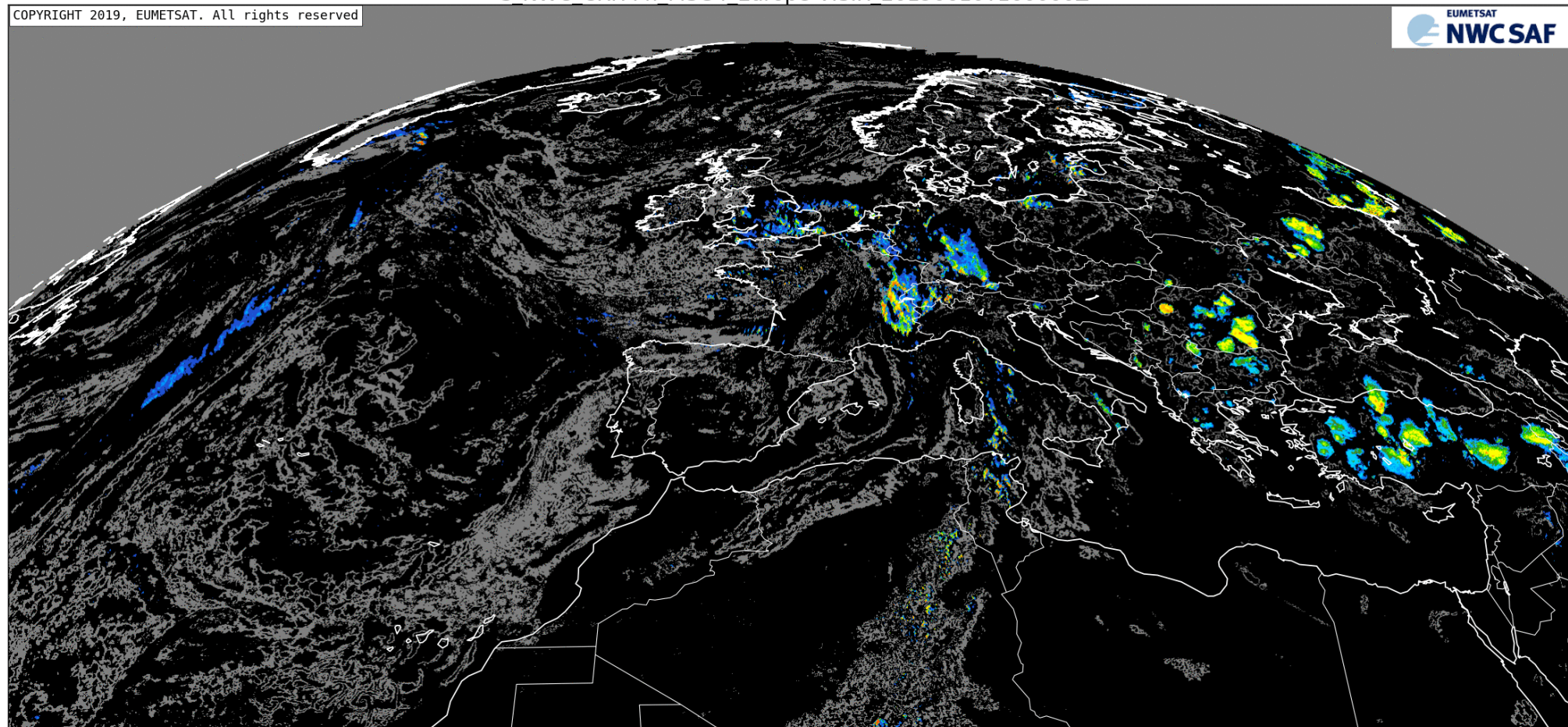


0 15000 30000 45000 60000 75000 90000 105000

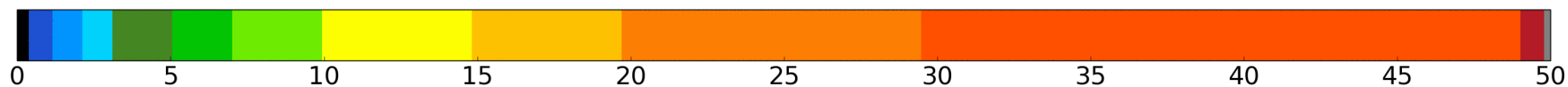


S NWC CRR-Ph MSG4 Europe-VISIR 20190610T160000Z

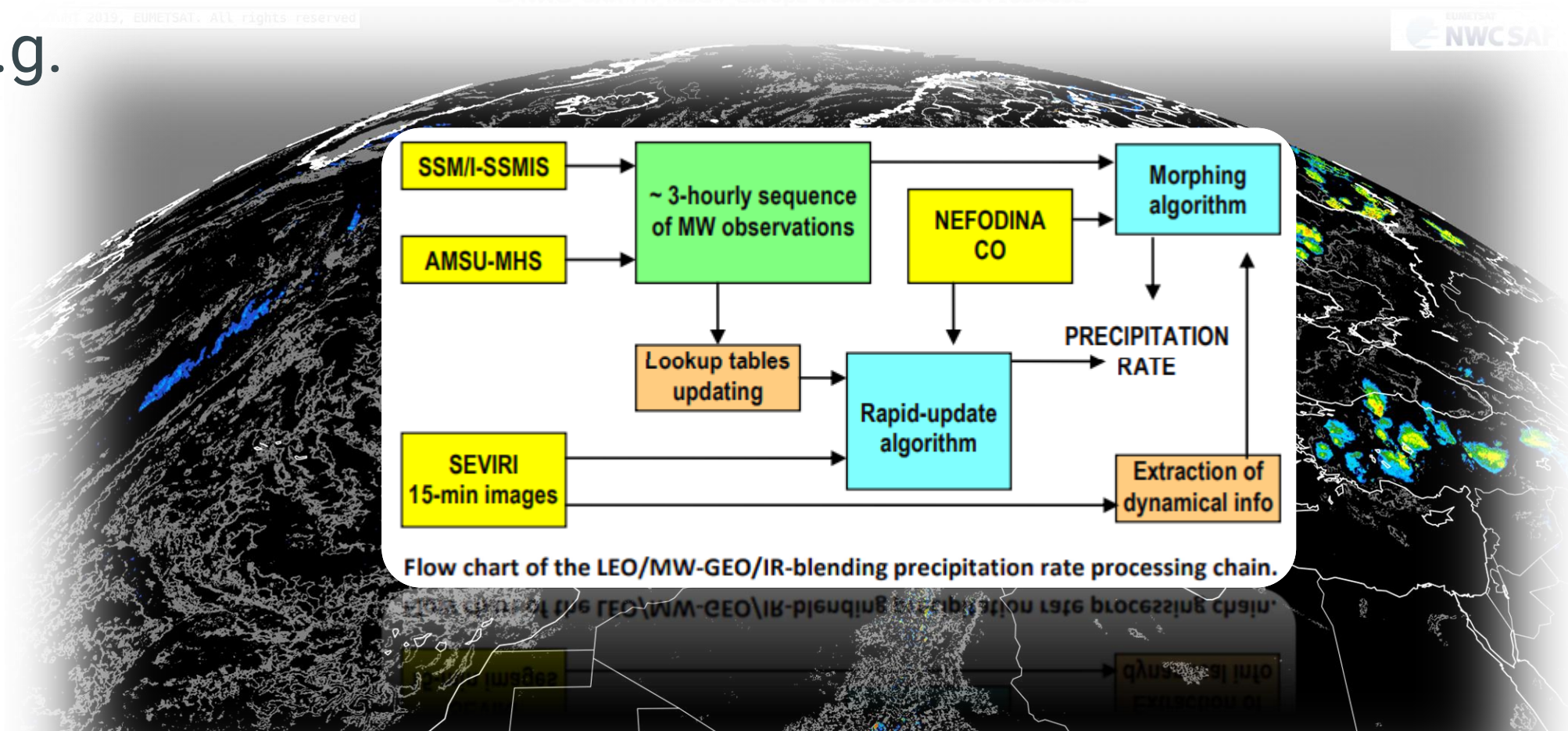
COPYRIGHT 2019, EUMETSAT. All rights reserved



NWC GEO v2018 CTMP-CRR Convective Rainfall Intensity (mm/h)



- E.g.



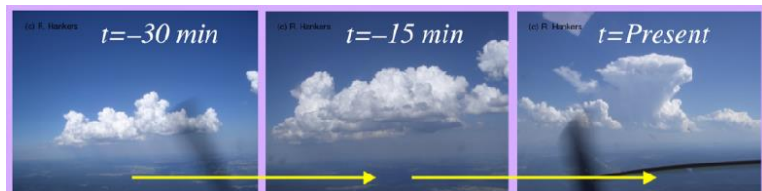
NWC GEO v2018 CTMP-CRR Convective Rainfall Intensity (mm/h)



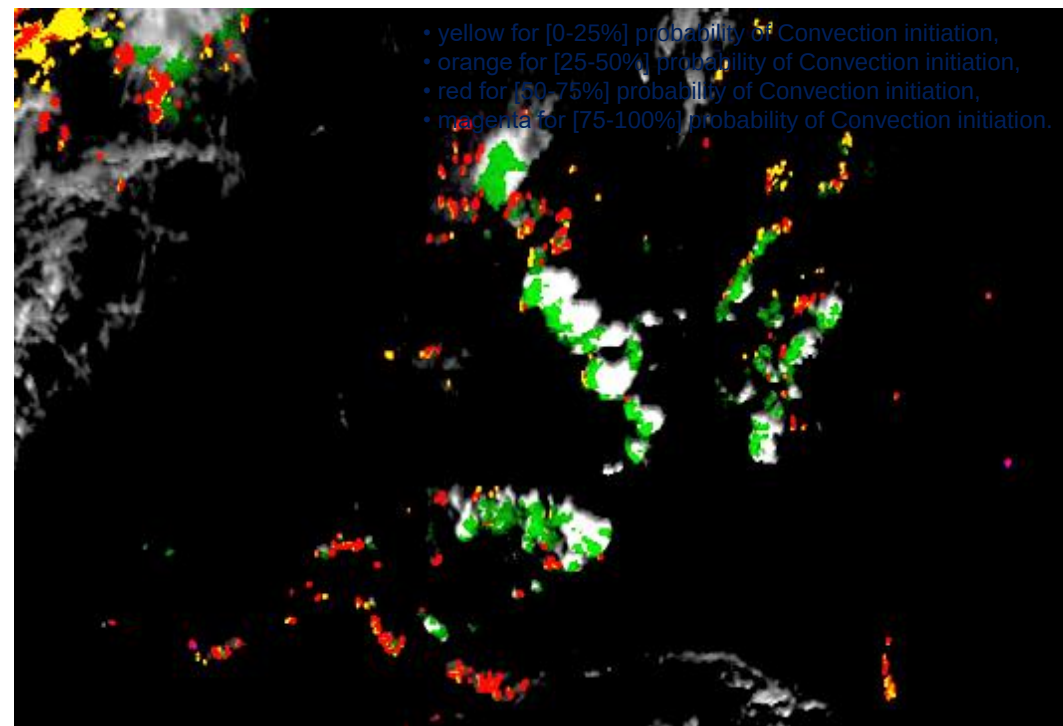
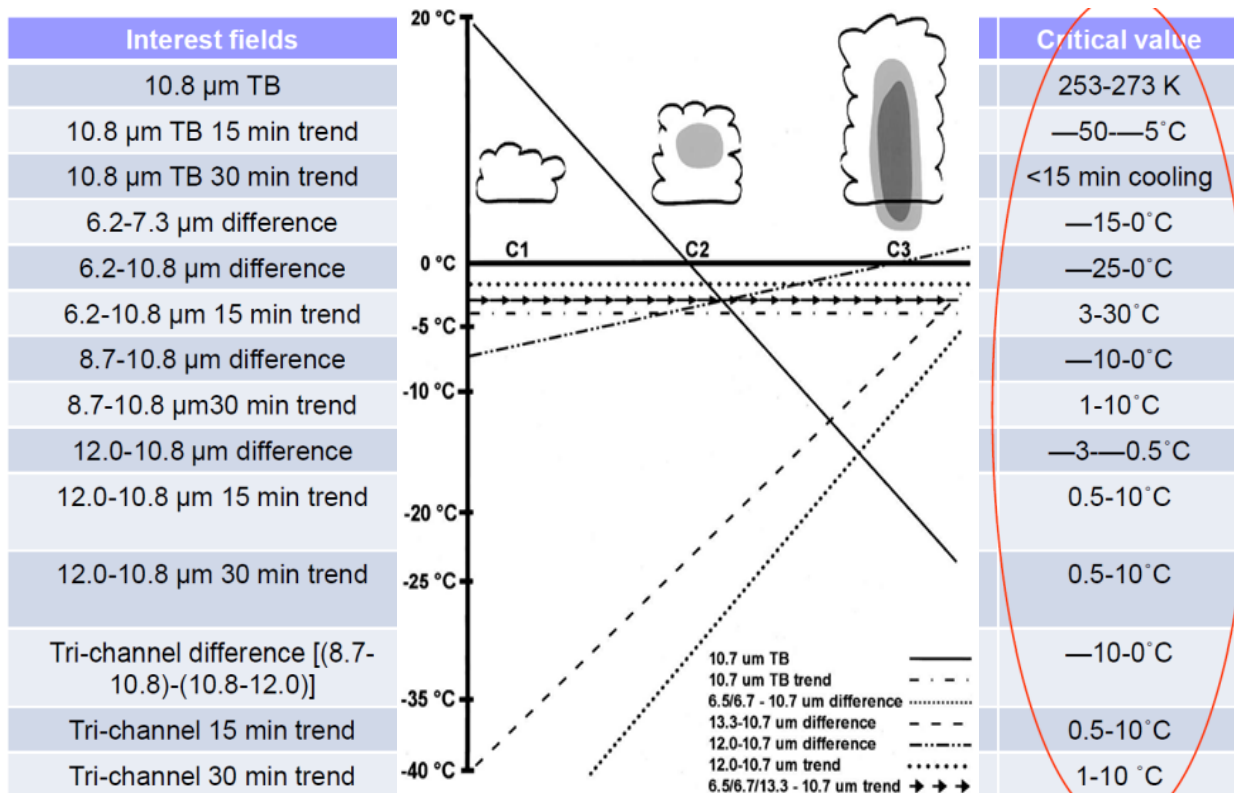


CI (Convective Initiation) Product

> Probability for a cloudy pixel to become a thunderstorm?



Mecikalski et al. 2010

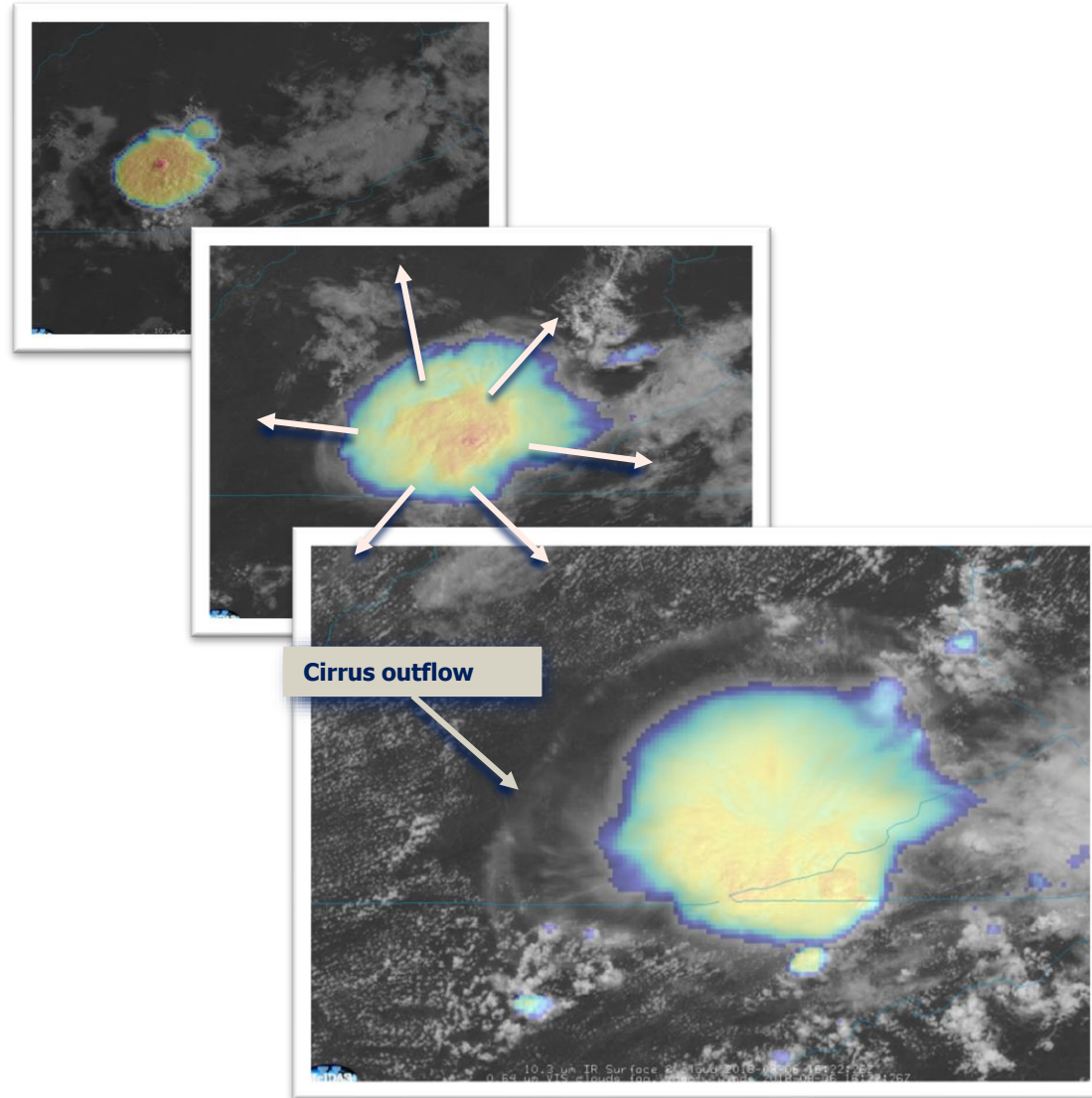
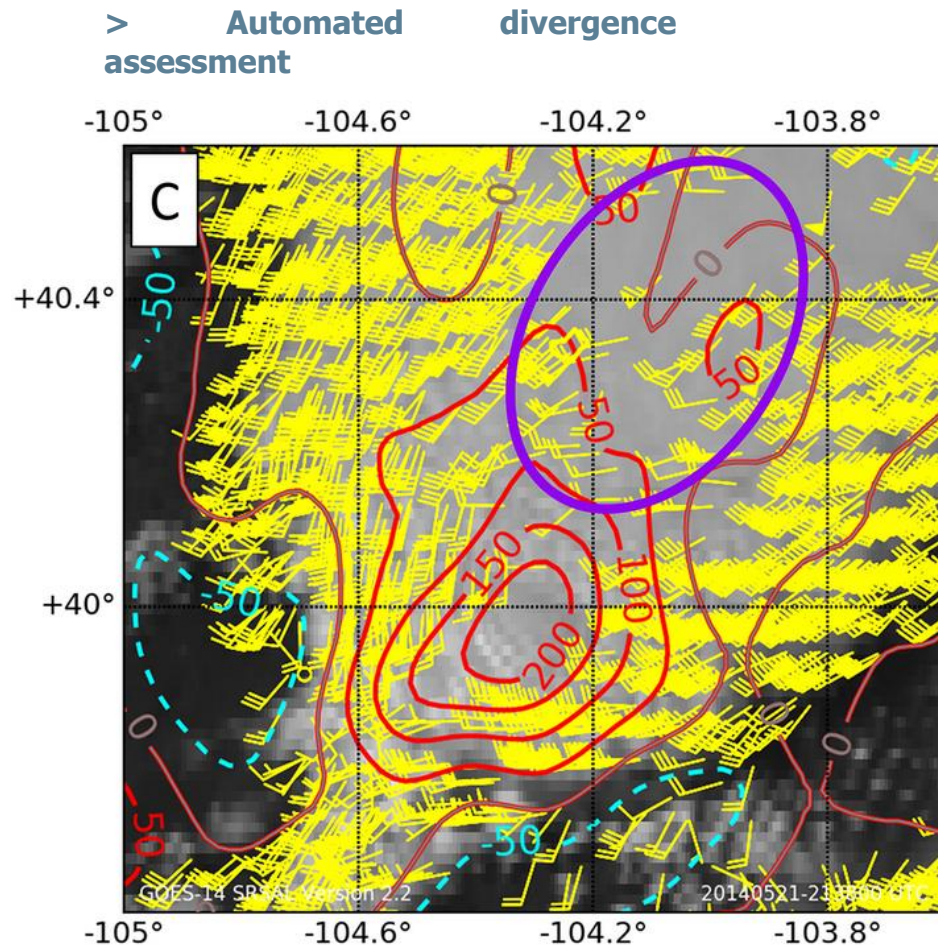


Main limitations of the product?

- In cases of cold air masses (fast-moving fractional clouds)
- High FAR inherent to CI, particularly at the edges of cold cloud systems
- Lack of validation

Critical values is not fixed → need to be regionally tuned

Upper-level divergence product



=> Anvil growth as a **proxy for upper level divergence** process

=> **Thin cirrus ring** in case of very abrupt vertical (turned into horizontal) flow

=> **Divergence indicate variations in anvil dynamics** and related vertical motions beneath

=> Out of **different satellite-related products**, storm top divergence seems to be the best discriminator

=> Meaningful only with advanced temporal/spatial resolution -> **FCI**



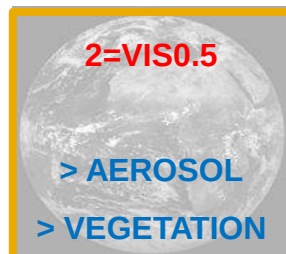
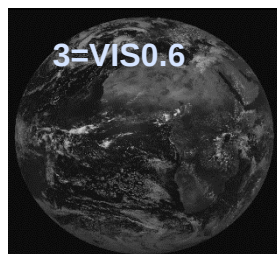
FCI applications

Real examples with proxy data



FCI applications – True Colour RGB

www.eumetsat.int

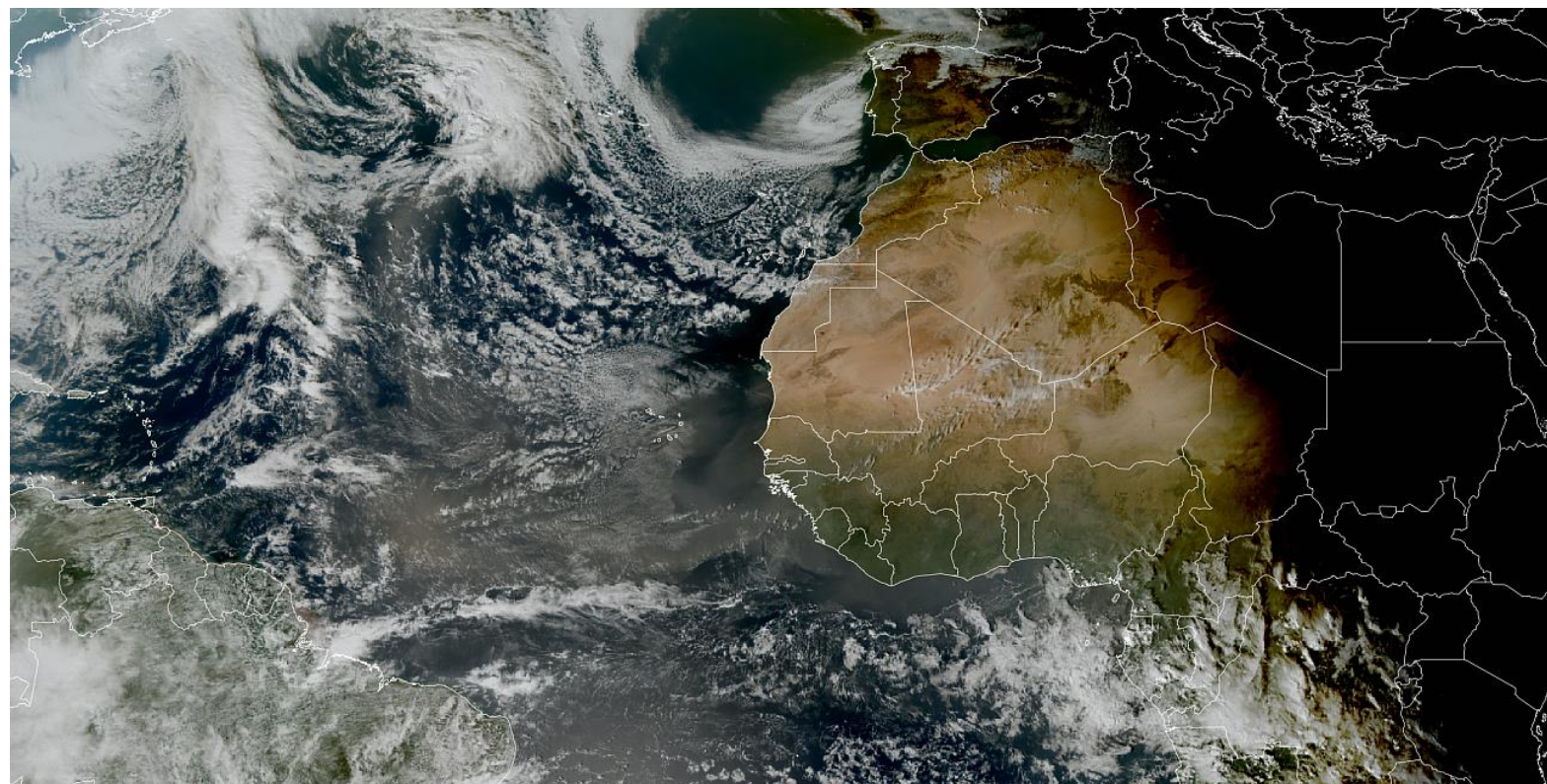


- Aerosols (dust, ash, smoke, smog)
- Vegetation
- Ocean Colour
- Ice/snow
- (Clouds)

R VIS0.6

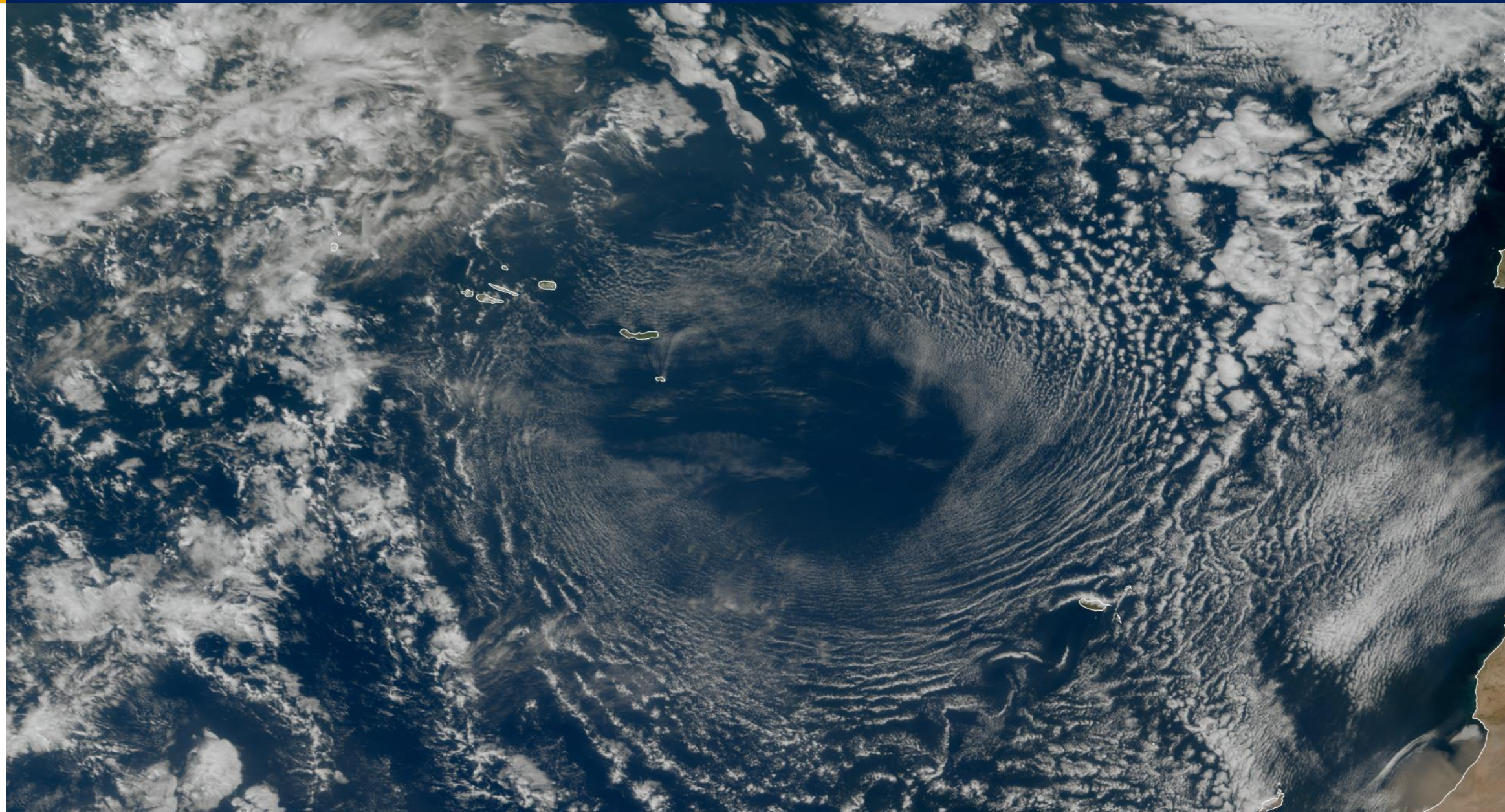
G VIS0.5

B VIS0.4





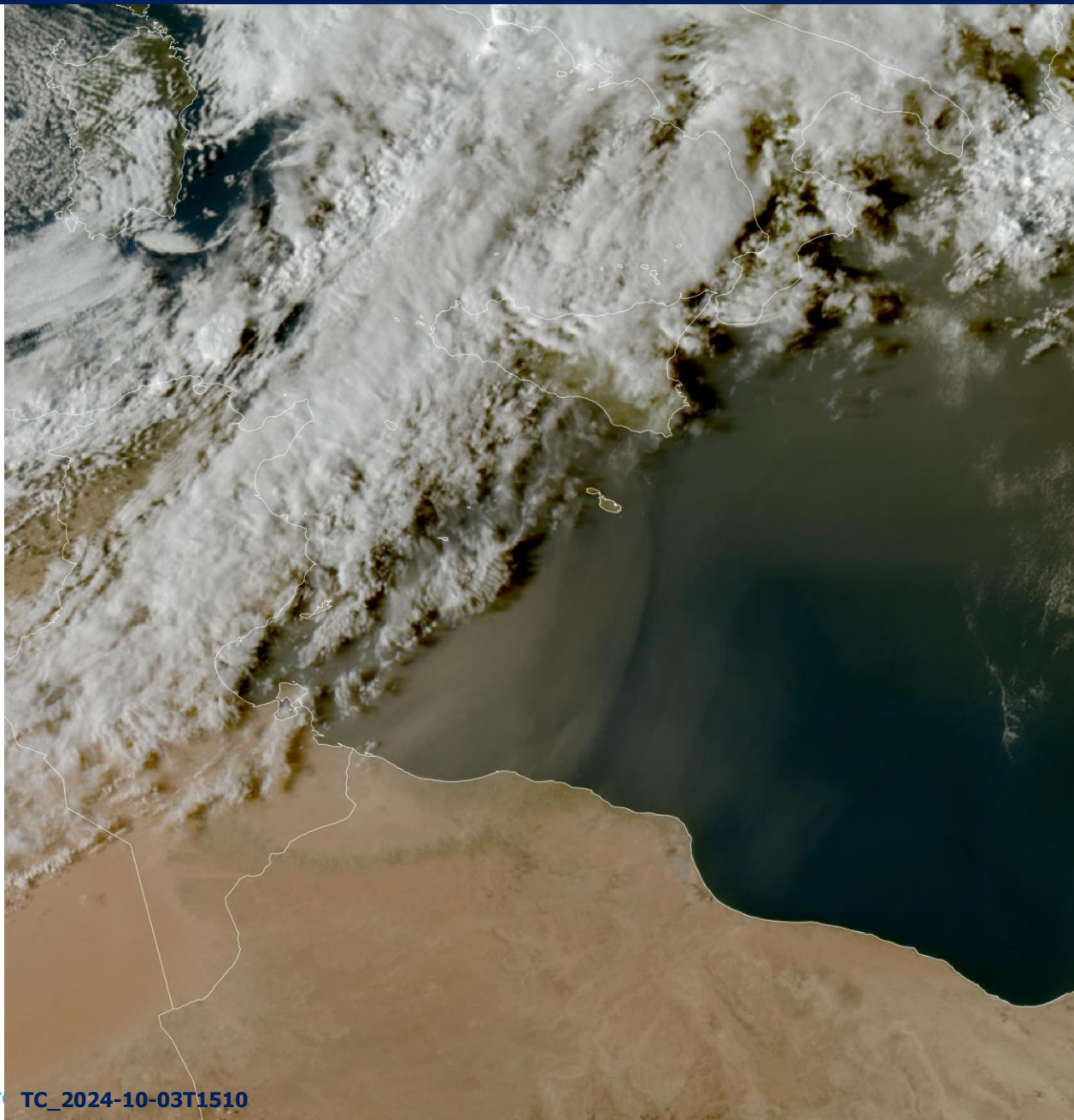
FCI applications - True Colour RGB (Anticyclone / Atlantic)





FCI applications – True Colour RGB (Dust outbreak)

www.eumetsat.int

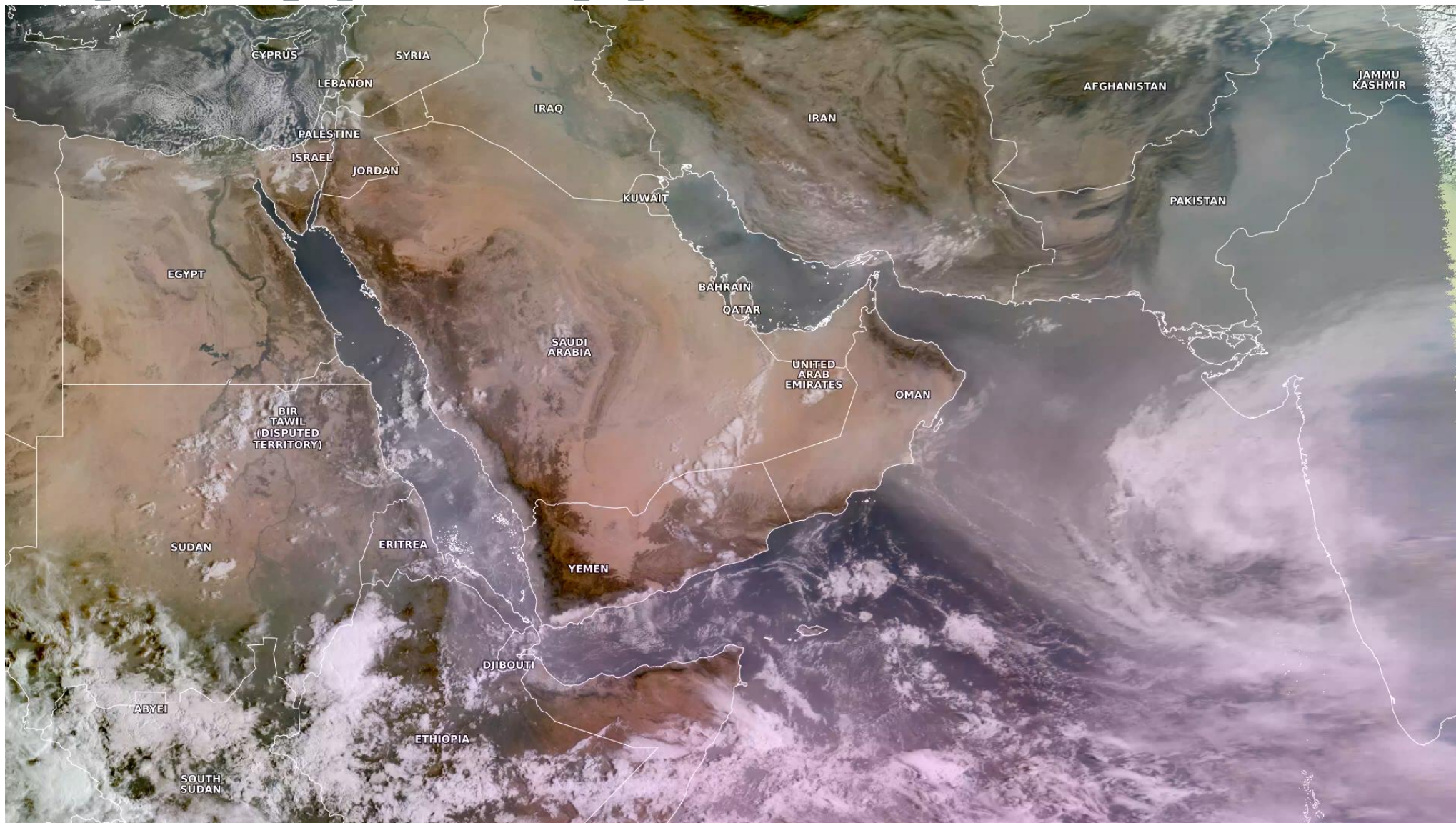




FCI applications – True Colour RGB (haze Middle East/East Africa)

• Haze in the East_2024-10-10_05_00-2024-10-25_05_00

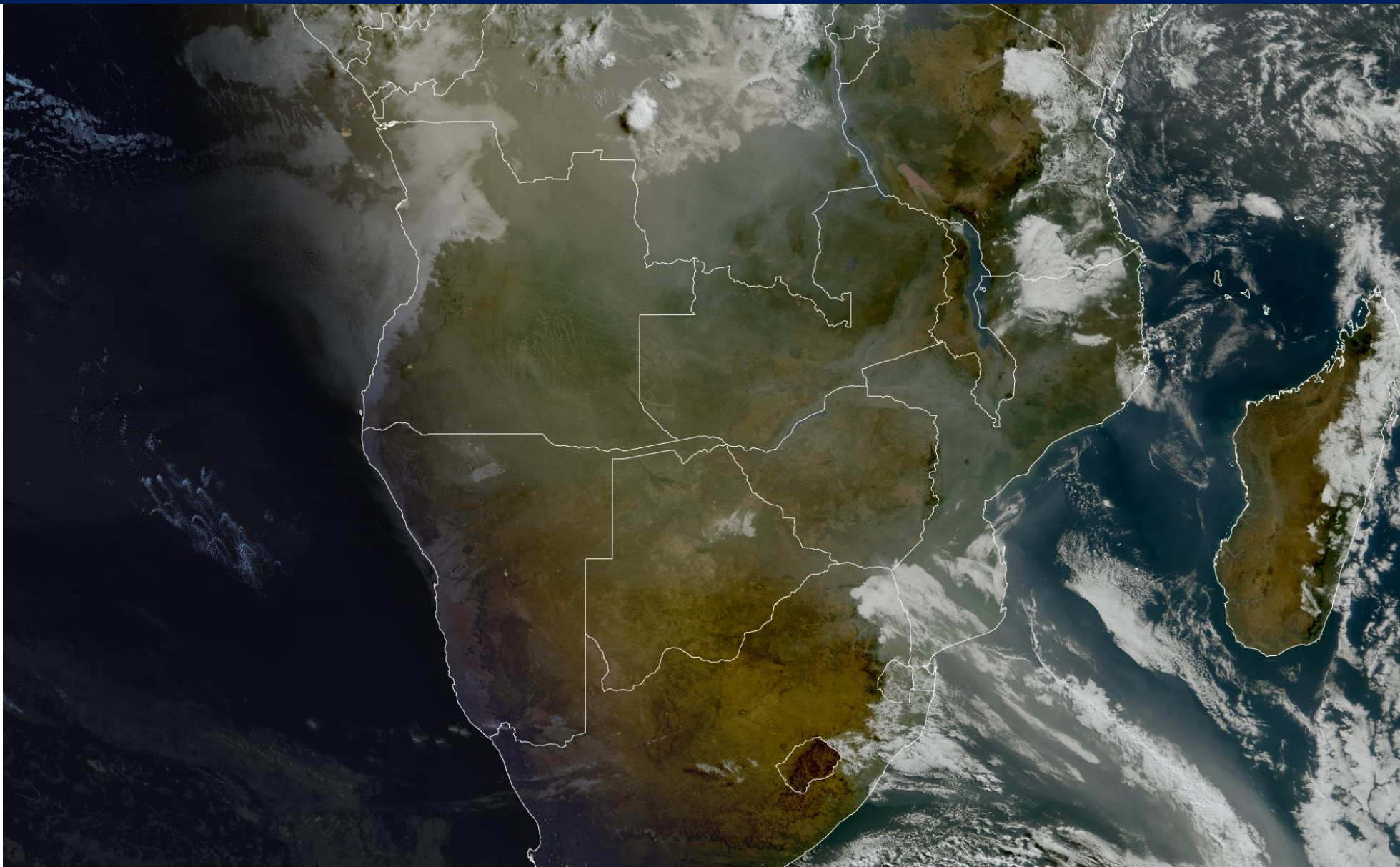
www.eumetsat.int





Smoke central - vegetation / south Africa / Atlantic

w.eumetsat.int

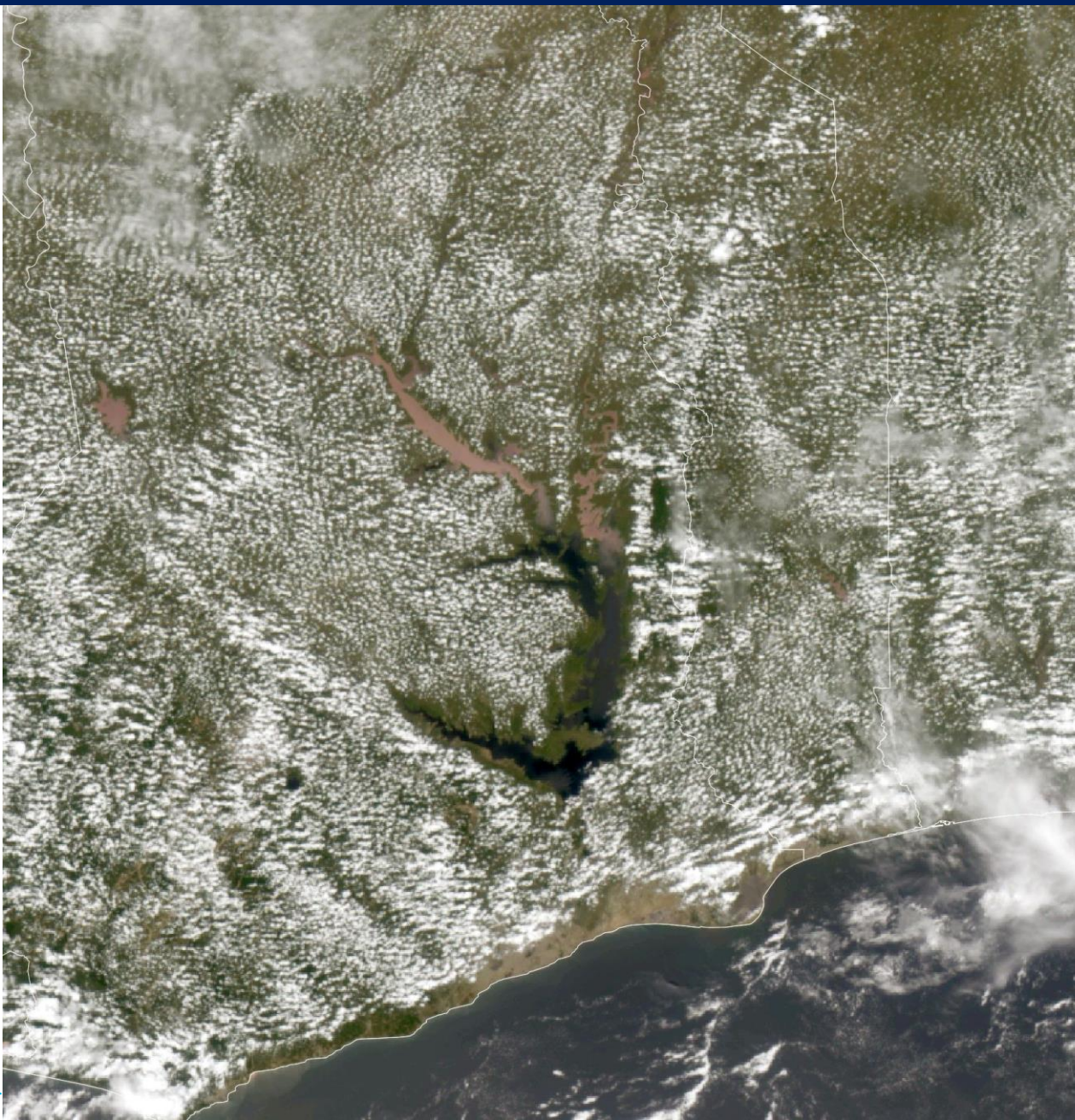


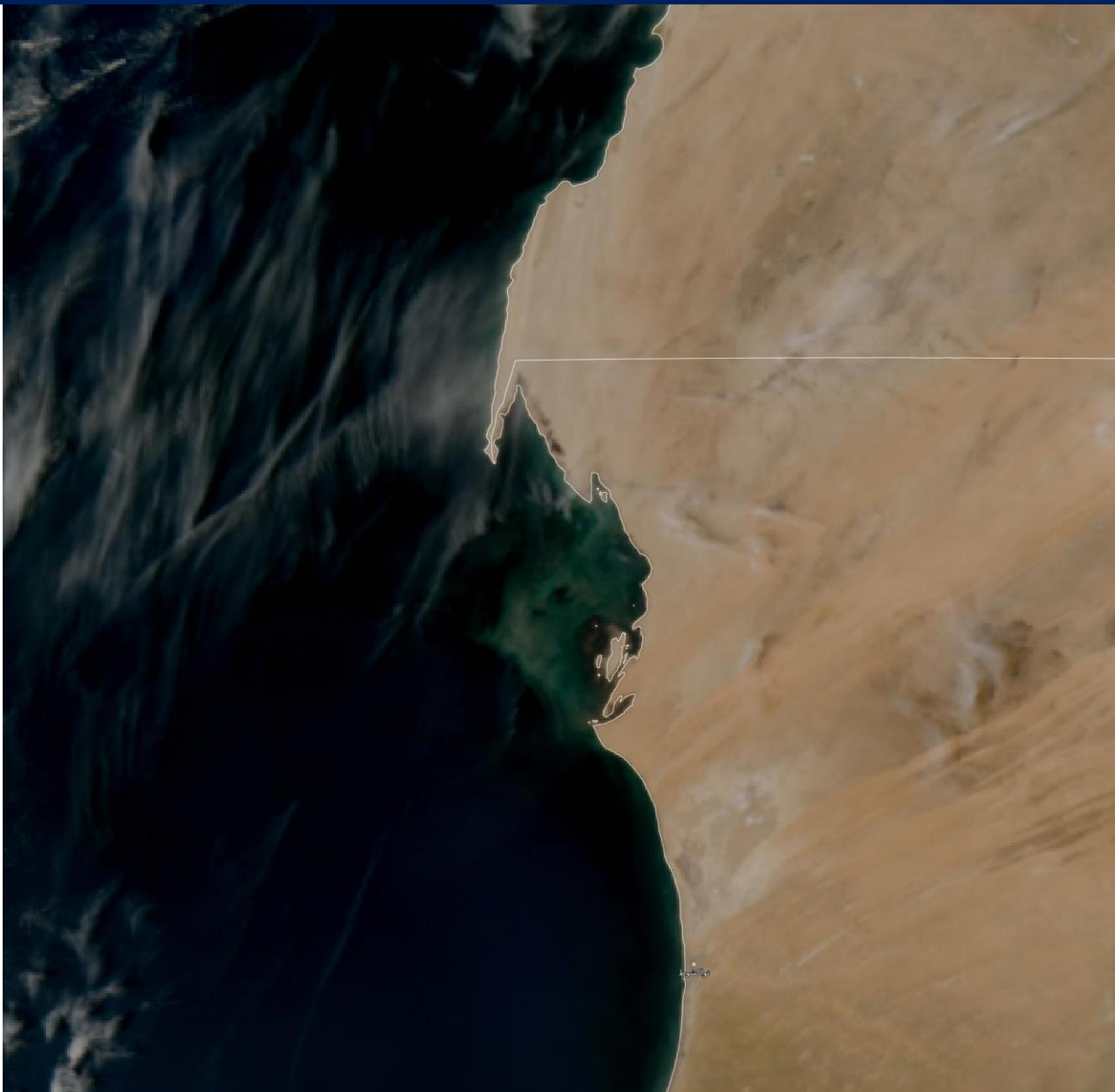


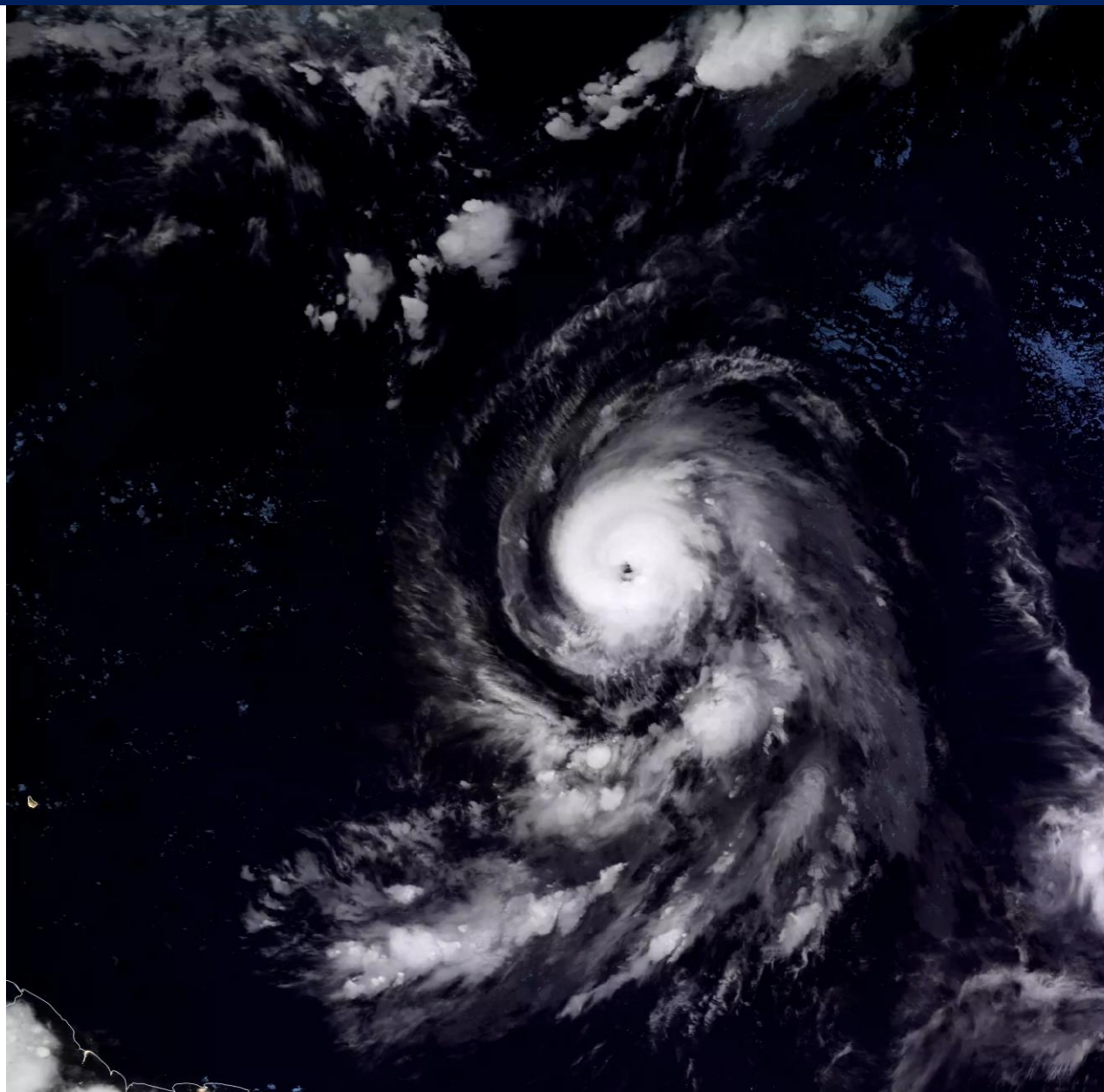
River convection – vegetation – turbidity / Ghana

www.eumetsat.int

TC-at-500m_2024-10-16T1200

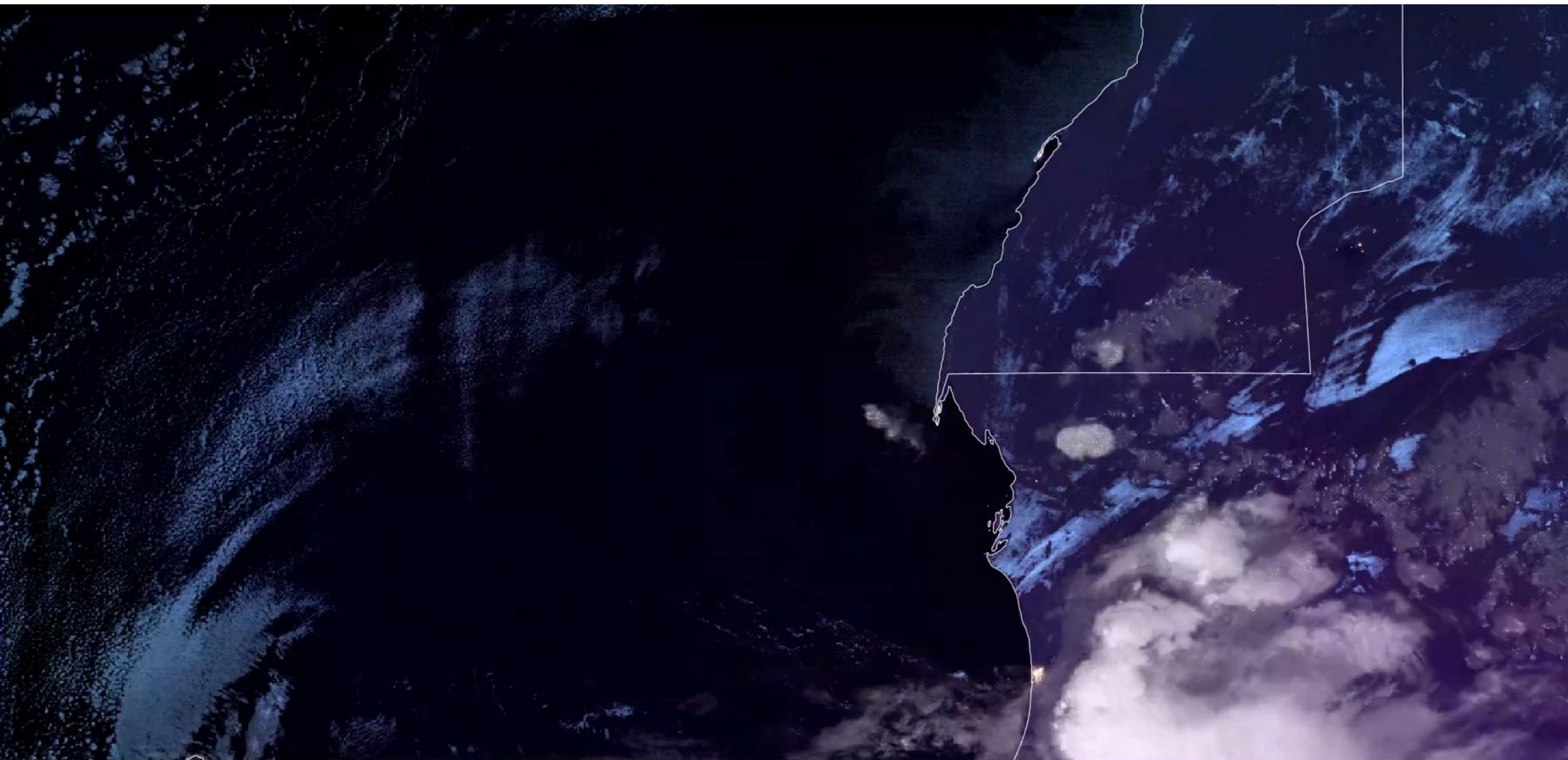








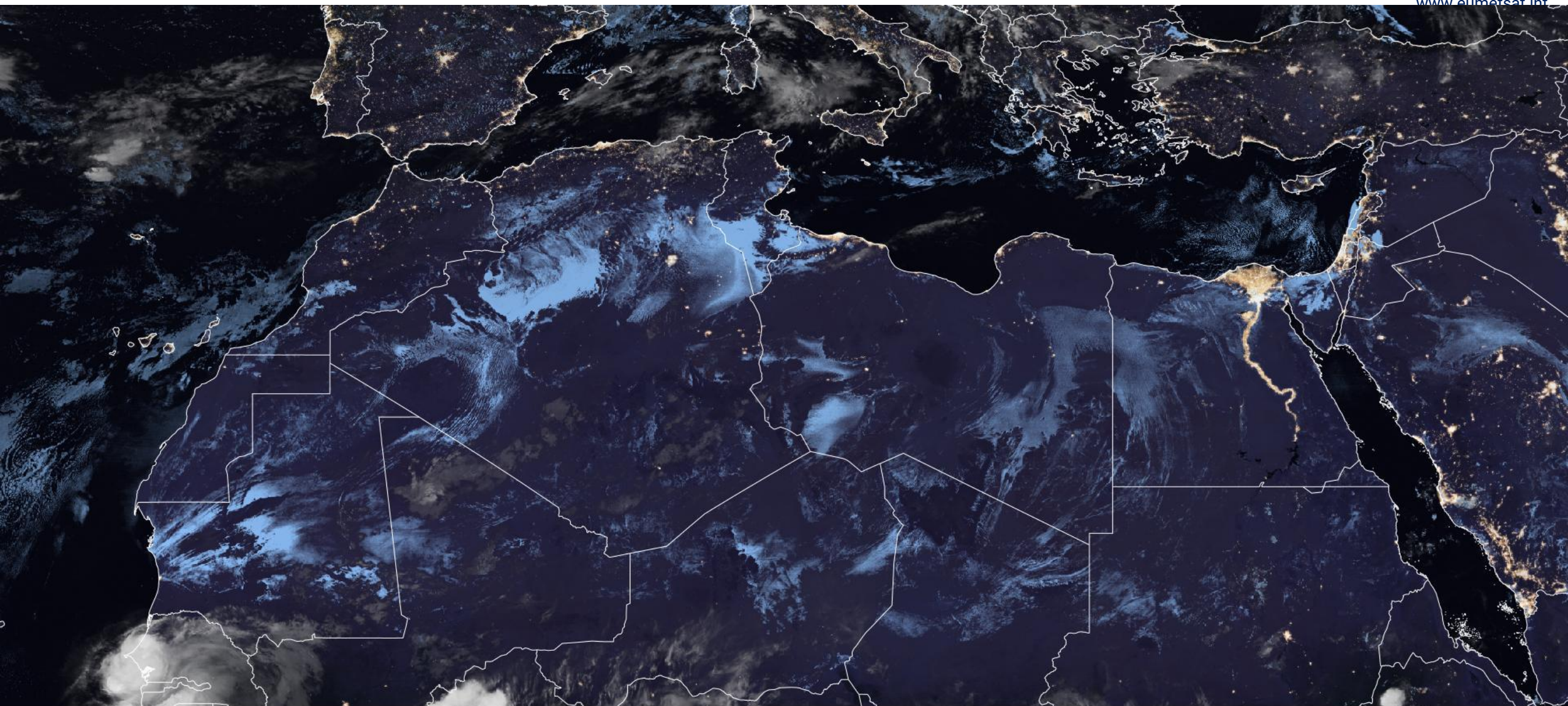
Undular bore – outflow – dust / west Africa





Fog in GC – artefact / Sahara

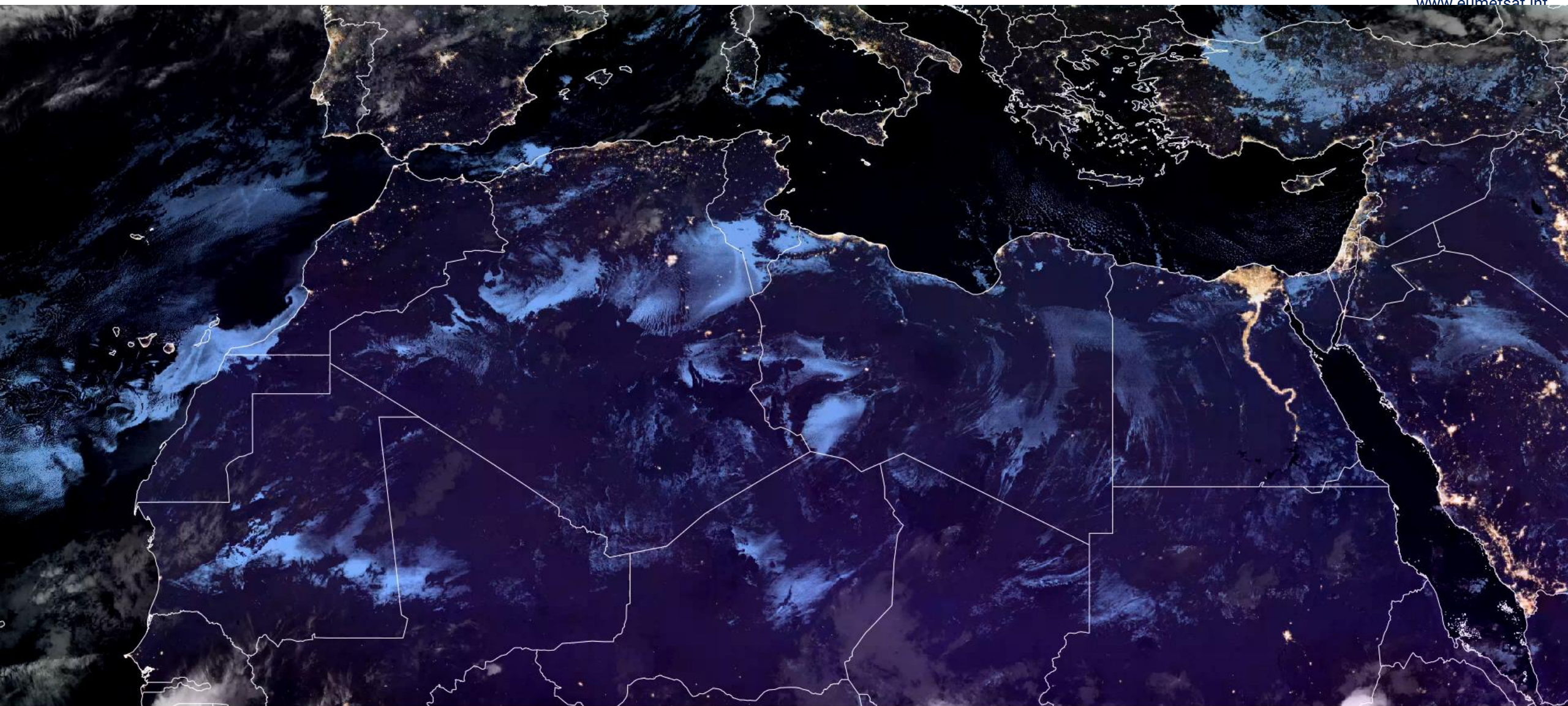
www.eumetsat.int





Fog in GC – artefact / Sahara

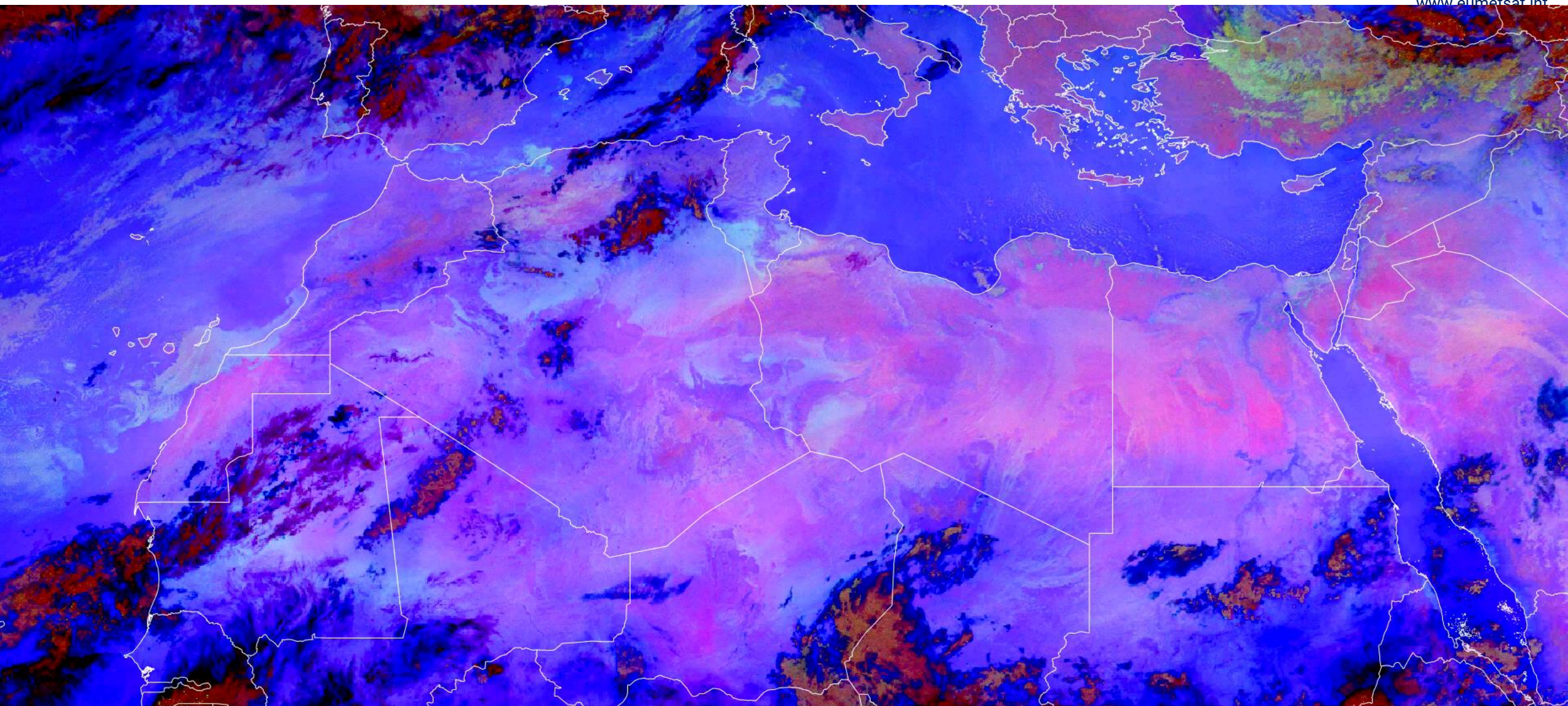
www.eumetsat.int





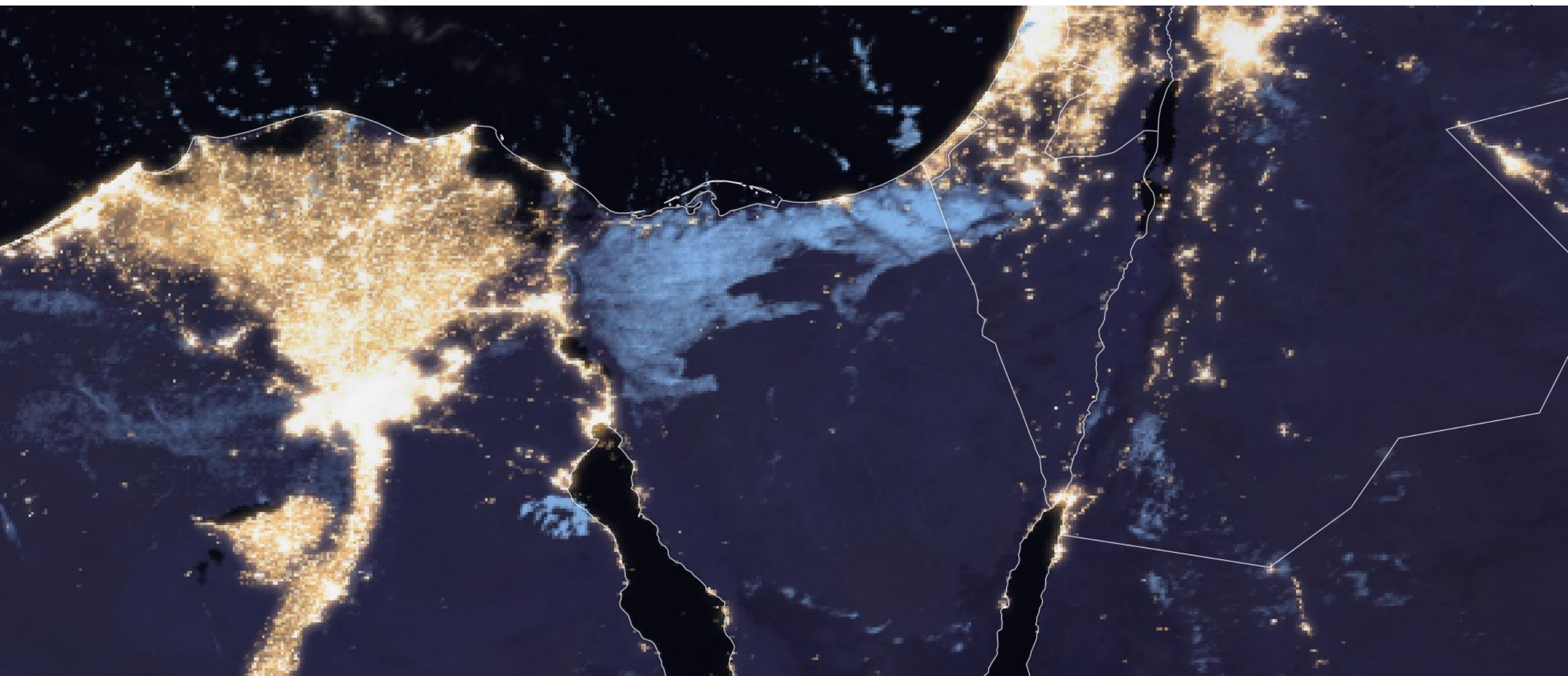
Fog in GC – artefact / Sahara

www.eumetsat.int



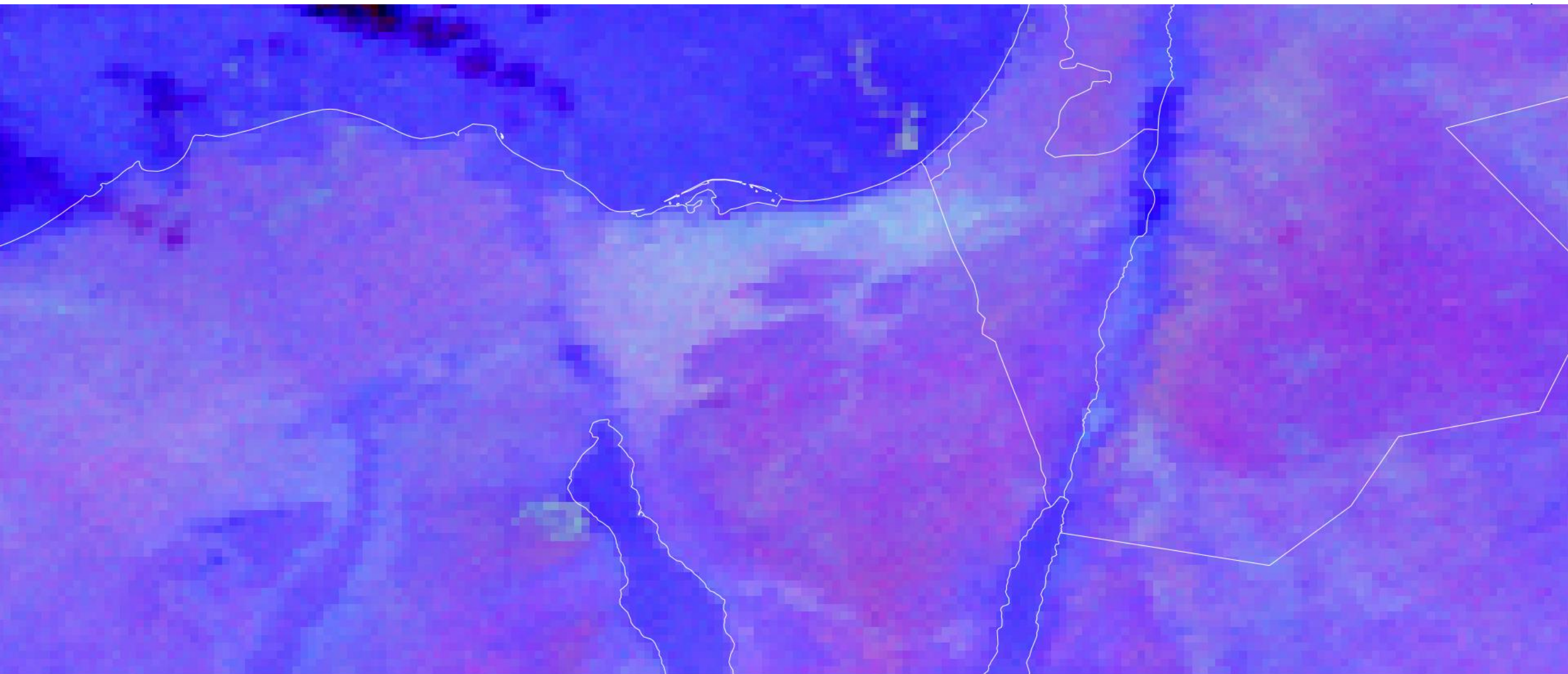


Fog in GC / Egypt



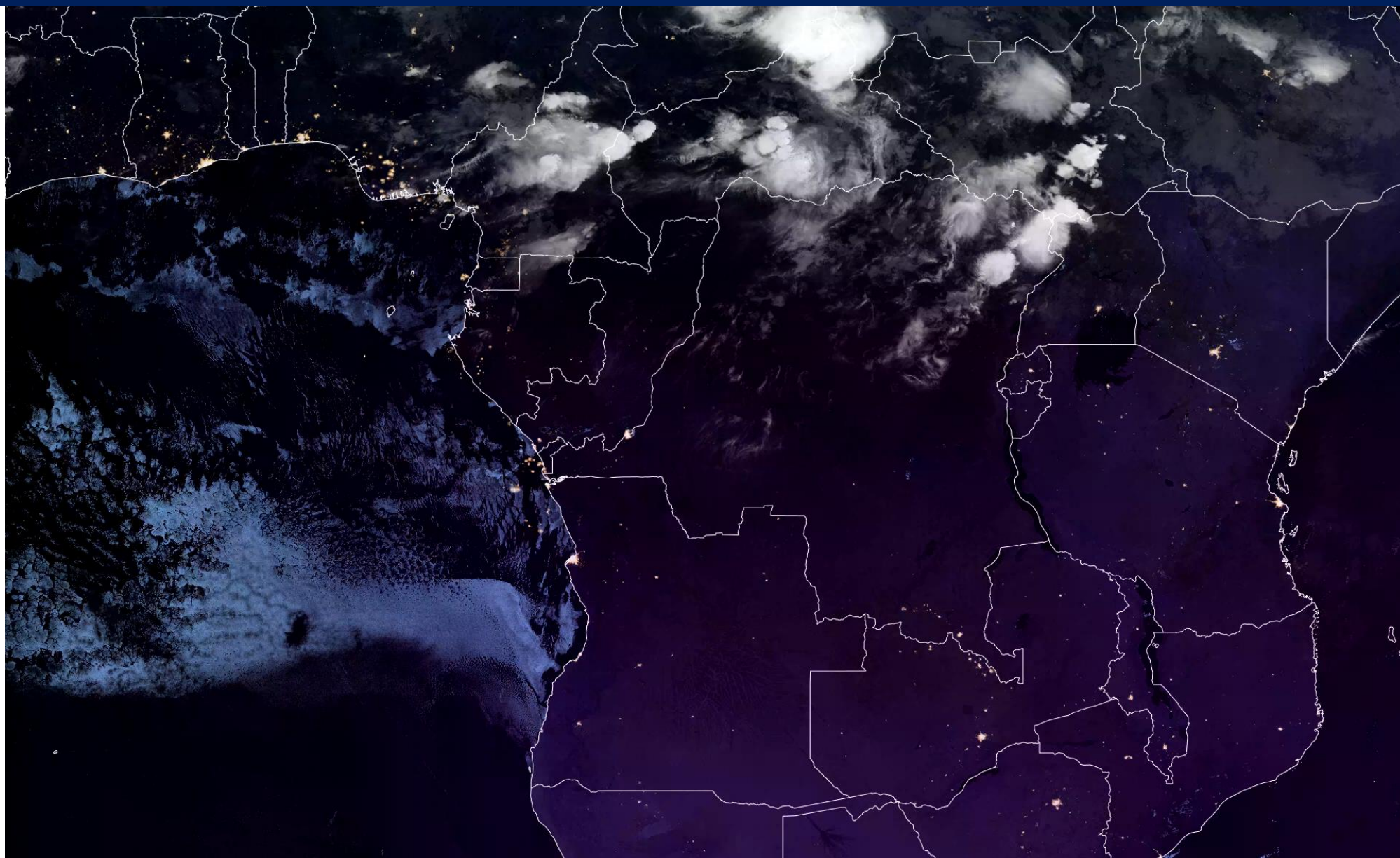


Fog in GC / Egypt





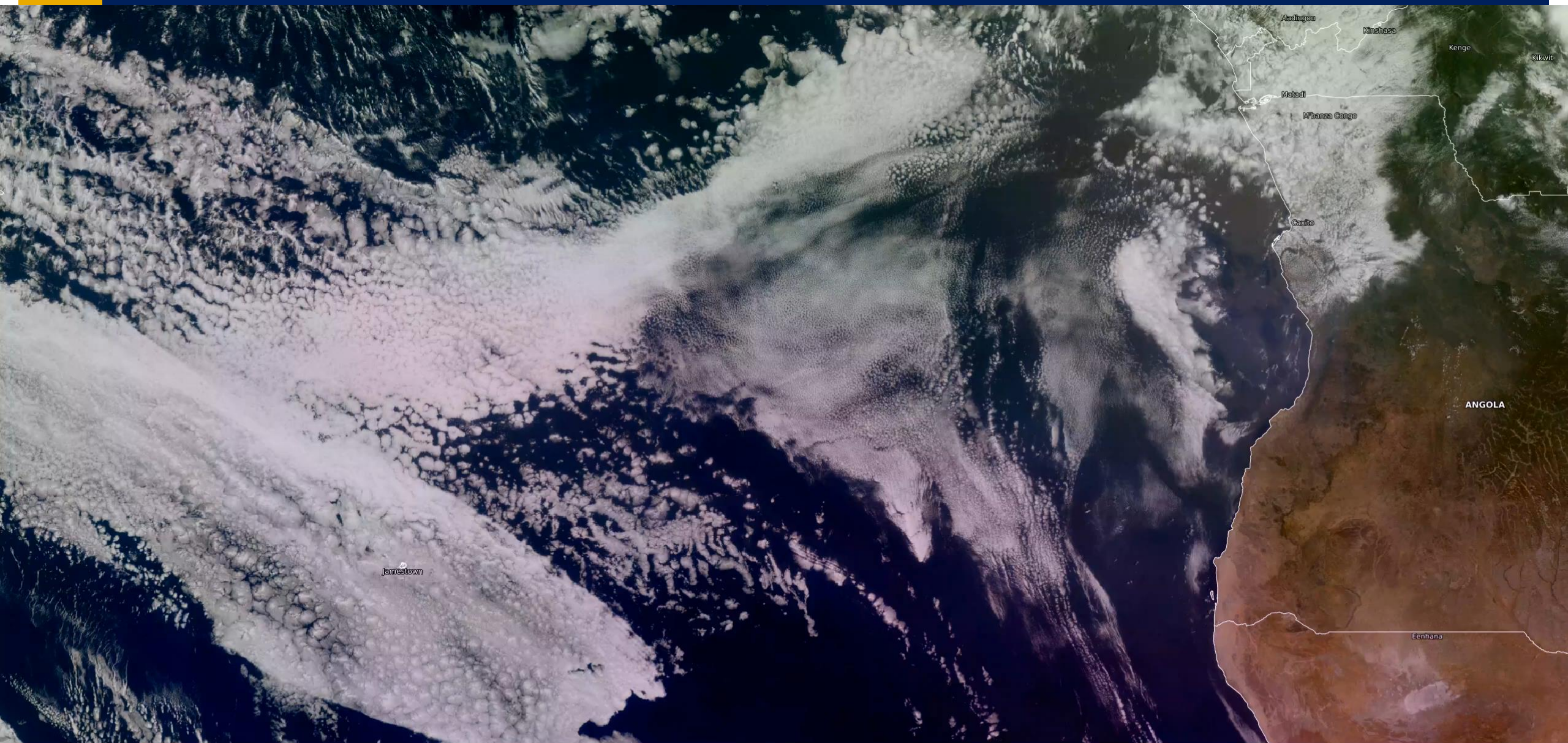
No fog over land – Smoke central / south Africa / Atlantic

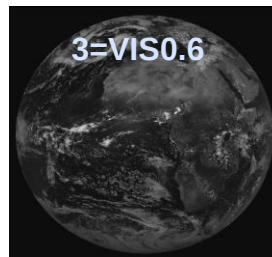
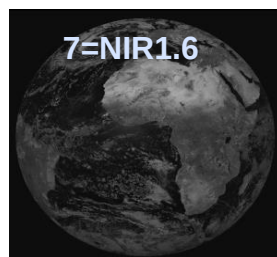


v.eumetsat.int



Bore – Waves – Shiptrails – Outflow – smoke – sea breeze/ CW Africa



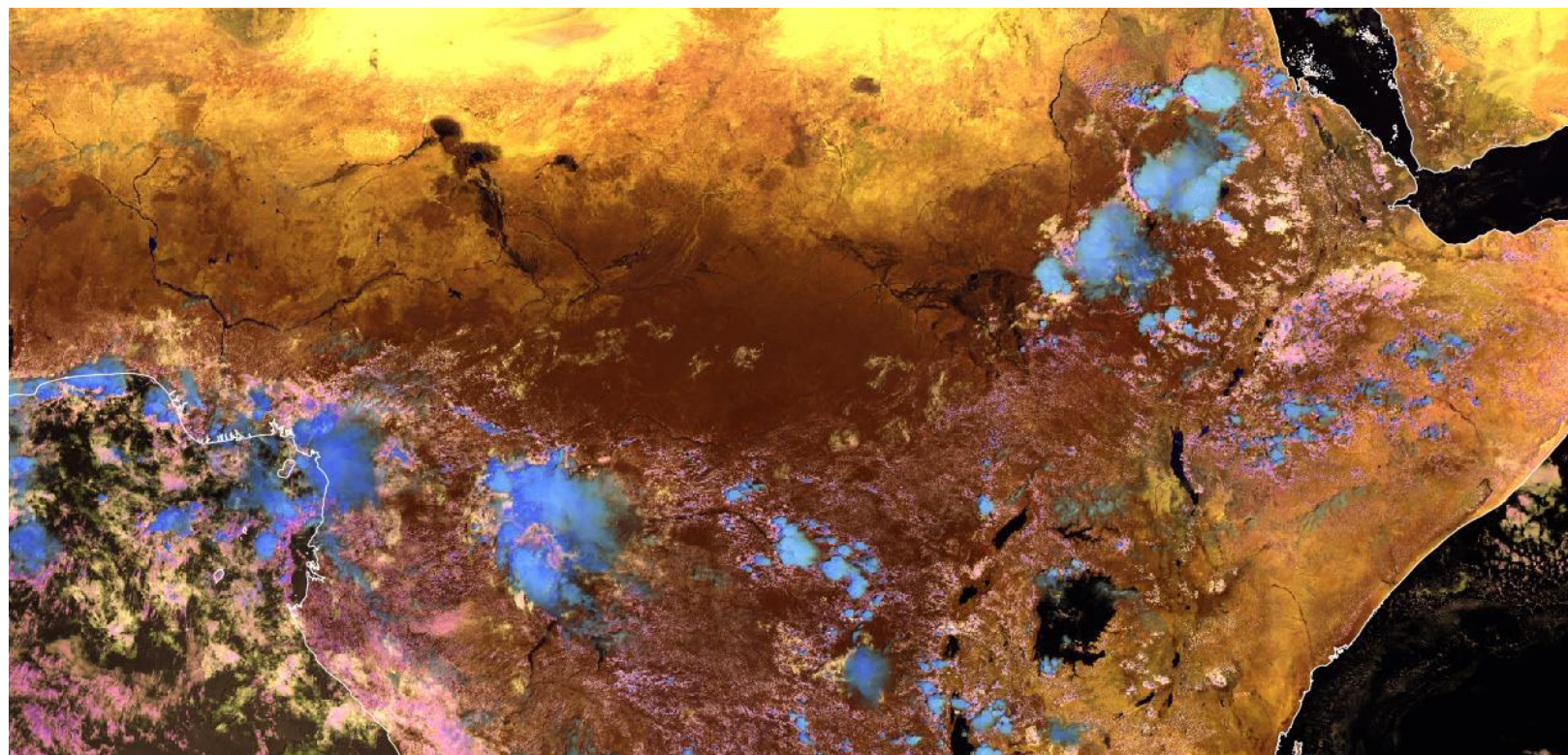


- Cloud phase
- Particle size
- Snow/ice
- (Aerosols)
- (Vegetation)
- (Hot fires)

R NIR1.6

G NIR2.3

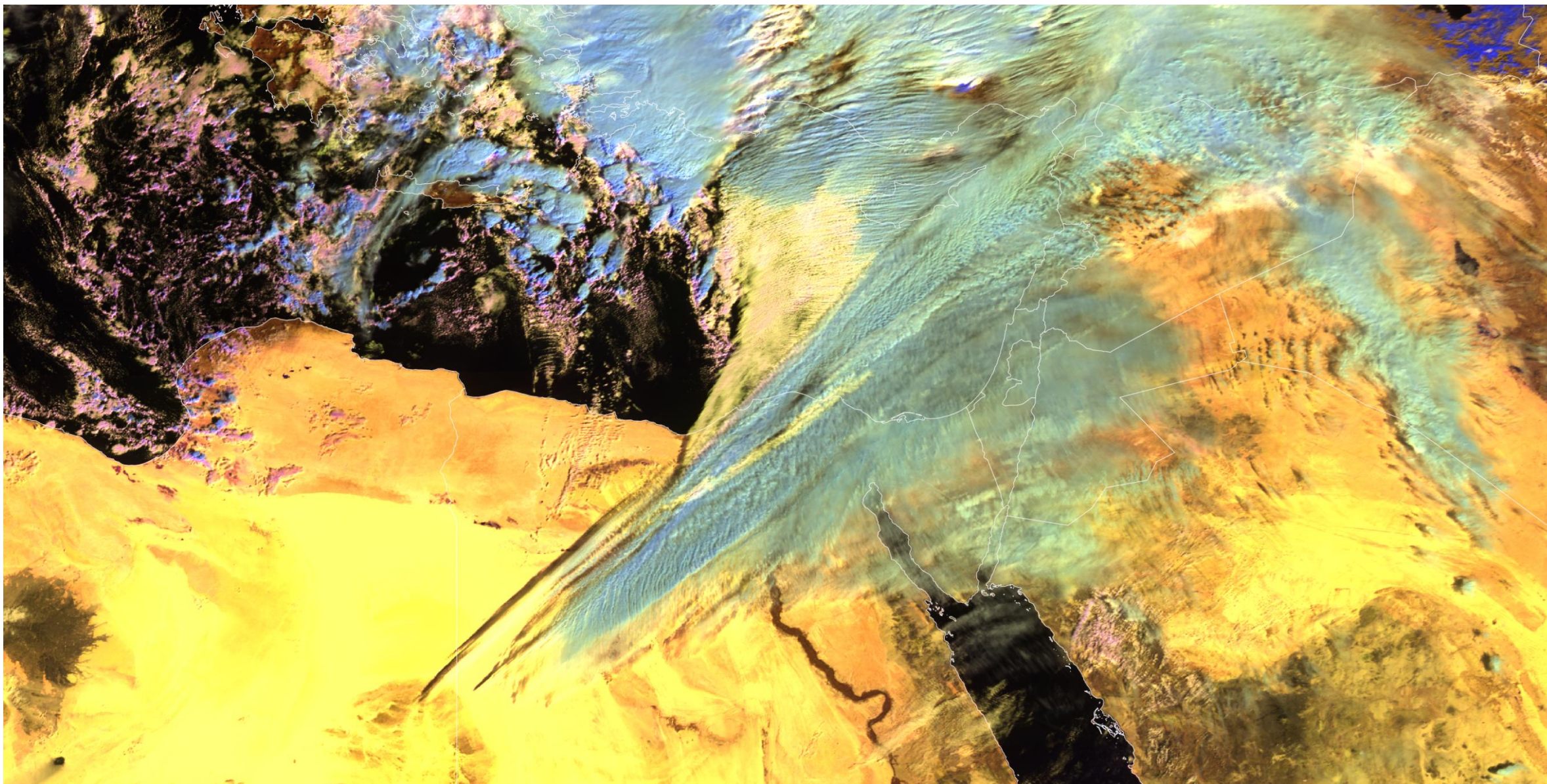
B VIS0.6





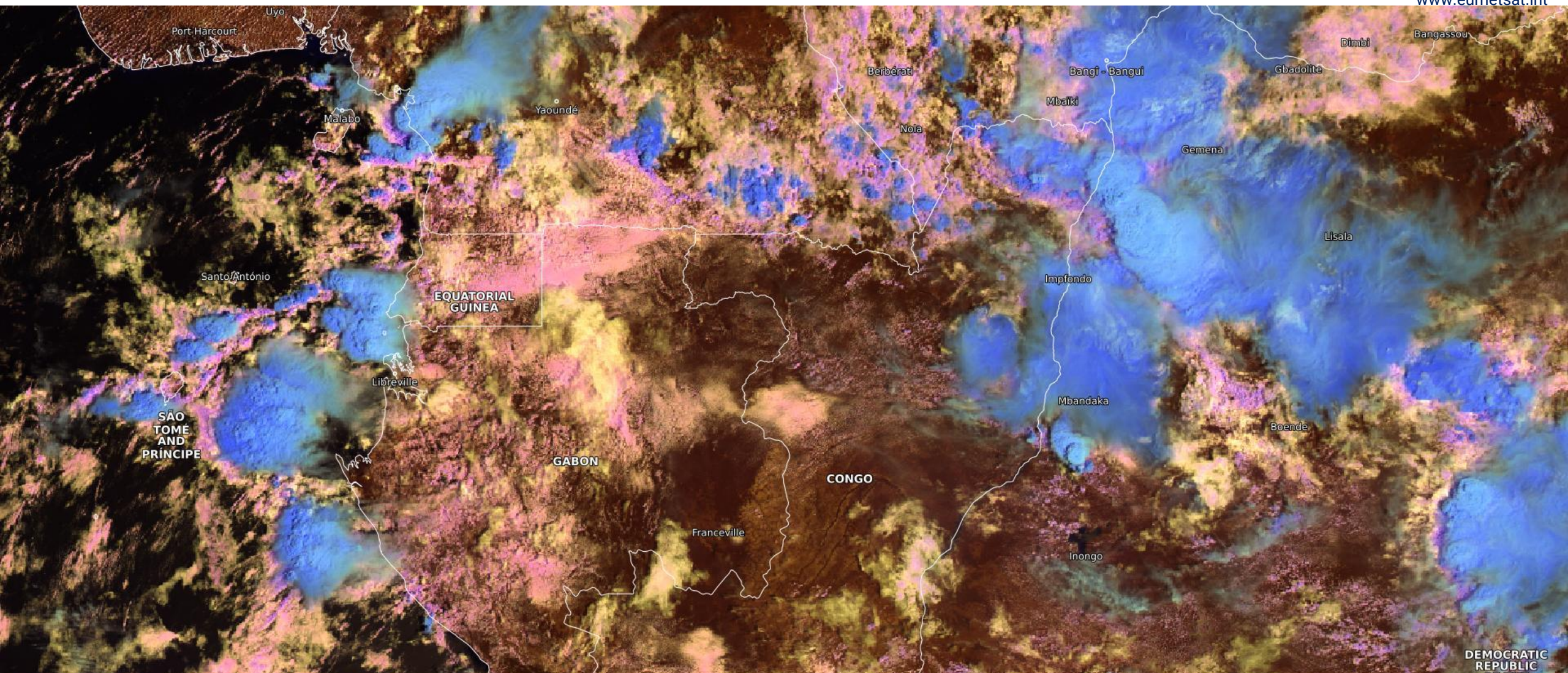
FCI applications – Cloud Phase RGB

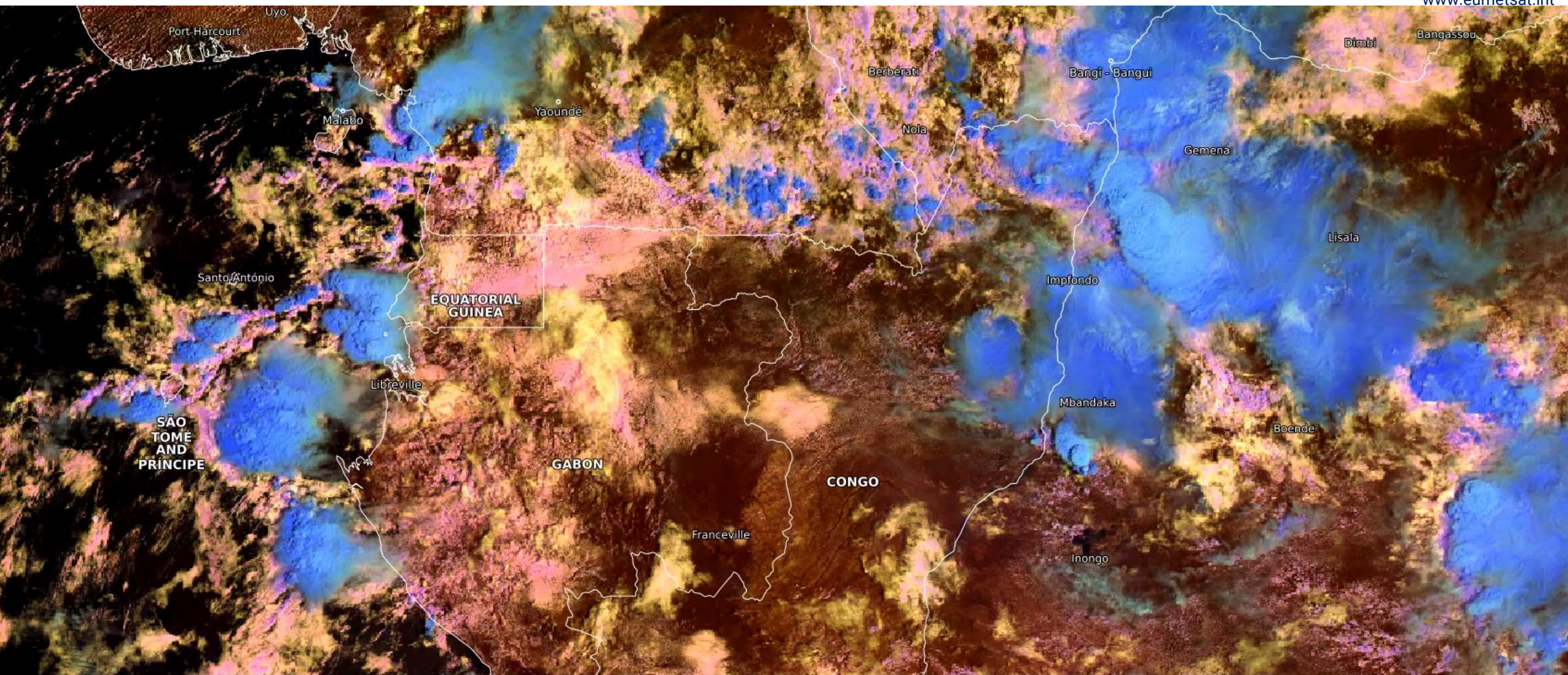
umetsat.int



CloudPhase_2023-12-21T0830

EUM/EPSSGUP/VWG/22/1292638, v1 Draft, 19 March 2022









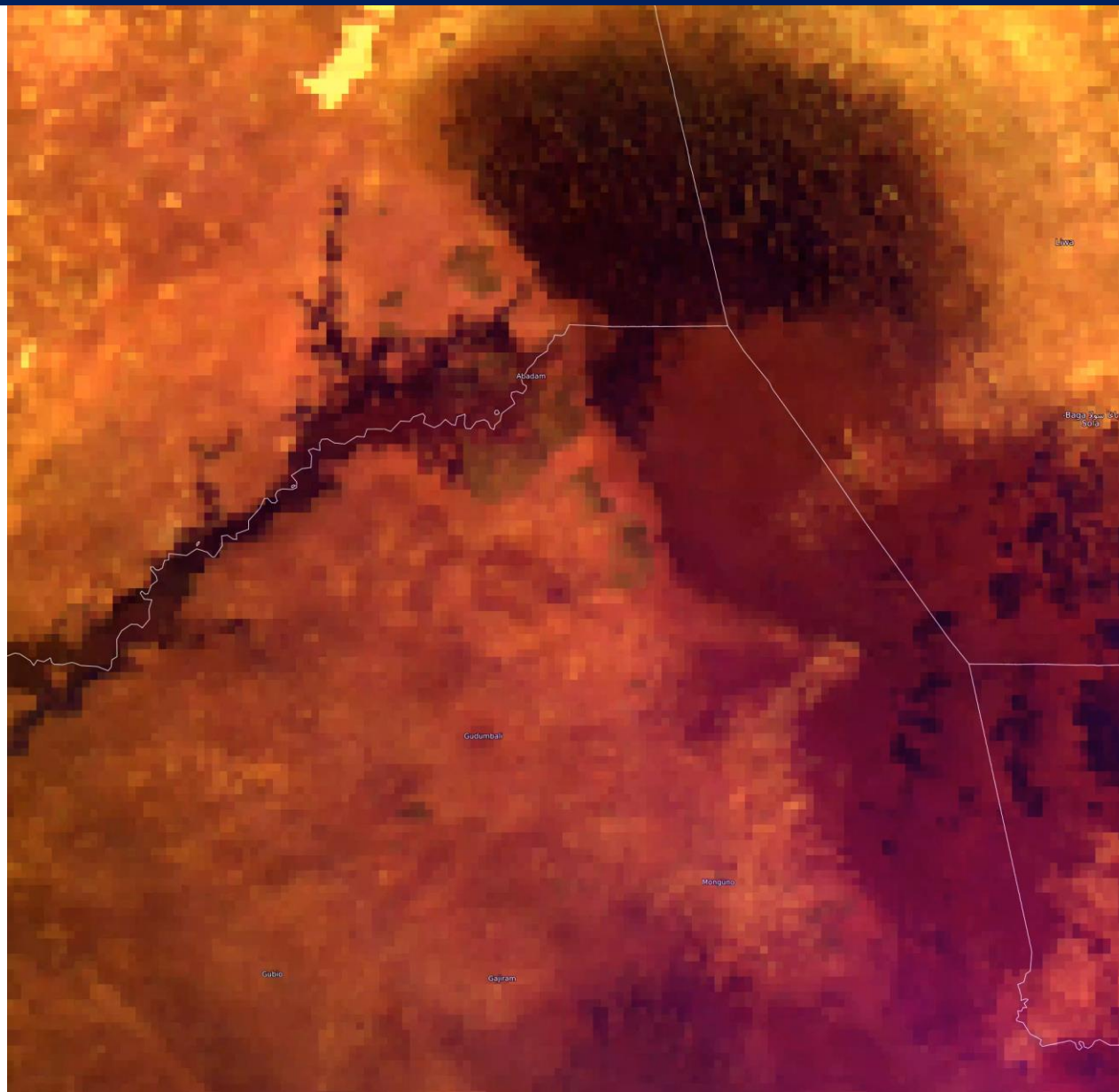
A false-color satellite map of East Africa, showing the Great Rift Valley and surrounding regions. The map includes labels for Djemah, Kibiro, Kampala, Nairobi, and the ELERI TRIANGLE. The map is oriented with North at the top.



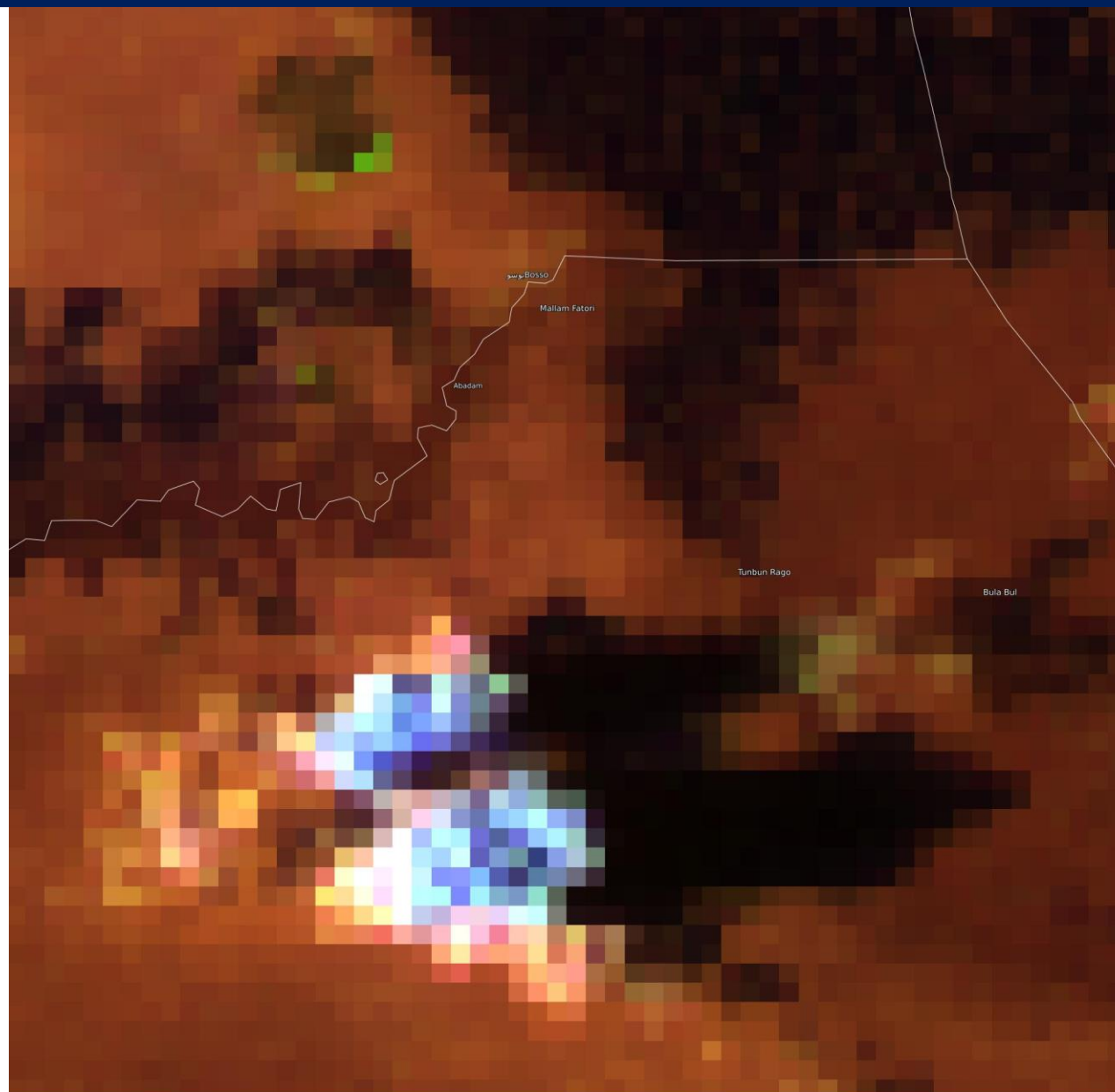


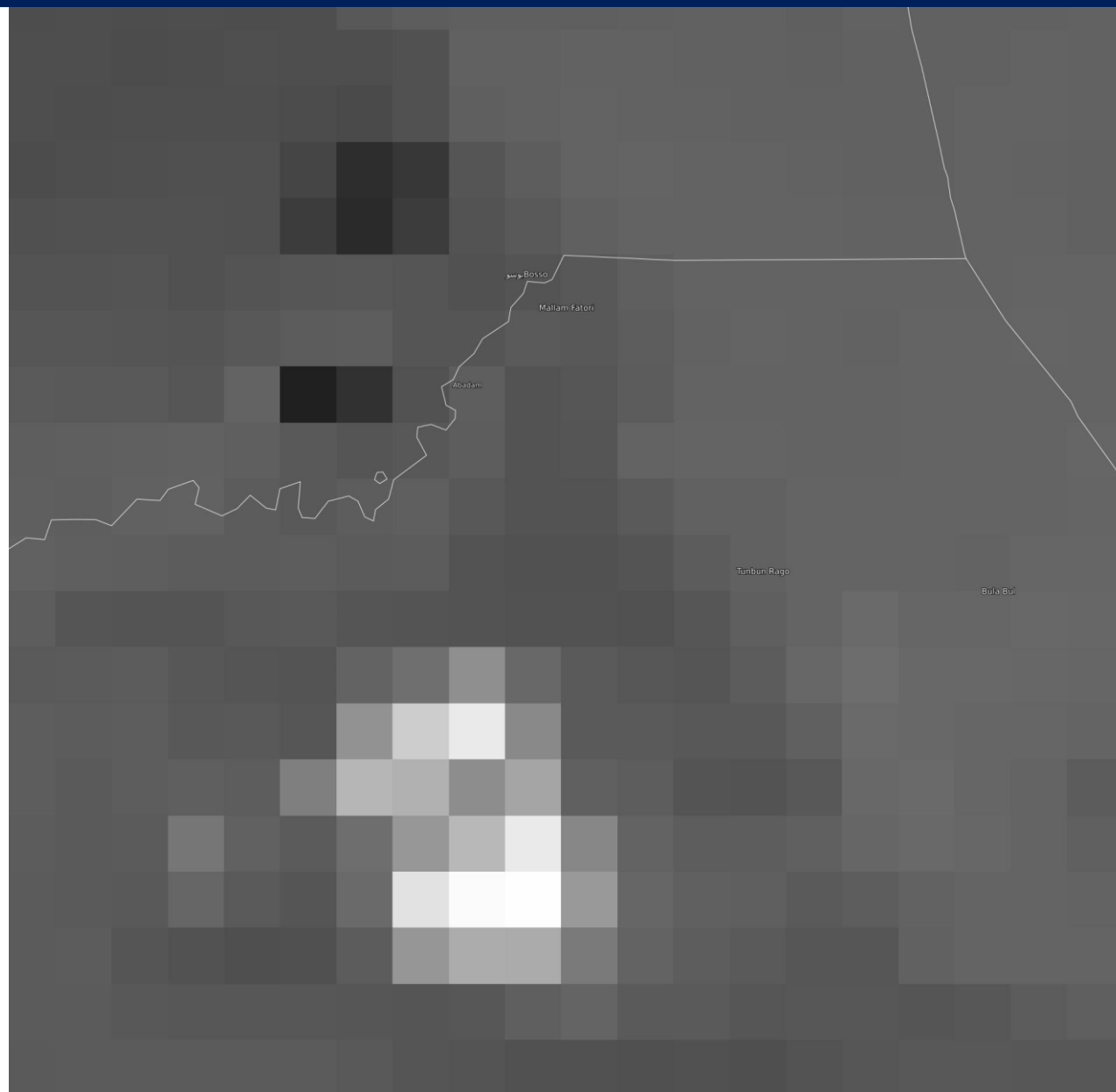
Fires smoke / Lake Chad Africa

www.eumetsat.int



**fires_Chad-
lake_CP_IR39__6fps_
2024-10-23_06_00-
2024-10-24_12_00**

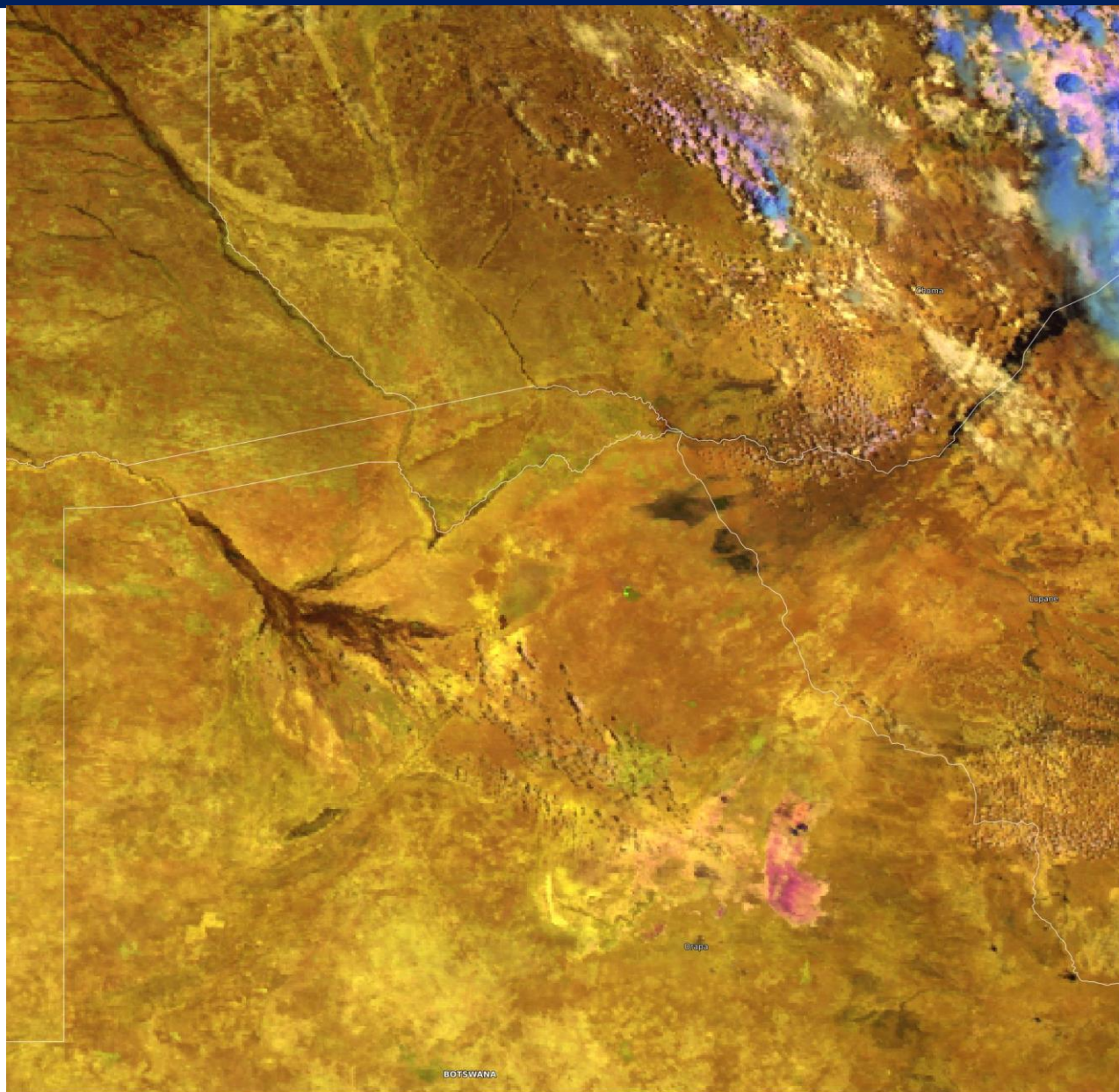






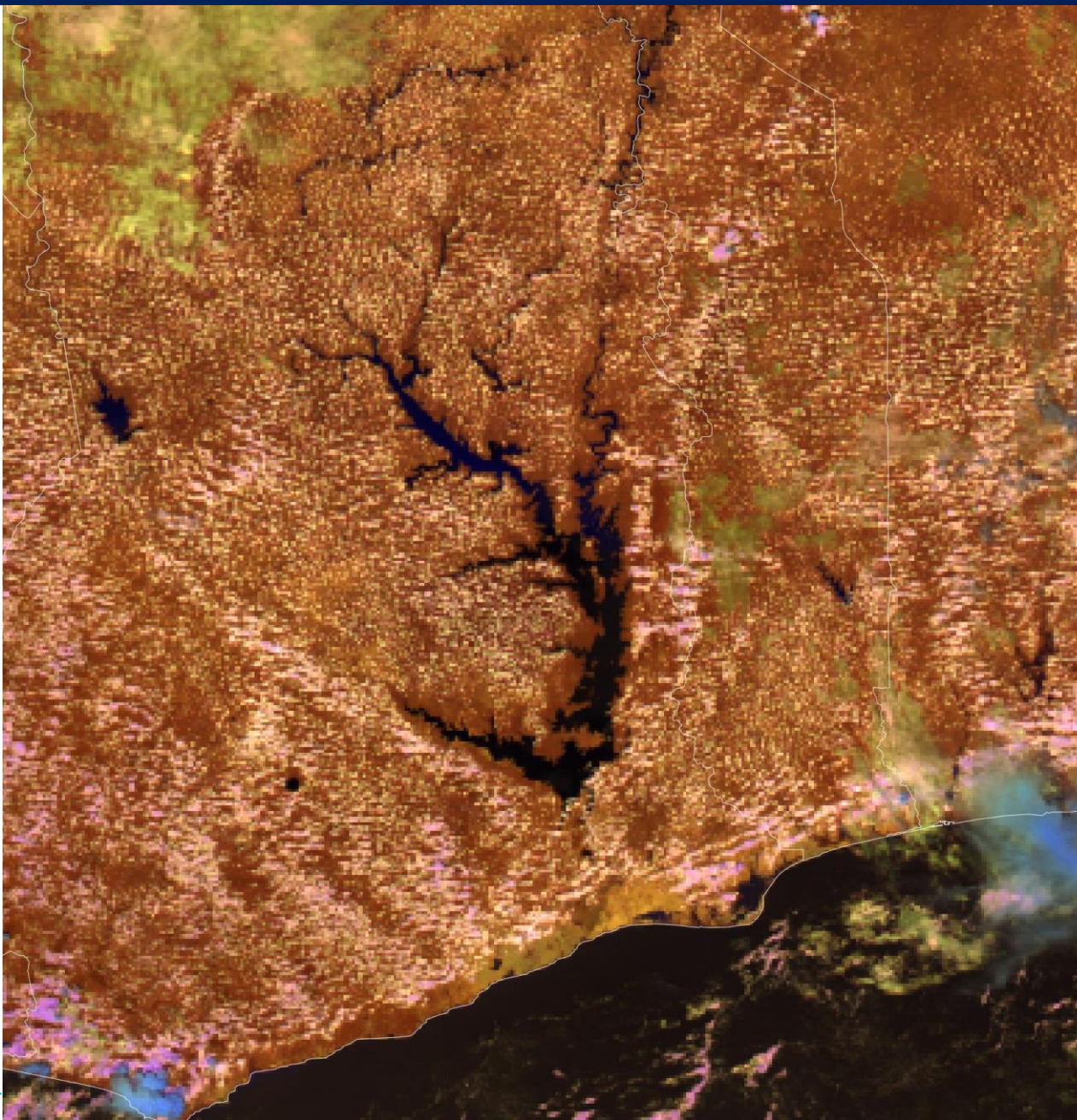
Salt lake – vegetation – fire / Okavango, Makgadikgadi Pans, Botswana

www.eumetsat.int





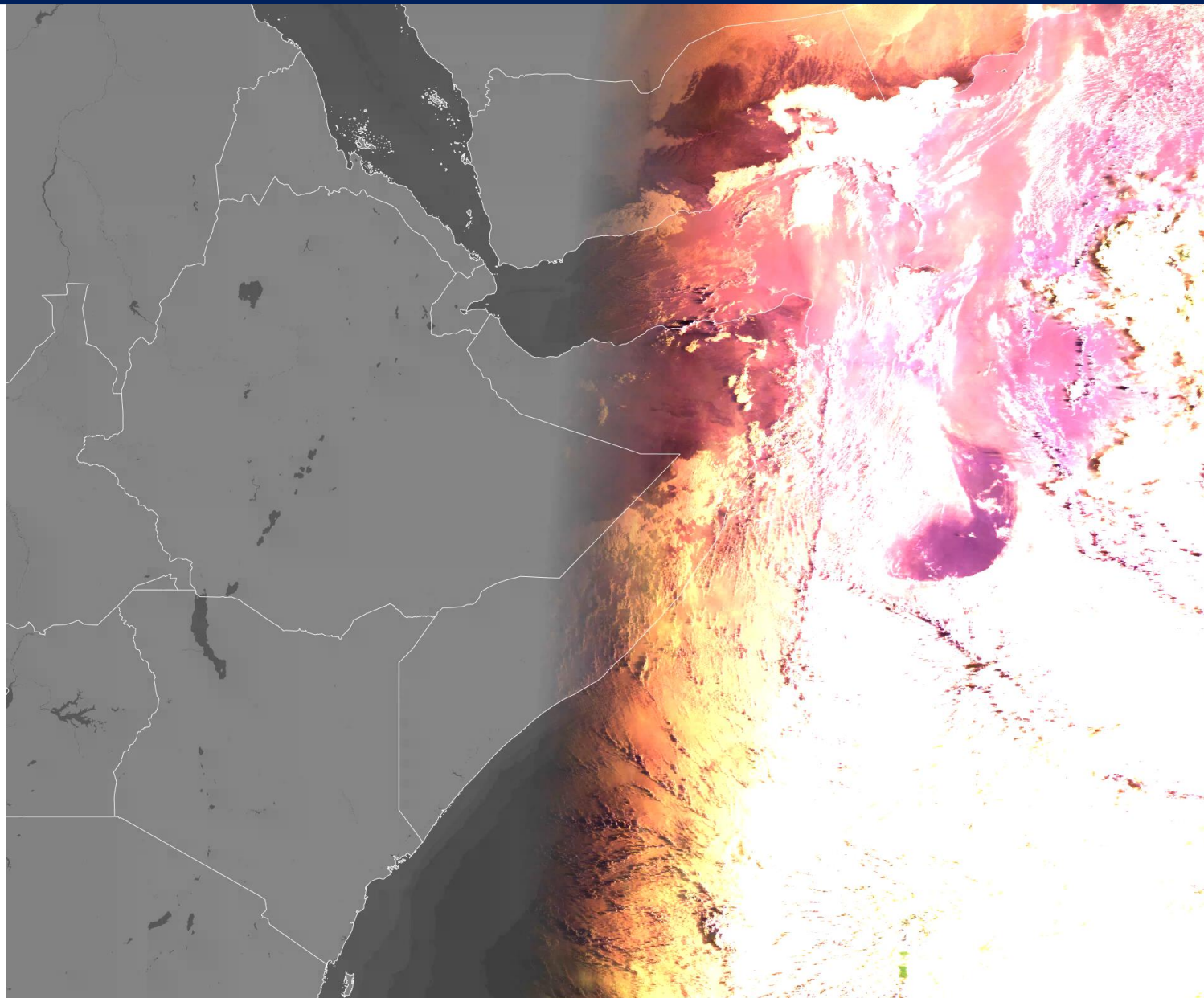
CloudPhase-at-1km_2024-10-16T1200

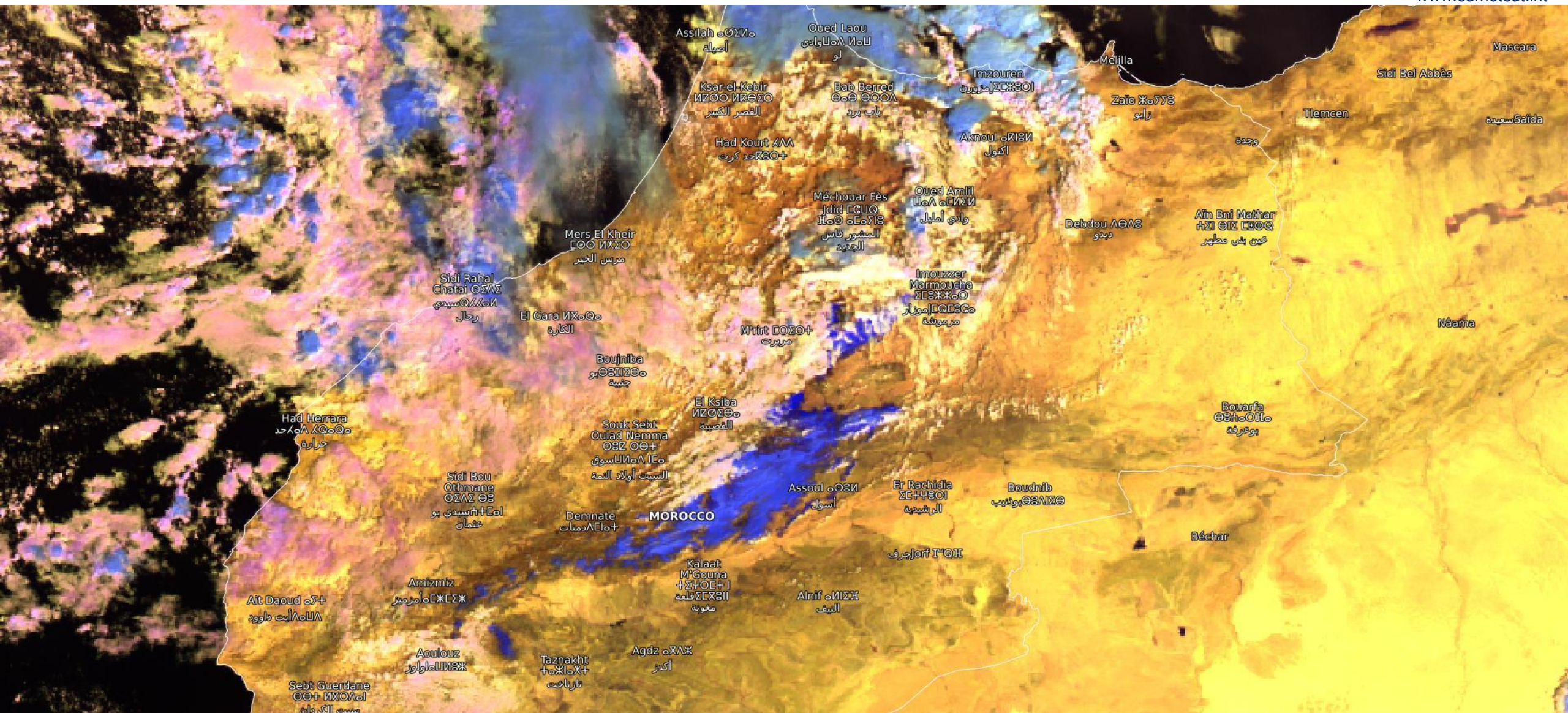




Morning over East Africa (Cloud Phase RGB)

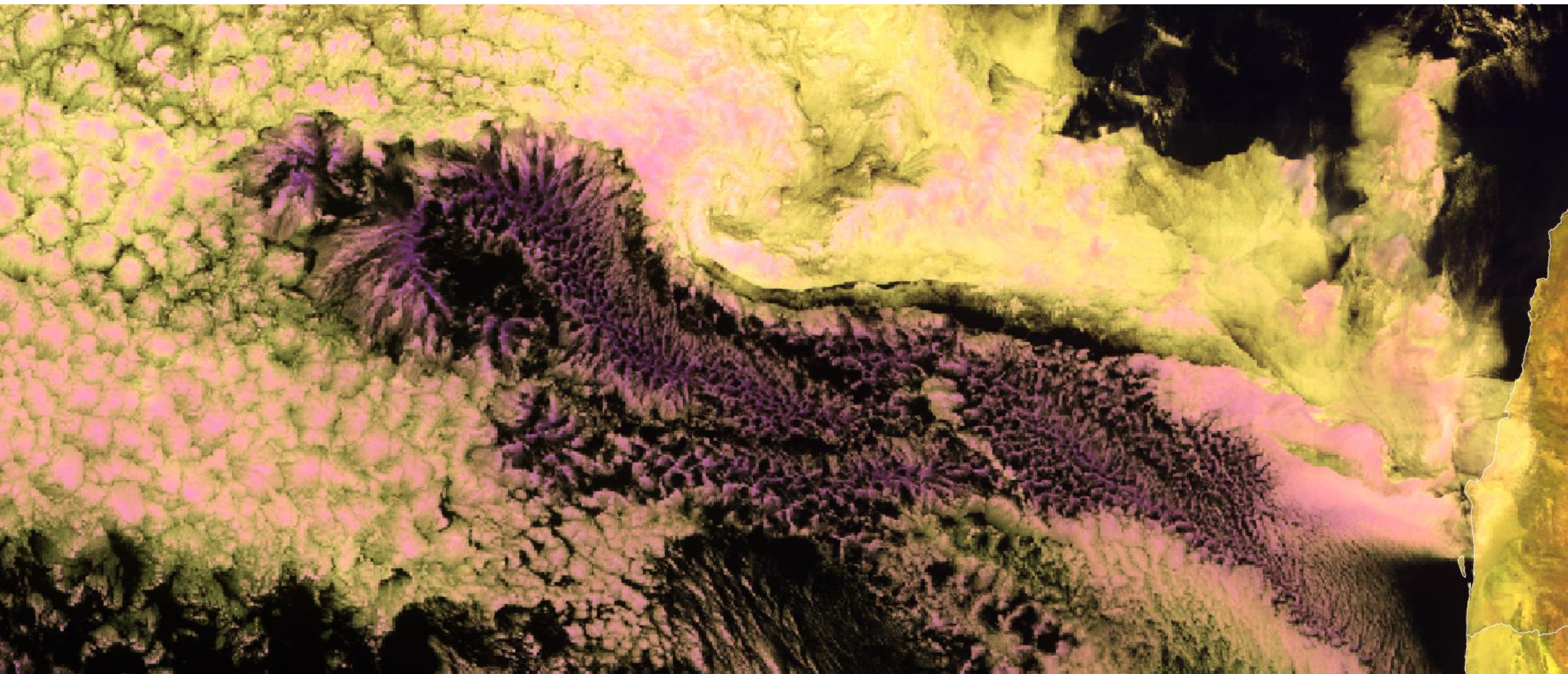
www.eumetsat.int







Open/closed cells / Atlantic

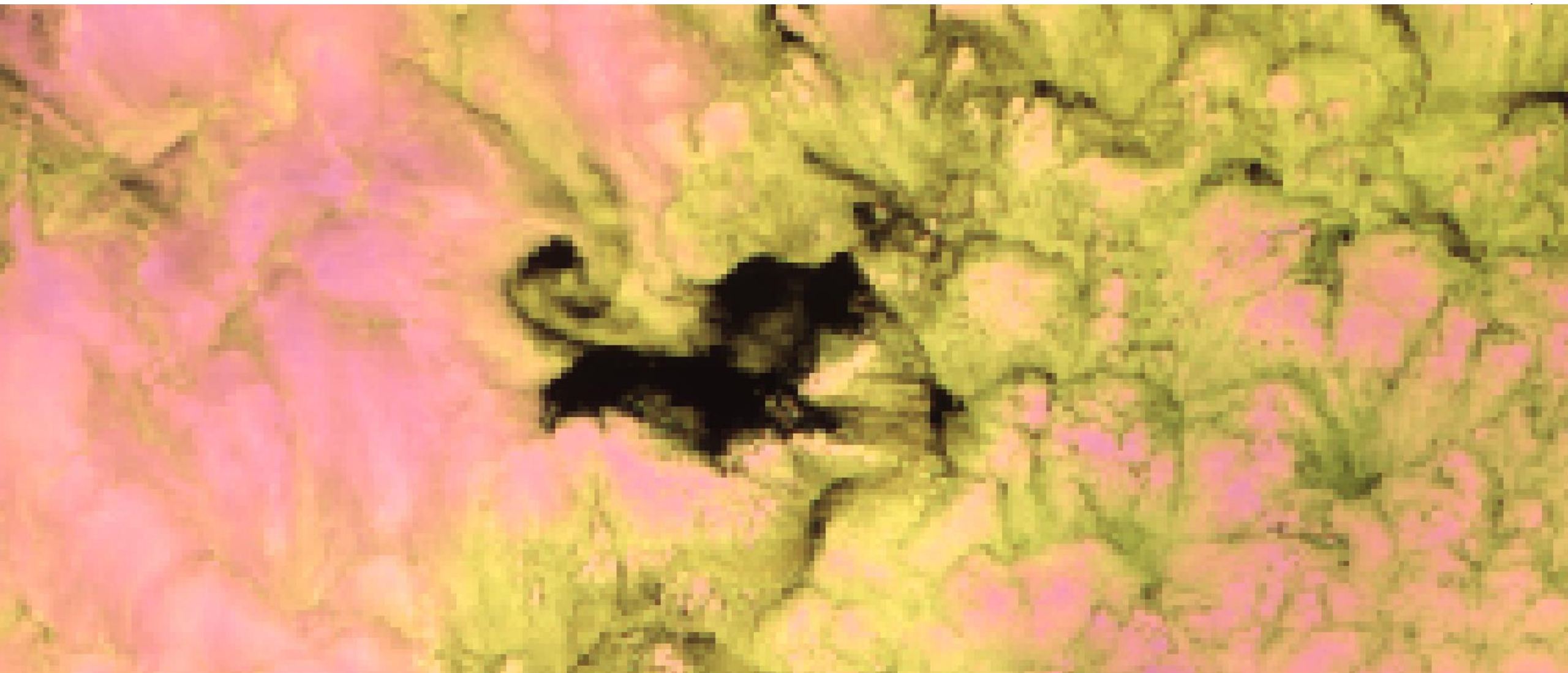




Bore – Waves – Shiptrails – Outflow – smoke – sea breeze/ CW Africa

www.eumetsat.int

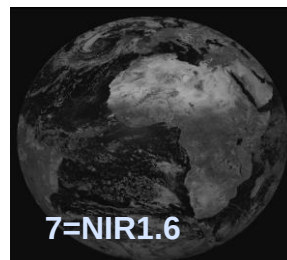
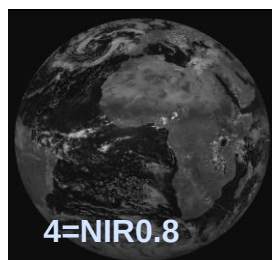






FCI applications – Cloud Type RGB

www.eumetsat.int



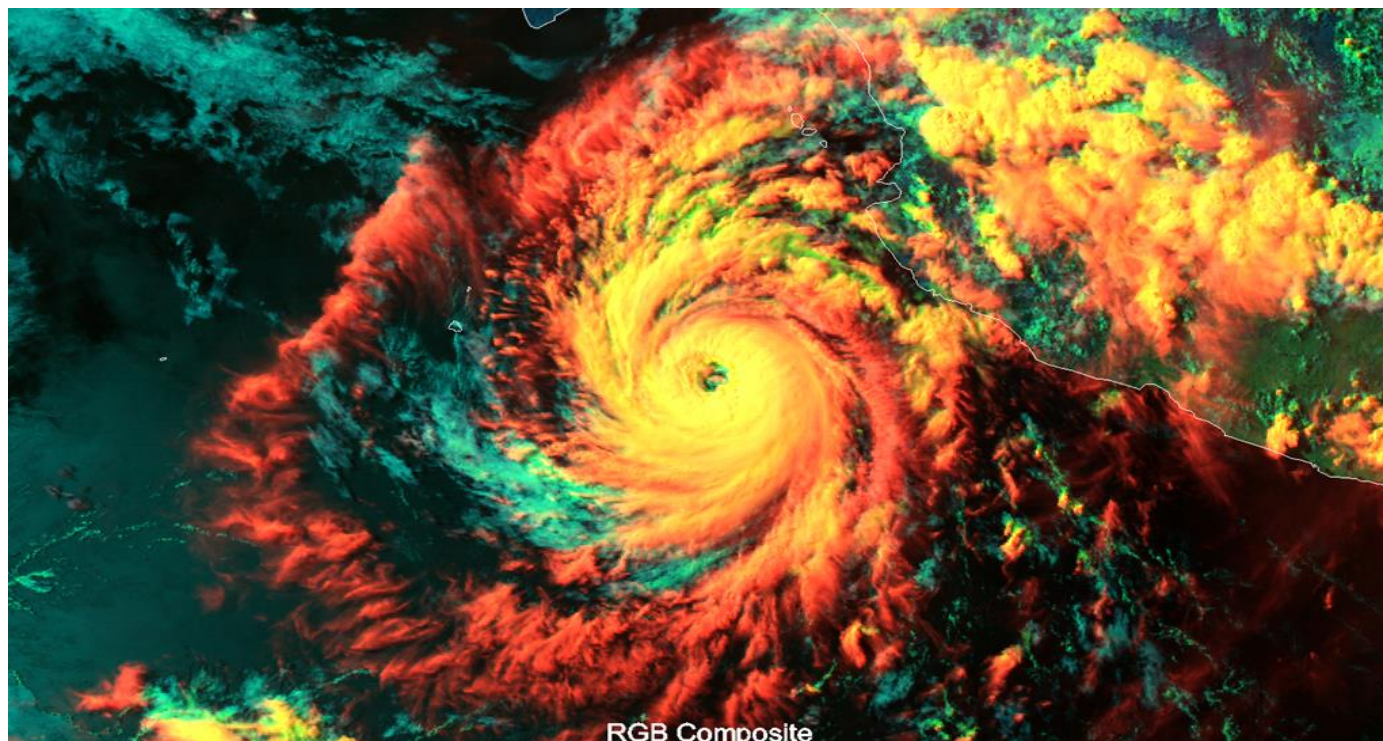
- Thin cirrus
- Cloud height/phase
- (Aerosols)
- (Vegetation)
- (Snow)

R NIR1.3

G VIS0.8

B NIR1.6

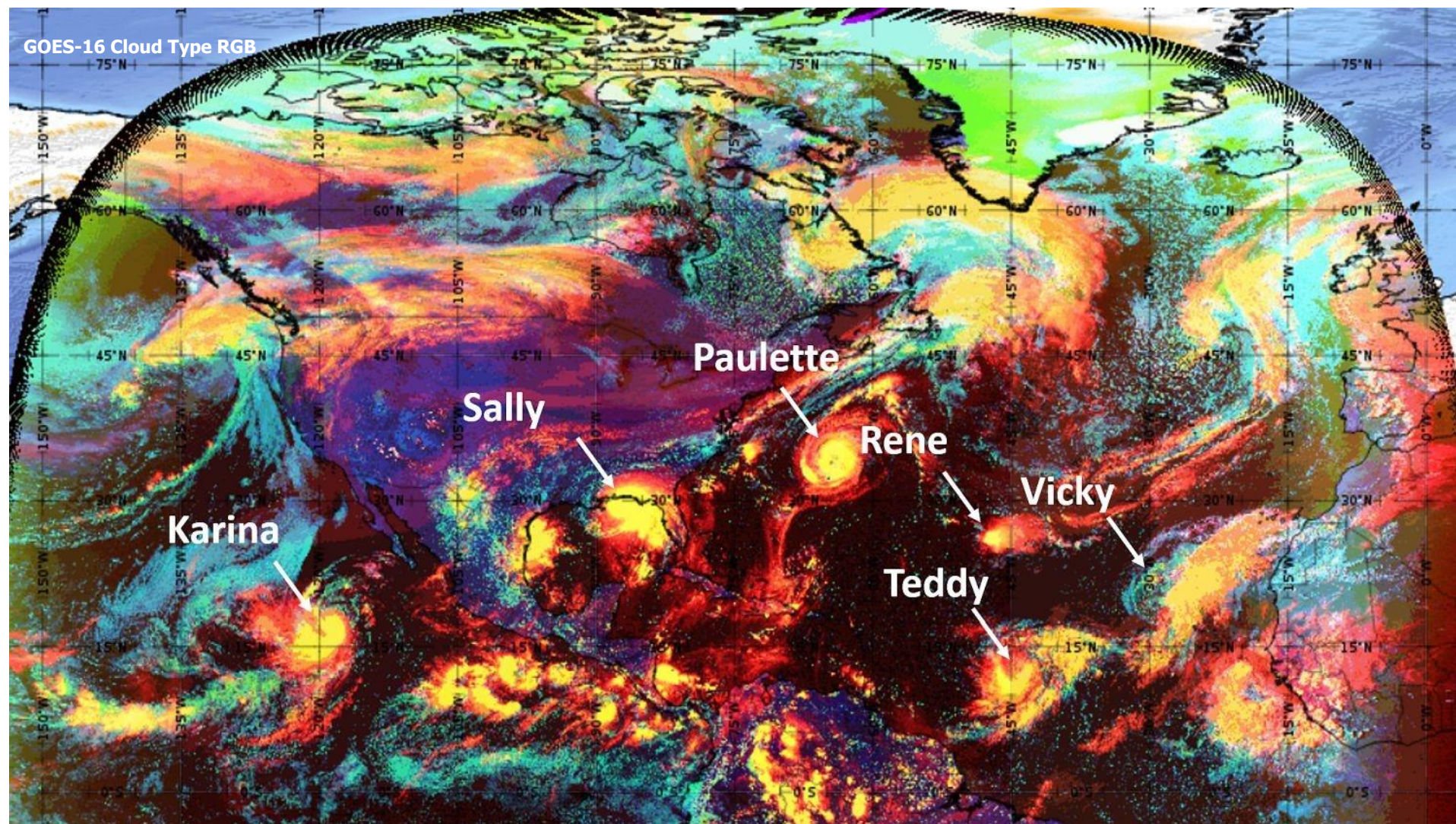
La Palma



RGB Composite

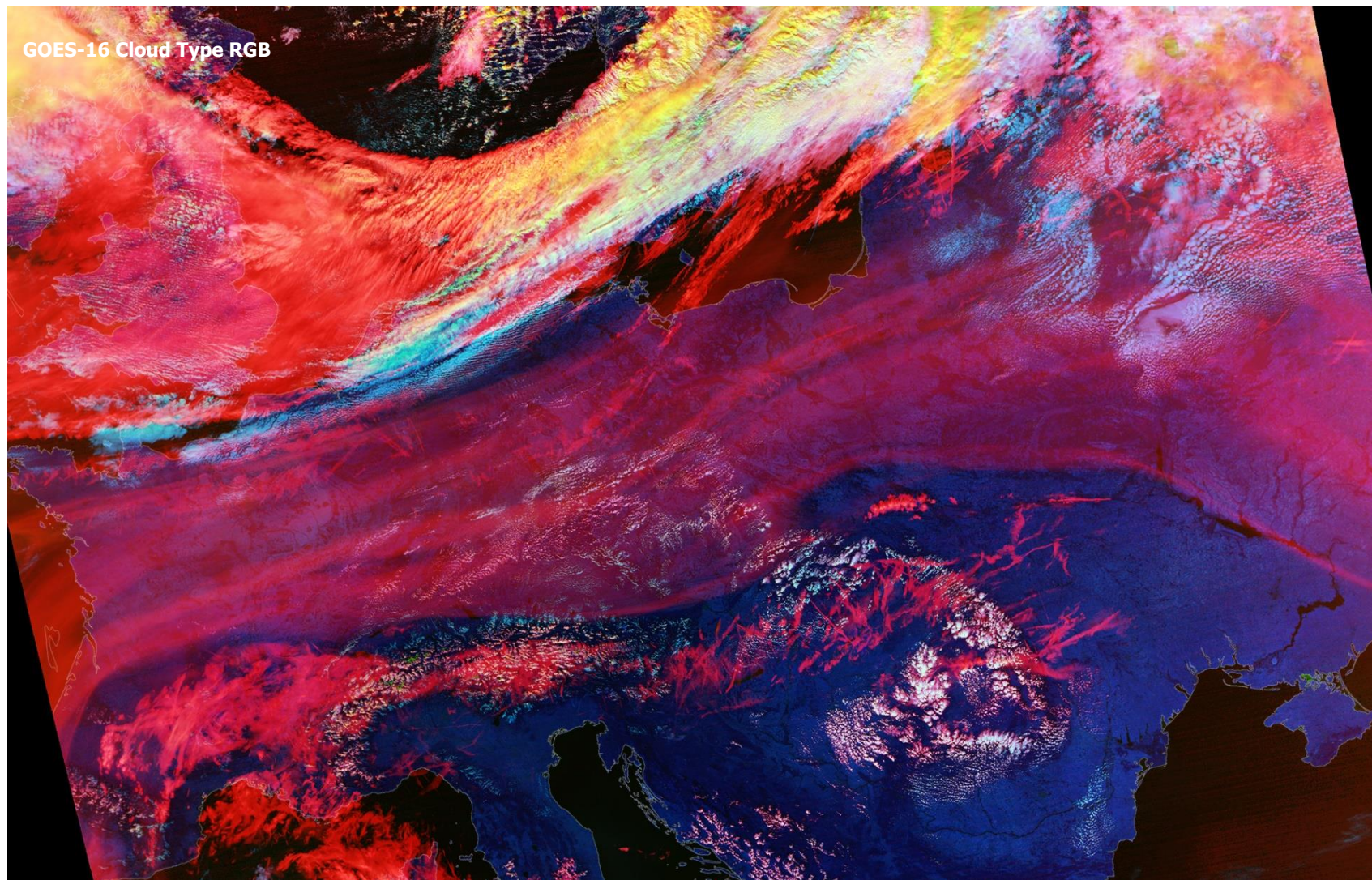


- Busy 2020 tropical cyclone season 14/09/2021



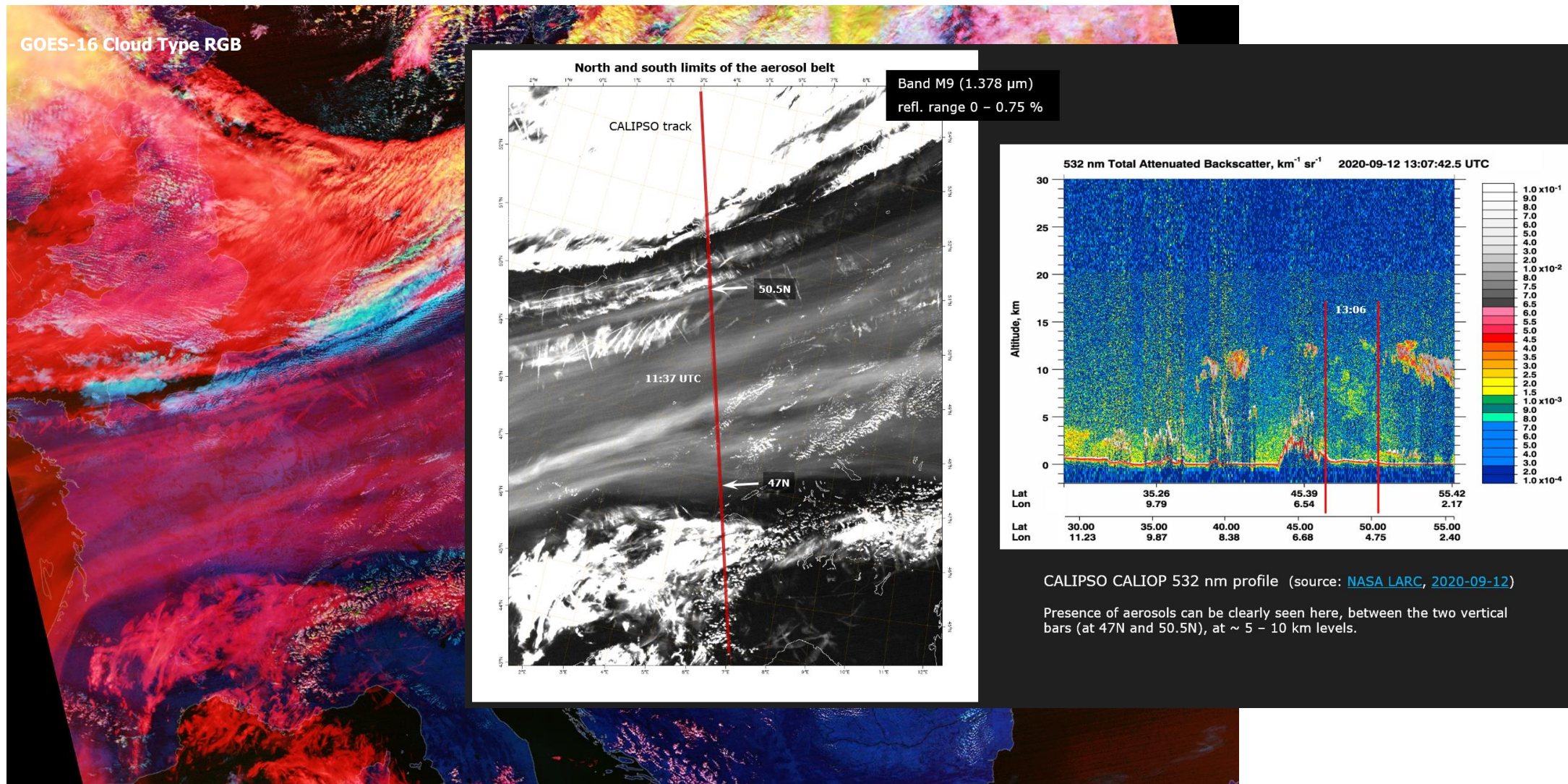


- Long-range smoke transport 12/09/2020



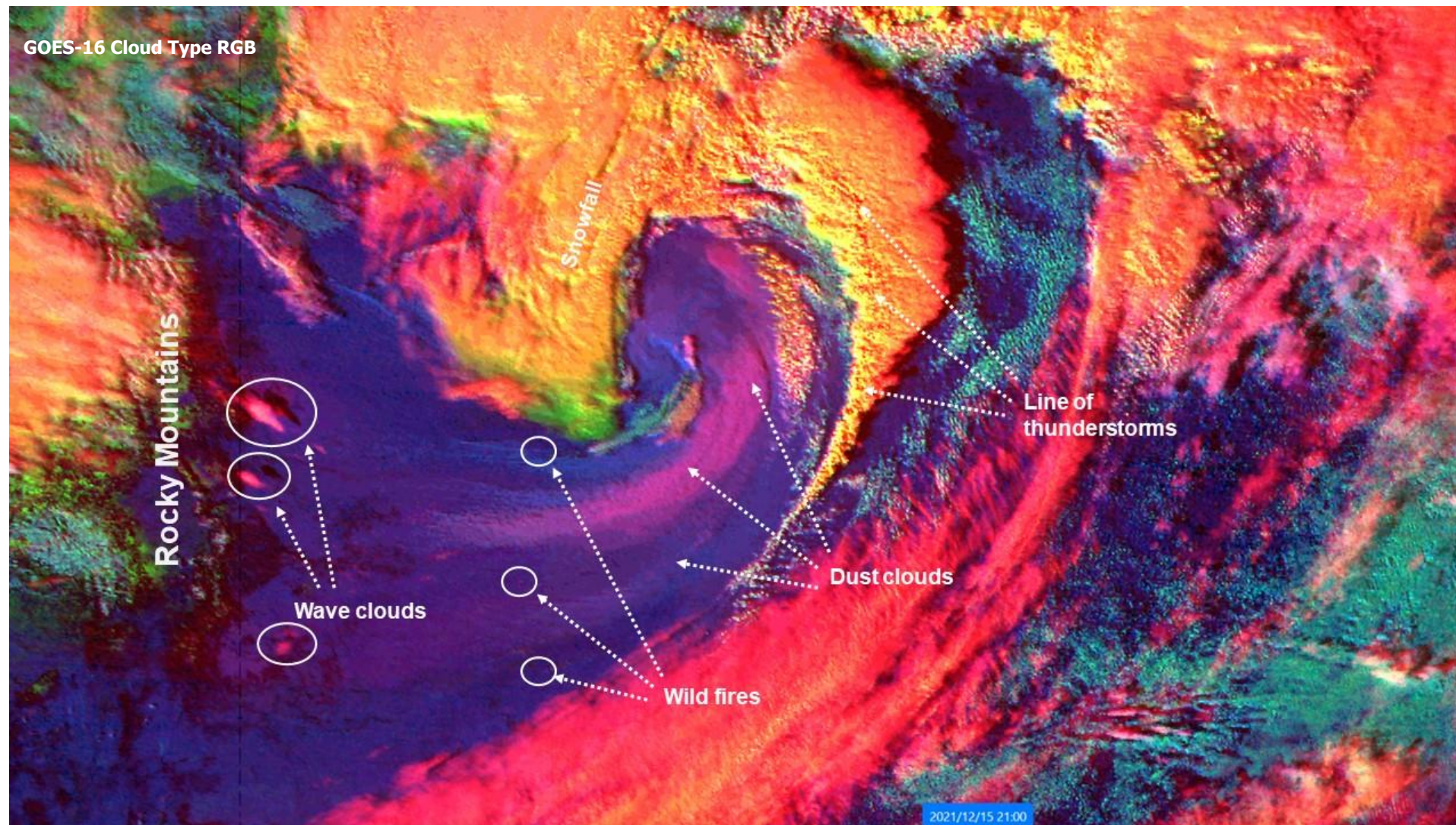


- Long-range smoke transport 12/09/2020



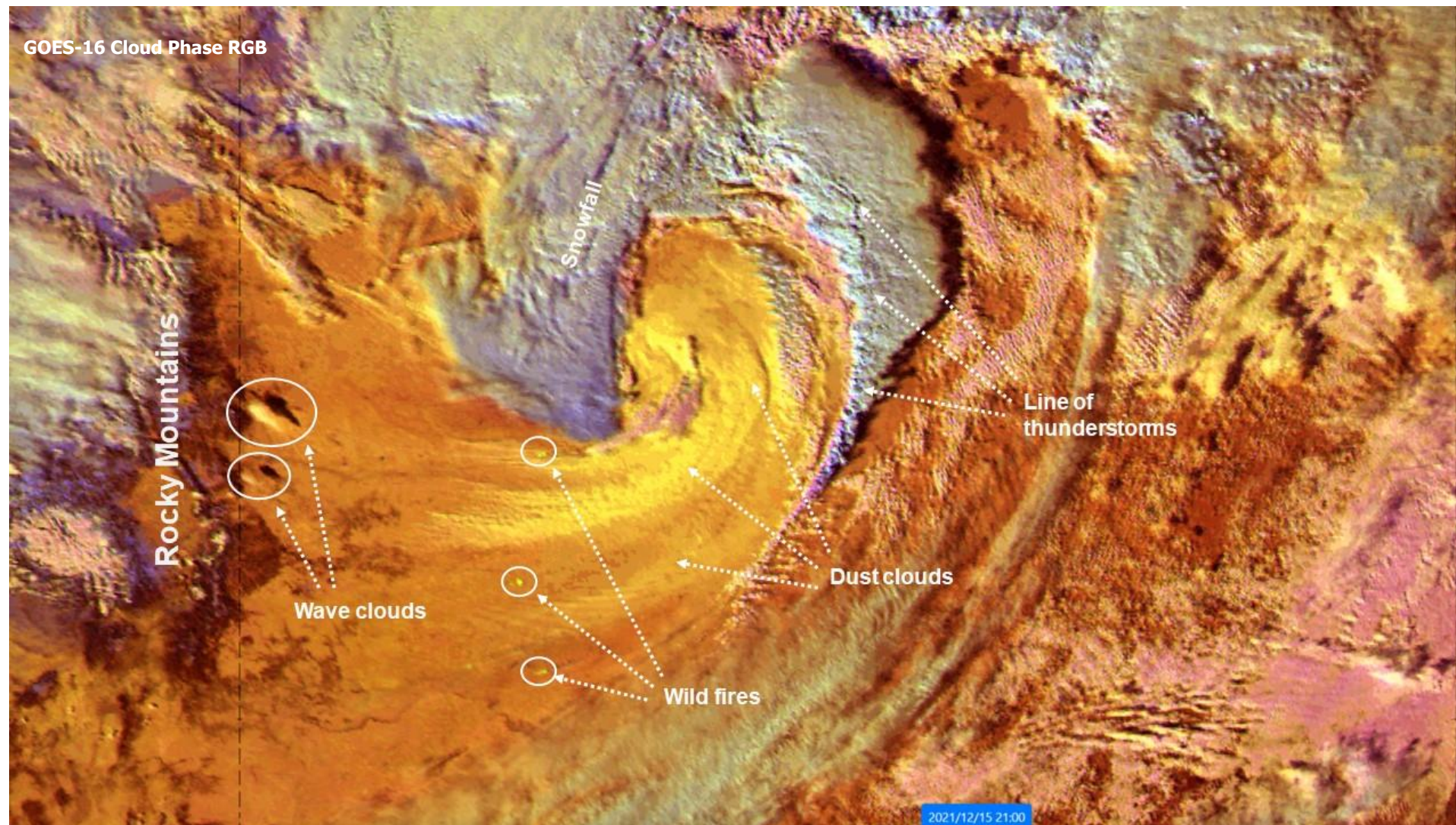


- Dust over US 15/12/2021



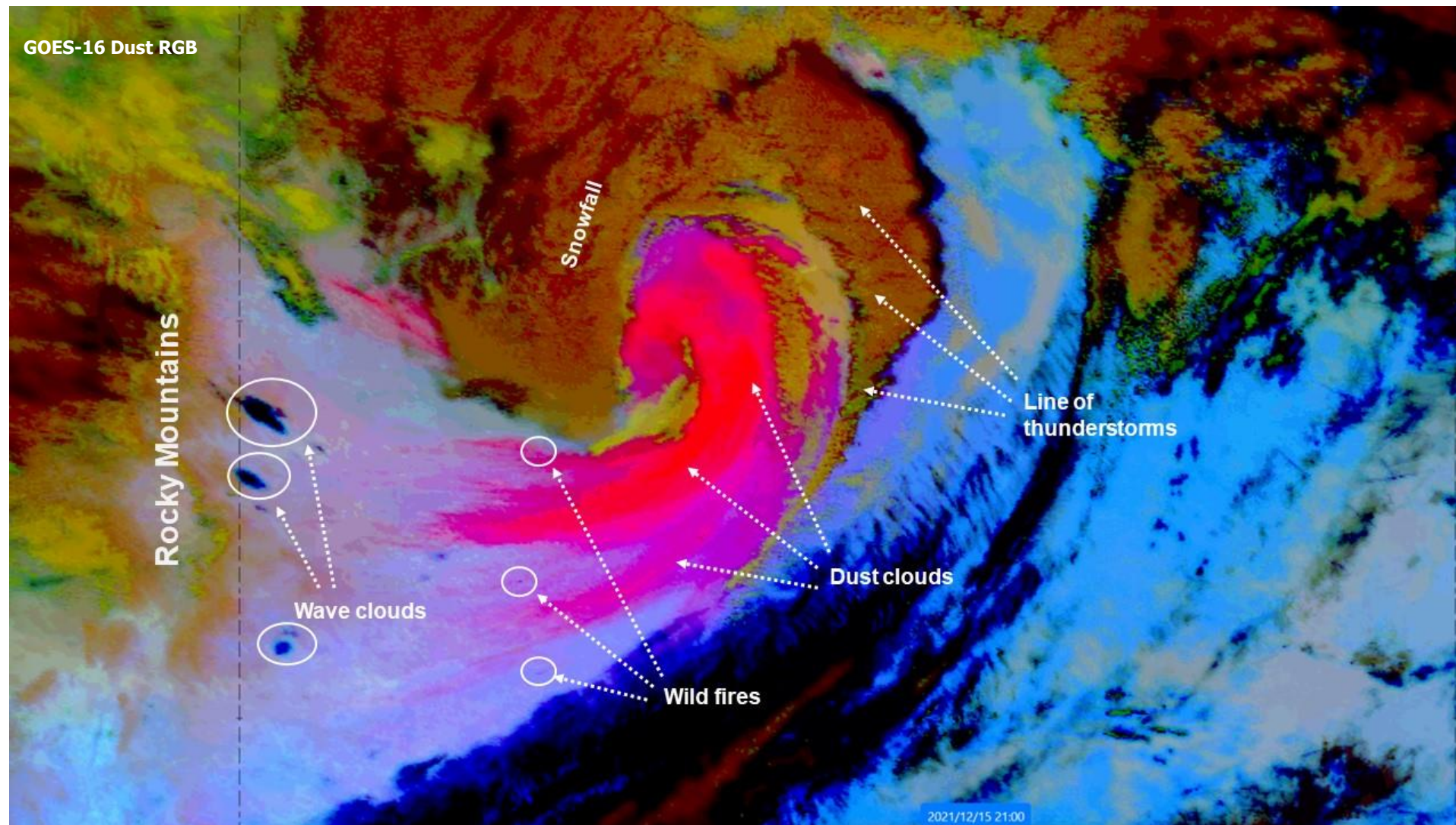


- Dust over US 15/12/2021





- Dust over US 15/12/2021

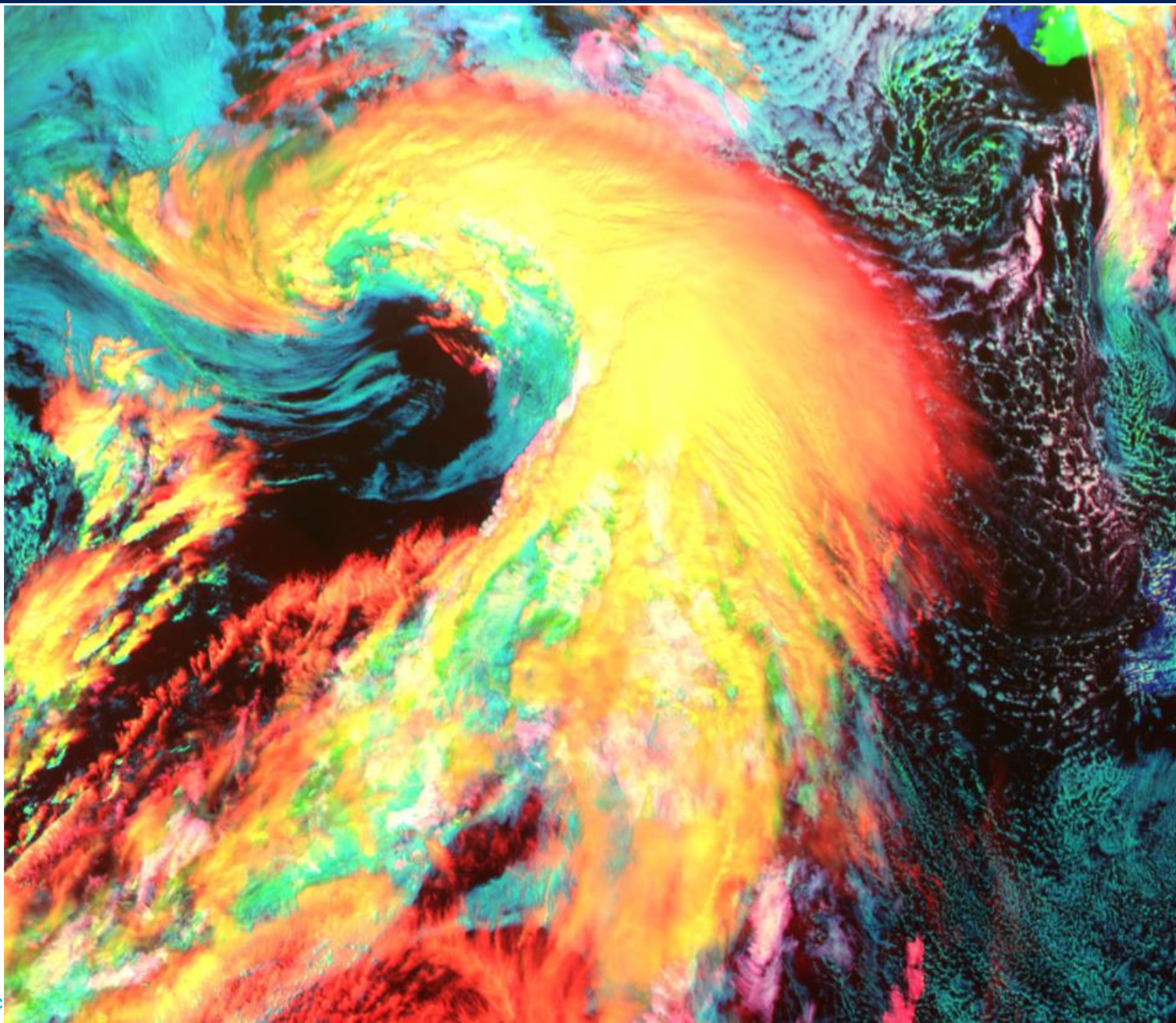




FCI applications – Cloud Type RGB

- FCI Cloud Type RGB, 18 March 2023, 11:50 UTC

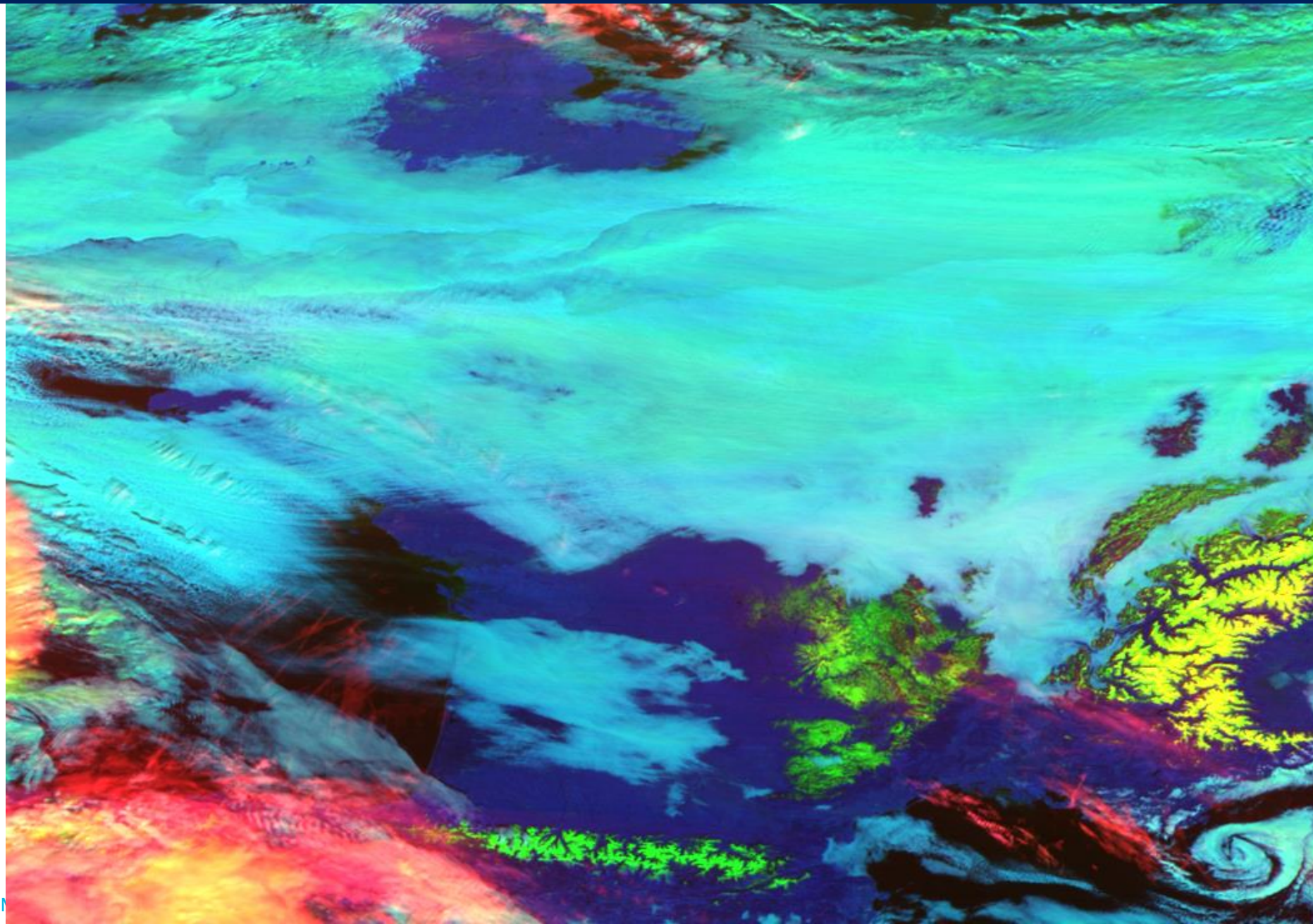
www.eumetsat.int





FCI applications – Cloud Type RGB

- MTGF FCI Cloud Type RGB taken on 13 January 2024 at 11:50 UTC)

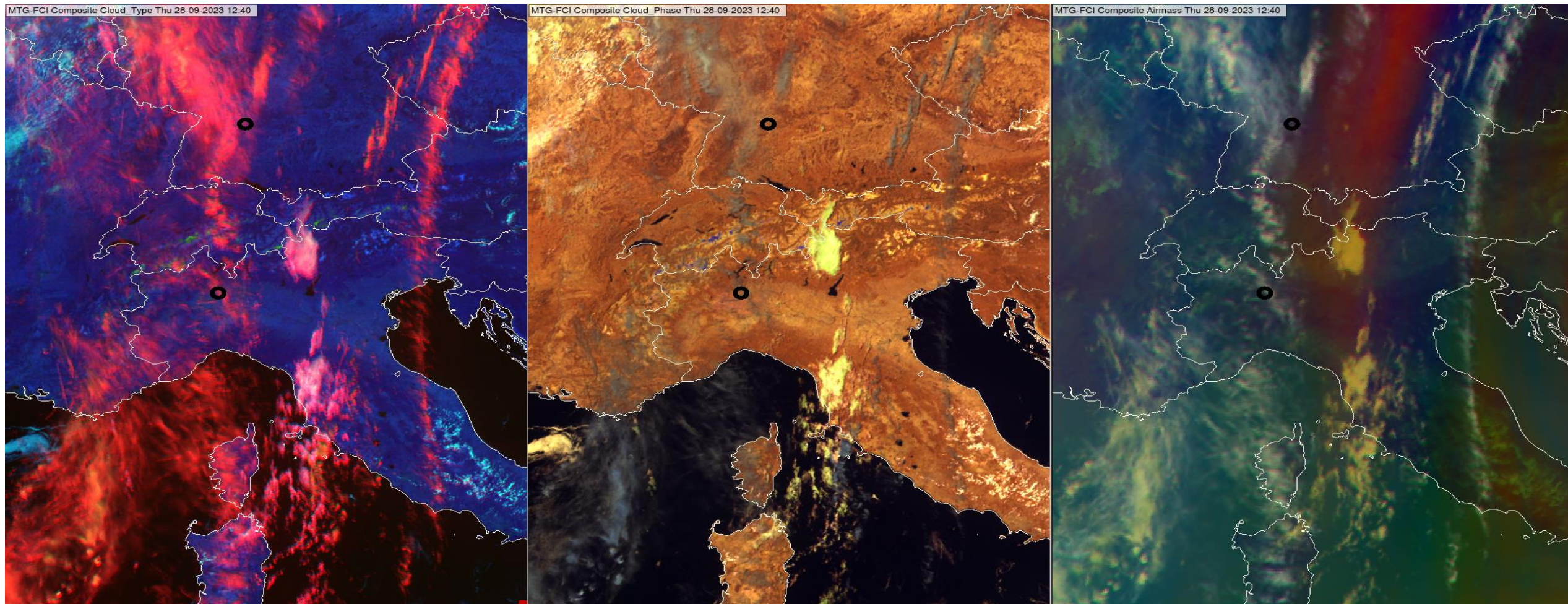


at.int



FCI applications – Cloud Type RGB

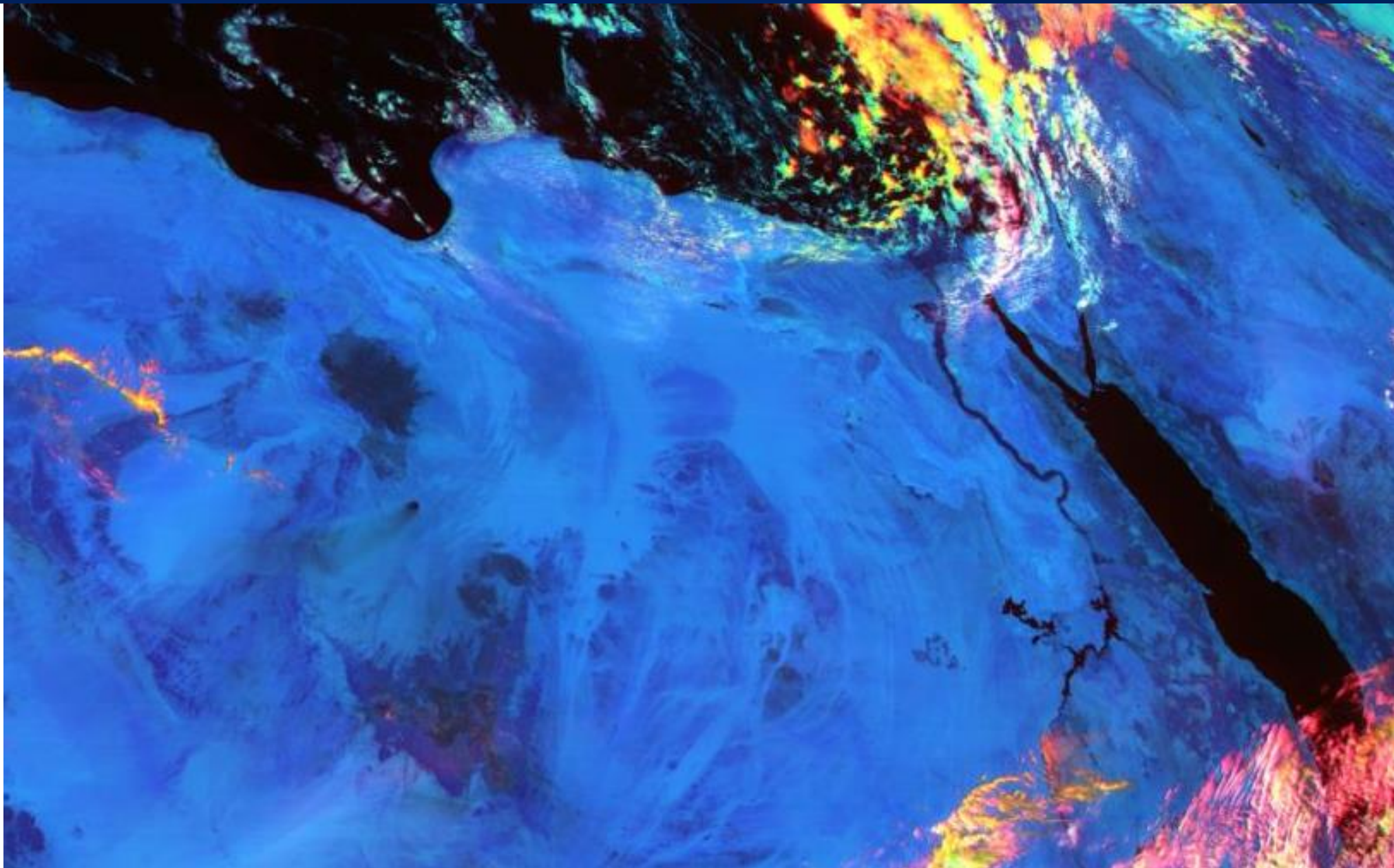
- MTG FCI Cloud Type RGB (upper left), Cloud Phase RGB (upper middle panel) and Airmass RGB (upper right) taken on 28 September 2023 at 12:40 UTC. www.eumetsat.int





FCI applications – Cloud Type RGB

- MTG FCI Cloud Type RGBs 18 March 2023, 11:50 UTC.



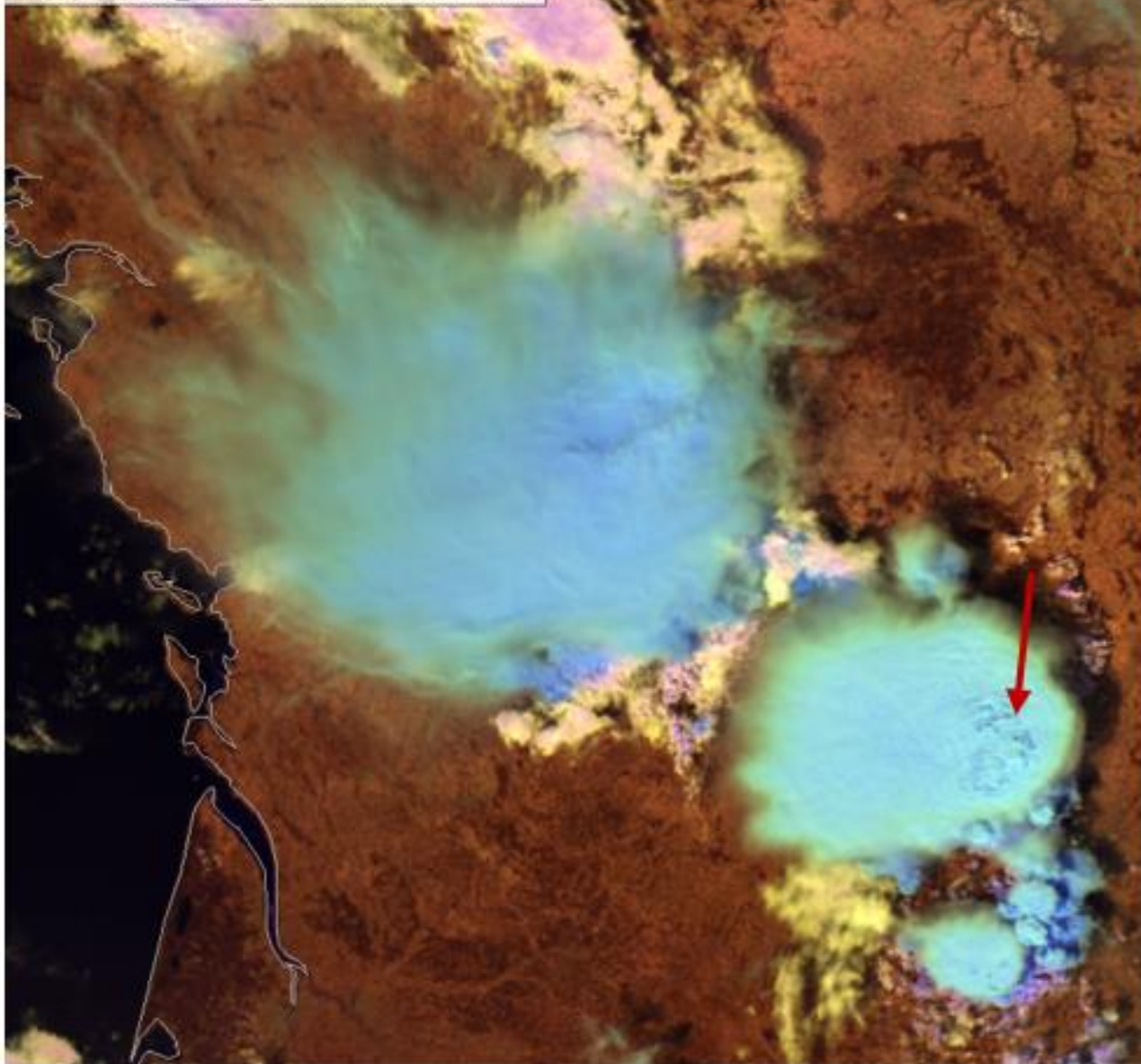


FCI applications – Cloud Type RGB

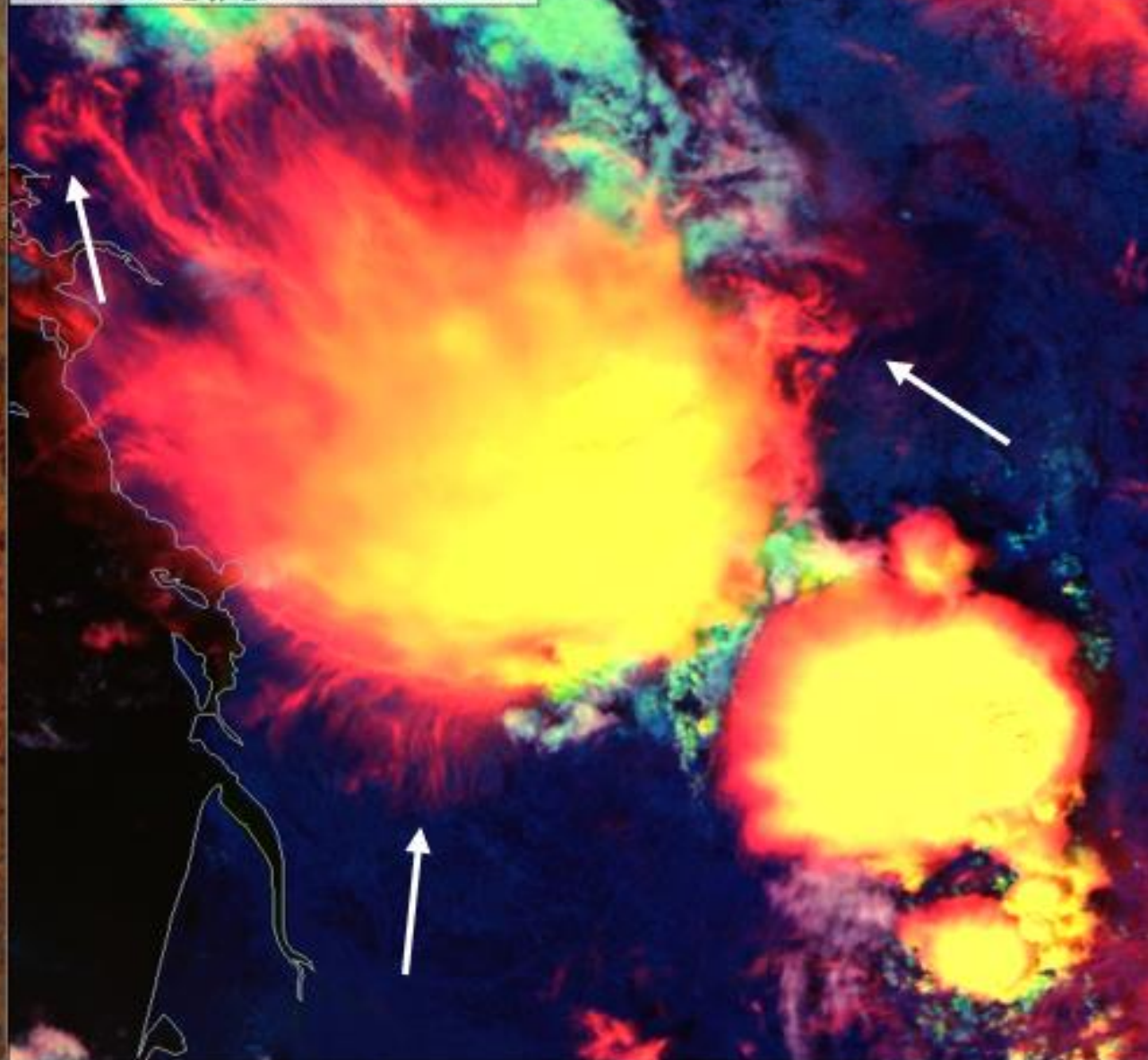
- VIIRS Cloud Phase and Cloud Type RGBs from 30 August 2020, 11:27 UTC

www.eumetsat.int

VIIRS RGB Cloud_Phase_RGB Mon 10-08-2020 11:51



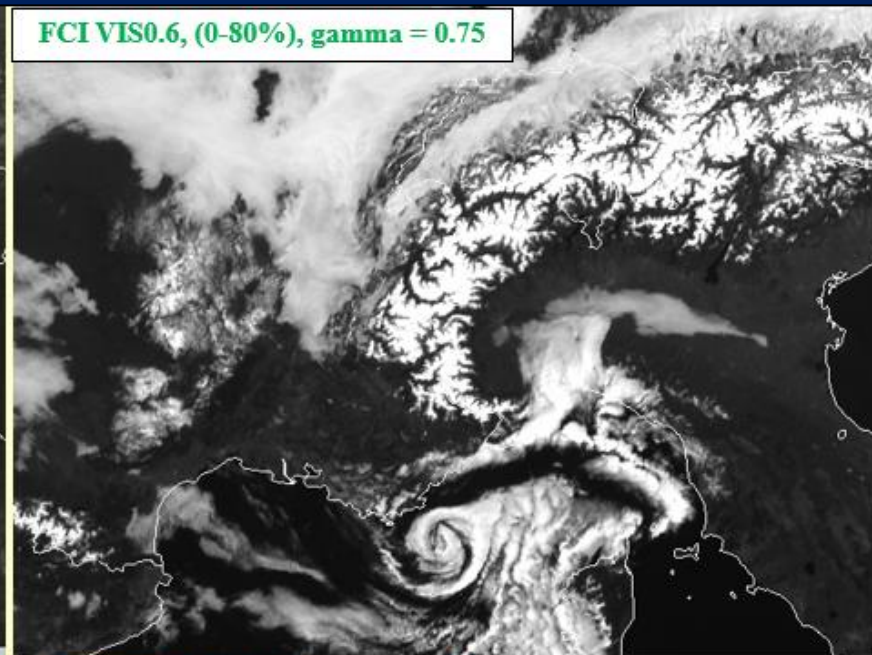
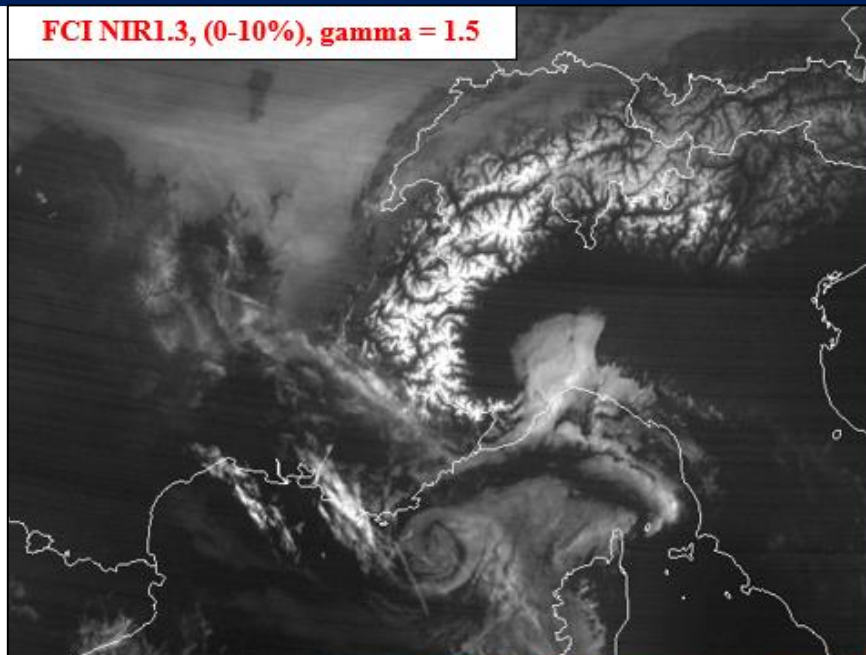
VIIRS RGB Cloud_Type_RGB Mon 10-08-2020 11:51



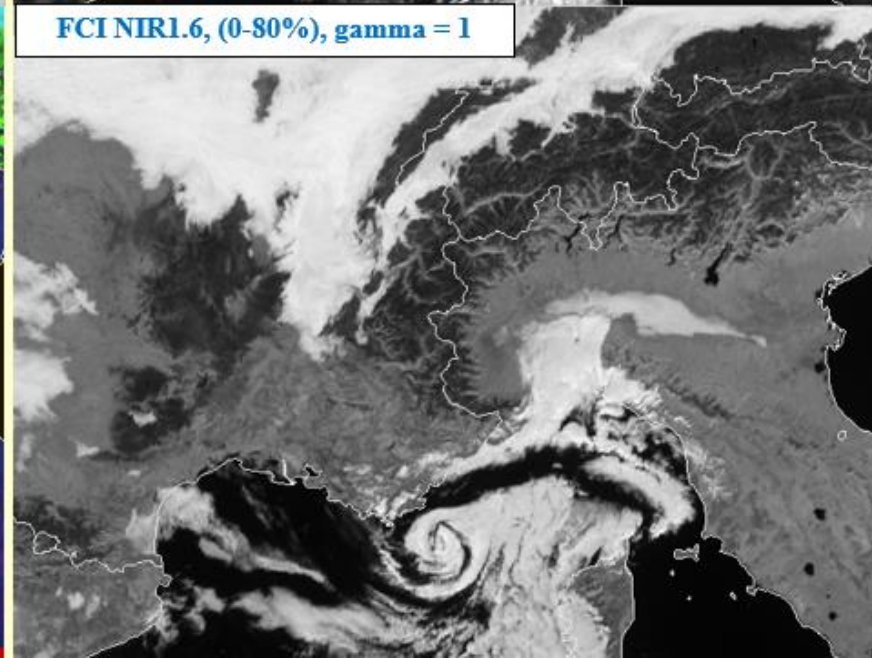
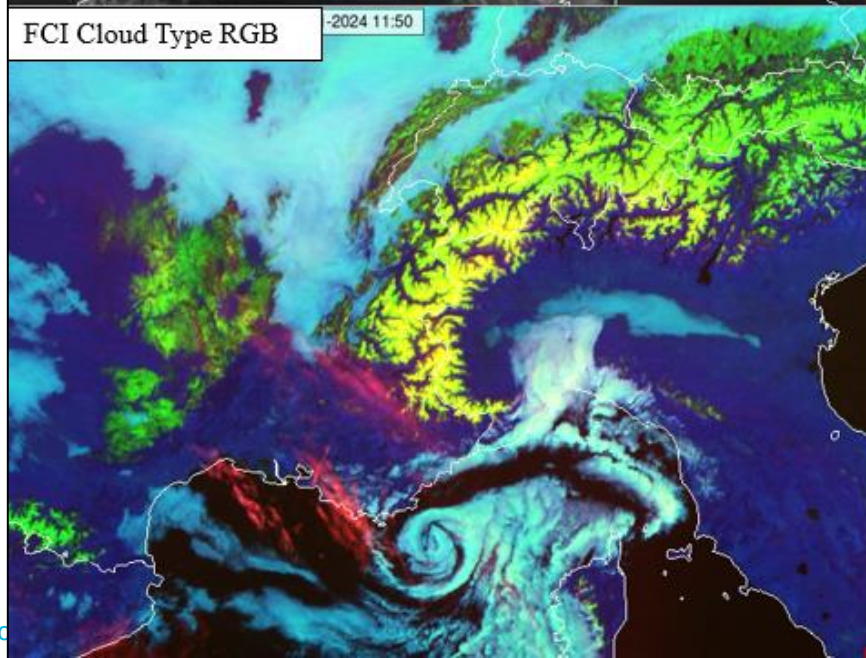


FCI applications – Cloud Type RGB

- MTG FCI Cloud Type RGB and its components, 13 January 2024, 11:50 UTC.



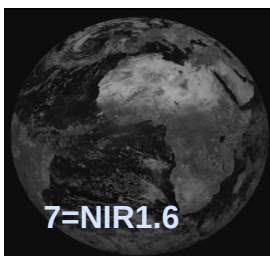
metsat.int





FCI applications – Fire Temperature RGB

www.eumetsat.int



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

R IR3.8

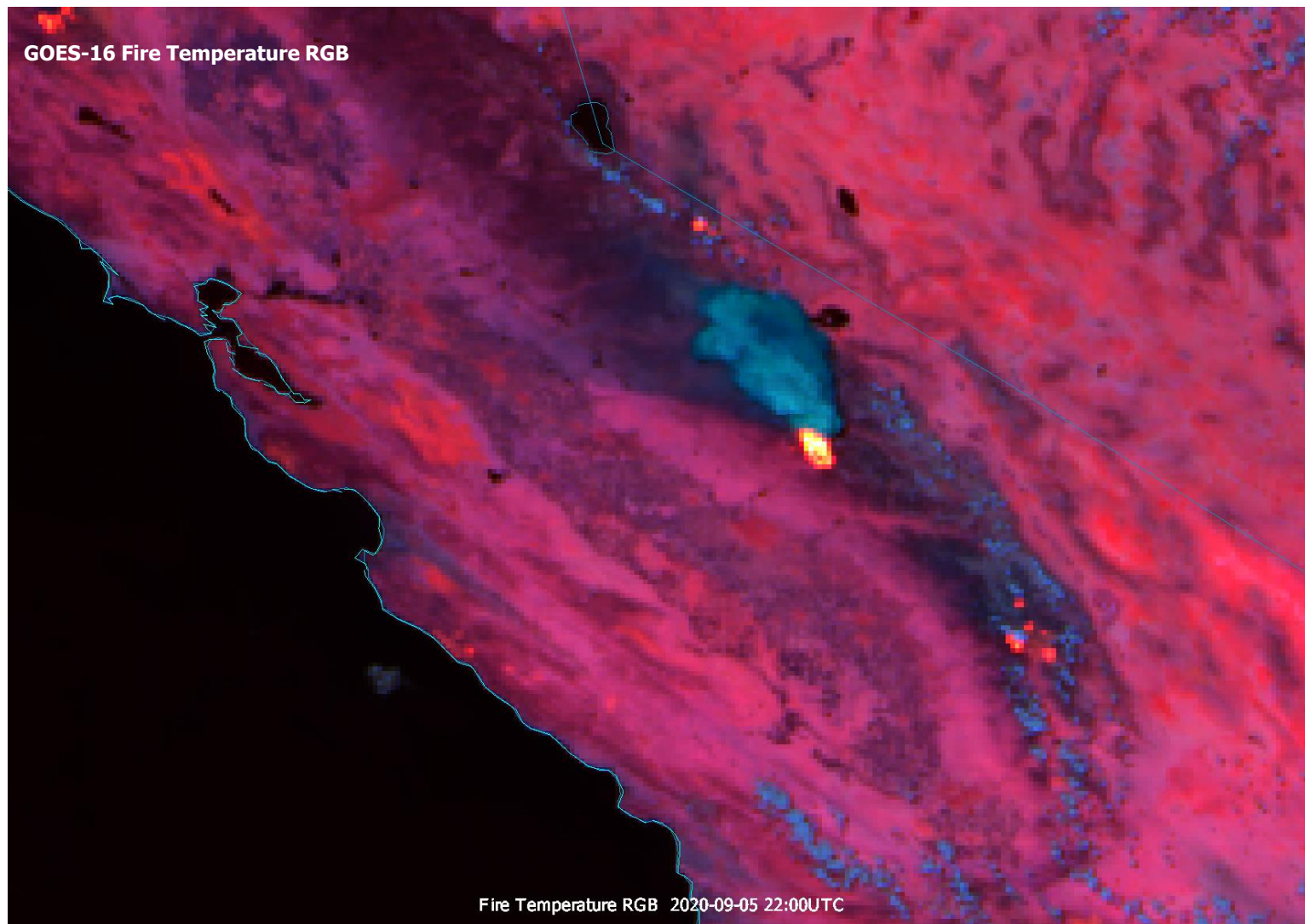
G NIR2.3

B NIR1.6



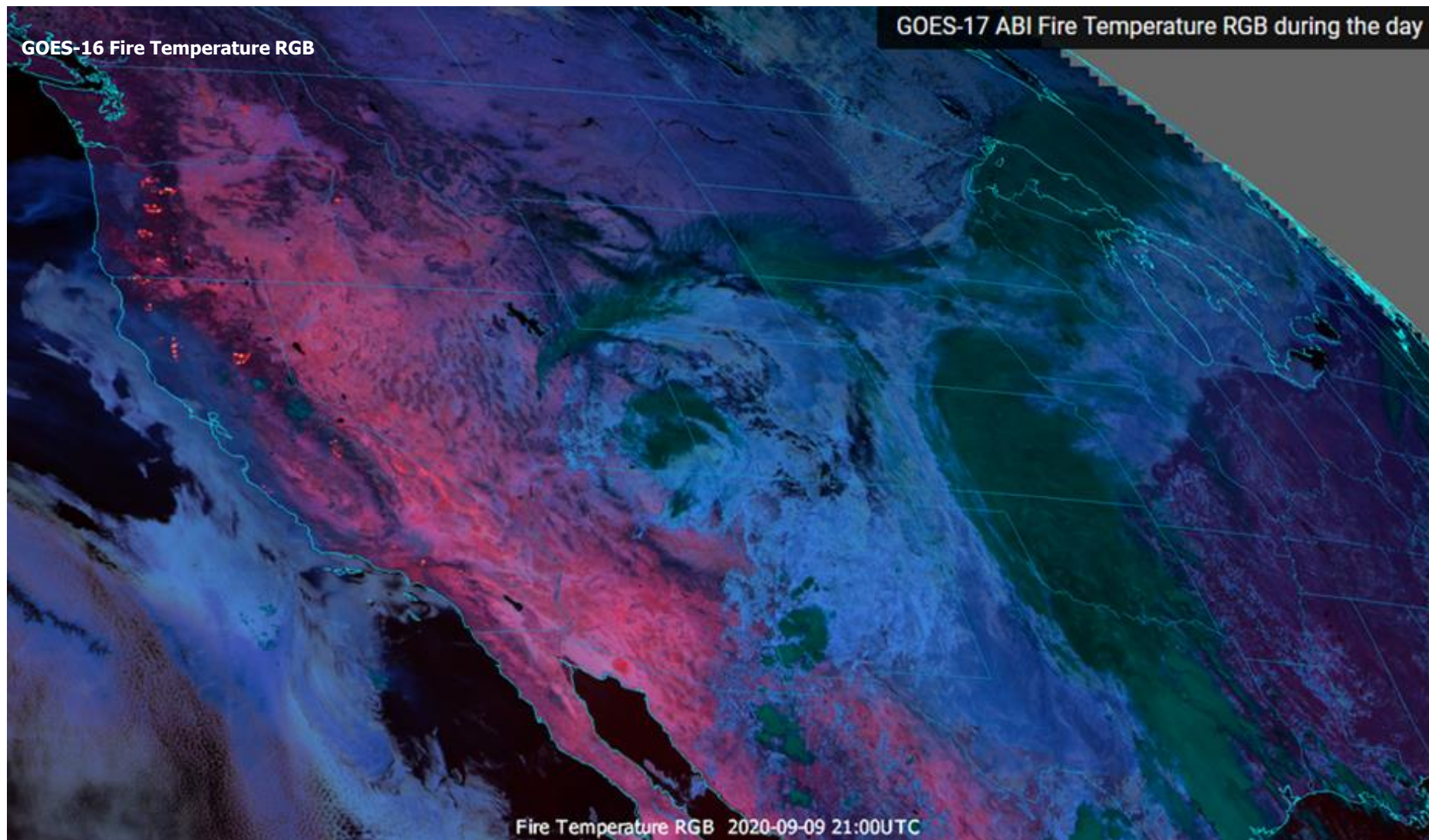


- Fires over California 05/09/2020



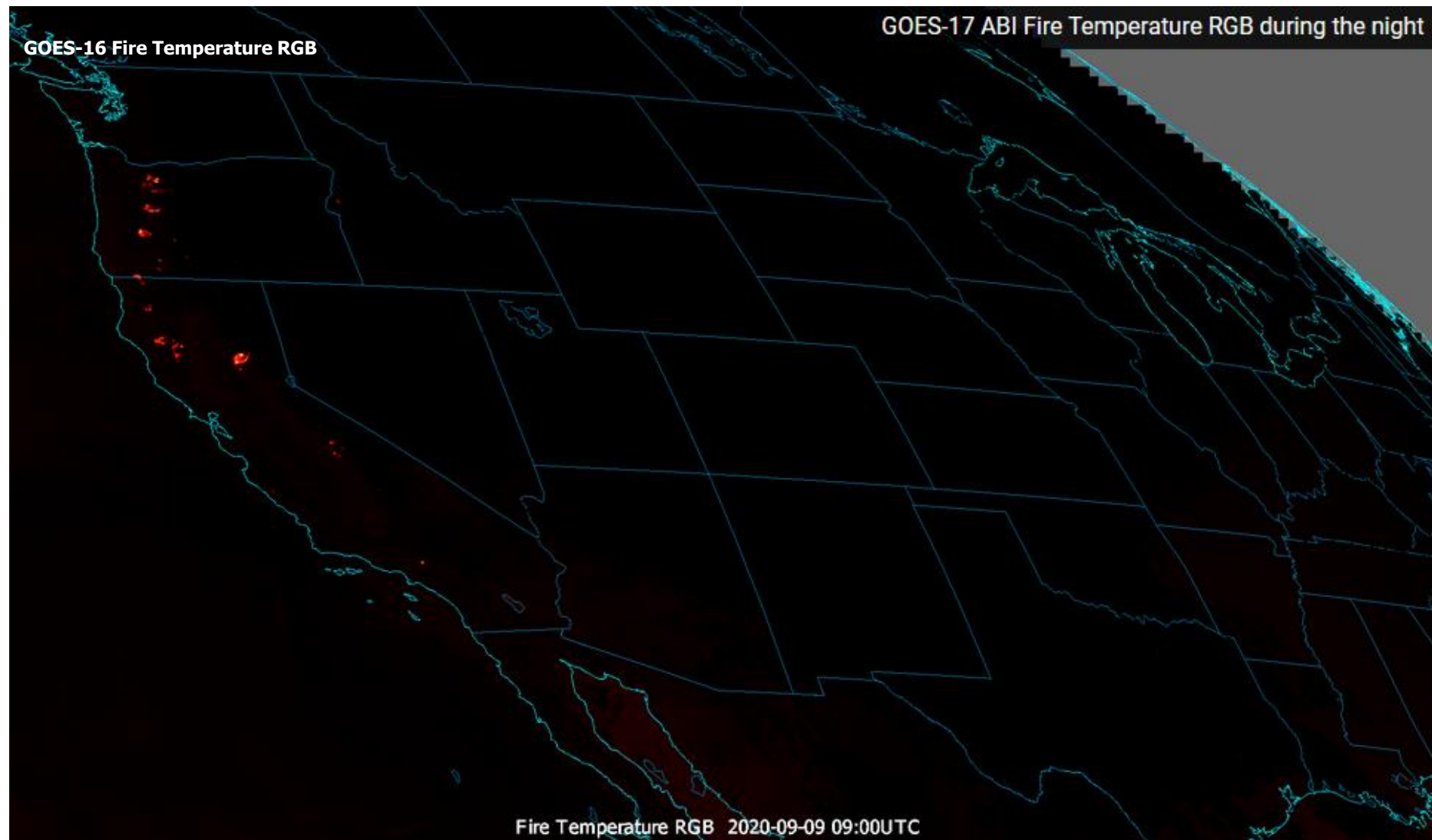


- Fires over California 09/09/2020





- Fires over California 09/09/2020





Himawari-08, New Fire Temperature RGB

16-17 October 2017

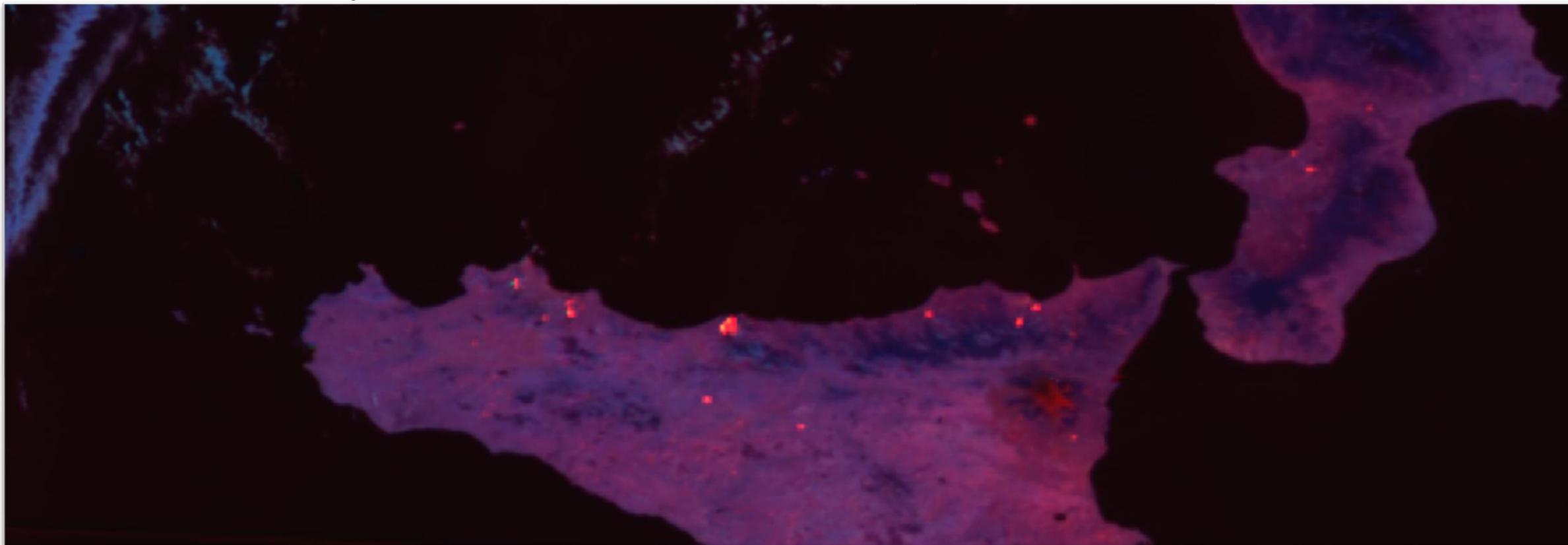
Temperature
Level

1 2 3



FCI Fire Temperature RGB

22.09.2023 10:40 UTC, Sicily



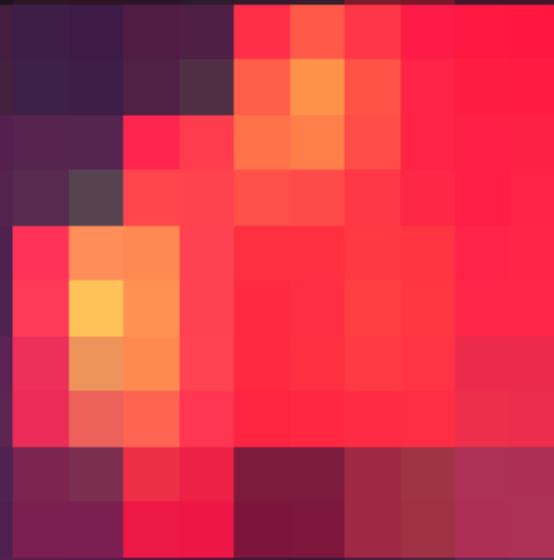
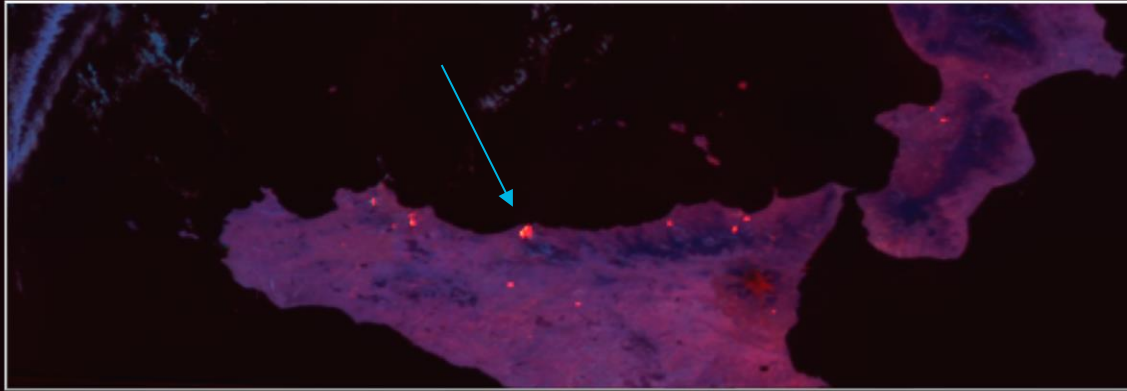
FCI Fire Temperature RGB 500m

22.09.2023 10:40 UTC

Demonstrating FCI's capabilities

Observing Fires in Sicily

Preliminary results



FCI NIR1.6 1km

22.09.2023 10:40 UTC

0-75% Refl

Demonstrating FCI's capabilities

Observing Fires in Sicily

Preliminary results



FCI IR3.8 1km
22.09.2023 10:40 UTC
273-333K, 0.4 Gamma

Demonstrating FCI's capabilities
Observing Fires in Sicily
Preliminary results



FCI NIR2.2 500m

22.09.2023 10:40 UTC

0-100% Refl

Demonstrating FCI's capabilities

Observing Fires in Sicily

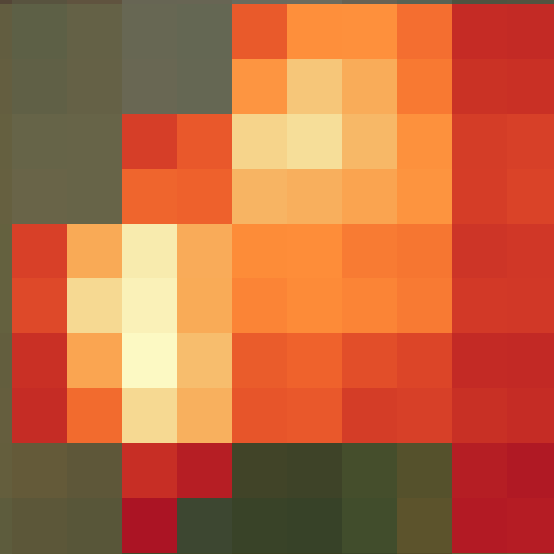
Preliminary results



FCI True Color 0.5km
Fire Temperature 0.5km
22.09.2023 10:40 UTC



Demonstrating FCI's capabilities
Observing Fires in Sicily
Preliminary results

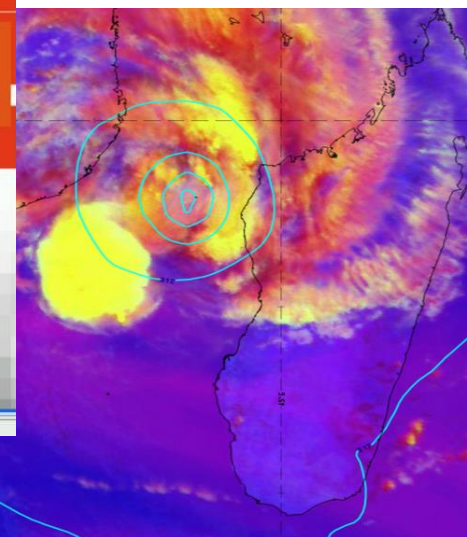
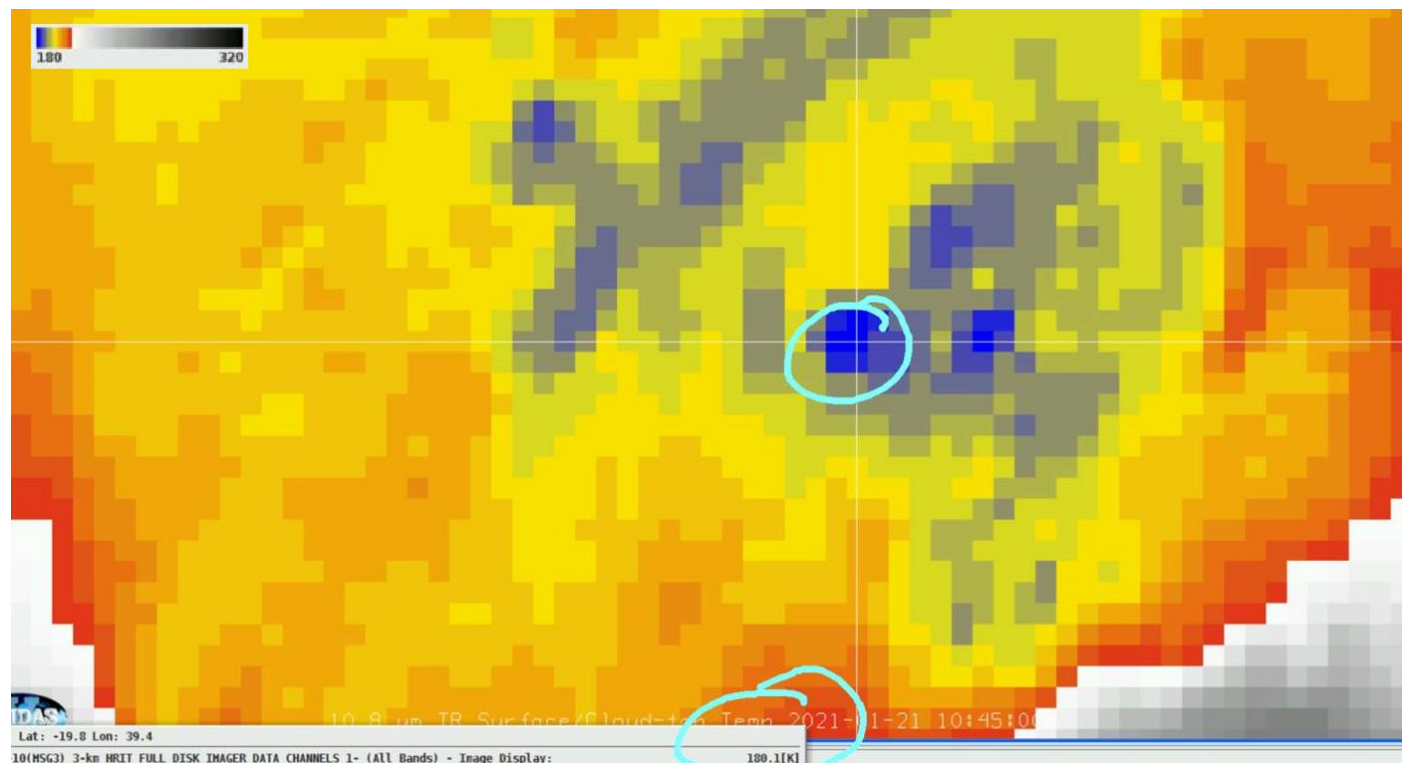




- TC Eloise – embedded convection

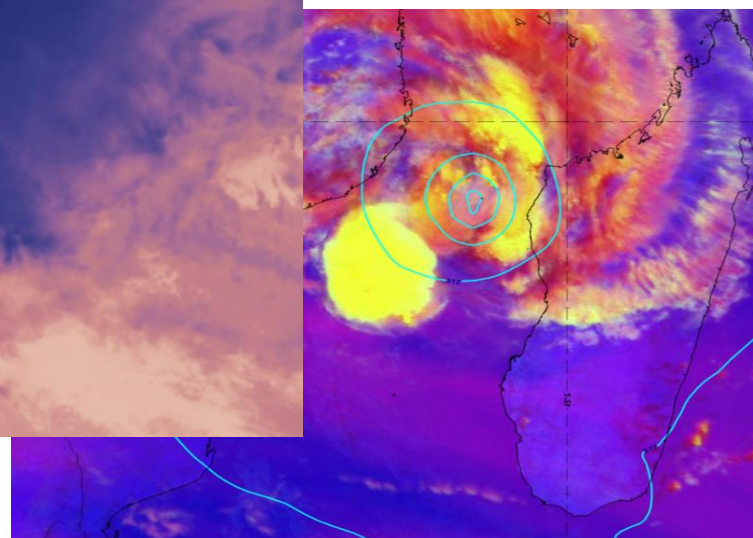
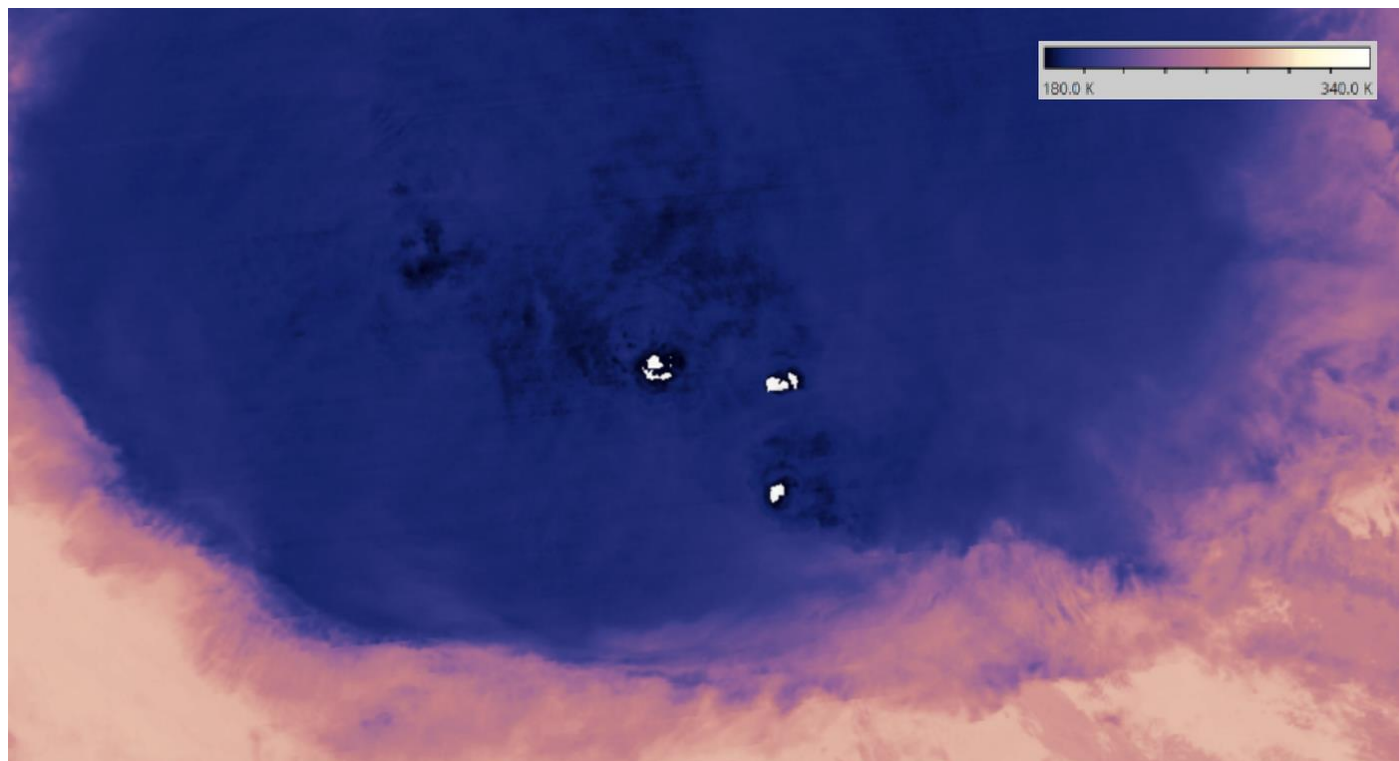
Spatial

Meteosat-11 IR10.8 window channel, 21 January 2021, 10:45 UTC



- TC Eloise – embedded convection

NOAA-20 VIIRS IR window channel, 21 January 2021, ca. 10:45 UTC



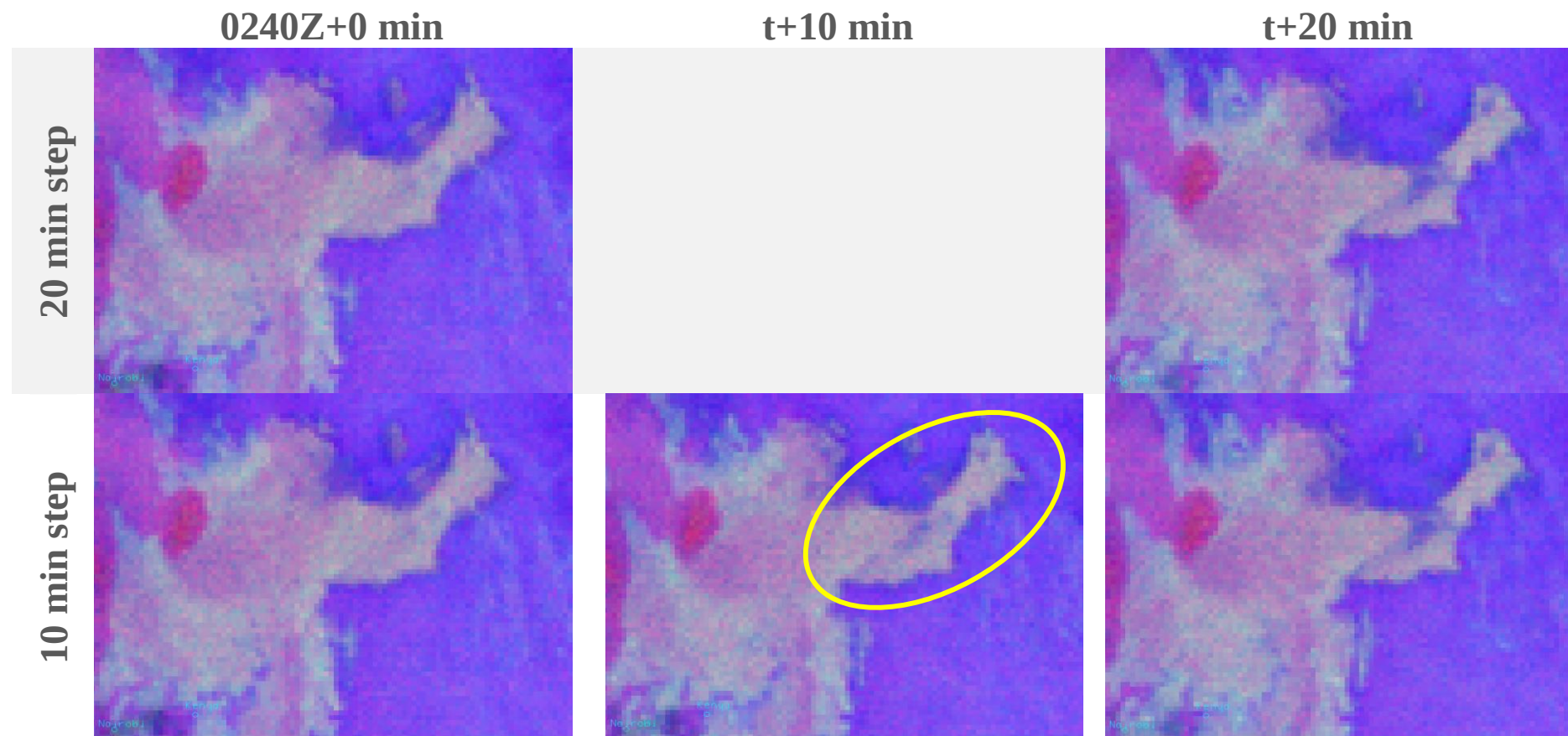
Spatial



- Fog Kenya

SEVIRI Night Microphysics RGB, 26 May 2016

Temporal

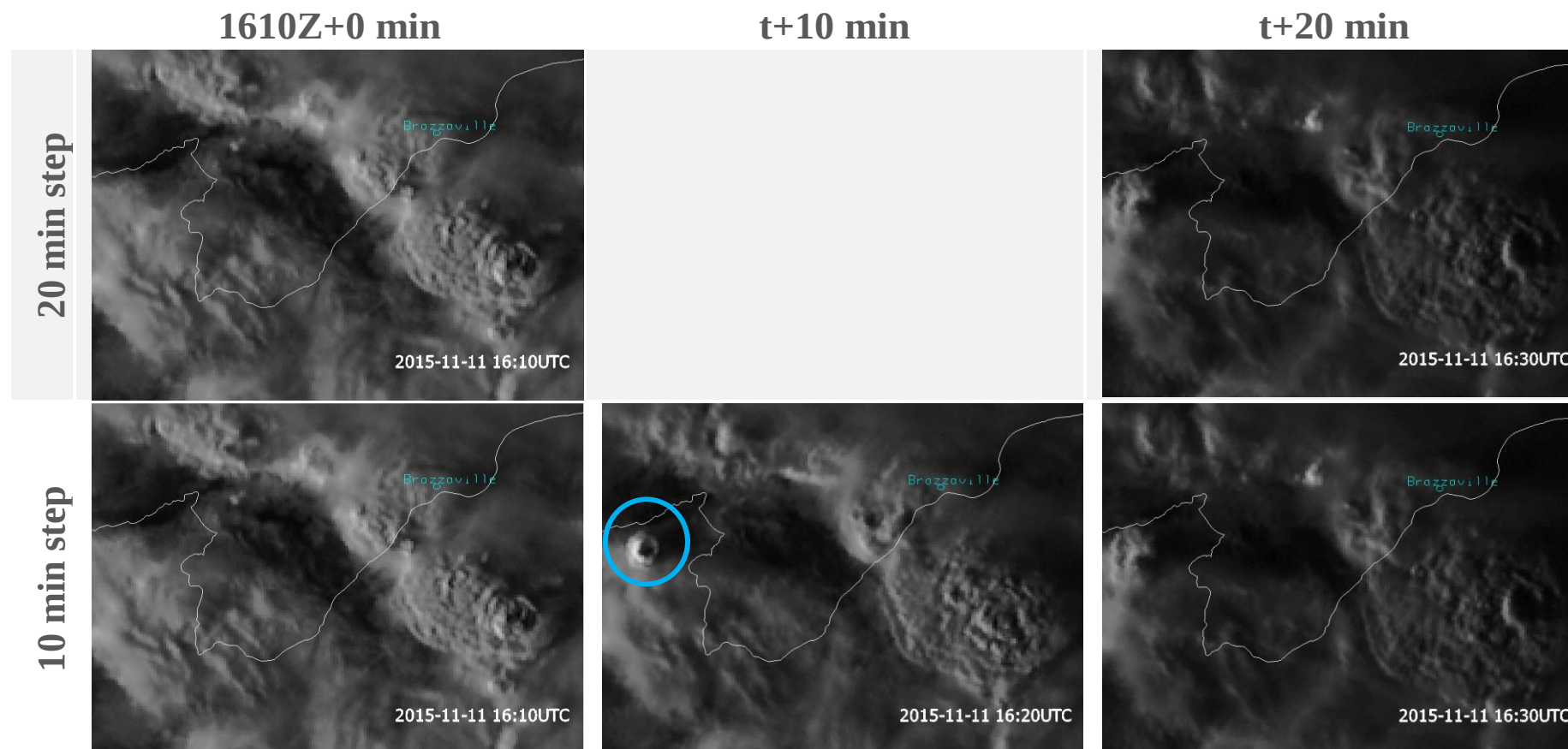




- Convection development, Congo

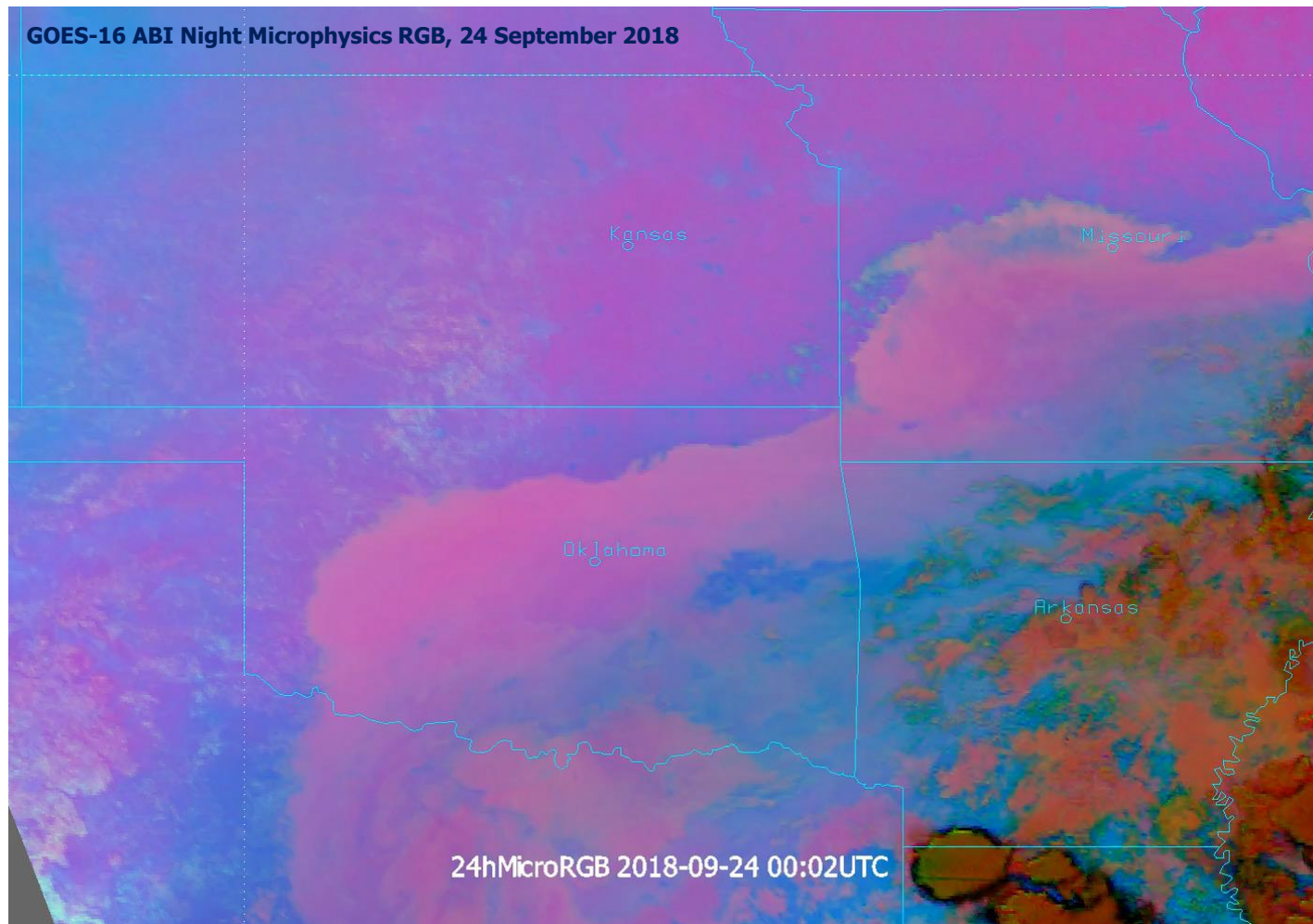
SEVIRI HRVIS channel, 11 November 2015

Temporal





- Fog/stratus dynamics, central US



Radiometric



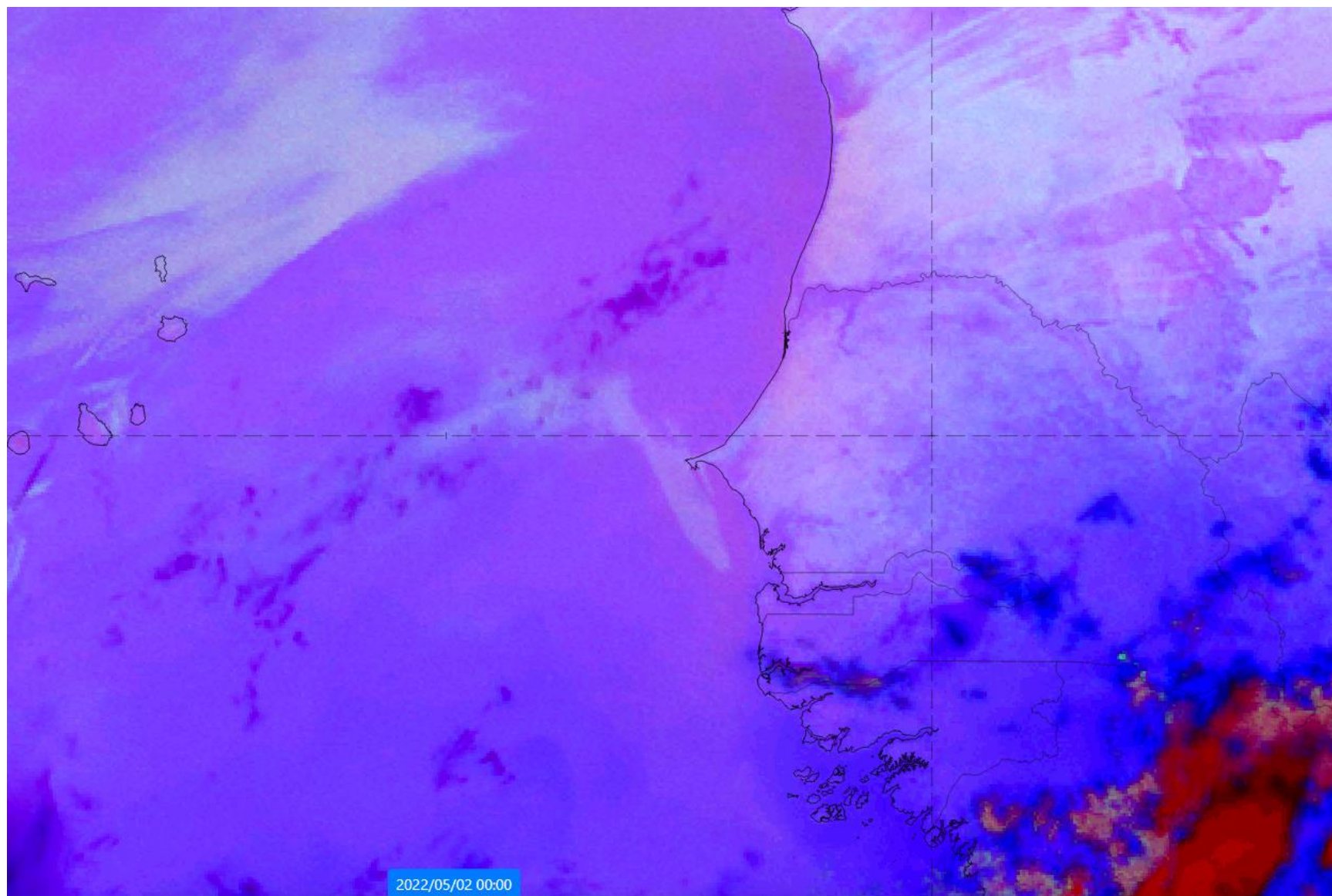
FCI view on the advection fog Epilogue to a case 2 May 2022 over Dakar.



FCI applications – case 2 May 2022 over Dakar

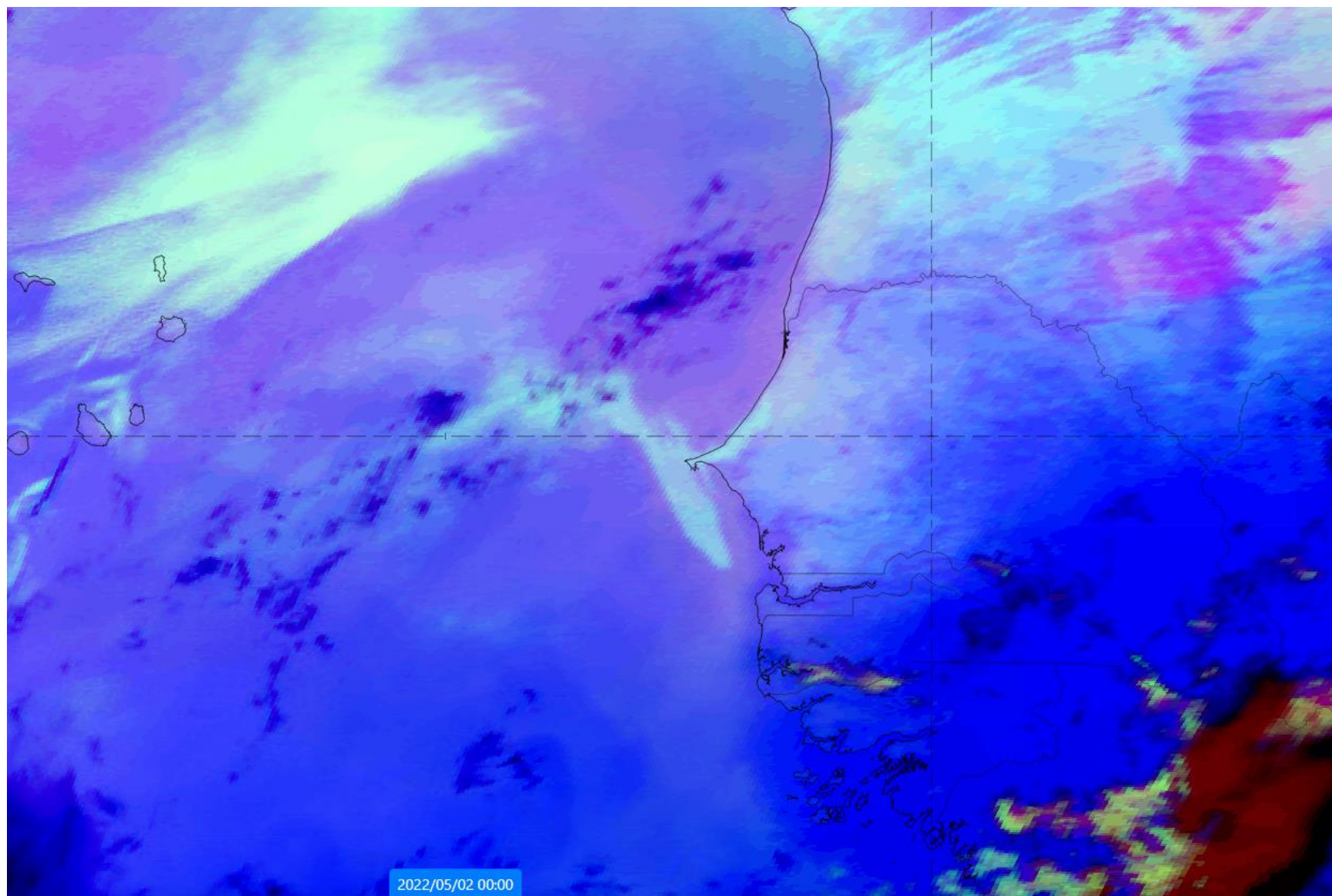
www.eumetsat.int

SEVIRI Night Microphysics RGB, 02 May 2022





GOES-16 ABI Night Microphysics RGB, 24 September 2018

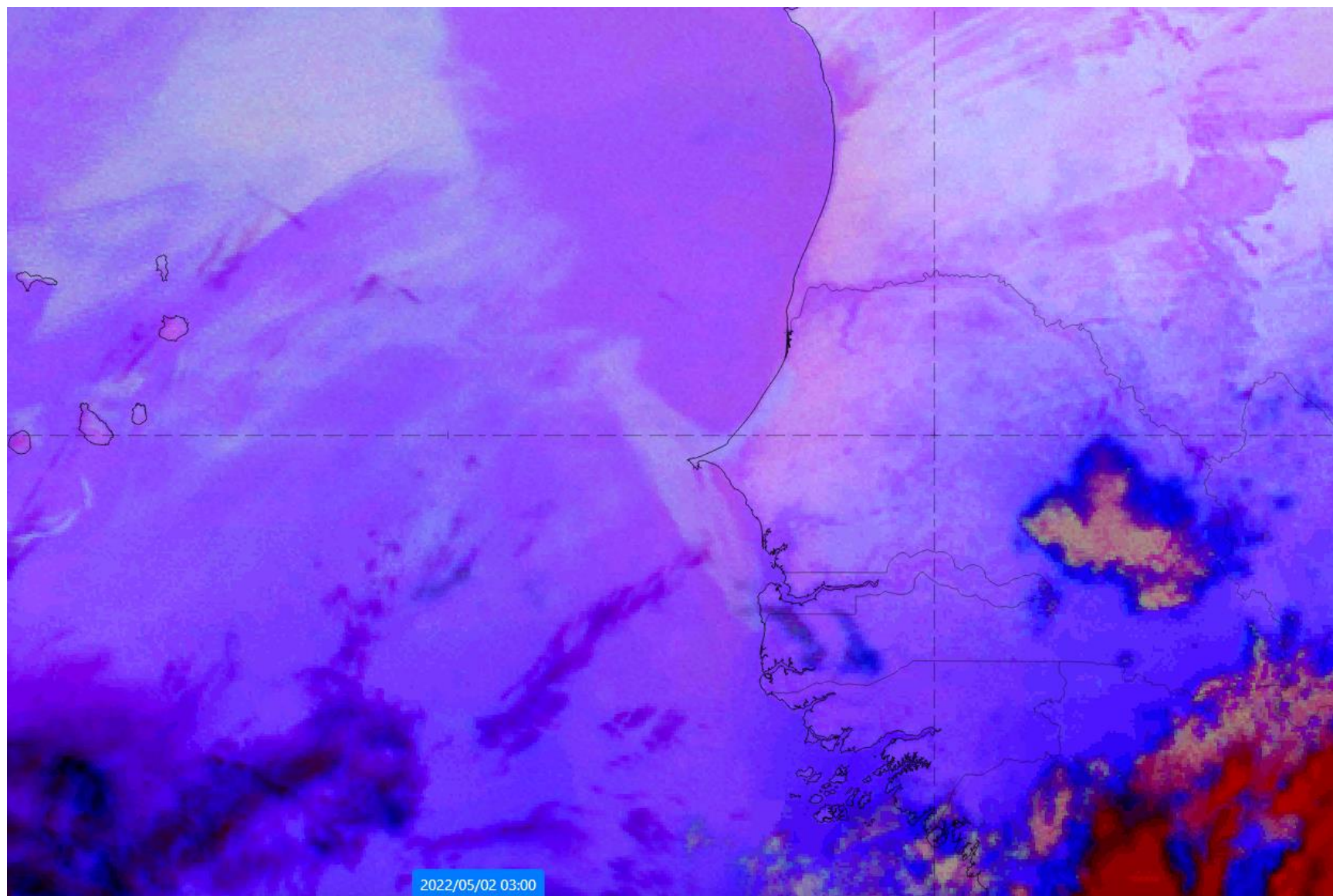




FCI applications – case 2 May 2022 over Dakar

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SEVIRI Night Microphysics RGB, 02 May 2022

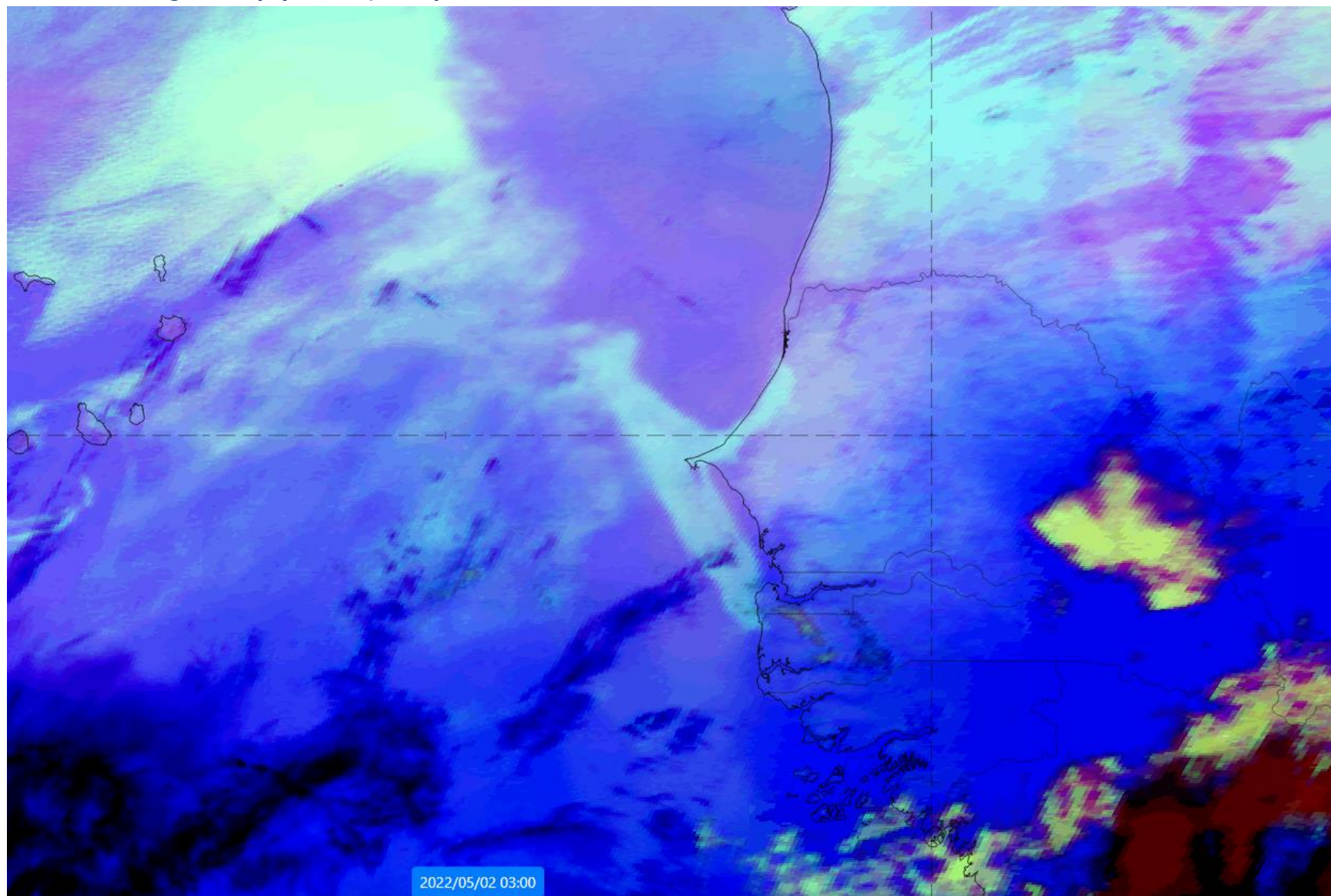




FCI applications – case 2 May 2022 over Dakar

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GOES-16 ABI Night Microphysics RGB, 24 September 2018



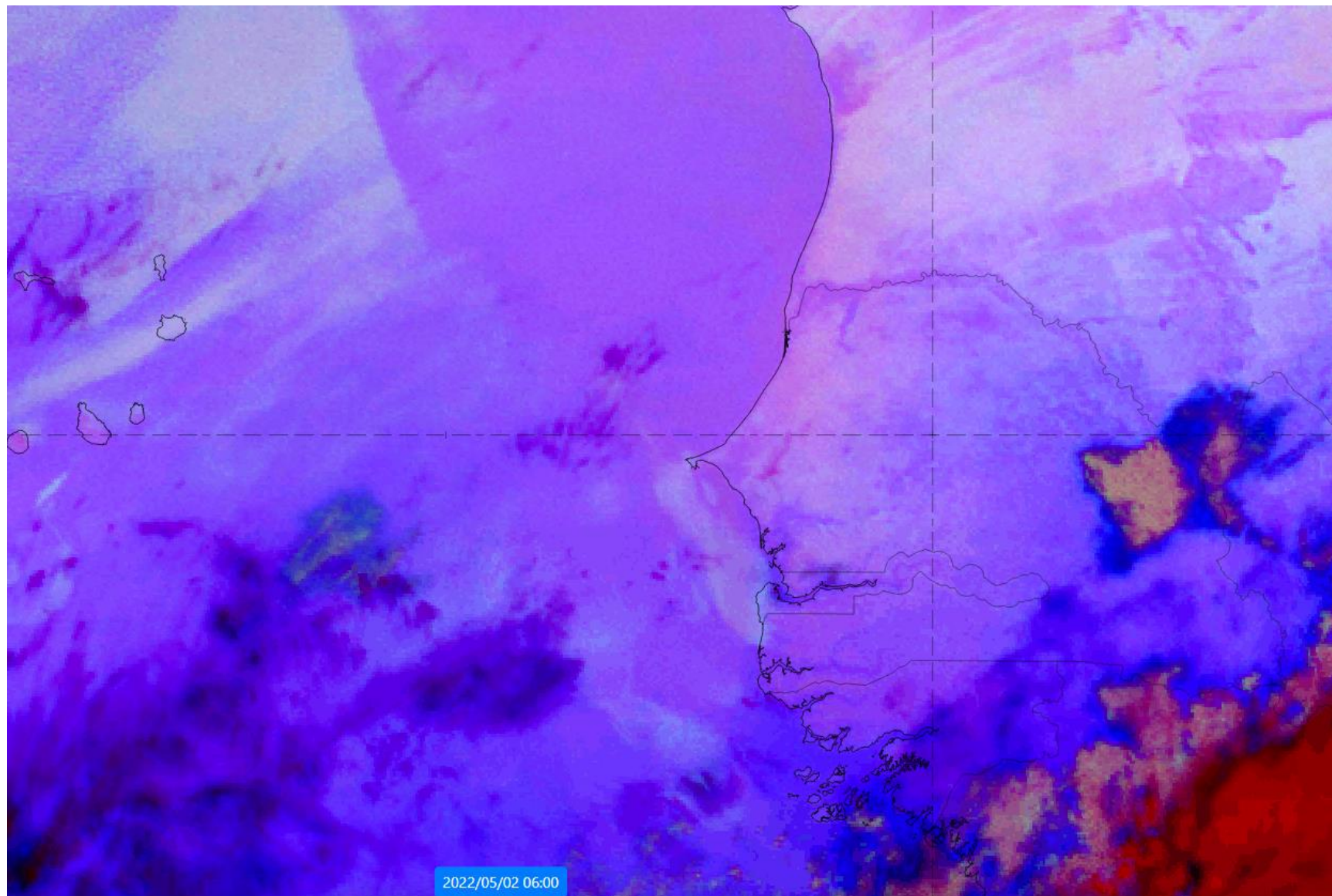
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SEVIRI Night Microphysics RGB, 02 May 2022

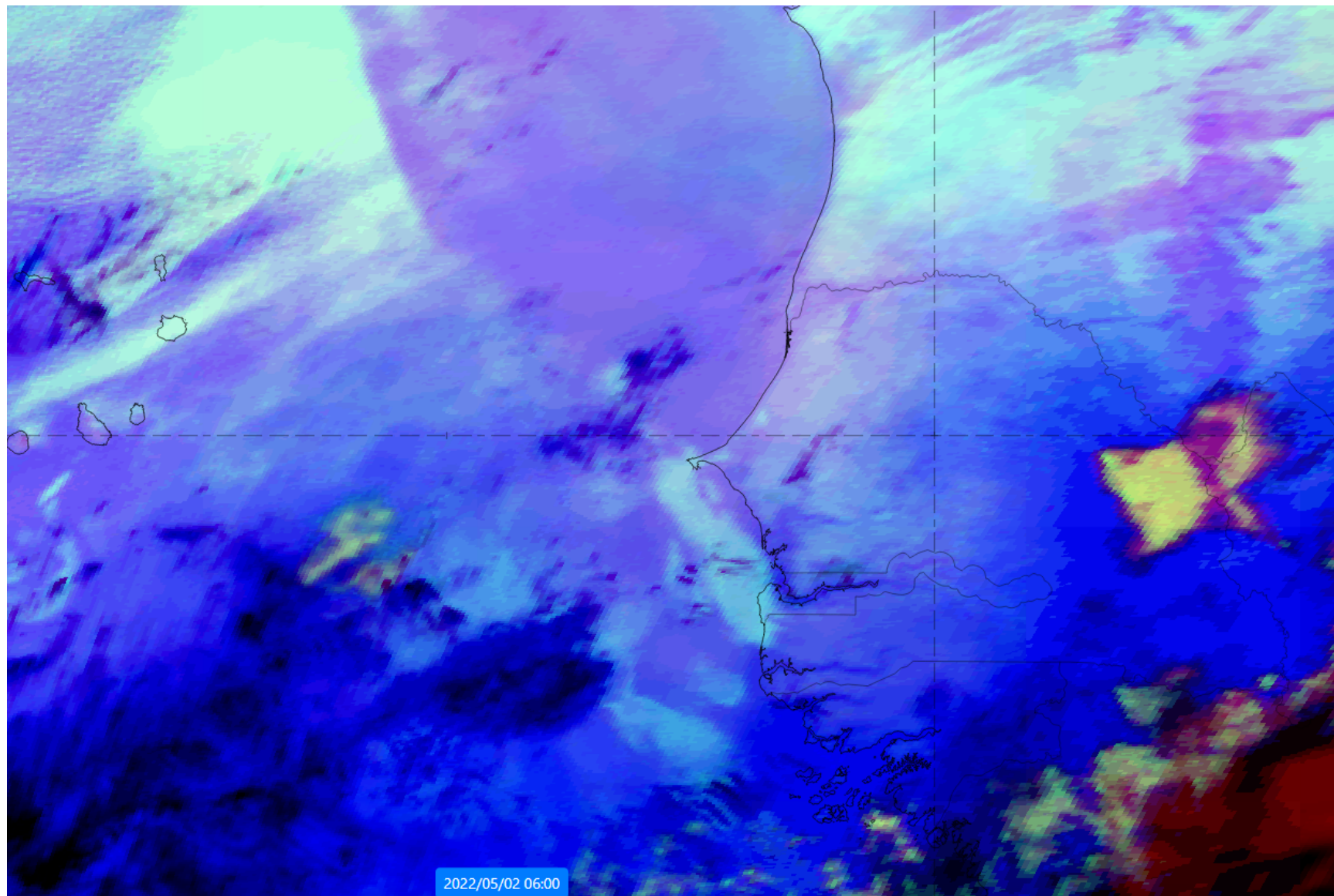




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GOES-16 ABI Night Microphysics RGB, 24 September 2018



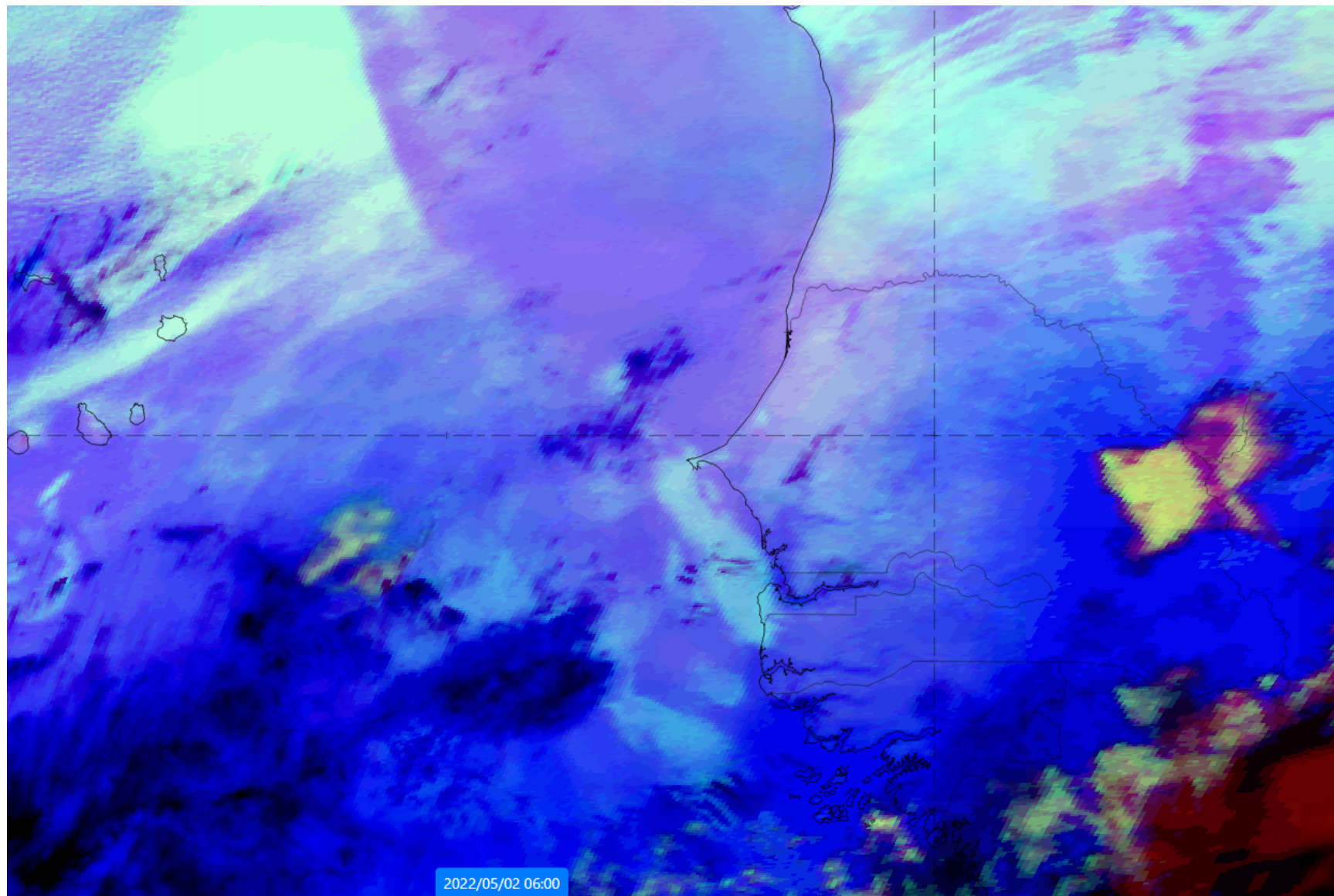
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FCI applications – case 2 May 2022 over Dakar

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GOES-16 ABI Night Microphysics RGB, 24 September 2018



2022/05/02 06:00

G-16 VIS06 view

Asante!

Questions are welcome.

2020-06-29 15:50UTC

