Short Course: Marine Weather Forecasting – Examples

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EUMETSAT Training Team

EUMETSAT Short Courses, 8 June 2022

Agenda

Marine weather analysis

Synoptic analysis, weather patterns, hazards

Sea state analysis

Surface winds and waves

Ocean properties

Ocean height, temperature, colour, sea ice

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slido

What is the ultimate origin of energy contained in the ocean waves?

ⓘ Start presenting to display the poll results on this slide.

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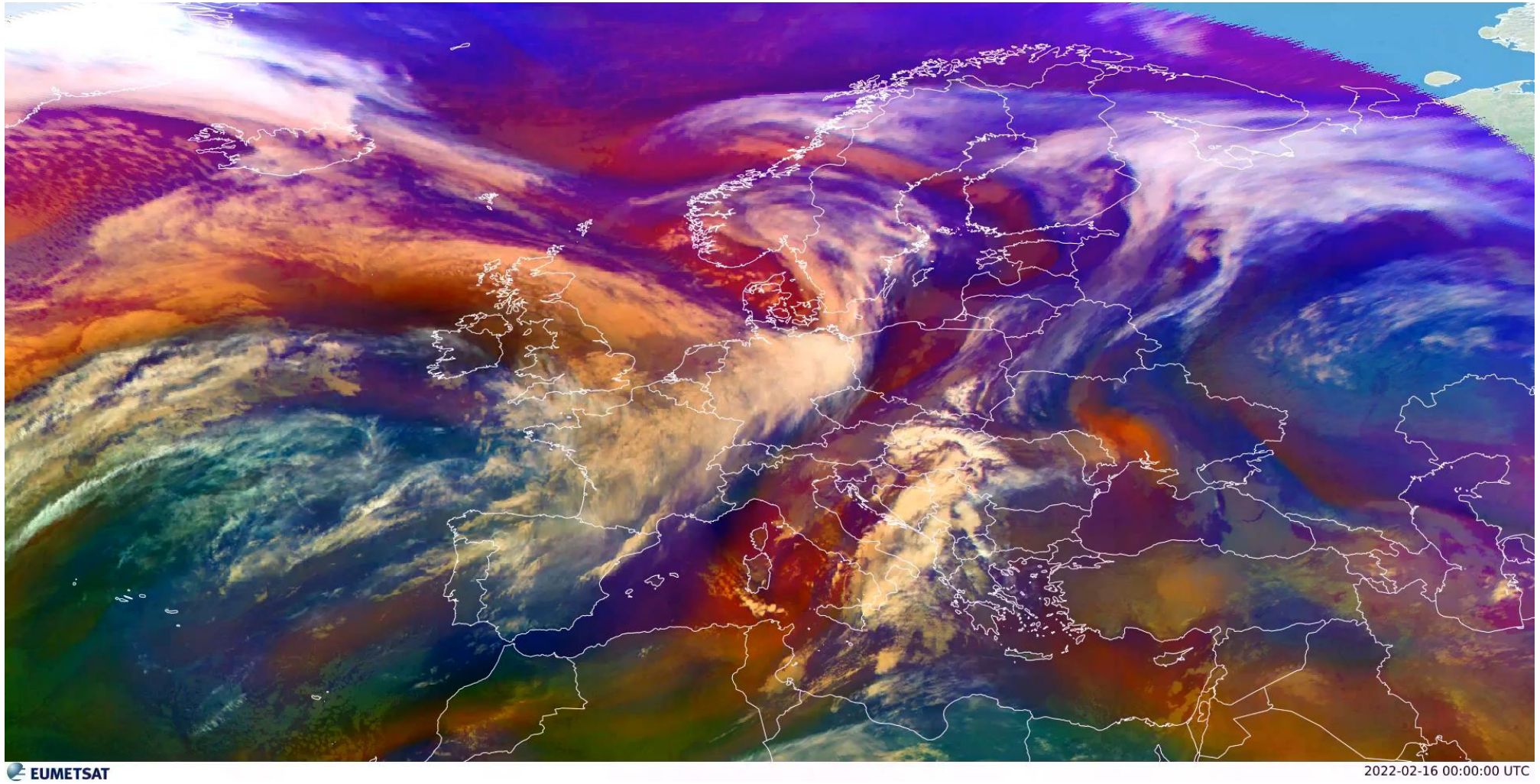
Marine weather analysis: **Synoptic scale**

www.eumetsat.int

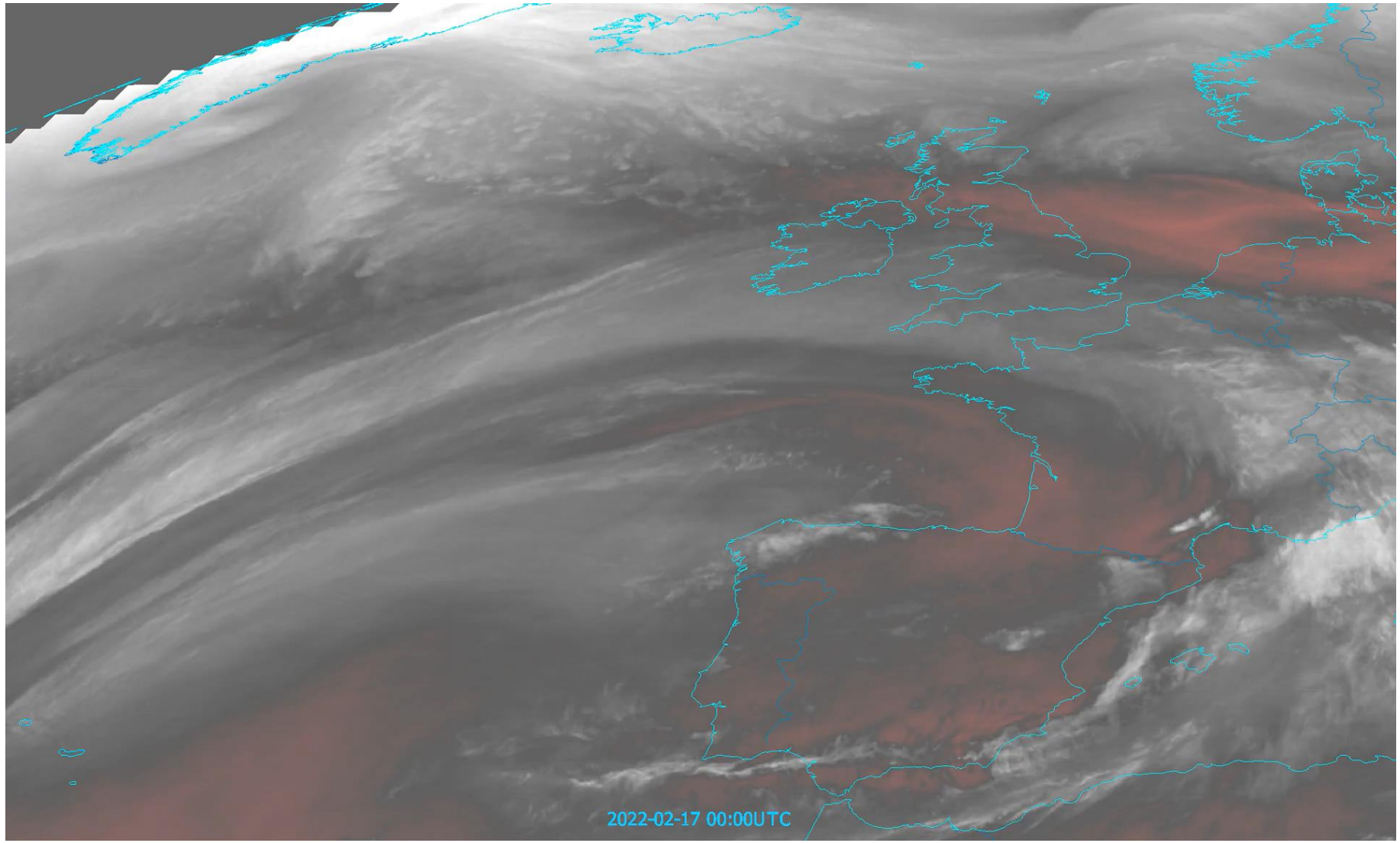
- **Distribution of air masses**
- **Synoptic dynamics**
- **Wind forcing**



Storm Dudley: Meteosat-11 Airmass RGB, 16 February 00:00 UTC-17 February 2022 12:00 UTC

Marine weather analysis: **Synoptic scale**

- Distribution of air masses
- Synoptic dynamics
- Wind forcing
- Conceptual models

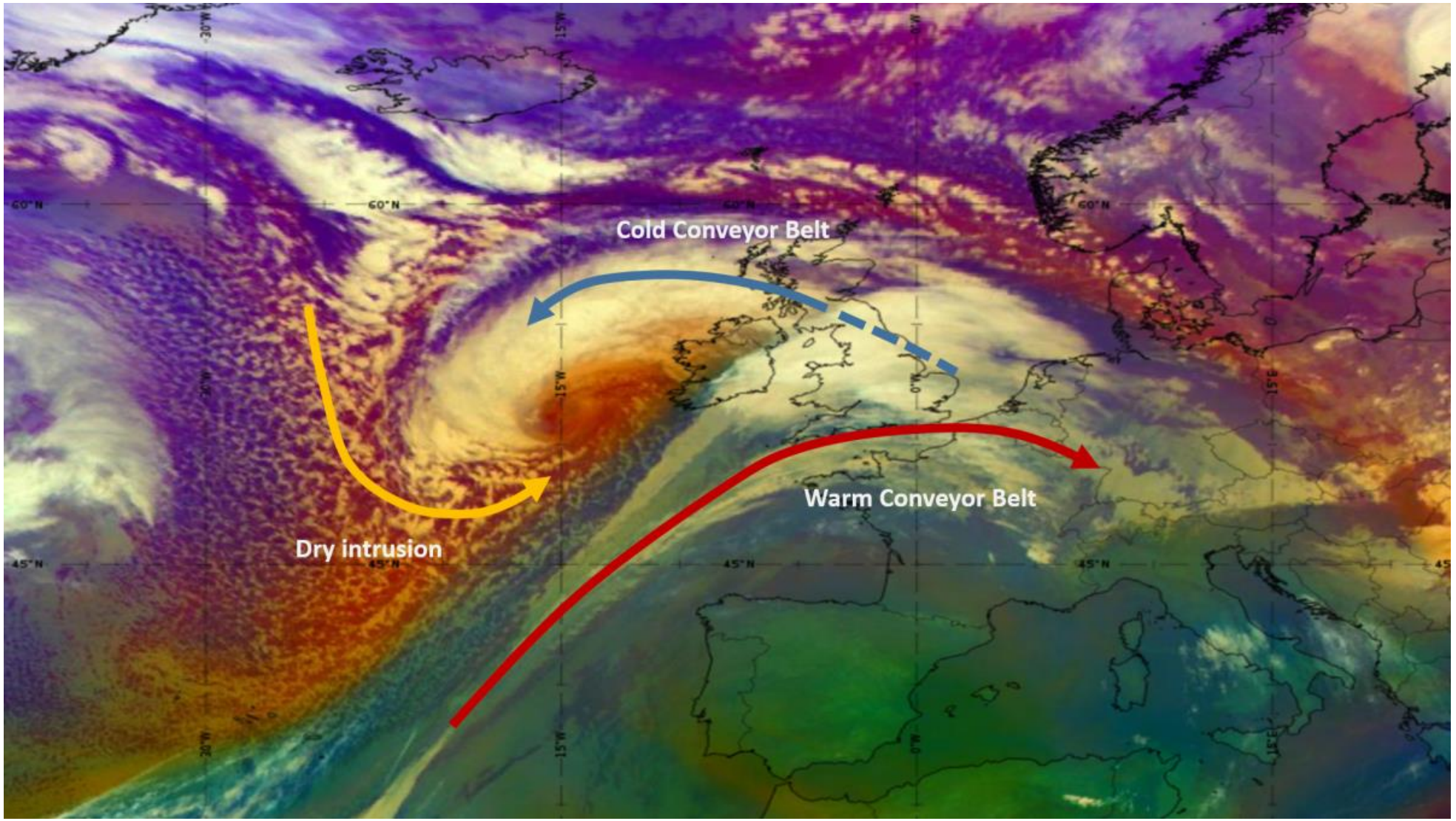


Explosive cyclogenesis process of Storm Eunice: Meteosat-11 water vapour, 17 February 00:00 UTC-18 February 2022, 10:00 UTC

Marine weather analysis: **Synoptic scale**

www.eumetsat.int

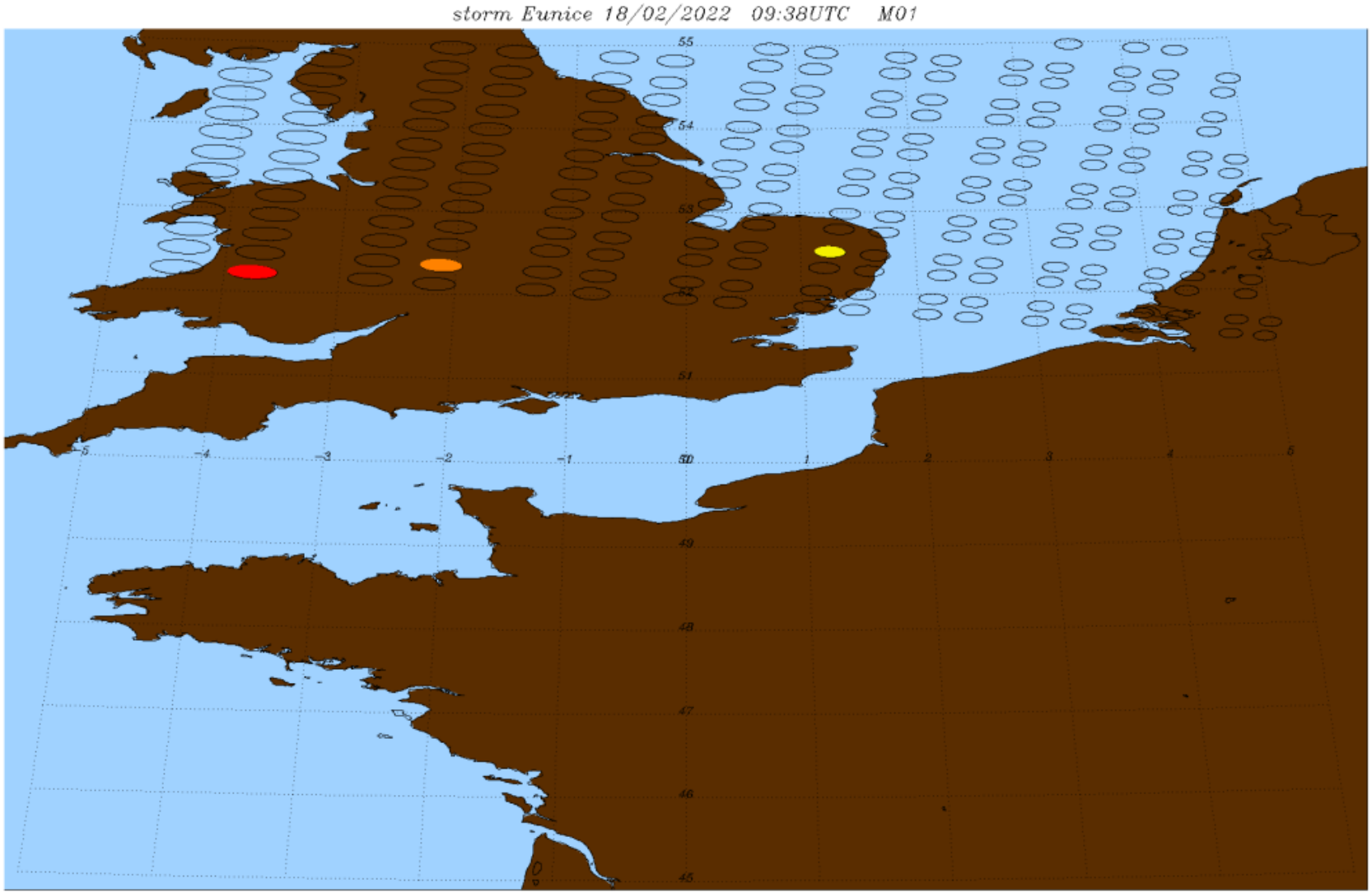
- Distribution of air masses
- Synoptic dynamics
- Wind forcing
- Conceptual models



Storm Eunice: Meteosat-11 Airmass RGB, 18 February 2022, 00:00 UTC

Marine weather analysis: **Synoptic scale**

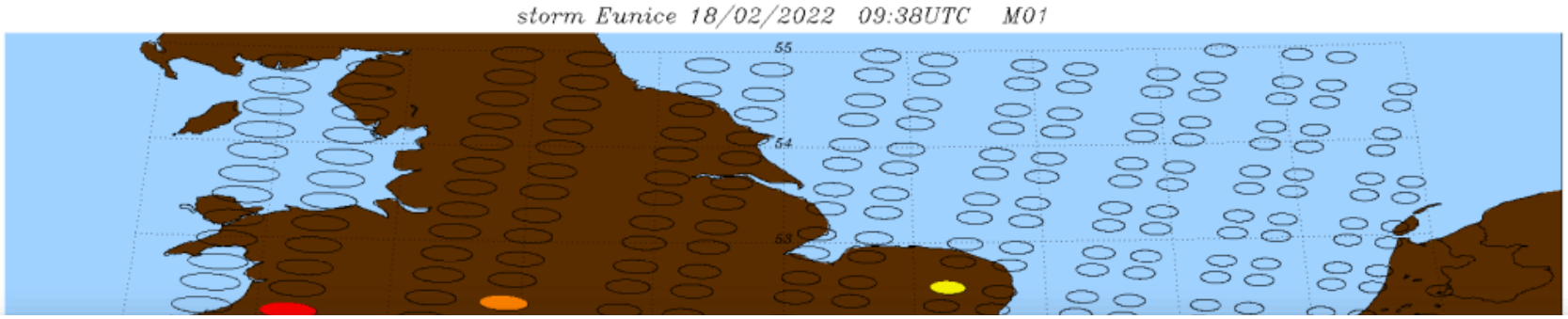
- **Distribution of air masses**
- **Synoptic dynamics**
- **Wind forcing**
- **Conceptual models**



Storm Eunice: IASI footprints overpass 18 Feb 2022 09:38 UTC

Marine weather analysis: **Synoptic scale**

- Distribution of air masses
- Synoptic dynamics
- Wind forcing
- Conceptual models



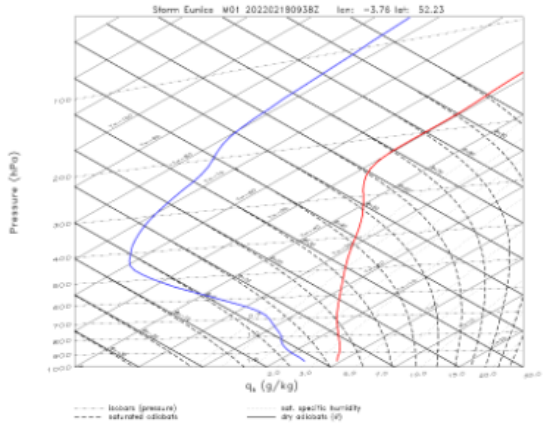


Figure a: Atmospheric temperature (red) and humidity (blue) sounding with IASI/AMSU/MHS on Metop-B, 18 February 09:38 UTC, within the storm (red dot in Figure).

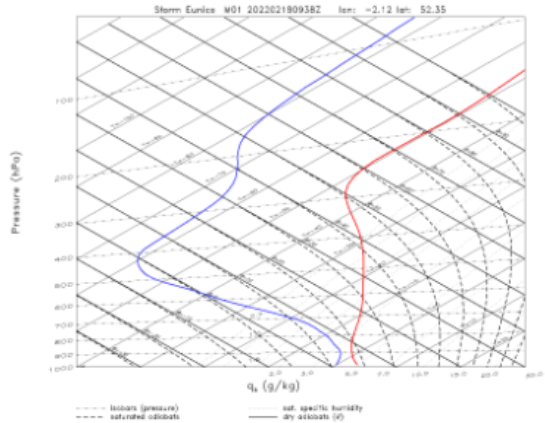


Figure b: Atmospheric temperature (red) and humidity (blue) sounding with IASI/AMSU/MHS on Metop-B, 18 February 09:38 UTC.

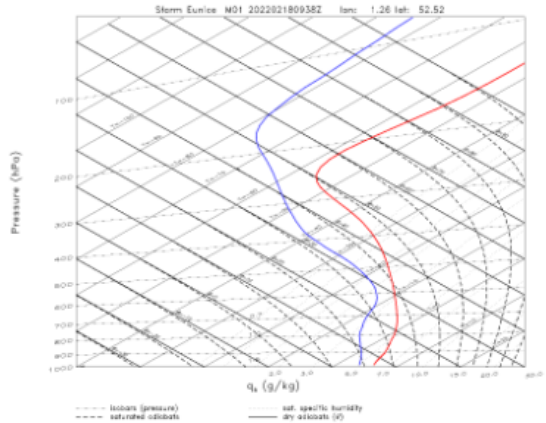


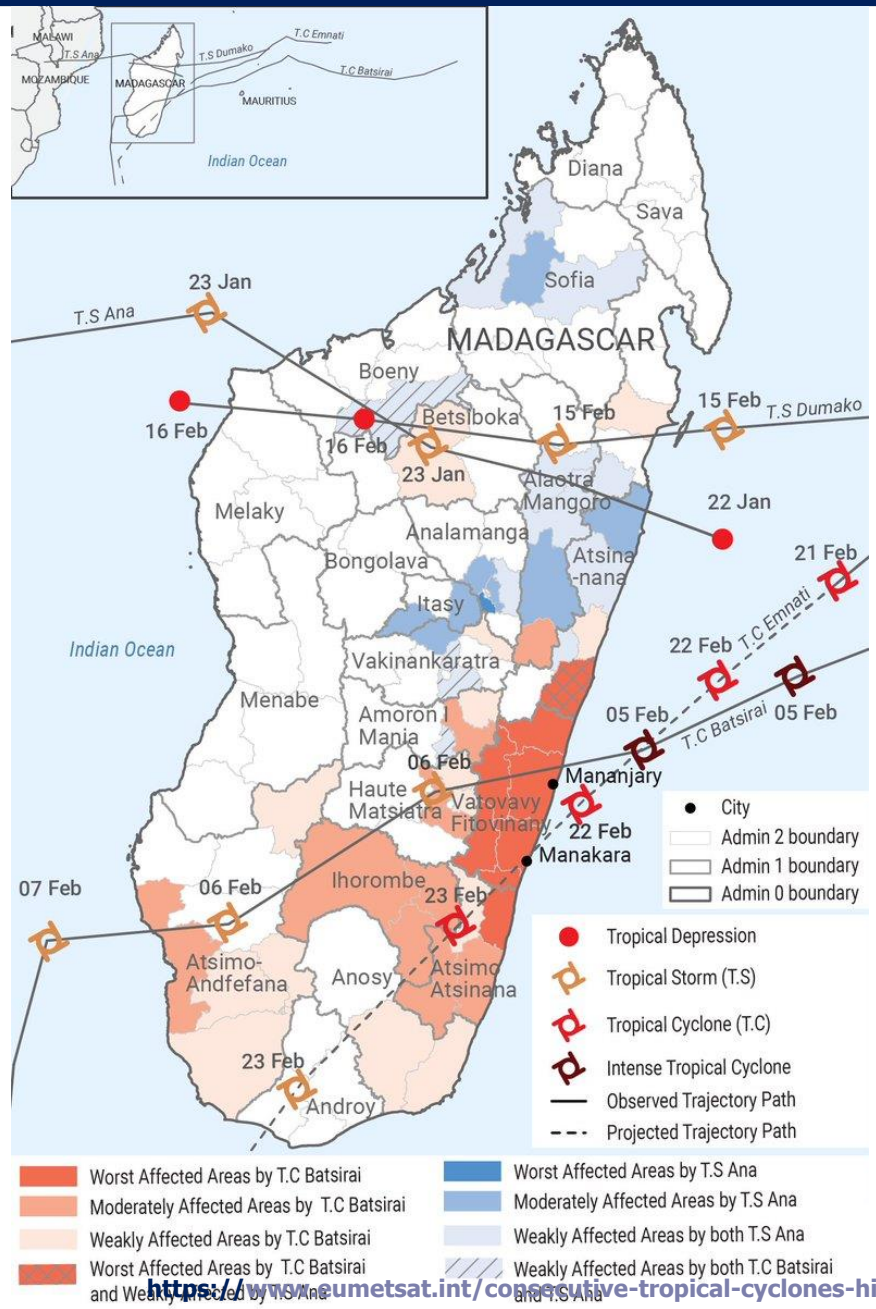
Figure c: Atmospheric temperature (red) and humidity (blue) sounding with IASI/AMSU/MHS on Metop-B, 18 February 09:38 UTC, ahead of the storm.

Storm Eunice: Metop-B temperature (red) and humidity (blue) sounding with IASI/AMSU/MHS18 Feb 2022 09:38 UTC

Marine weather analysis: **Tropics**

- **Similar products**
- **Better view with GEO satellites**
- **Different storm dynamics**

Consecutive tropical cyclones hit Madagascar



https://www.eumetsat.int/consecutive-tropical-cyclones-hit-madagascar

Marine weather analysis: **Tropics**

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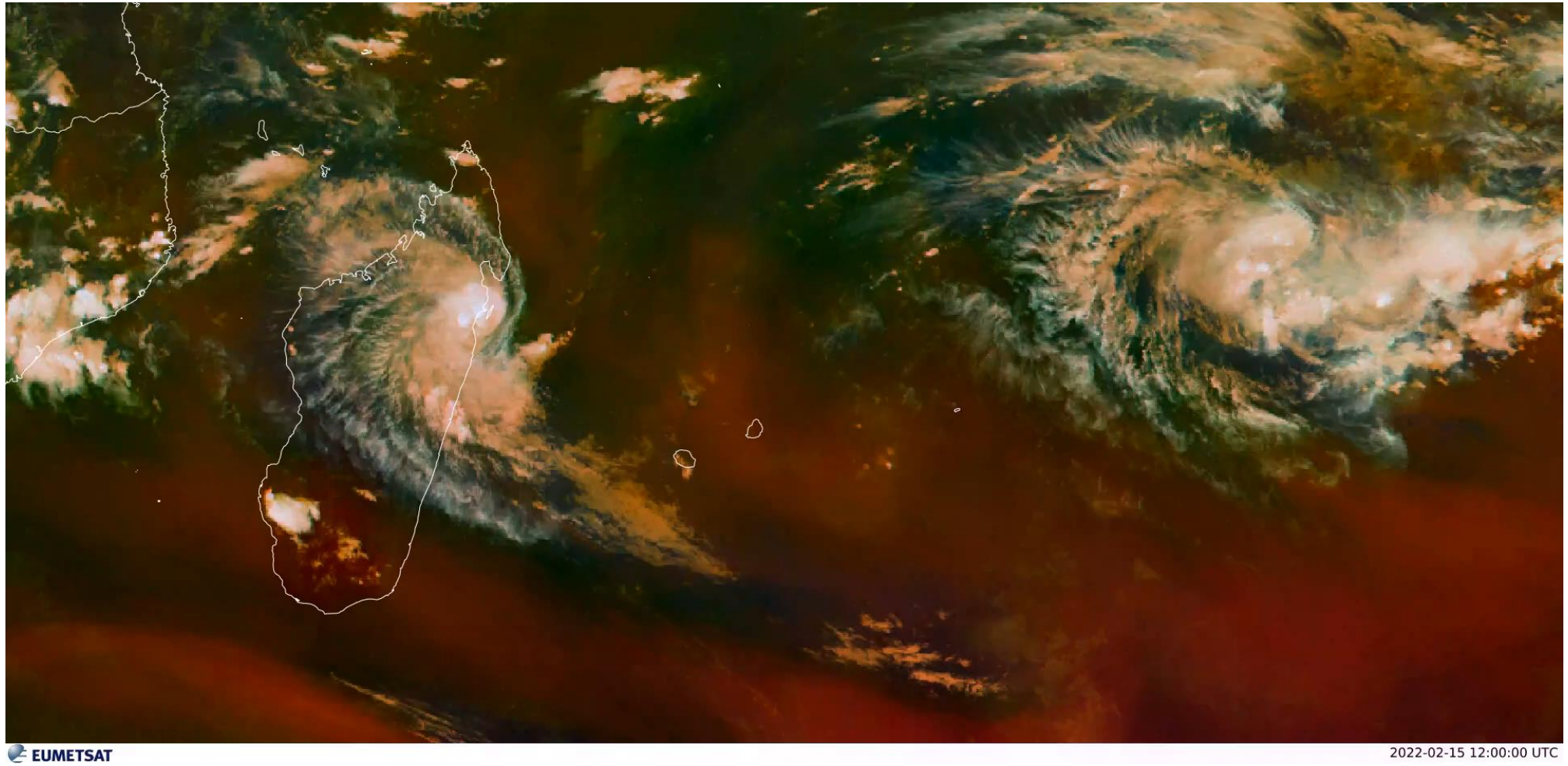
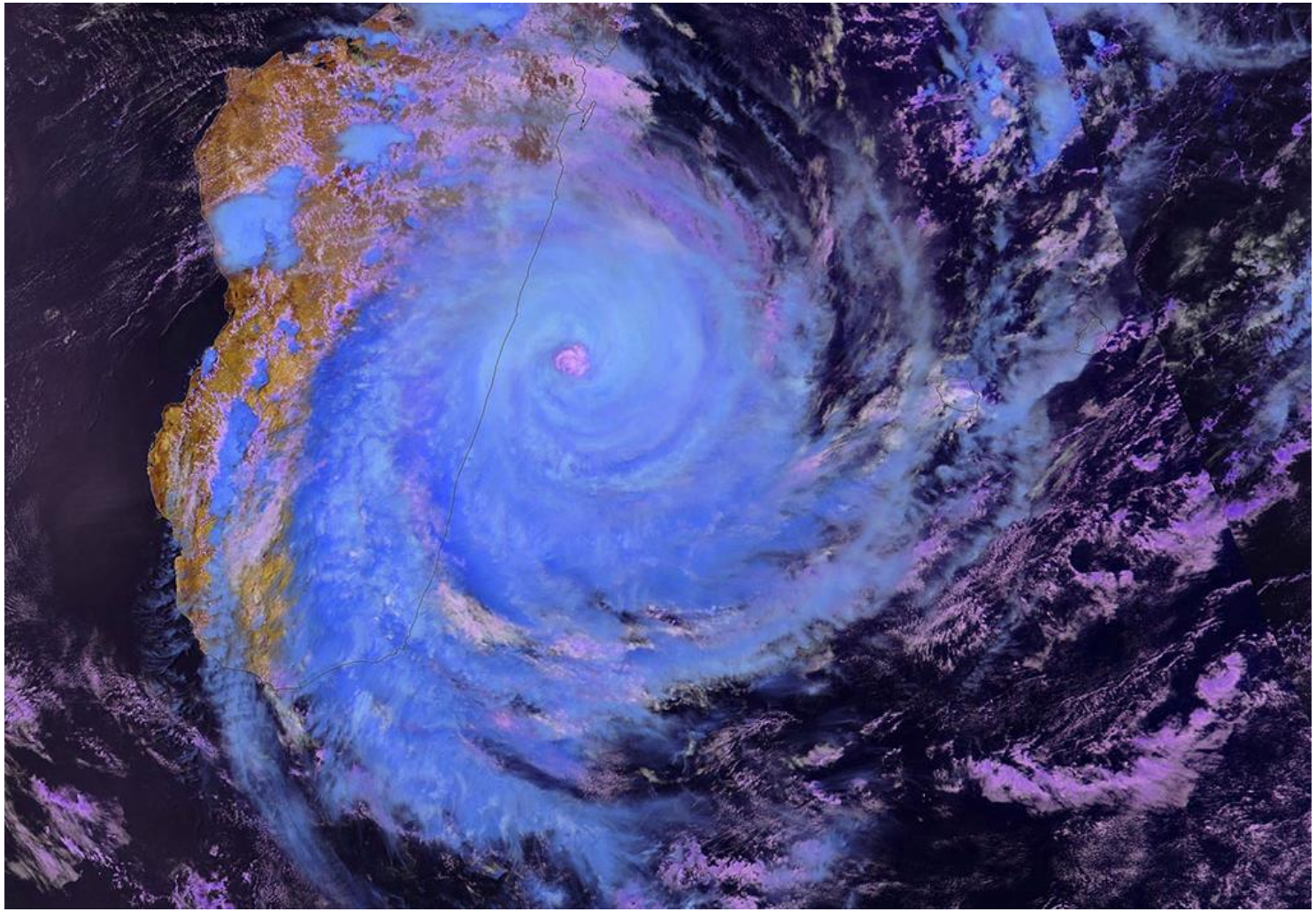


Tropical Cyclone Emnati: Meteosat-8 Airmass RGB, 15 February 12:00 UTC-23 February 14:00 UTC

Marine weather analysis: **Microphysics**

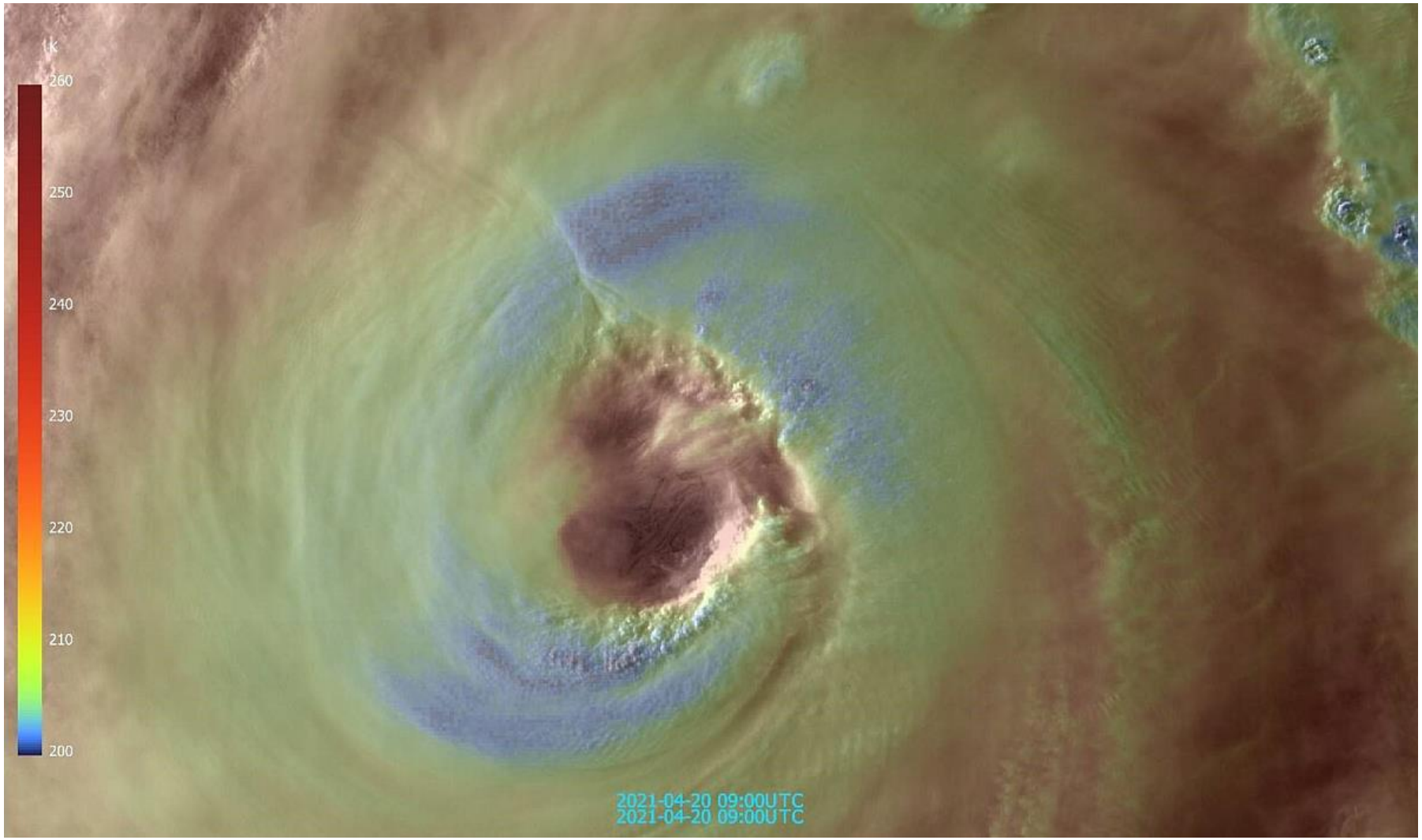
- **Particle size distribution**
- **MSG and MTG capability**



Tropical Cyclone Batsirai : Suomi NPP RGB combination of channels NIR1.61, NIR2.25, VIS0.49, 5 February 10:45 UTC

Marine weather analysis: **Cloud top features**

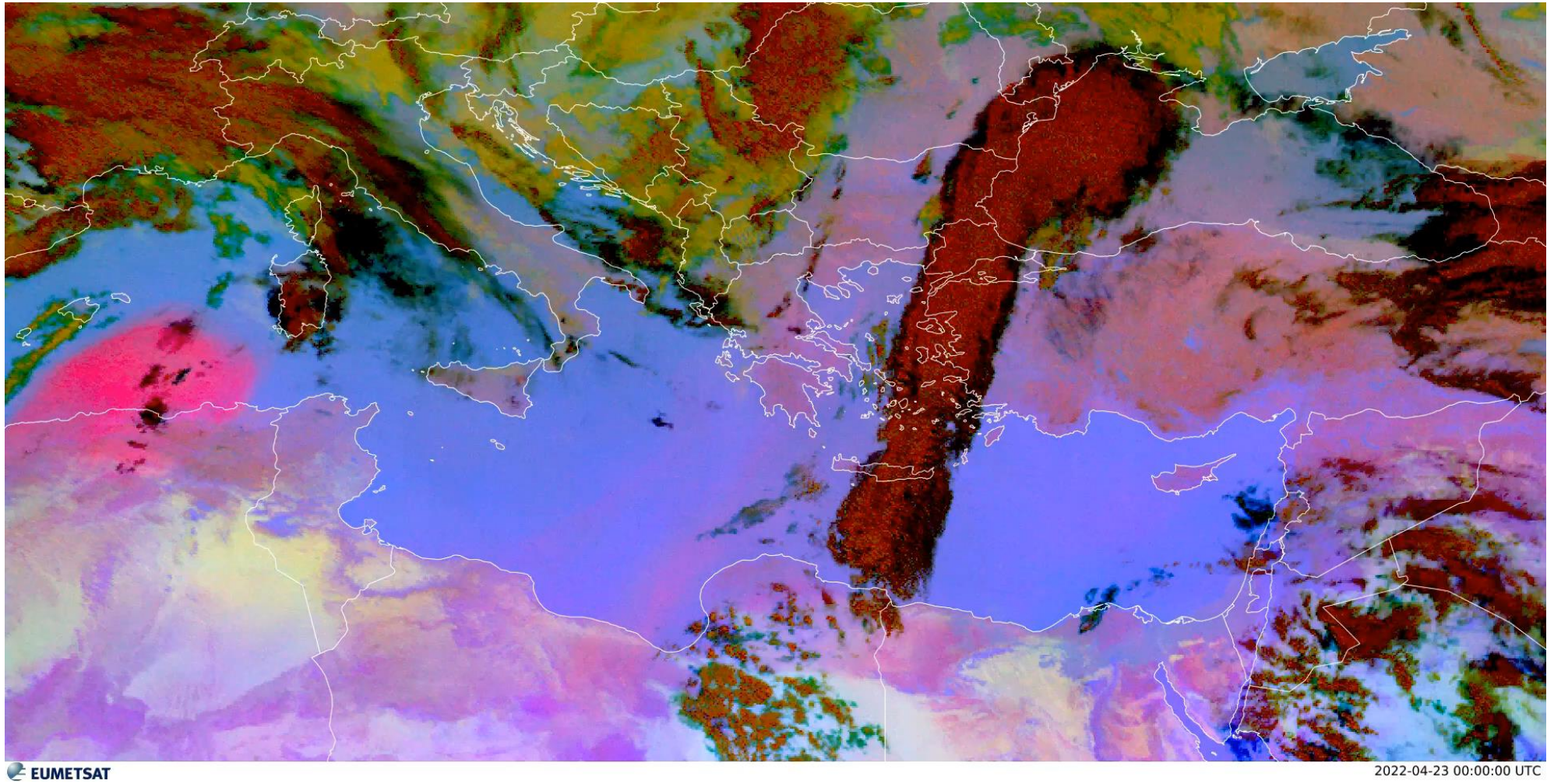
- **Visible and infra-red information**
- **Cloud top orography**
- **Cloud top temperature**
- **Cyclone dynamics**



Super Typhoon Surigae: Himawari-8 sandwich product 20 April 2021, 09:00 UTC (VIS0.6 channel overlaid with IR10.4 channel)

Marine weather analysis: Aerosols

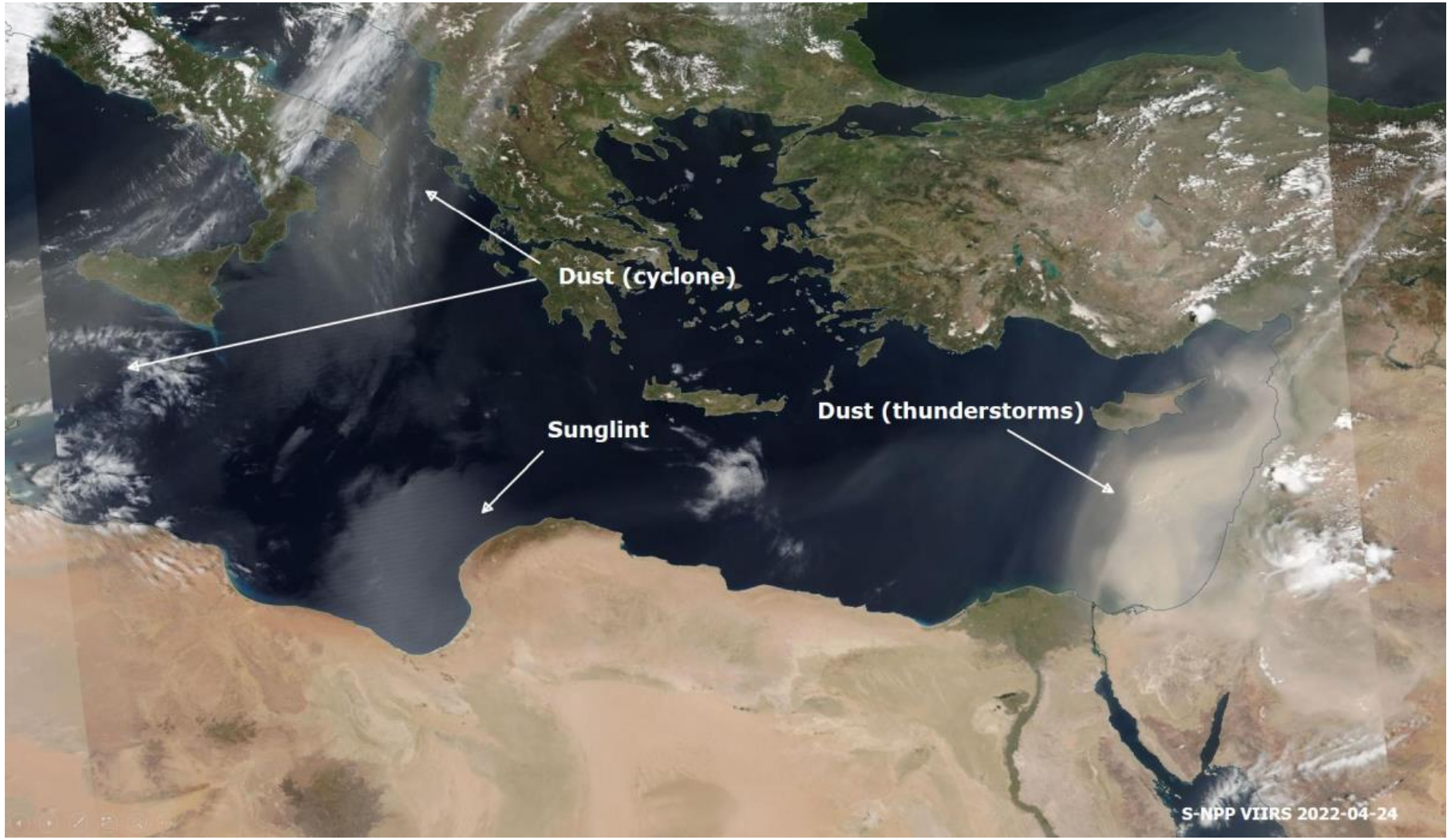
- Synoptic and mesoscale processes
- Reduced visibility and health hazards



Dust events over Mediterranean Sea: Met-8 view on both dust events, Dust RGB loop 23 April 2022, 00:00UTC to 24 April 12:00 UTC

Marine weather analysis: Aerosols

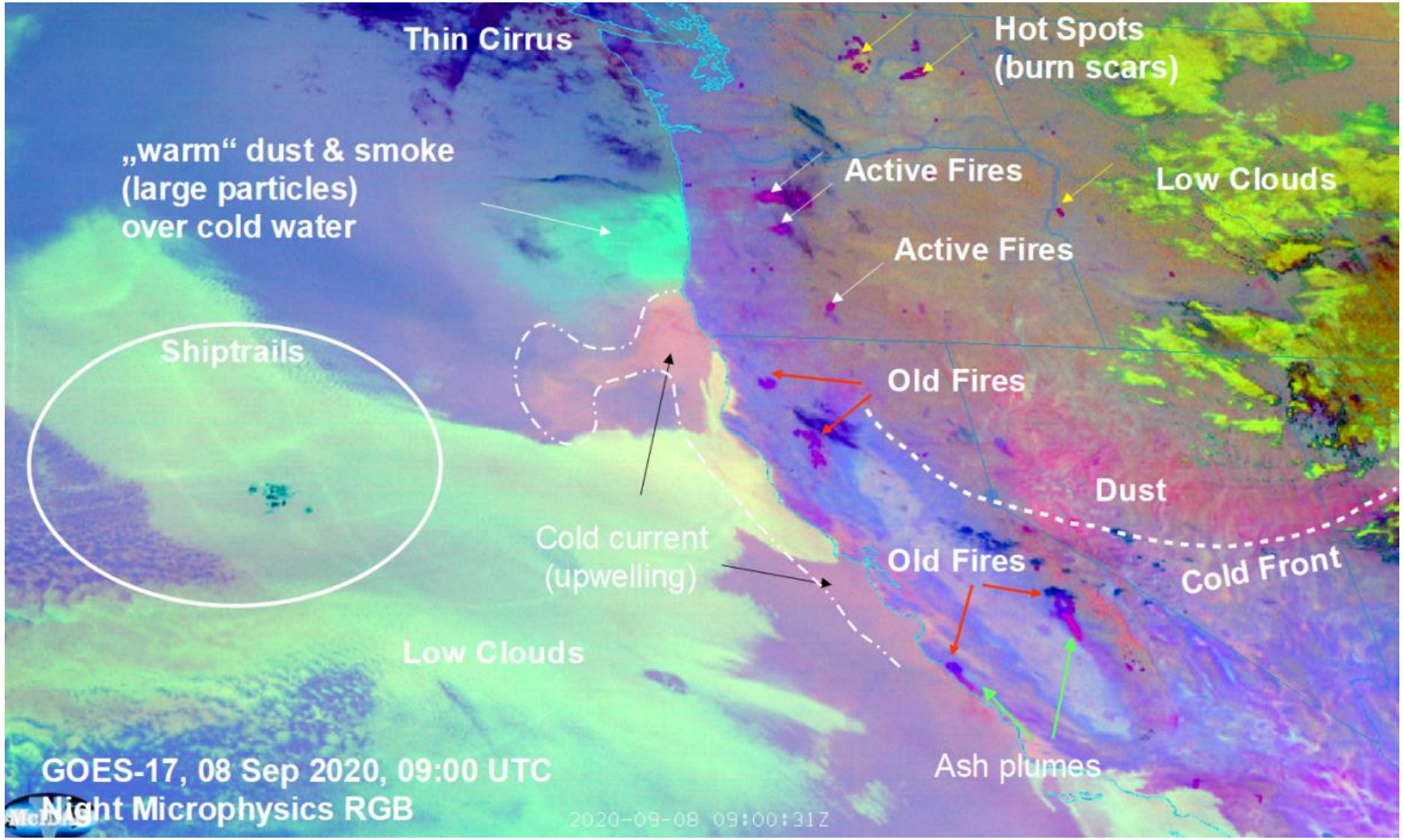
- Synoptic and mesoscale processes
- Reduced visibility and health hazards



Dust events over Mediterranean Sea: SNPP True Color RGB of the two dust events on 24 April 2022 11:40 UTC

Marine weather analysis: Low clouds (Fog) and Aerosols

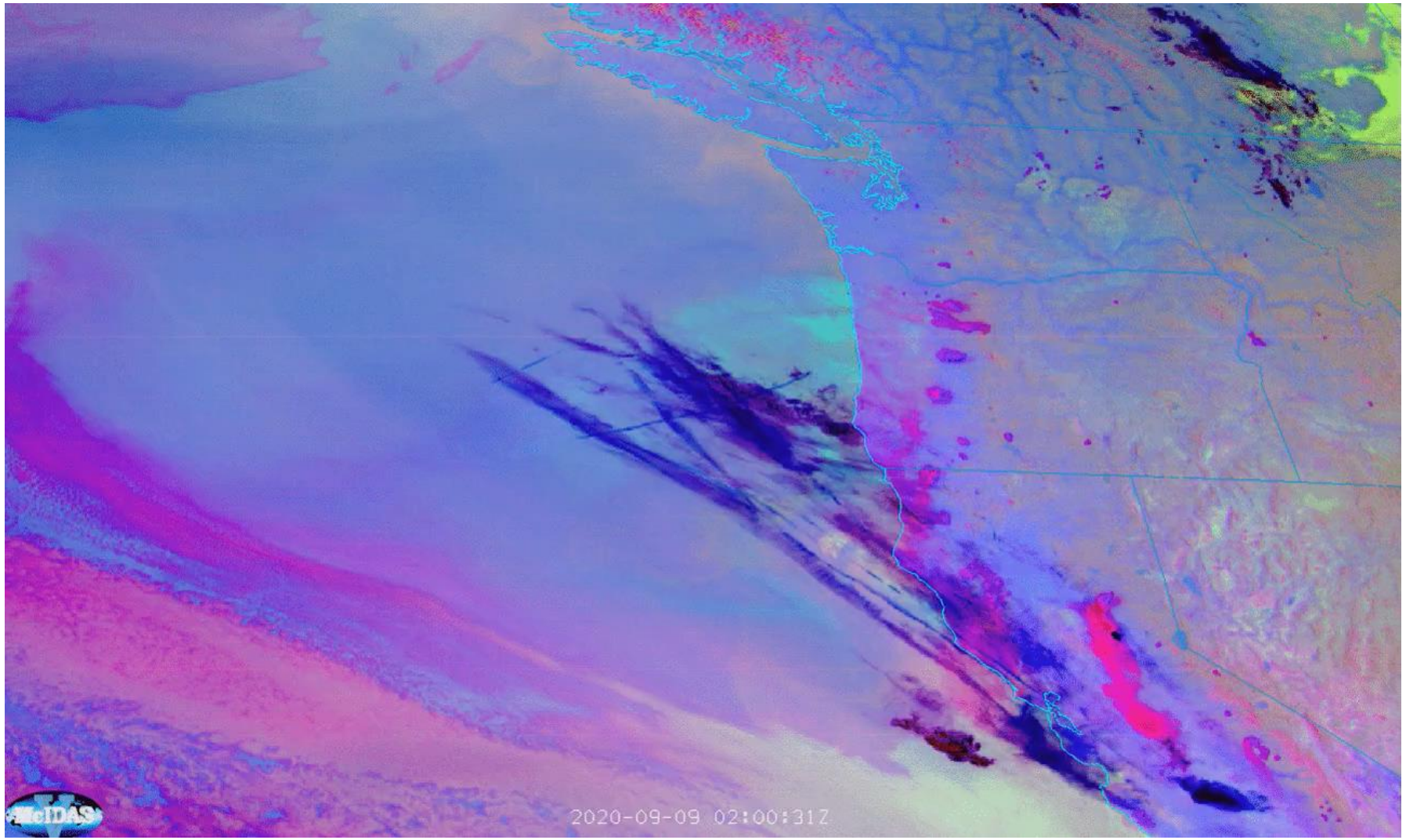
- Synoptic and mesoscale processes
- Reduced visibility and health hazards



Low clouds and smoke over West Pacific: GOES-17 Night Microphysics RGB, 8 September 2020, 09:00 UTC.

Marine weather analysis: Low clouds (Fog) and Aerosols

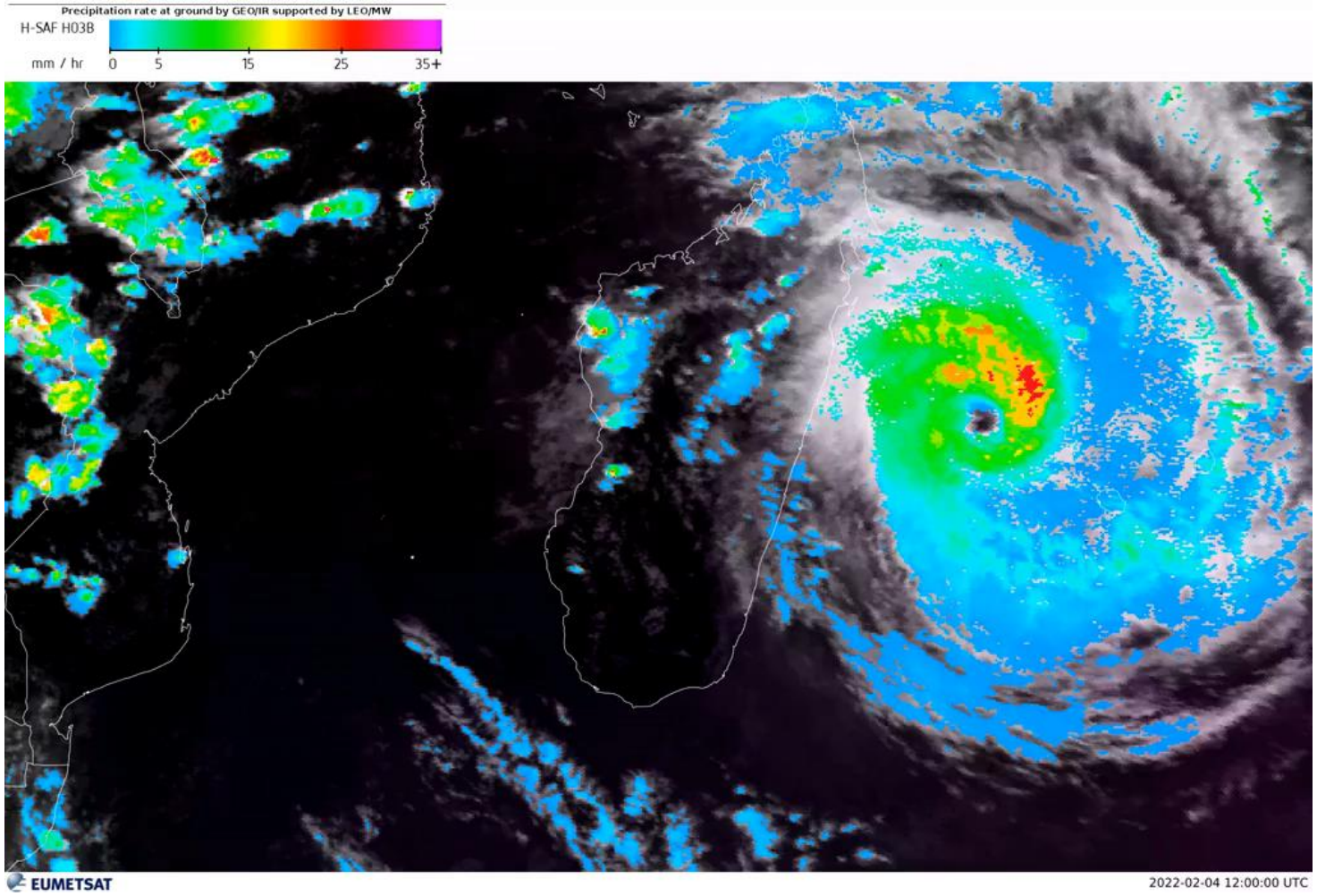
- Synoptic and mesoscale processes
- Reduced visibility and health hazards



Low clouds and smoke over West Pacific: GOES-17 Night Microphysics RGB, 9 September 2020, 02:00-12:30 UTC

Marine weather analysis: L2 **Geophysical products**

- **Synergy of different satellite data (GEO and LEO)**
- **Quantitative analysis**
- **Number of products related to cloud classification, precipitation, wind, aerosols, etc.**



Tropical Cyclone Batsirai : Meteosat-11 IR 10.8 micron image overlaid with HSAF H03B precipitation product, 4 February 12:00 UTC to 6 February 2022, 12:00 UTC

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Synoptic analysis, weather patterns, hazards

Sea state analysis

Surface winds and waves

Ocean properties

Ocean height, temperature, colour, sea ice

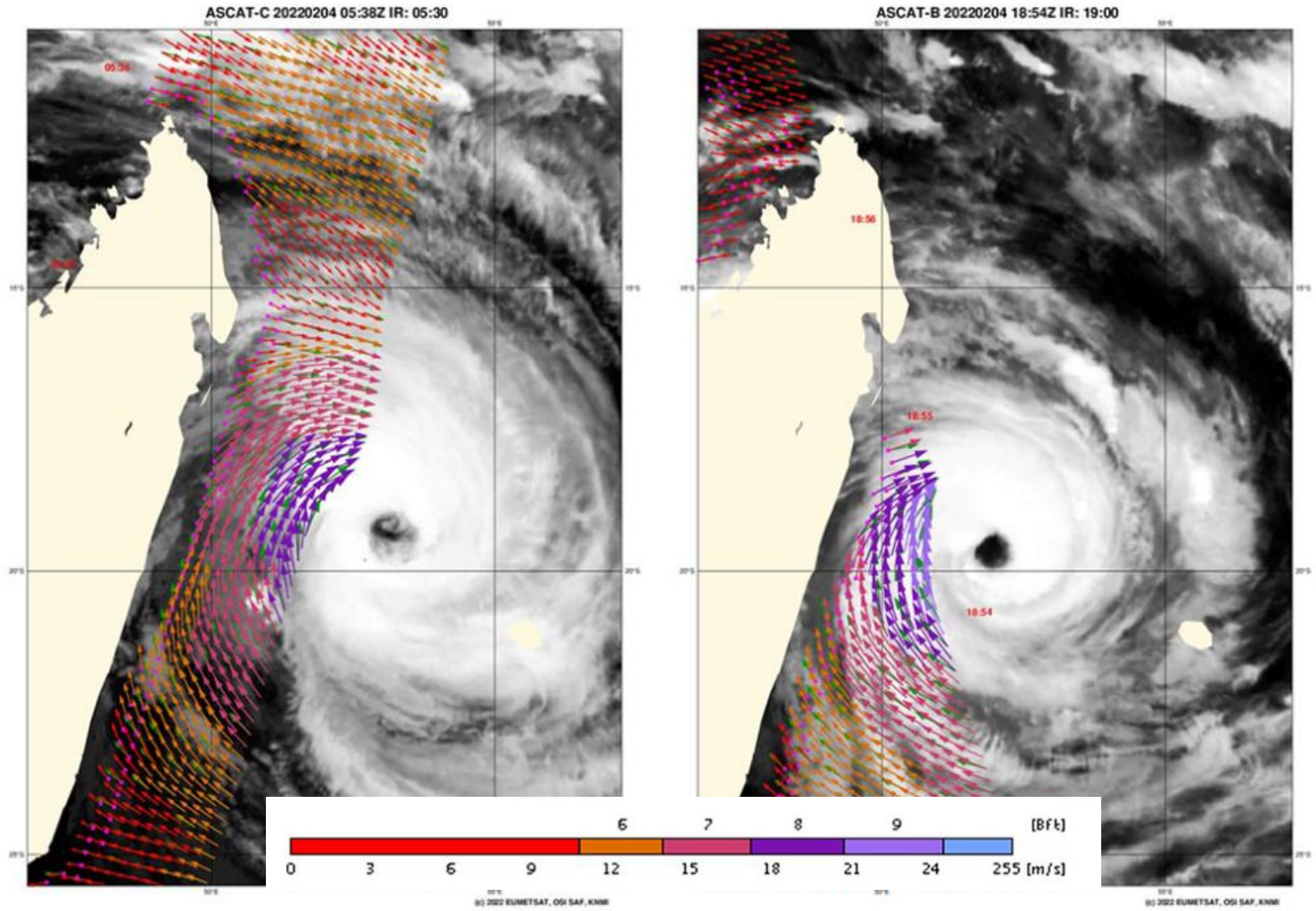
slido

Using altimeter data we can derive:

ⓘ Start presenting to display the poll results on this slide.

Sea state analysis: **Scatterometers**

- Surface-level wind speed and direction
- Direct measure of weather forcing
- No parallax shift
- Position of low-pressure system
- Narrow swath



Tropical cyclone Batsirai : Metop-B & C ASCAT scatterometer winds, 4 February 05:38 UTC, 4 February 18:54 UTC, 5 February 06:05 UTC and 6 February 2022, 05:45 UTC. Credit: OSI SAF

Sea state analysis: **Scatterometers**

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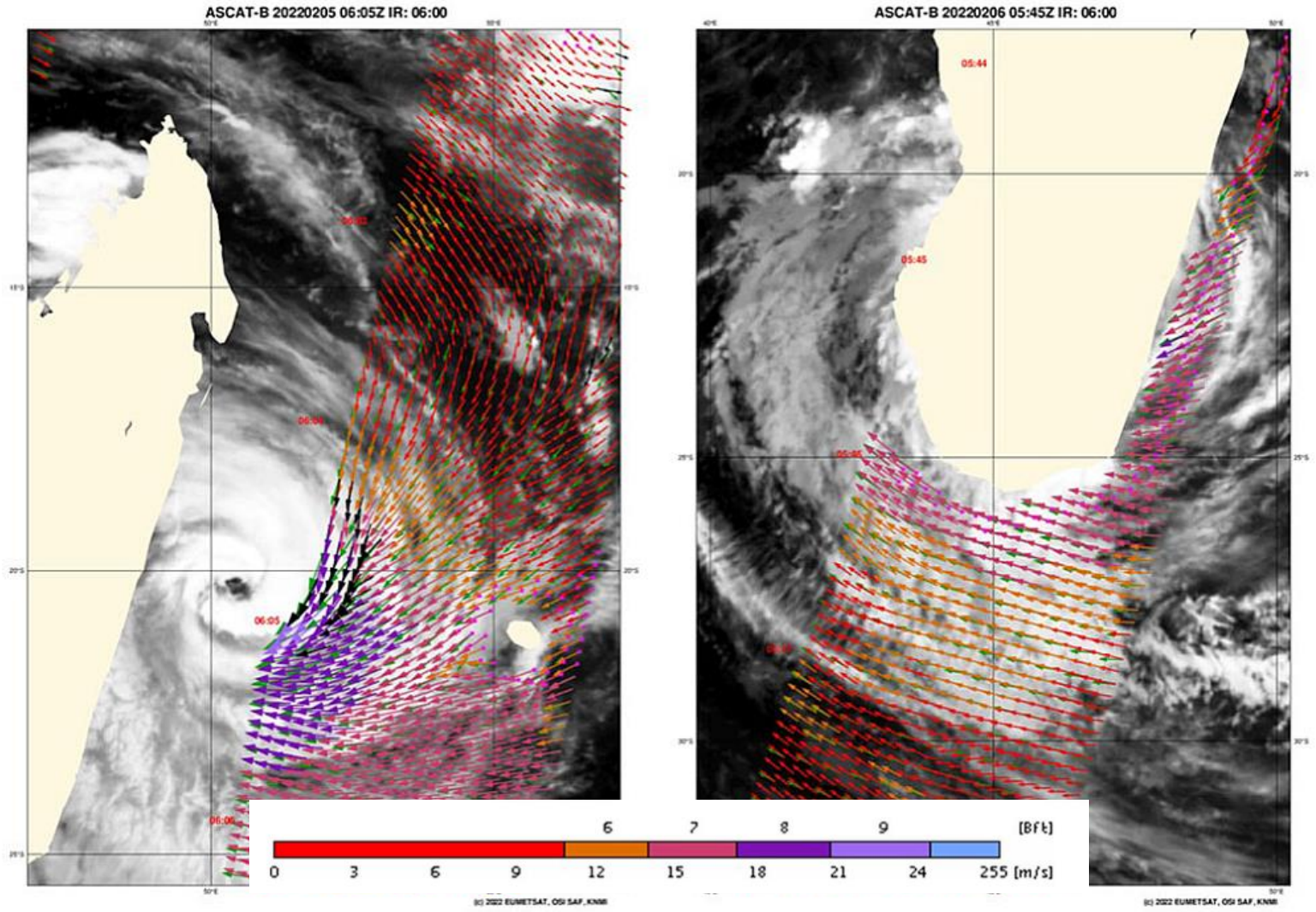

Tropical cyclone Batsirai : Metop-B & C ASCAT scatterometer winds, 4 February 05:38 UTC, 4 February 18:54 UTC, 5 February 06:05 UTC and 6 February 2022, 05:45 UTC. Credit: OSI SAF

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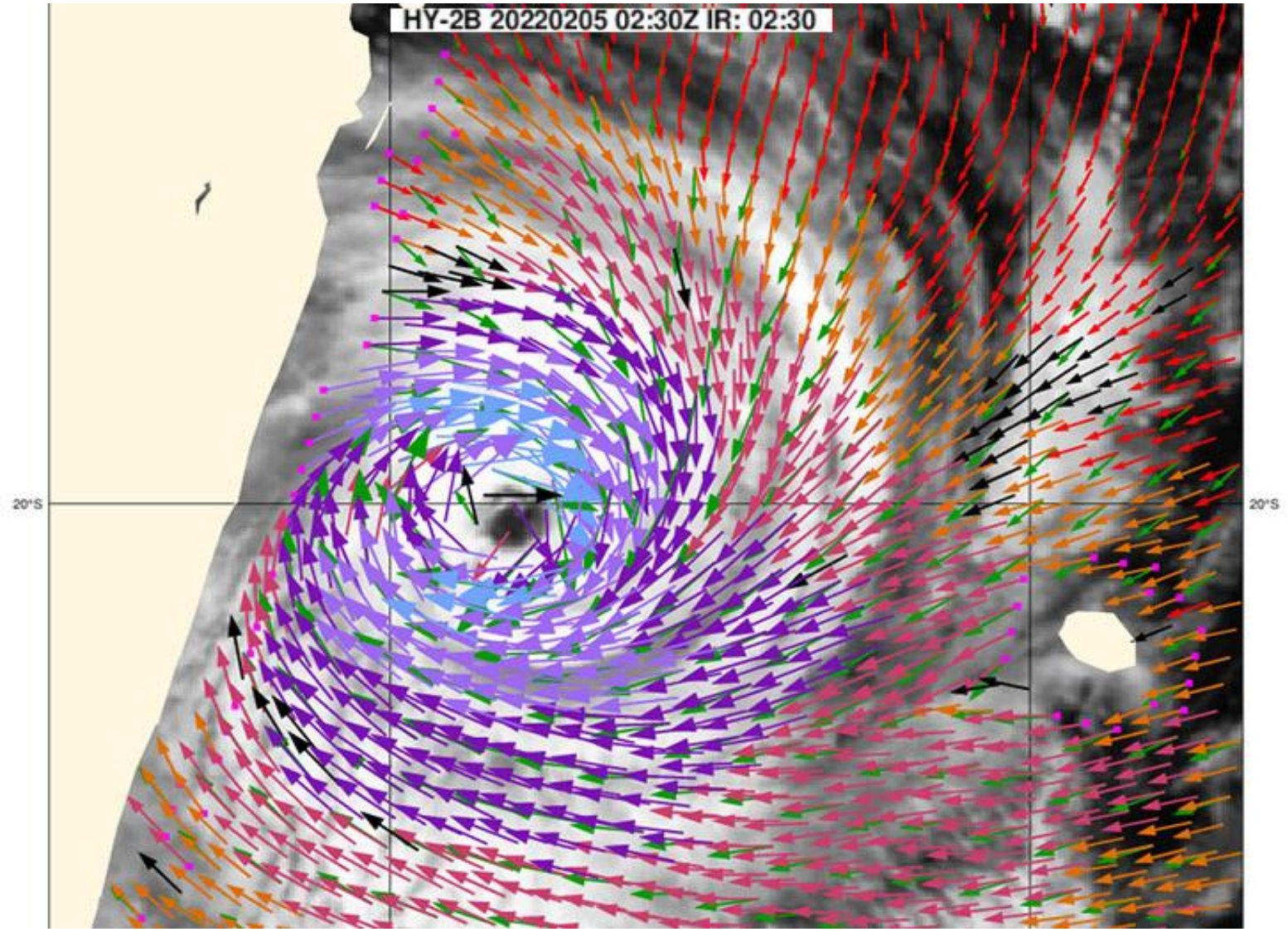

Tropical cyclone Batsirai : Hai Yang 2B SCAT winds, 5 February 2022, 02:30 UTC. Credit: OSI SAF, KNMI

Sea state analysis: **Scatterometers**

- Surface-level wind speed and direction
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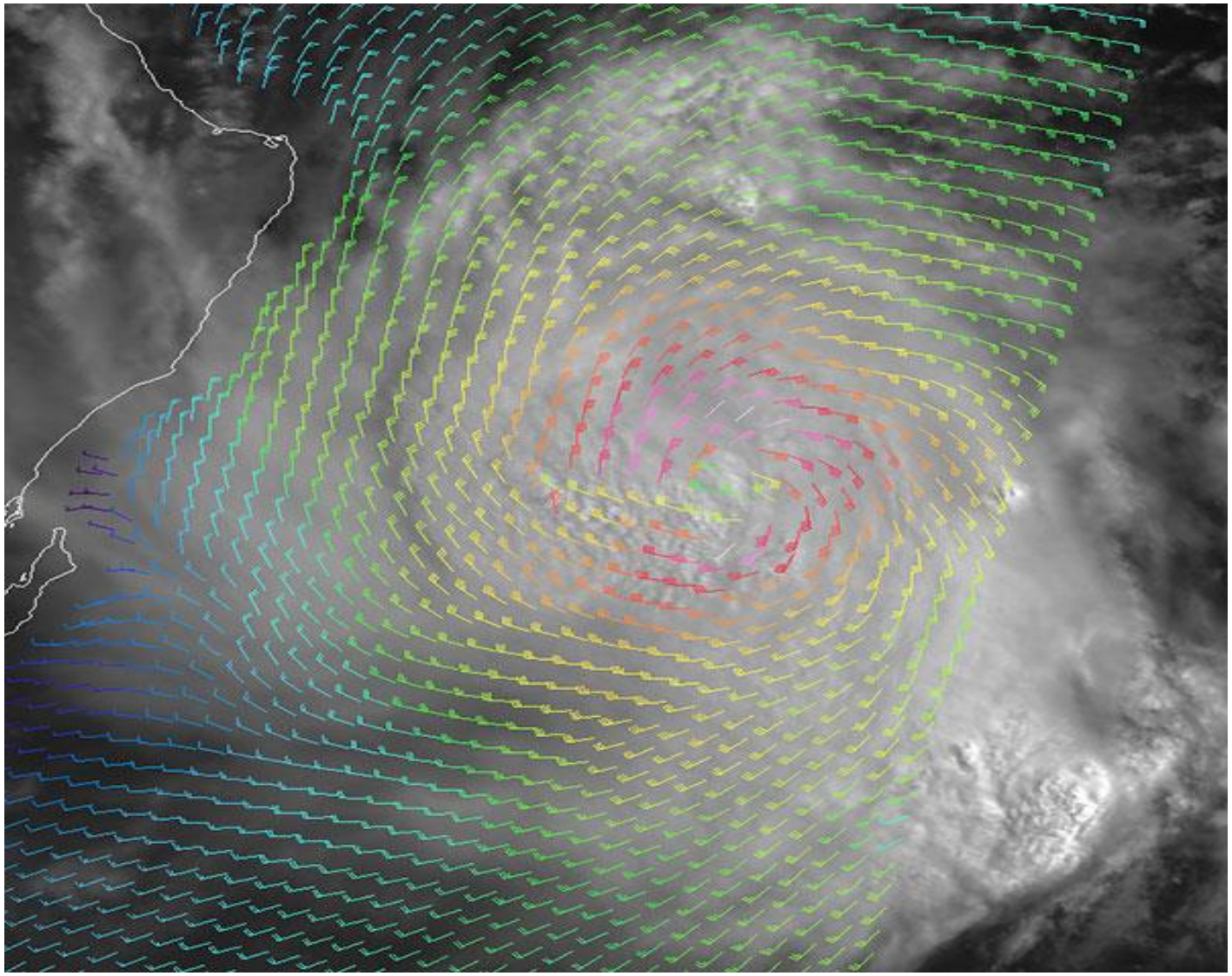
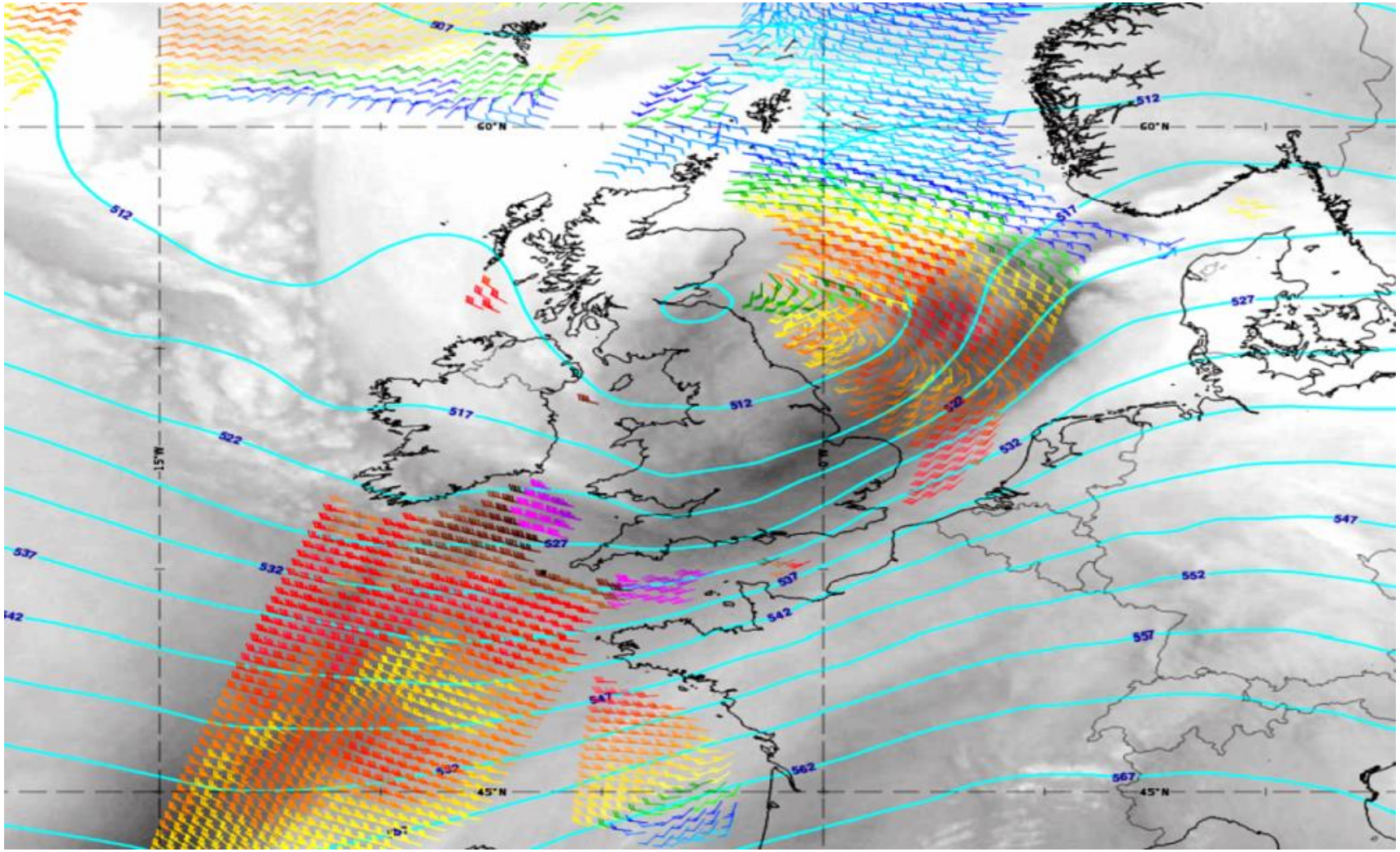


Tropical cyclone Ashobaa : Comparison of Metop-A visible images, on which the second image has ASCAT winds overlaid, 10 June 2015, 05:18 UTC

Sea state analysis: **Scatterometers**

- Surface-level wind speed and direction
- Direct measure of weather forcing
- No parallax shift
- Position of low-pressure system
- Narrow swath
- Better coverage at high latitudes



Storm Eunice : Meteosat-11 WV6.2 with Metop-B ASCAT winds overlaid, 18 February 2022

Sea state analysis: **Altimeters**

- **Parallel wind and wave measurements**
- **Narrow swath**
- **Reality check for other data**

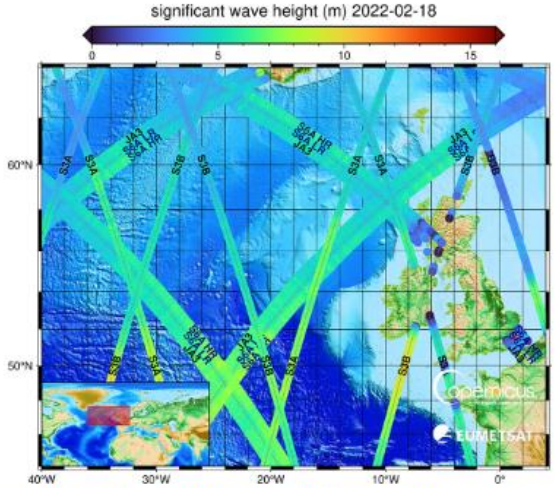


Figure 1a: Significant Wave Heights, 18 February

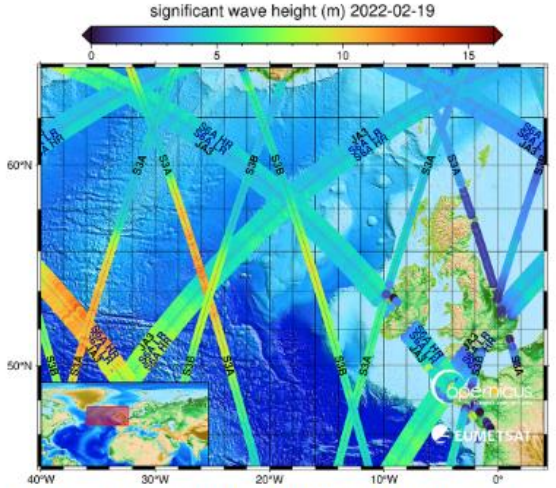


Figure 1b: Significant Wave Heights, 19 February

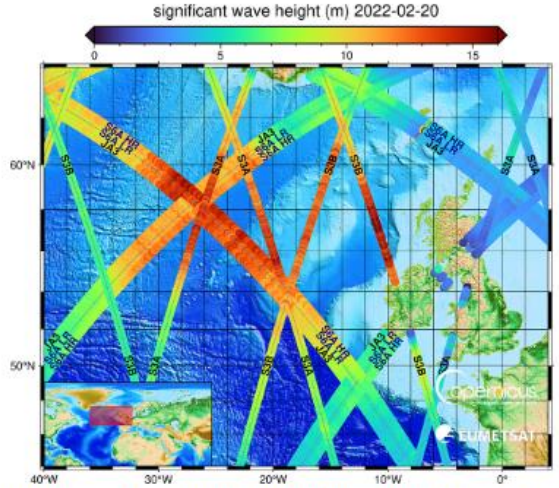


Figure 1c: Significant Wave Heights, 20 February

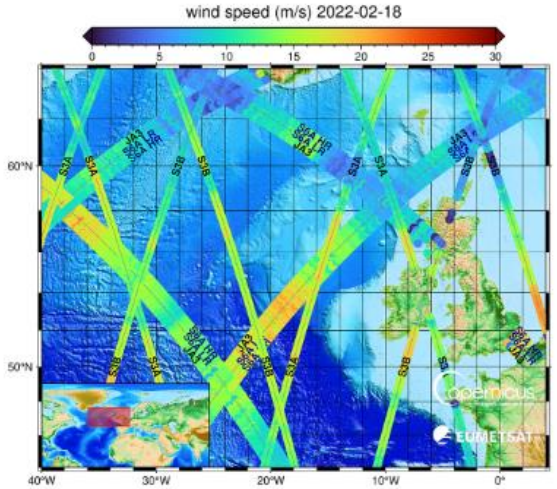


Figure 2a: Wind speeds m/s, 18 February

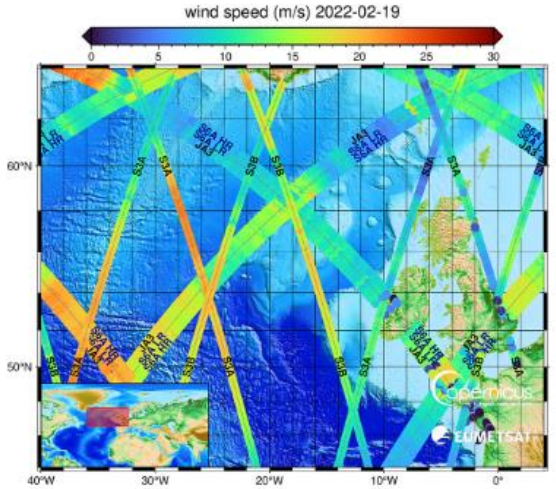


Figure 2b: Wind speeds m/s, 19 February

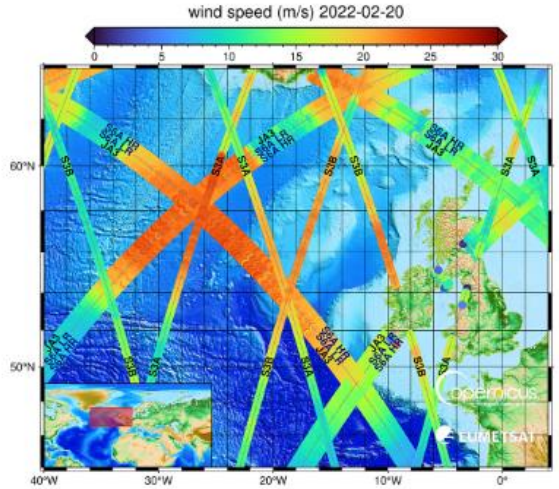


Figure 2c: Wind speeds m/s, 20 February

Storm Franklin: Copernicus altimeter missions Sentinel-3A, Sentinel-3B, Sentinel-6A, and Jason-3, on 18, 19, and 20 February (up to 17 meters and 93km/h)

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We can observe sea state using imager data in the solar ('visible') region during night time?

ⓘ Start presenting to display the poll results on this slide.

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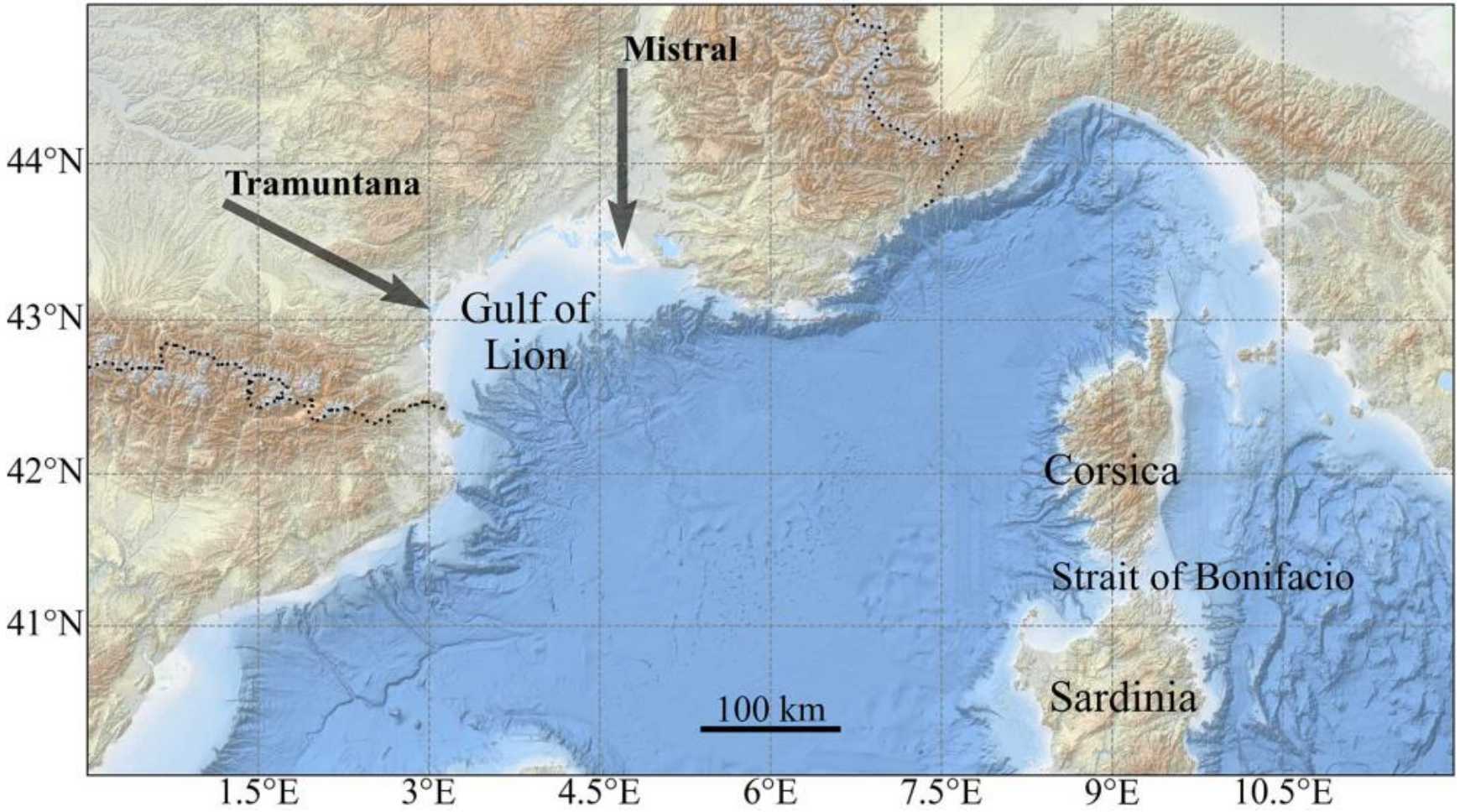
Ocean height, temperature, colour, sea ice

Ocean properties: Winds and sea temperature

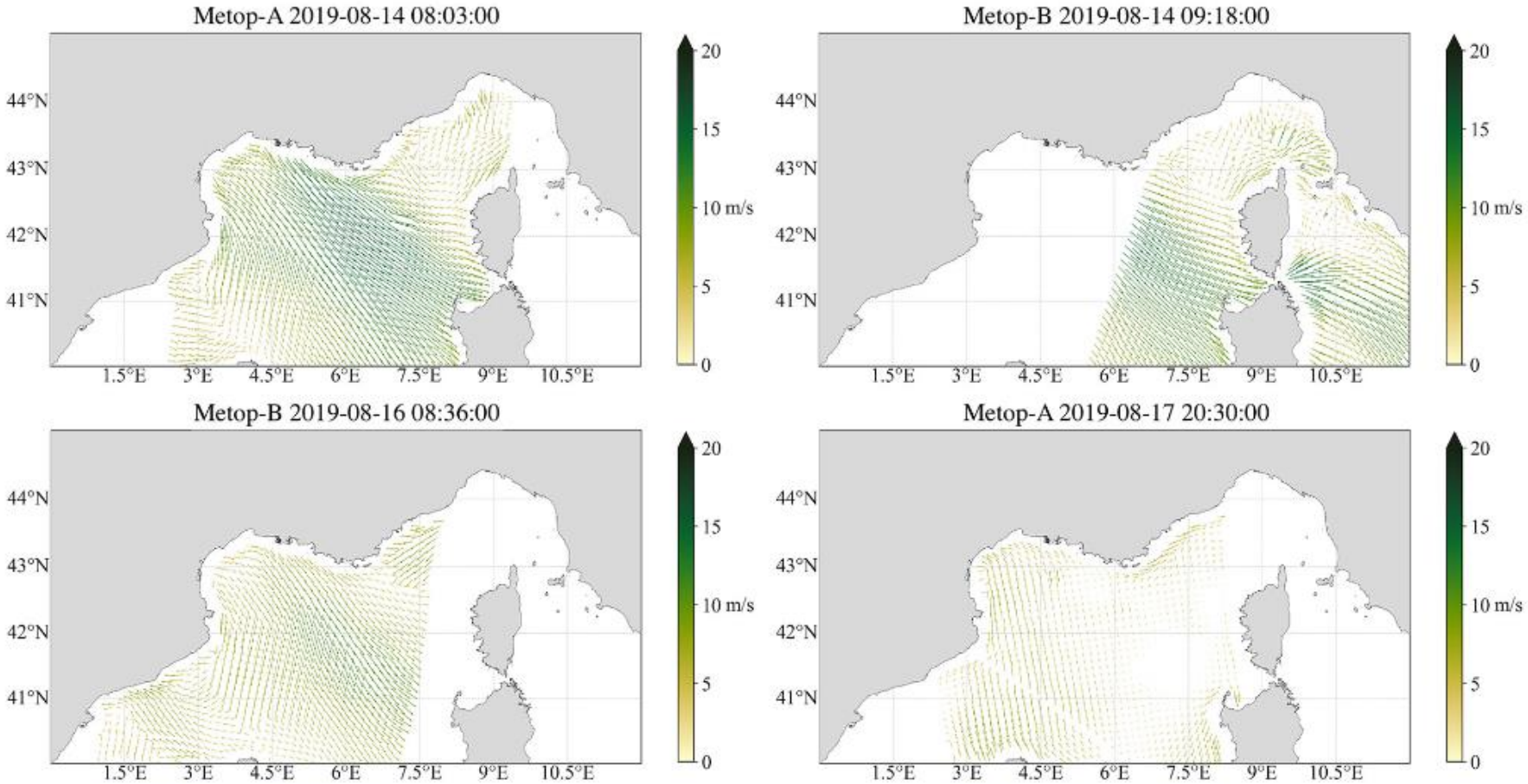
- Wind forcing effect on the sea surface temperature
- Cooling of the surface & and enhanced mixing



Mistral and Tramontane winds: S France, 2019/2022

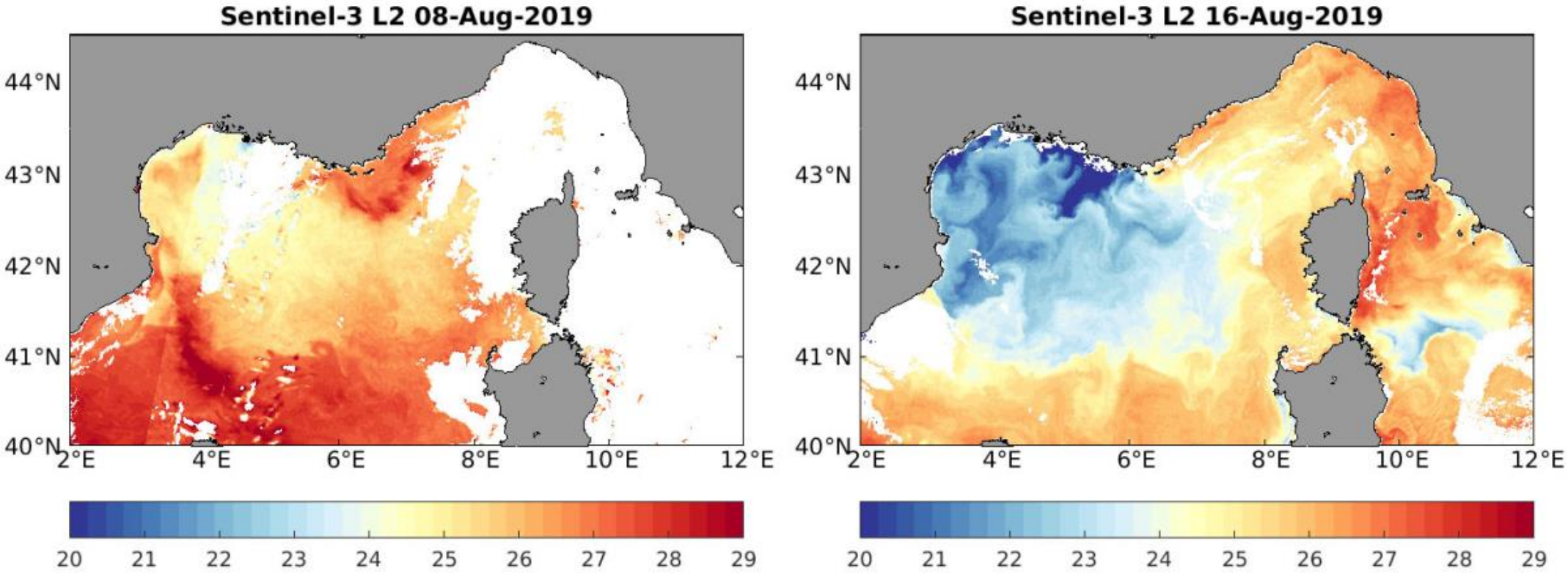
Ocean properties: Winds and sea temperature

- **Wind forcing effect on the sea surface temperature**
- **Cooling of the surface & and enhanced mixing**



Mistral and Tramontane winds: Metop-A and Metop-B during the period 14 to 17 August 2019. Note the intense winds on 14 August 2019, the relaxation on 16-17 August

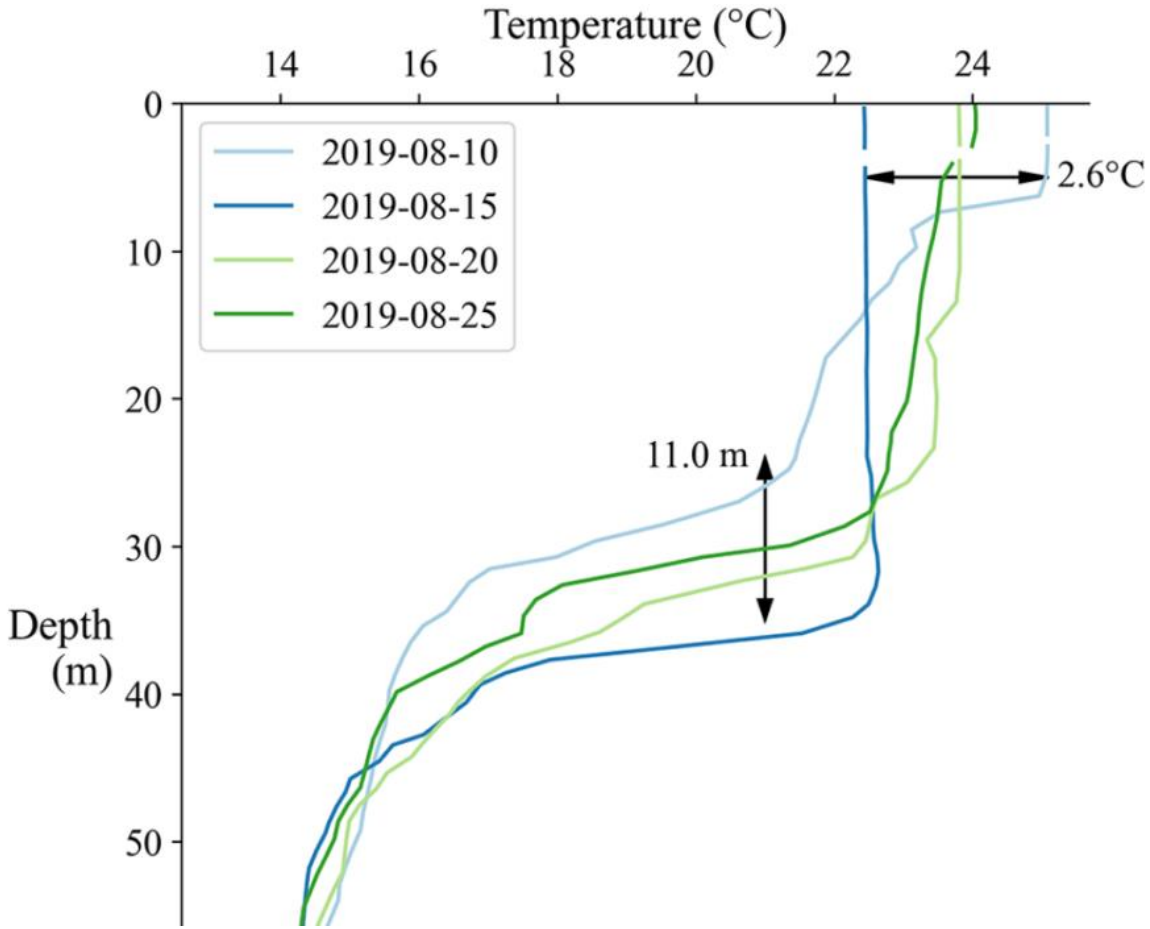
Ocean properties: Winds and sea temperature



Mistral and Tramontane winds: Sea surface temperature change before (left) and after (right) a strong Mistral/Tramontane event in August 2019

Ocean properties: Winds and sea temperature

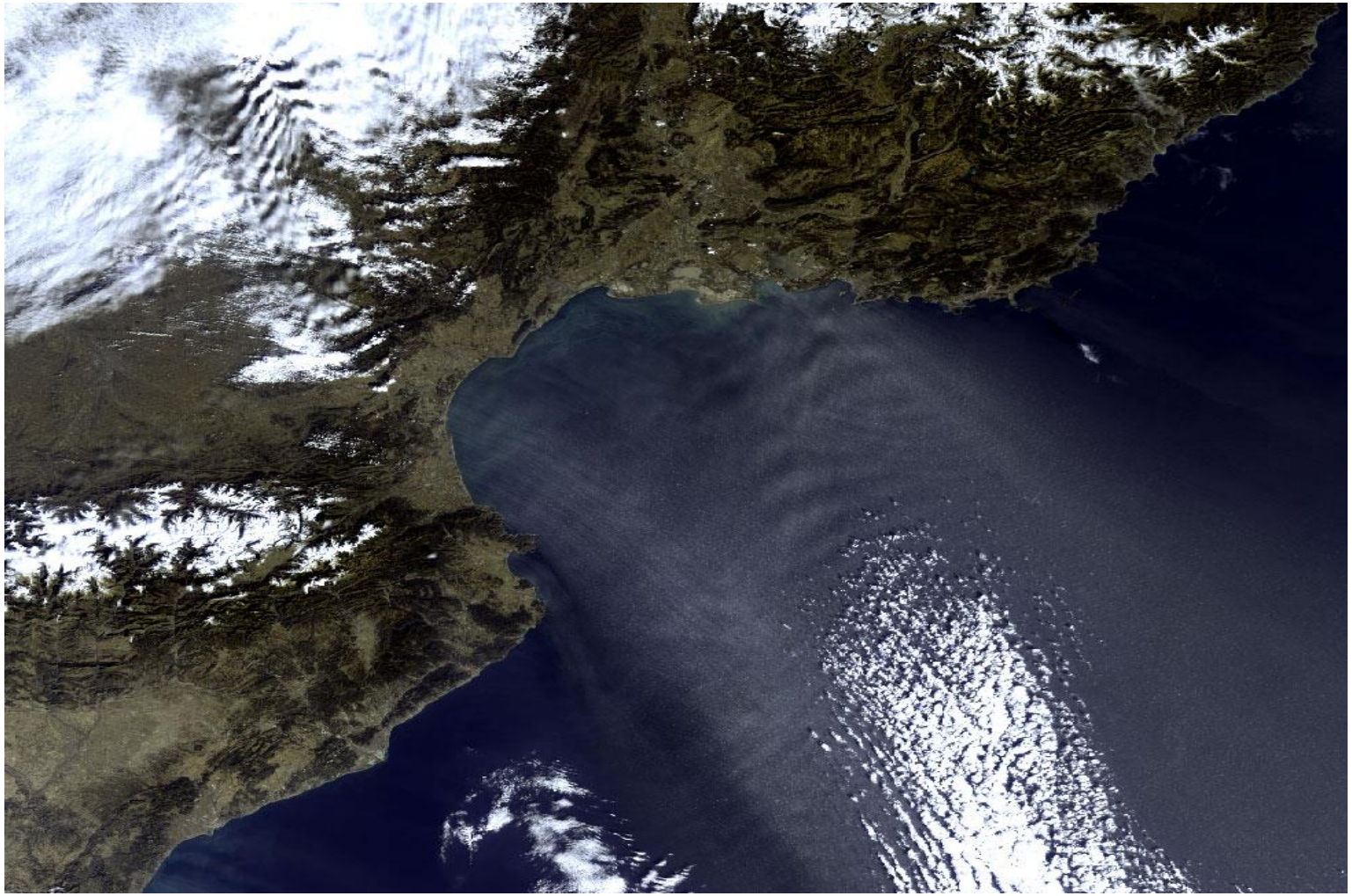
- Wind forcing effect on the sea surface temperature
- Cooling of the surface & and enhanced mixing
- Thermocline shift



Mistral and Tramontane winds: Temperature profiles from the PROVOR CTS3-DO Profiling Argo Float. The effect of the wind event on the surface layer is evident from 10 to 15 August 2019

Ocean properties: Winds and sea temperature

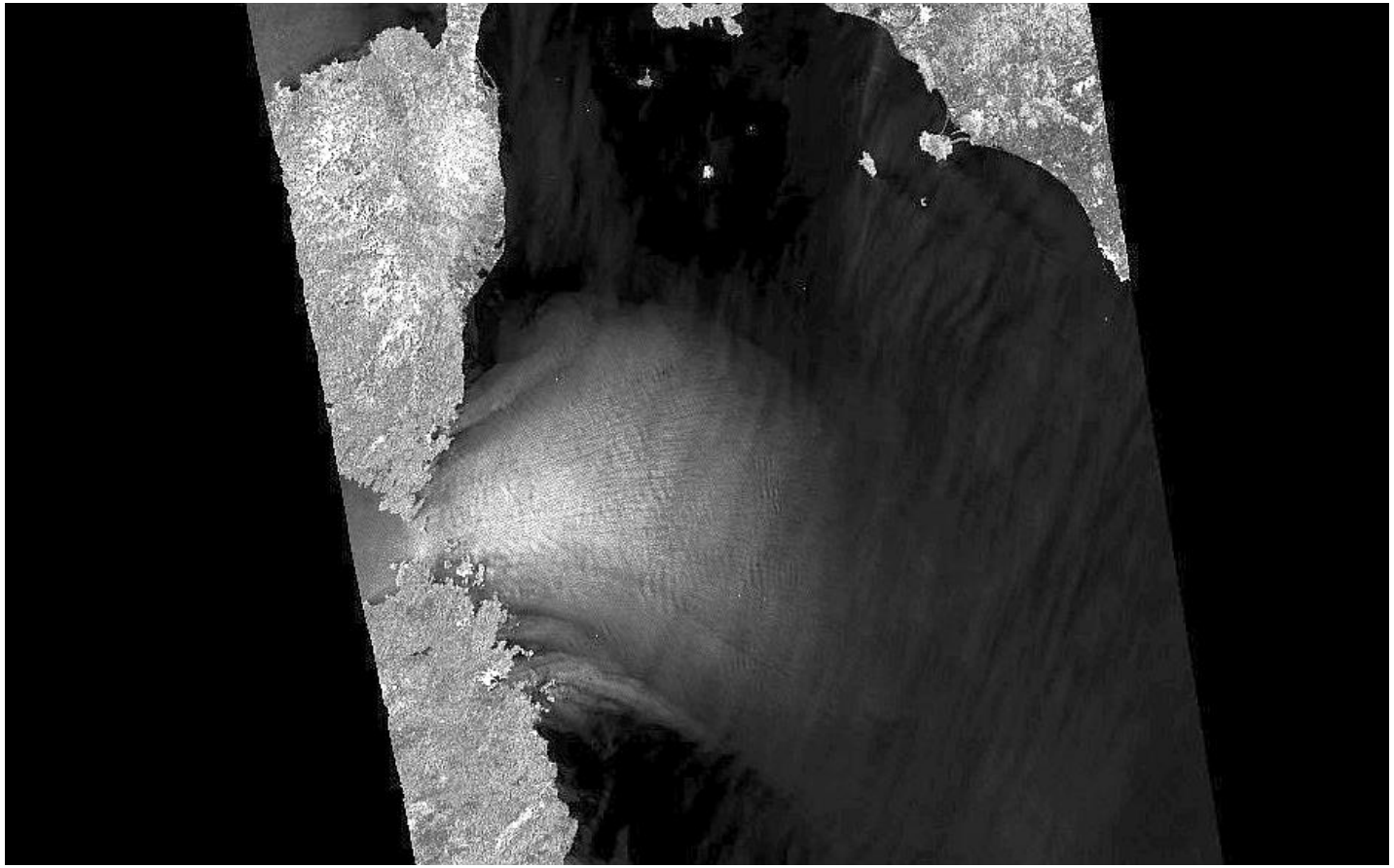
- Wind forcing effect on the sea surface temperature
- Cooling of the surface & and enhanced mixing
- Friction of wind with the sea surface (white caps and sea spray)



Mistral and Tramontane winds: Sentinel-3 True colour from the OLCI sensor on 1 February 2022. The strong Mistral and Tramontane winds cause widespread whitecaps and sea spray at the sea surface, which can be seen in this image as the white colours emanating from the Gulf of Lion.

Ocean properties: Winds and sea temperature

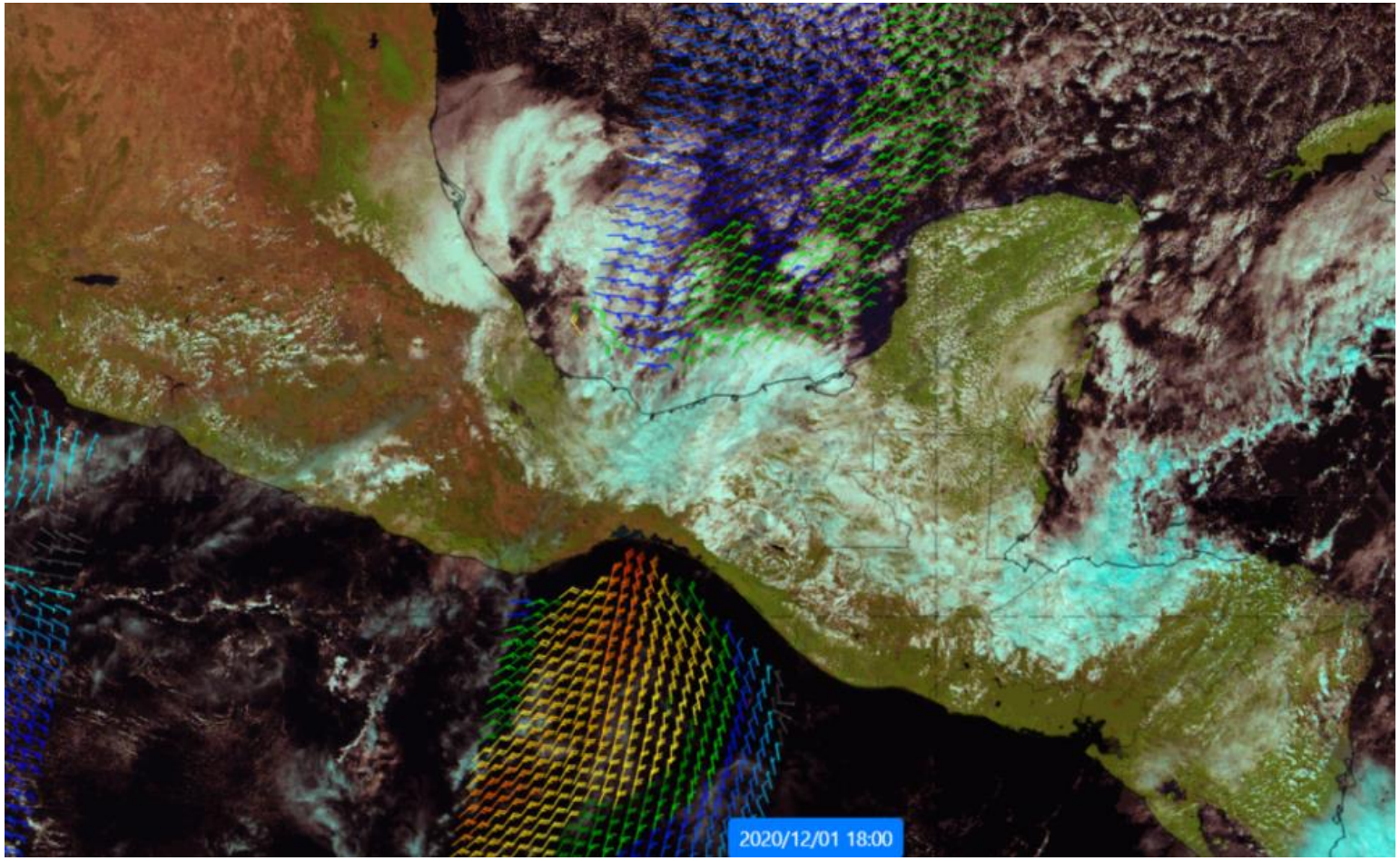
- Wind forcing effect on the sea surface temperature
- Cooling of the surface & and enhanced mixing
- Reflection from the radar instrument (surface roughness)



Mistral and Tramontane winds: Sea surface roughness as seen by Sentinel-1 on 2 February 2022. Light colours over the sea indicate higher roughness due to the action of the winds being channelled through the Strait of Bonifacio.

Ocean properties: Winds and deep circulation

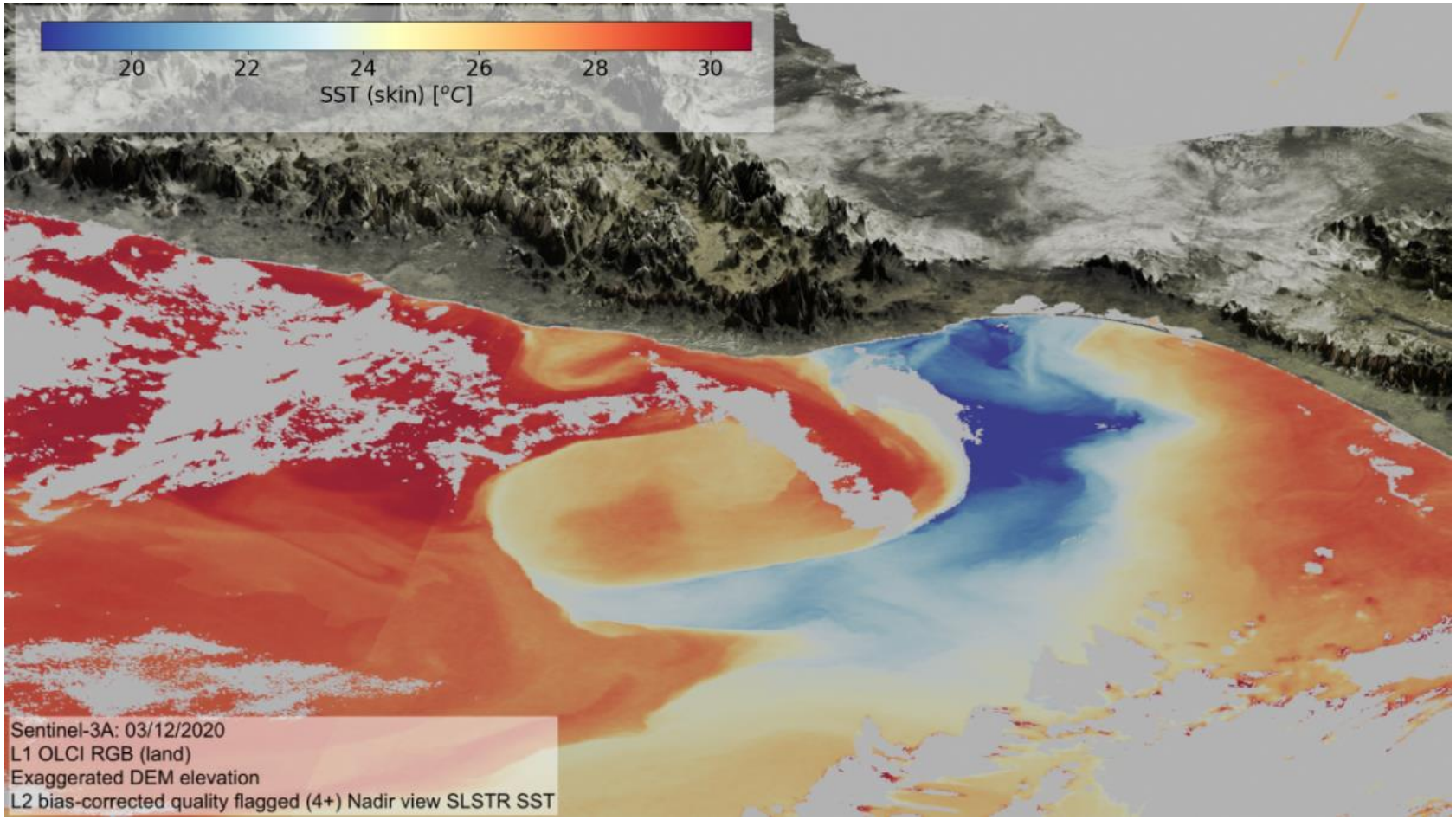
- Wind forcing effect on the sea surface temperature
- Forcing the deep water circulation



Tehuano wind upwelling: GOES-16 Natural Colour RGB overlaid with Metop-B ASCAT wind barbs, 1 December 2020, 18:00 UTC..

Ocean properties: Winds and deep circulation

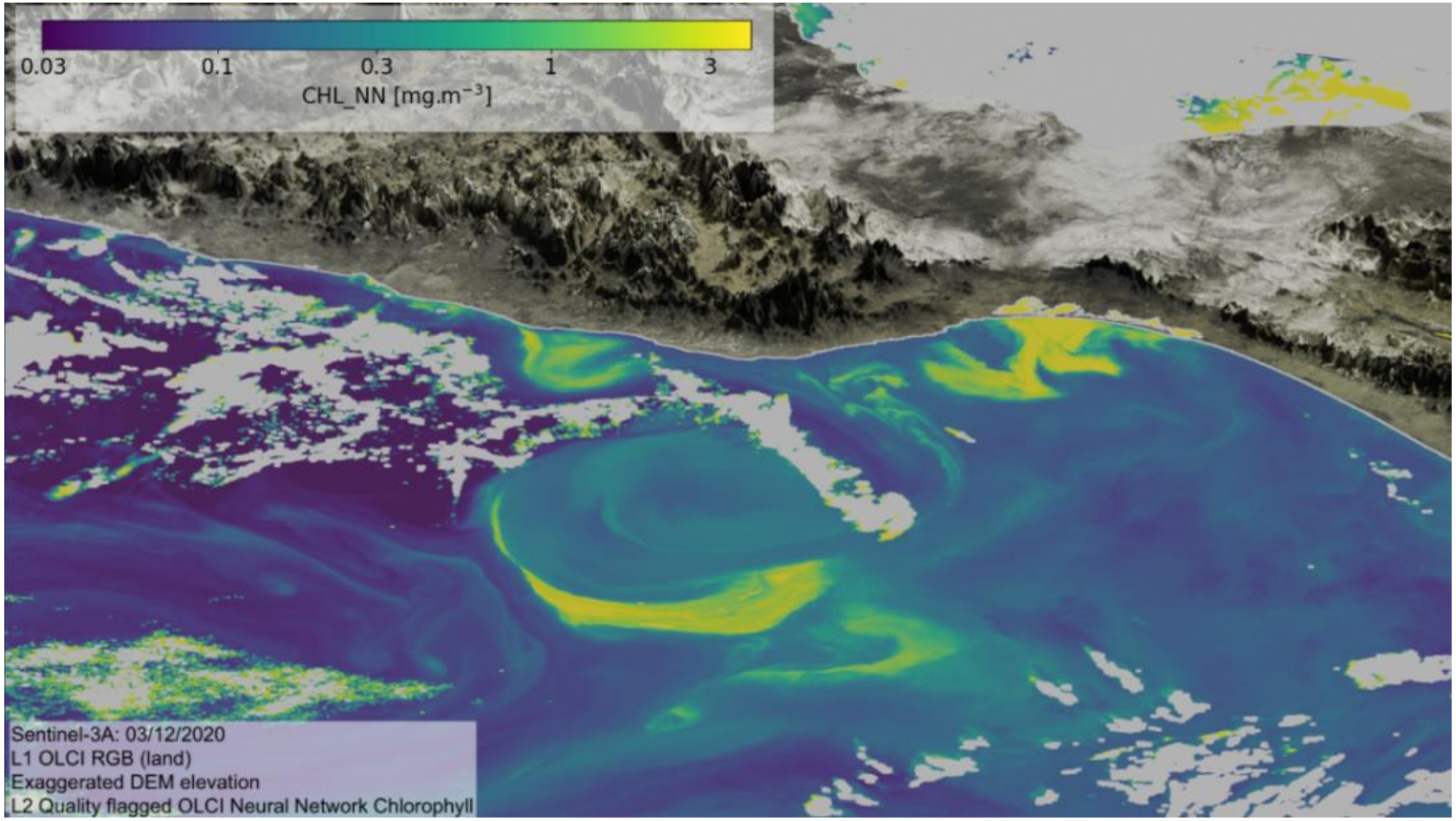
- Wind forcing effect on the sea surface temperature
- Forcing the deep water circulation



Tehuano wind upwelling: Sea Surface Temperature at 1 km, 3 December 2020, Sentinel-3A SLSTR. Level 1 data from OLCI is used to provide a True colour over Digital Elevation Model (DEM).

Ocean properties: Winds and deep circulation

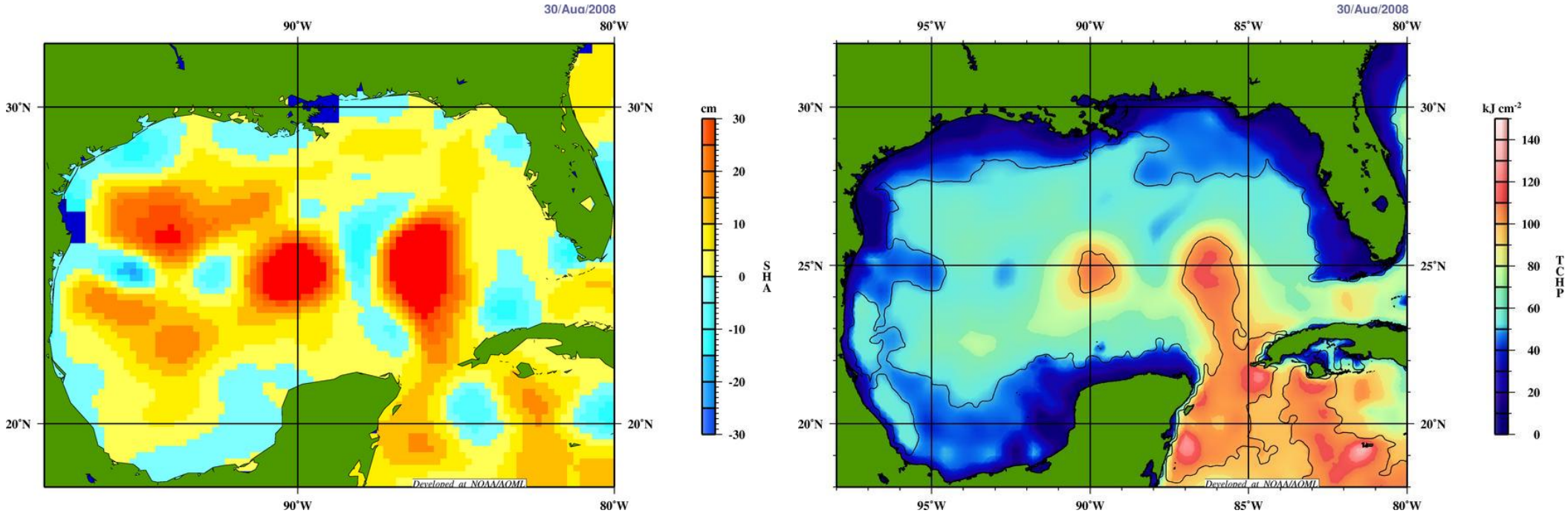
- Wind forcing effect on the sea surface temperature
- Forcing the deep water circulation
- Upwelling of nutrients



Tehuano wind upwelling: Chlorophyll-a concentrations 300 m, 3 December 2020, derived from Sentinel-3A OLCI. Level 1 data from OLCI is used to provide a True colour over Digital Elevation Model (DEM).

Ocean properties: Altimeters and ocean heat

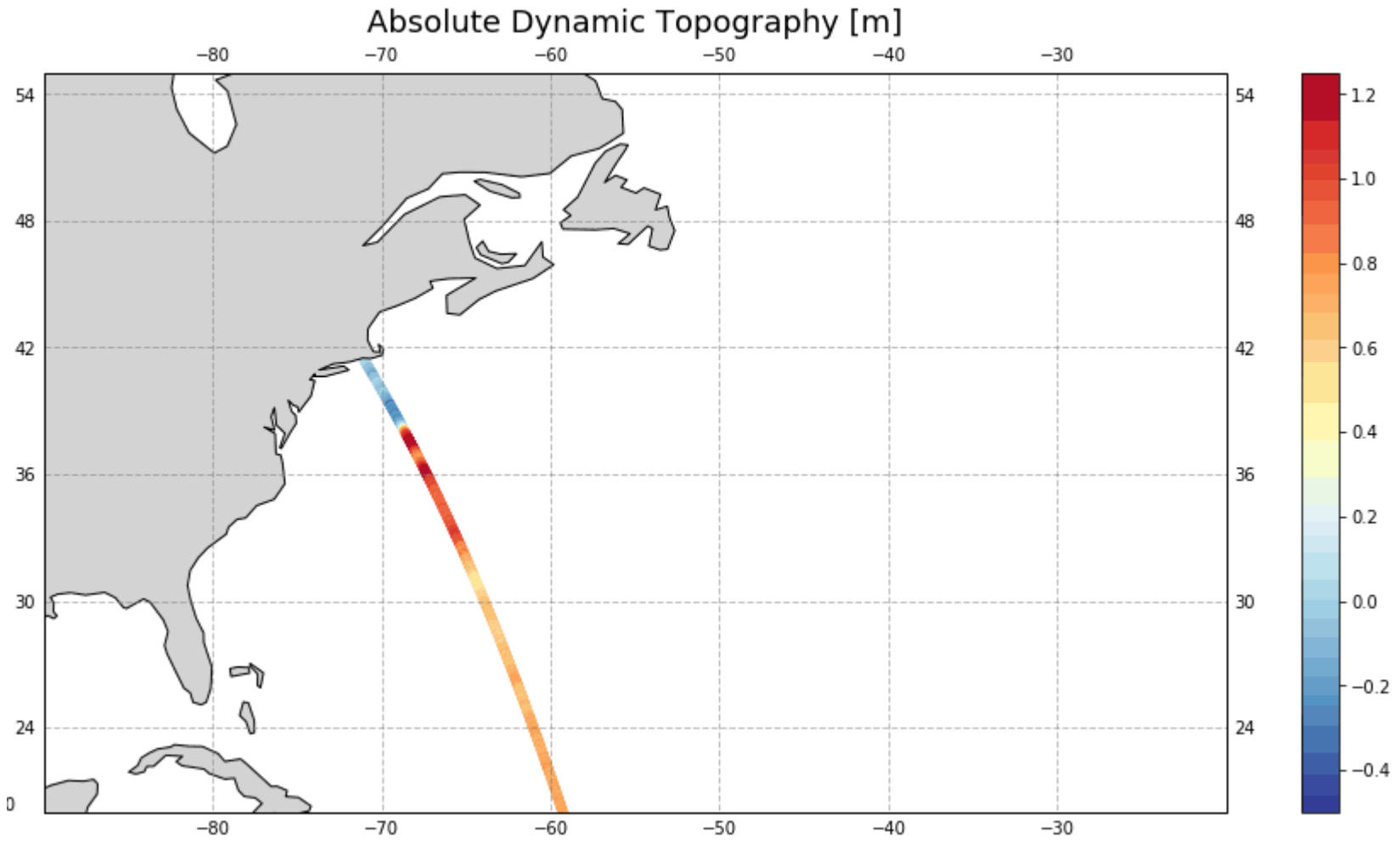
- **Ocean height as a proxy for heat content**



TCs Gustav, Hanna, Ike and Josephine: Satellite (altimetry)-derived field of sea level anomaly (SLA), 30 August 2008 vs Tropical Cyclone Heat Potential (TCHP), 30 August 2008.

Ocean properties: **Altimeters and ocean currents**

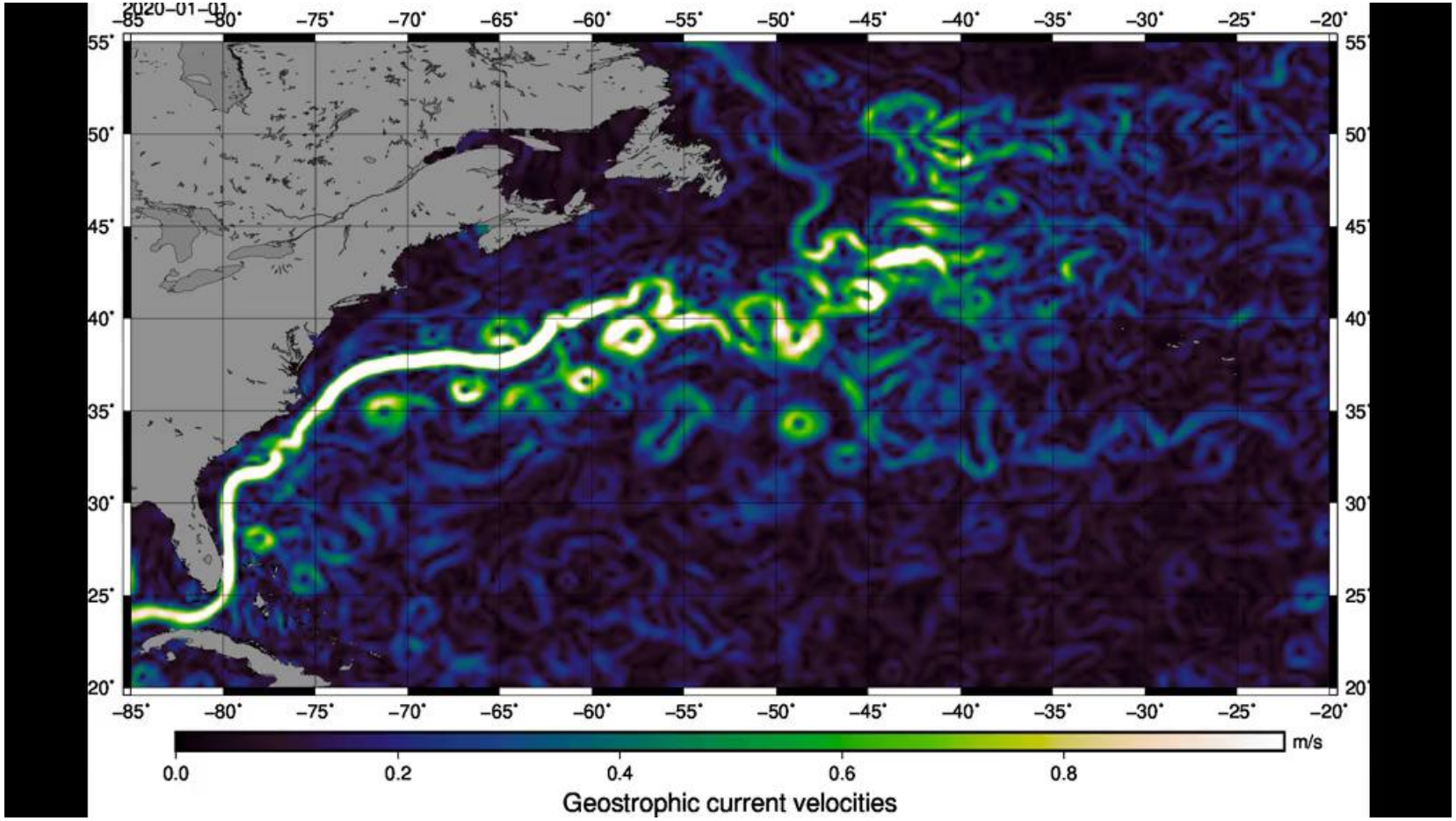
- surface geostrophic currents from the ocean topography in two dimensions (gradient of the surface slopes)



Gulf current measurement: The Absolute Dynamic Topography from Jason-3 (level 2 Non Time Critical data along the track #126), 2020. The along-track plot shows the steep drop in the surface height which correspond to the main flow of the Gulf Stream, and its moves along the year (data CNES/EUMETSAT, figure CLS).

Ocean properties: Altimeters and ocean currents

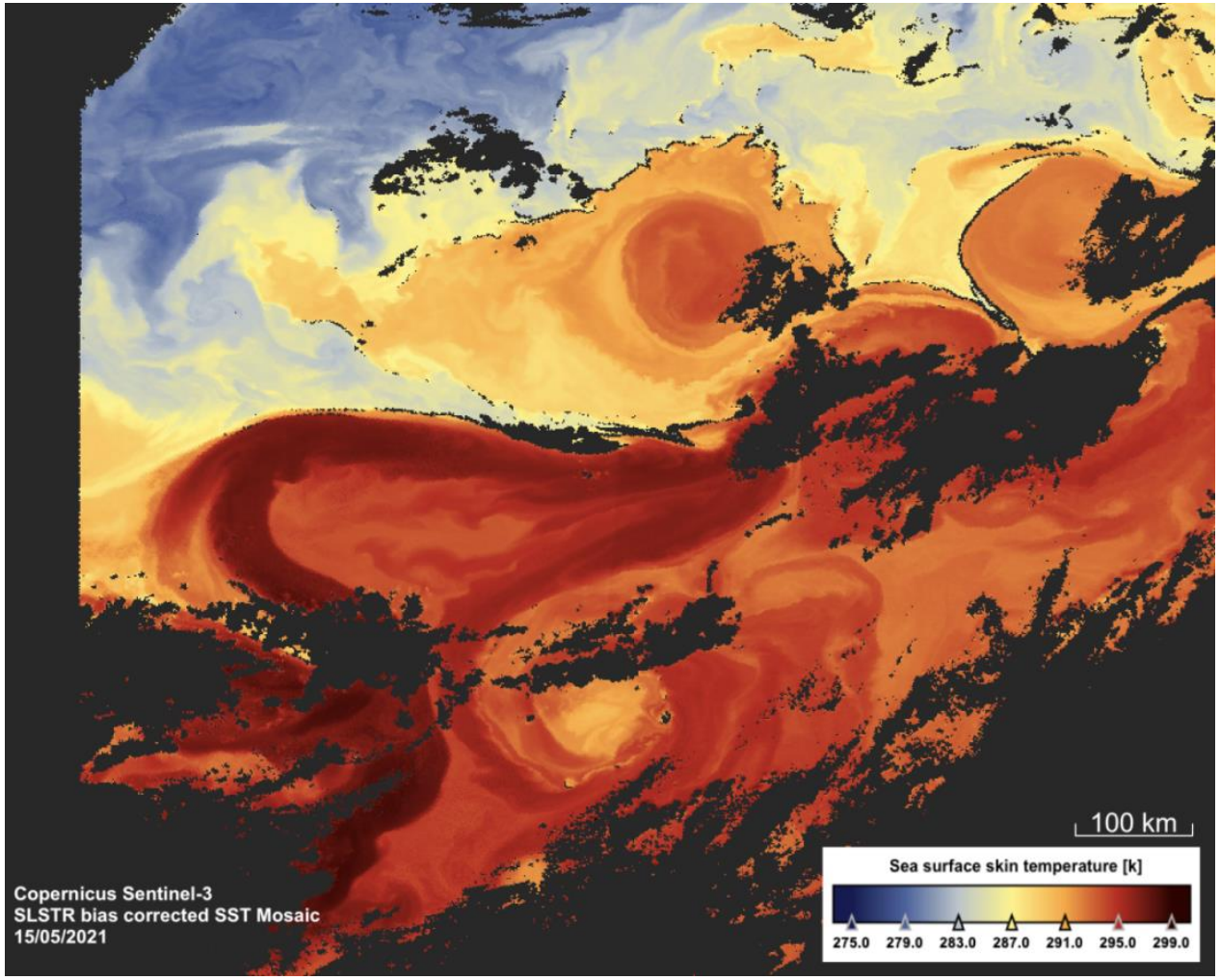
- surface geostrophic currents from the ocean topography in two dimensions (gradient of the surface slopes)



Gulf current measurement: Absolute geostrophic current velocities over the Gulf Stream for 2020, computed from the dynamic heights of the ocean as observed by all altimeters (Sources: CMEMS/CLS).

Ocean properties: **Altimeters and ocean currents**

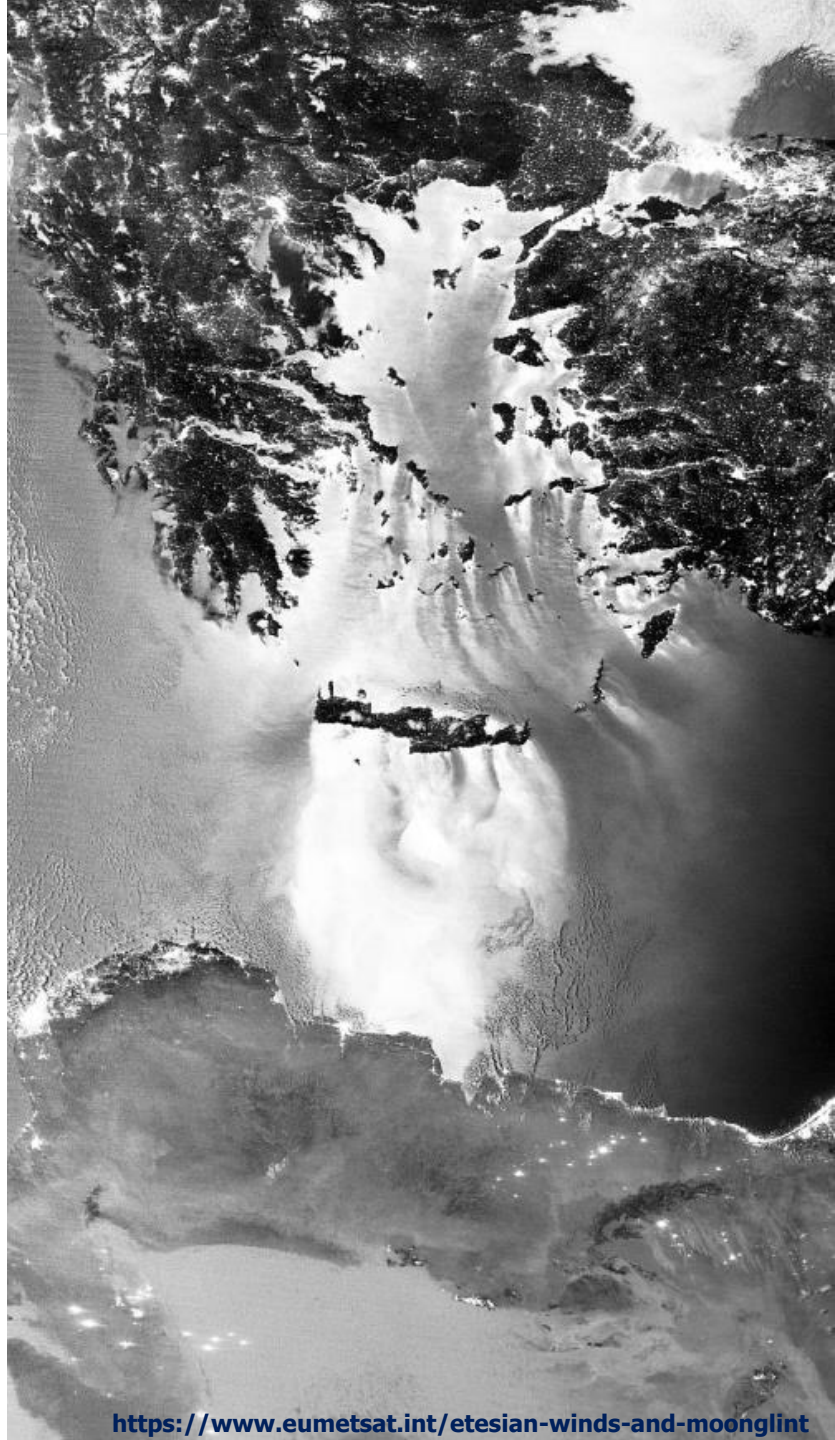
- surface geostrophic currents from the ocean topography in two dimensions (gradient of the surface slopes)



Gulf current measurement: Example SLSTR Nadir view sea surface skin temperature image for the Gulf Stream on 15 May 2021.

Thank you!

Questions are welcome.



https://www.eumetsat.int/etesian-winds-and-moonglint