



# EUMETSAT Marine data resources and handling

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*Météo-France*

*Contributions from Hayley Evers-King and Ben Loveday*

*03/07/2023*





## The European Organisation for the Exploitation of Meteorological Satellites.

- An international organisation with 30 member states.
- Providing observations and data services for operational weather and Earth system monitoring and forecasting, and for climate services.
- Establishing additional capabilities in partnerships with the European Union and other satellite operators to achieve synergy with our own satellite missions for the common benefit of Member States and partners.
- Strong international collaborations within Europe, the US, and Africa & others.



# Current EUMETSAT satellites

[www.eumetsat.int](http://www.eumetsat.int)

## OPTIONAL AND THIRD-PARTY PROGRAMMES (INCLUDING COPERNICUS)

### SENTINEL-3A & -3B (98.7° incl.)

Low Earth, sun-synchronous orbit

Copernicus satellites delivering marine data services from 814km altitude

### JASON-3 (63° incl.)

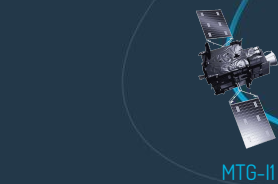
Low Earth, non-synchronous orbit

Copernicus ocean surface topography mission (shared with CNES, NOAA, NASA and Copernicus)

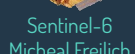
### Sentinel-6 Michael Freilich (66° incl.)

Low Earth, non-synchronous orbit

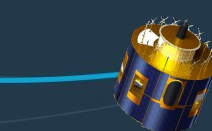
Copernicus ocean surface topography mission (shared with NASA, NOAA, ESA and Copernicus with support from CNES)



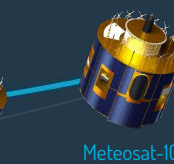
MTG-II



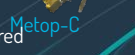
Sentinel-6 Micheal Freilich



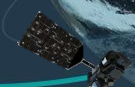
Meteosat-II



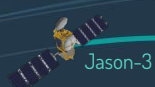
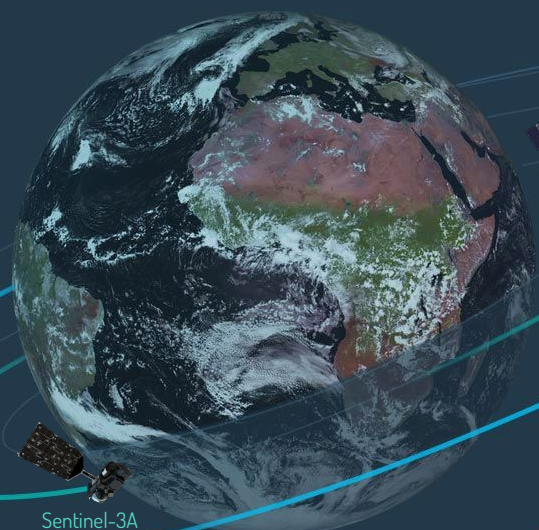
Meteosat-10



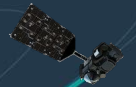
Metop-C



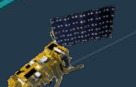
Sentinel-3A



Jason-3



Sentinel-3B



Metop-B



Meteosat-9

## MANDATORY PROGRAMMES

### METEOSAT-10, -11

Geostationary orbit

Meteosat Second Generation

Two-satellite system

Full disc imagery mission (15 mins) (Meteosat-11 (0°))

Rapid scan service over Europe (5 mins) (Meteosat-10 (9.5° E))

### METEOSAT-9 (45.5° E)

Geostationary orbit

Meteosat Second Generation providing Indian Ocean data coverage

### METOP-B & -C (98.7° incl.)

Low Earth, sun-synchronous orbit

EUMETSAT Polar System (EPS)/ Initial Joint Polar System

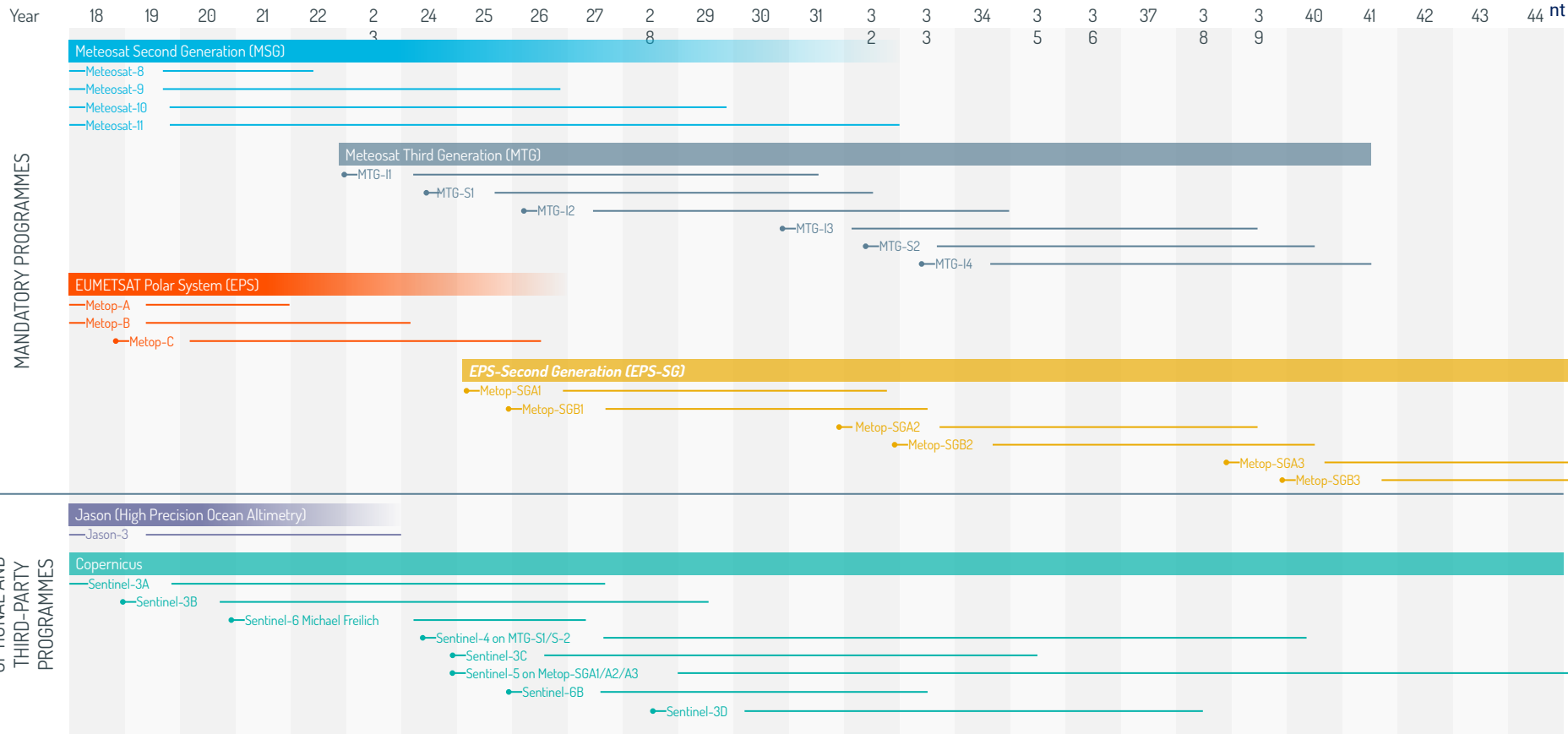
### MTG-II

Geostationary orbit

Meteosat Third Generation imaging mission, currently in commissioning phase



# EUMETSAT mission planning

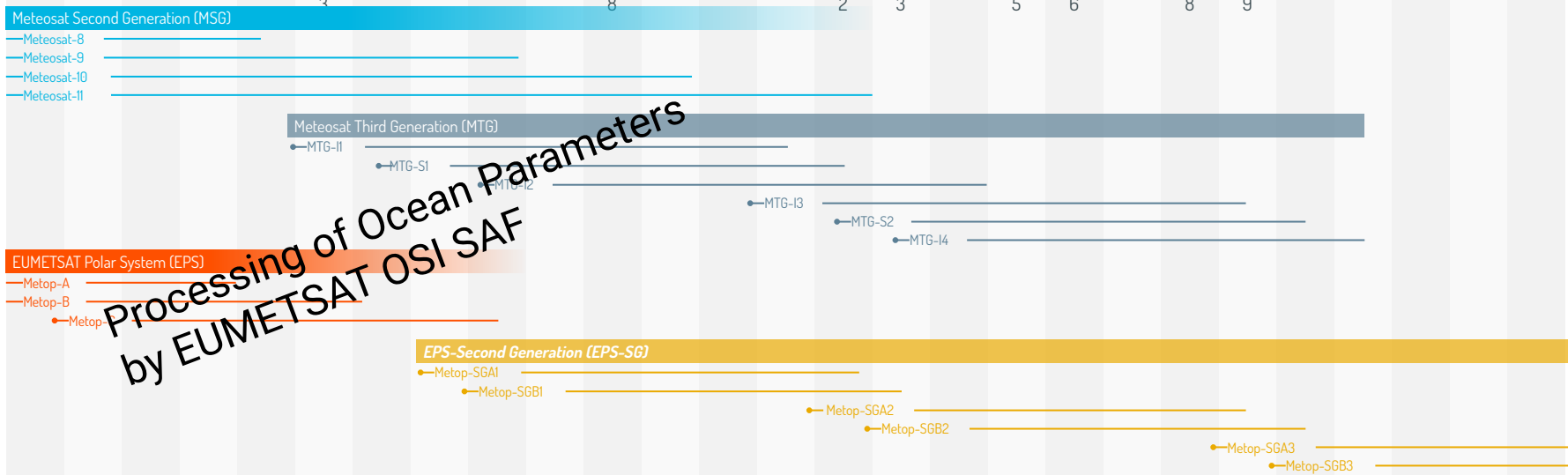




# EUMETSAT mission planning

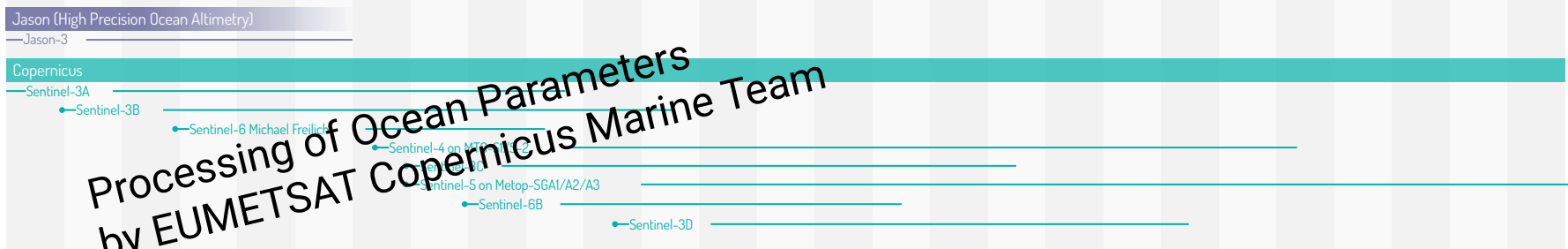
Year 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 nt

MANDATORY PROGRAMMES



Processing of Ocean Parameters by EUMETSAT OSI SAF

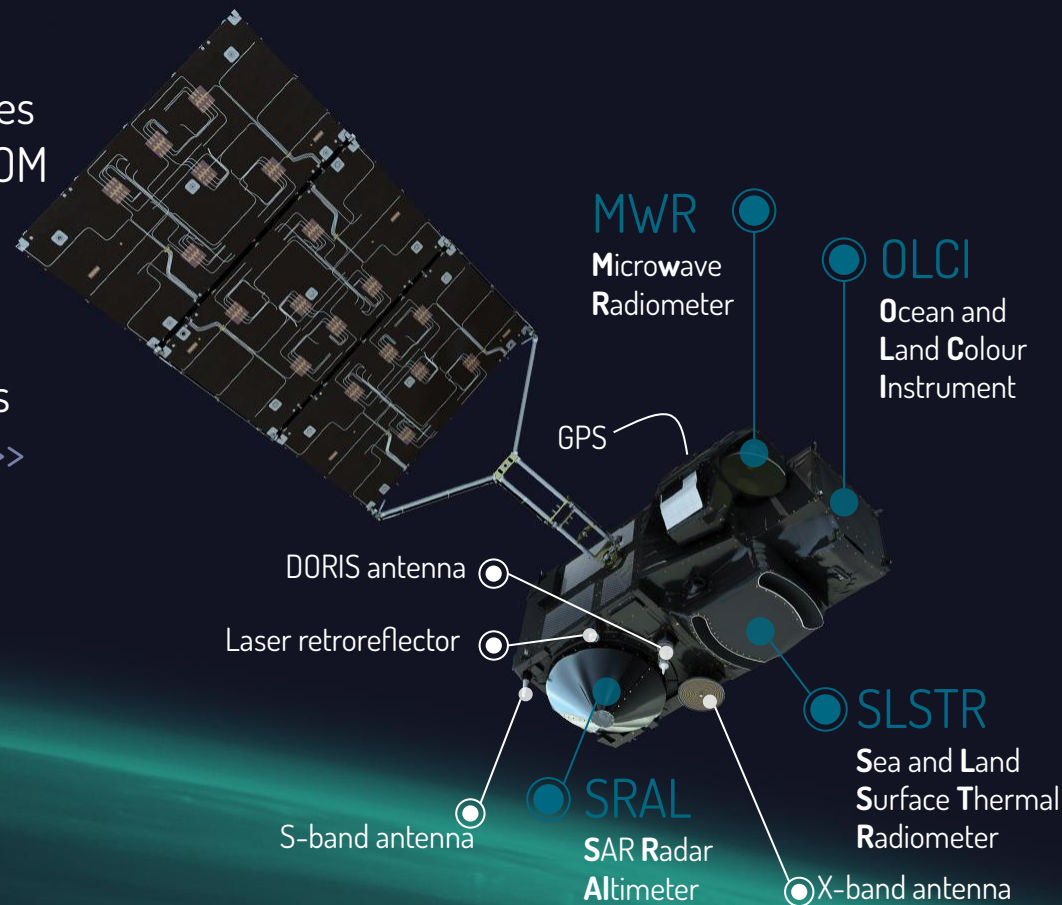
OPTIONAL AND THIRD-PARTY PROGRAMMES



Processing of Ocean Parameters by EUMETSAT Copernicus Marine Team

# Sentinel-3 instruments and variables

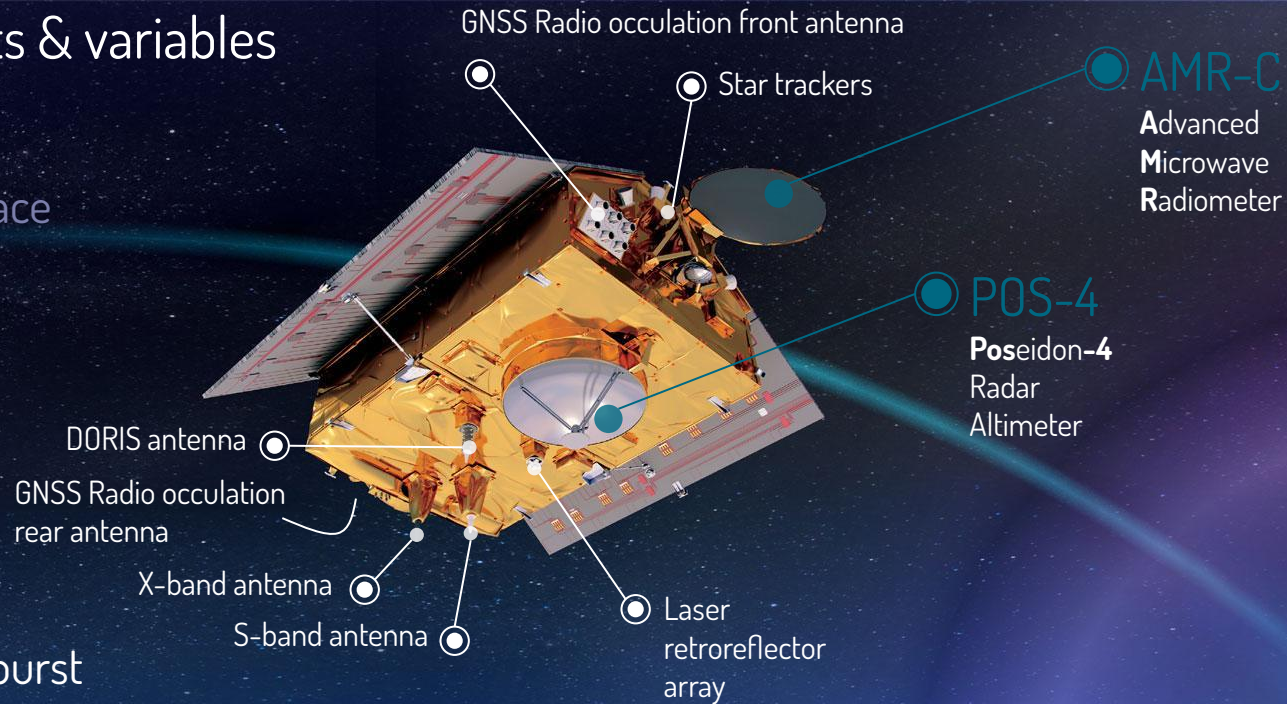
- OLCI >> visible radiometry
  - **ocean colour**: radiances & reflectances
  - chlorophyll, suspended sediment, CDOM
  - PAR / kd490
- SLSTR >> thermal radiometry
  - radiances & brightness temperatures
  - Sea and sea-ice surface temperatures
- SRAL / MWR / POD (DORIS/GNSS/LRR) >> surface topography mission
  - Sea surface height
  - Significant wave height
  - Wind speed





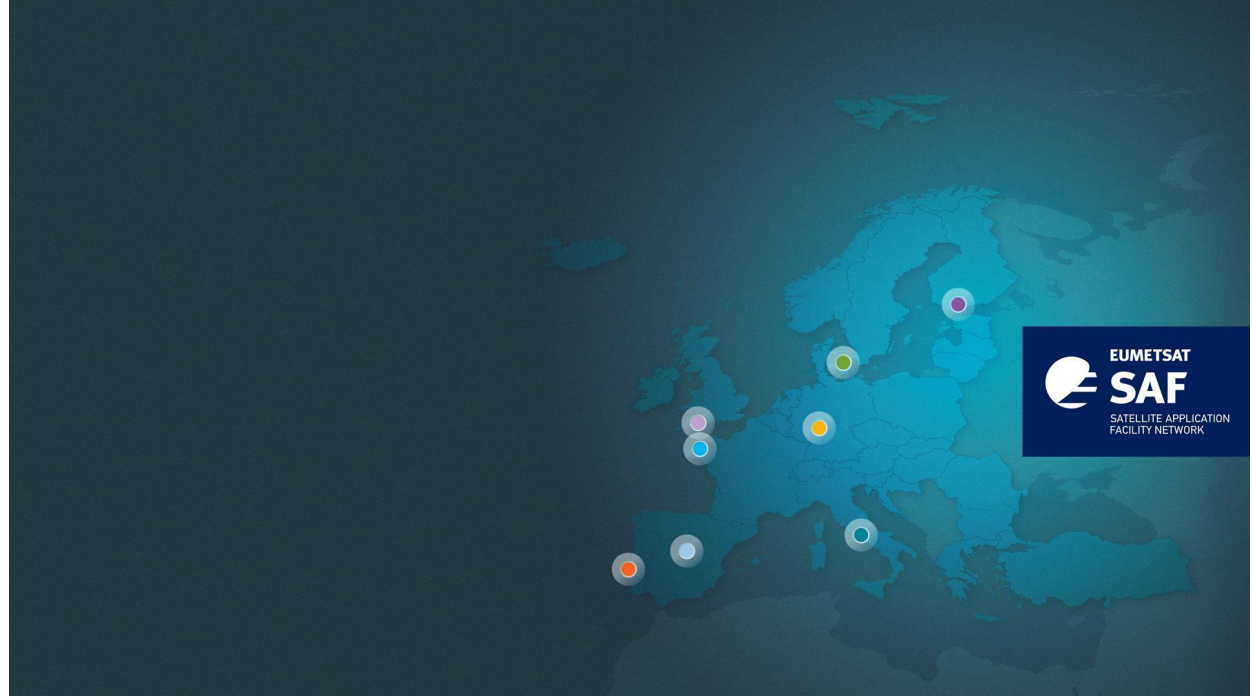
# Sentinel-6 instruments & variables

- POS-4 / AMR-C / POD (DORIS/GNSS/LRR) >> surface topography mission
  - Sea surface height
  - Significant wave height
  - Wind speed
- POS-4 ;
  - back compatible (climate continuity)
  - state-of-the-art (open burst transmission, low noise, improved resolution)



To carry out its activities on a European scale, and expand its ground segment, EUMETSAT has relied on the skills of the meteorological services of the Member States. Utilising specialist expertise from the Member States, Satellite Application Facilities (SAFs) are dedicated centres of excellence for processing satellite data. They form an integral part of the distributed EUMETSAT Application Ground Segment.

There are eight of them, each of which has taken charge of the development of a set of products derived from satellite data, or software using these data, with the ultimate goal of providing them to users in an operational framework.





The OSI SAF (Ocean and Sea Ice Satellite Application Facility) is the dedicated EUMETSAT centre for processing satellite data at the ocean-atmosphere interface.



**EUMETSAT**

**OSI SAF**

OCEAN AND SEA ICE



Norwegian  
Meteorological  
Institute



Danish  
Meteorological  
Institute

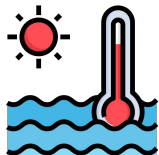


Royal Netherlands  
Meteorological Institute  
*Ministry of Infrastructure and the  
Environment*



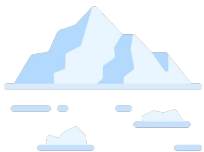
## Sea Surface Winds

- ❖ *Speed and Direction*



## Sea Surface Temperature

- ❖ *Surface temperature*



## Sea Ice Parameters

- ❖ *Concentration, Edge, Type, Emissivity, Drift*
- ❖ *IST - Sea Ice Surface Temperature*



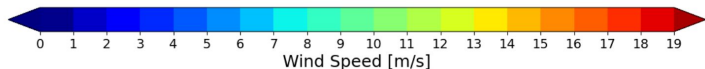
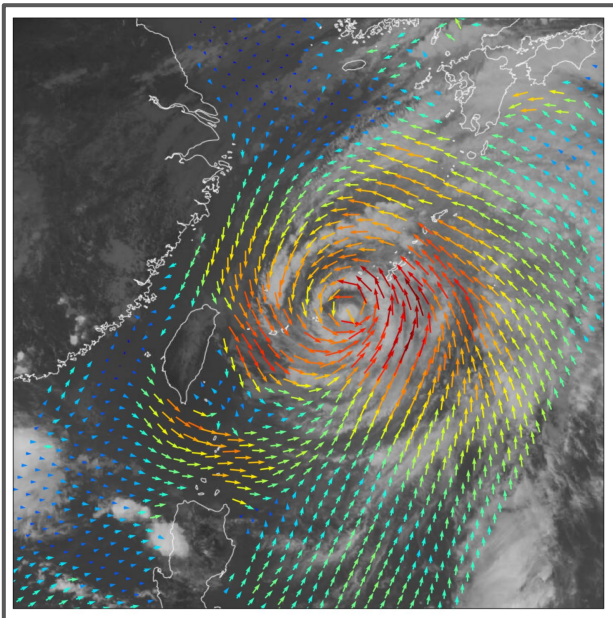
## Radiative fluxes

- ❖ *Downward longwave irradiance*
- ❖ *Surface solar irradiance*



**Operational and  
quality controlled  
products**

*Typhoon Mawar - HY-2B - 01/06/2023*



Winds are derived from scatterometer missions.

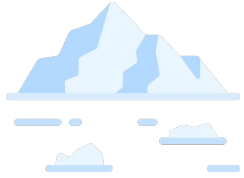
To ensure global coverage, the objective is to process most of them.

## Currently:

- Metop-B and -C satellites,
- HY-2B, HY-2C, and soon HY-2D

## Continuity with:

- CFOSAT,
- Oceansat-3,
- windRAD,
- Metop-SG-B/SCA and MWI



## Sea Ice Products

- Near real time
- Climate data records

- Sea Ice Concentration
- Sea Ice Edge
- Sea Ice Drift
- Sea Ice Type
- Sea Ice Emissivity
- Ice Surface Temperature



At both poles



## Satellites

- DMSP/SSMIS + GCOM2/AMSR2, Metop/ASCAT

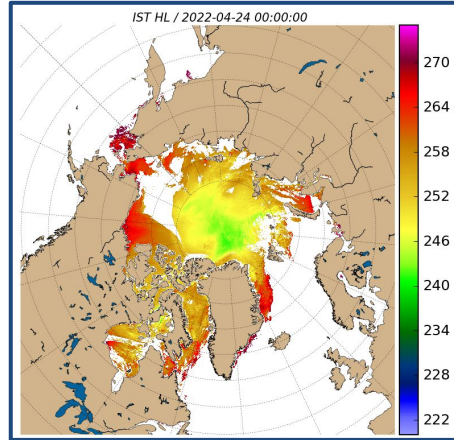
## Continuity with:

- (MWRI), Metop-SG-B/SCA and MWI

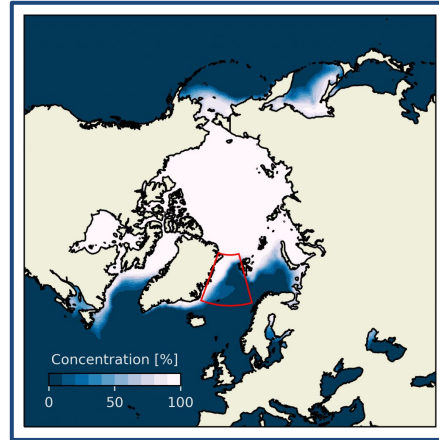
## New foreseen products

- Sea Ice Age
- Sea Ice Index
- Icebergs

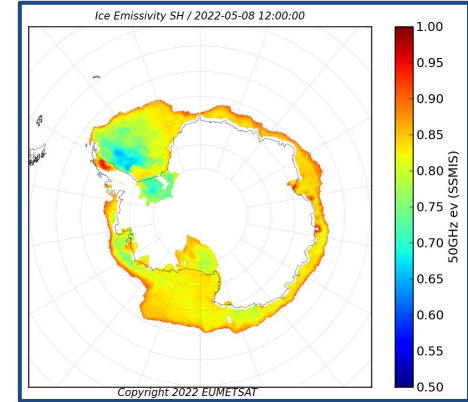
Ice surface temperature



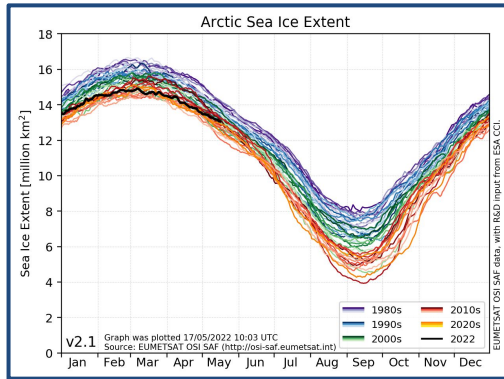
Sea Ice Concentration



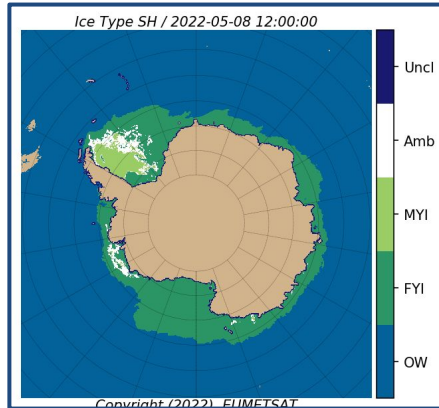
Ice Emissivity



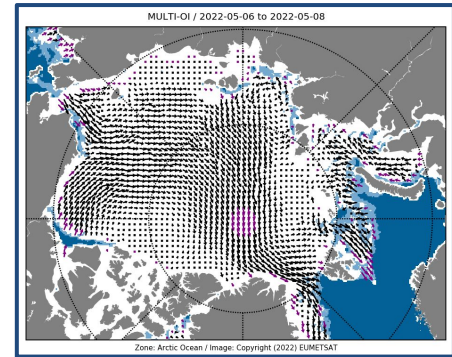
Sea Ice Extent



Sea Ice Type



Sea Ice Drift





## Case Studies & Distribution

**The Antarctic ice is completing the seasonal melting phase, following the Antarctic summer. The extent of the sea ice at the end of February 2022 is the lowest in the last 44 years - the period when satellites have been used to monitor the ice.**

Published on 02 March 2022

By Signe Aaboe and Thomas Lavergne (MET Norway), Christine Träger-Chatterjee (EUMETSAT)

The Satellite Application Facility on Ocean and Sea Ice (OSI SAF) is producing several satellite-derived products to monitor the evolution of sea ice in polar regions.

In February 2022 the OSI SAF Sea Ice Index (Figure 1) showed that the extent of the Antarctic sea ice was at its lowest since the beginning of satellite-based observations in 1979 (Figure 2).

**Figure 1: The Antarctic Sea Ice Index. Yellow line shows previous record minimum year (2017), red line shows the recent measurements**

## European State of Climate Reports & Data redistribution

**Daily Arctic sea ice extent**

**Monthly Arctic sea ice extent anomalies in March**

**Monthly Arctic sea ice extent anomalies in September**

Data: Sea ice extent derived from OSI SAF Global Sea Ice Concentration CDR v3.0 • Reference period: 1991-2020 • Credit: C3SECMWF

Logos: Copernicus Climate Change Service, European State of the Climate | 2022, PROGRAMME OF THE EUROPEAN UNION, Copernicus, ECMWF

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**Daily sea ice extent in Barents Sea**

**Sea ice concentration in May 2022**

Data: OSI SAF Global Sea Ice Concentration ICDR v3; C3S Sea Ice Edge CDR v3 • Reference period: 1991-2020 • Credit: C3SECMWF/EUMETSAT

Logos: Copernicus Climate Change Service, European State of the Climate | 2022, PROGRAMME OF THE EUROPEAN UNION, Copernicus, ECMWF



## Satellites

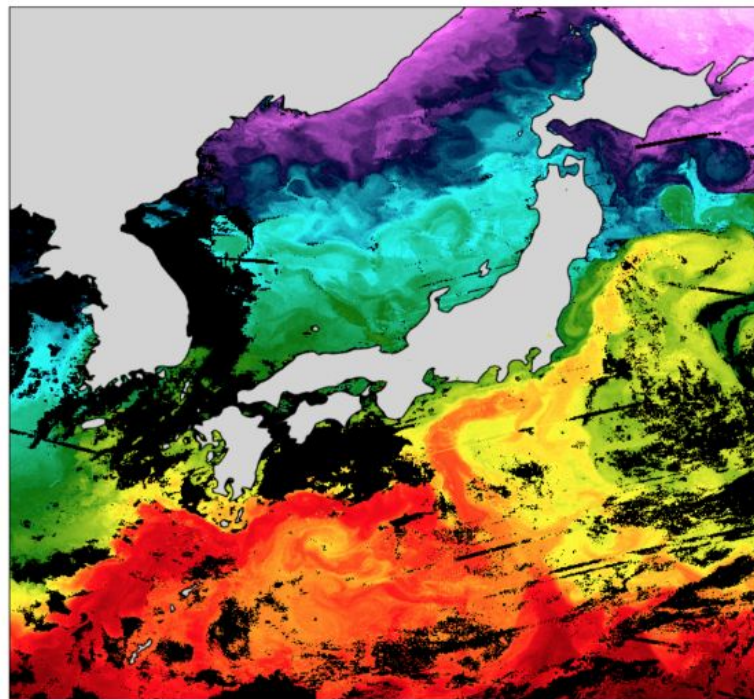
- Metop, NOAA, MSG-0°, MSG-IO, GOES-East

## Continuity with:

- MTG
- Metop-SG

## SST Products

- L2 products
- L3 Regional Products
- L3 Global Products



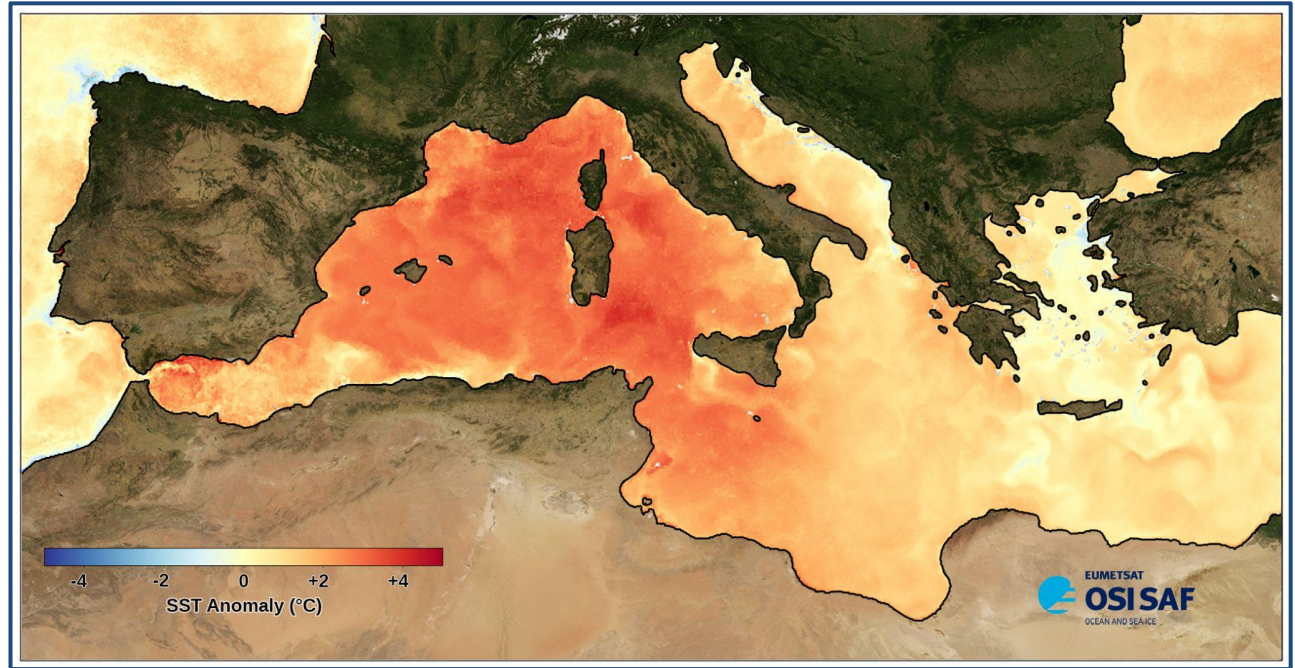
*Sea Surface Temperature Metop-B - 02/05/2023*

## Climate Application

- Monitoring surface temperature anomalies

## Continuity

- MTG high resolution SST for coastal applications
- Harmonization of the depth of the retrieval
- Homogenization of Single Sensor Error Statistics (SSES)



***Mean SST Anomaly - Metop-B - August 2022***



**Access our data, stay informed :**  
Register on <https://osi-saf.eumetsat.int>



## Products

- NetCDF format

## Access means

- FTP access
- EUMETCast / EUMETSAT Data Centre and Store
- Thredds

## Redistribution

- Copernicus
  - Marine and Climate Change Service
- NASA PODAAC



← Pull services      Push services →



Viewing your data (WMS / WCS)

EUMETView\*



Long term archive

EUMETSAT Data Centre



Copernicus operational and reprocessed data access

EUMETSAT Data store



Data customisation

Data Tailor



Near-real time data delivery via satellite networks

EUMETCast Satellite



Near-real time data delivery via terrestrial networks

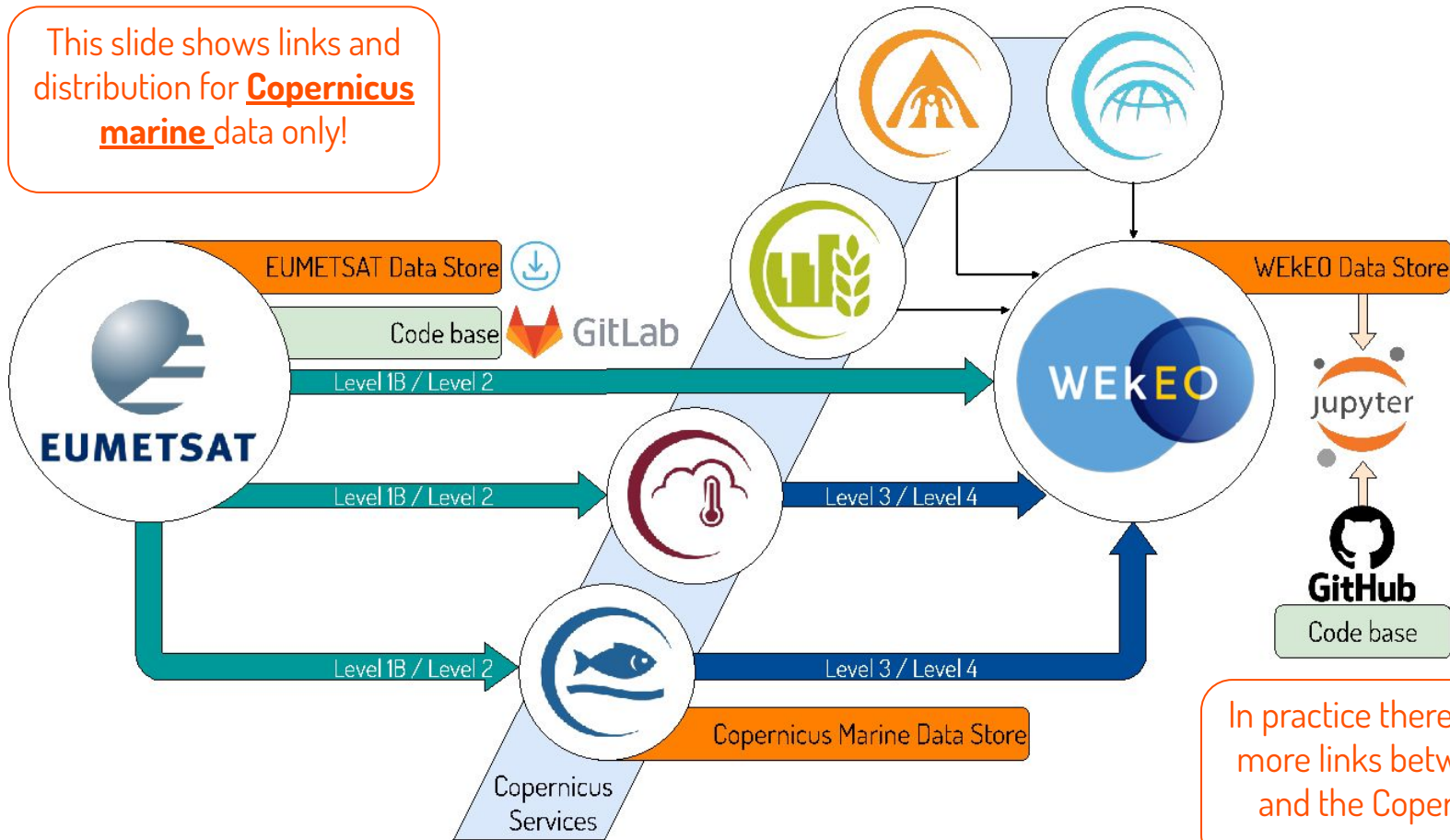
EUMETCast Terrestrial

\*new generation

Data Store has replaced the CODA and CODAREP services used by many Sentinel-3 users, offering unified access to operational and reprocessed data. It will allow access long time-series of the most up to data products, via a single point without the use of Data Centre in most cases (including to WEkEO).



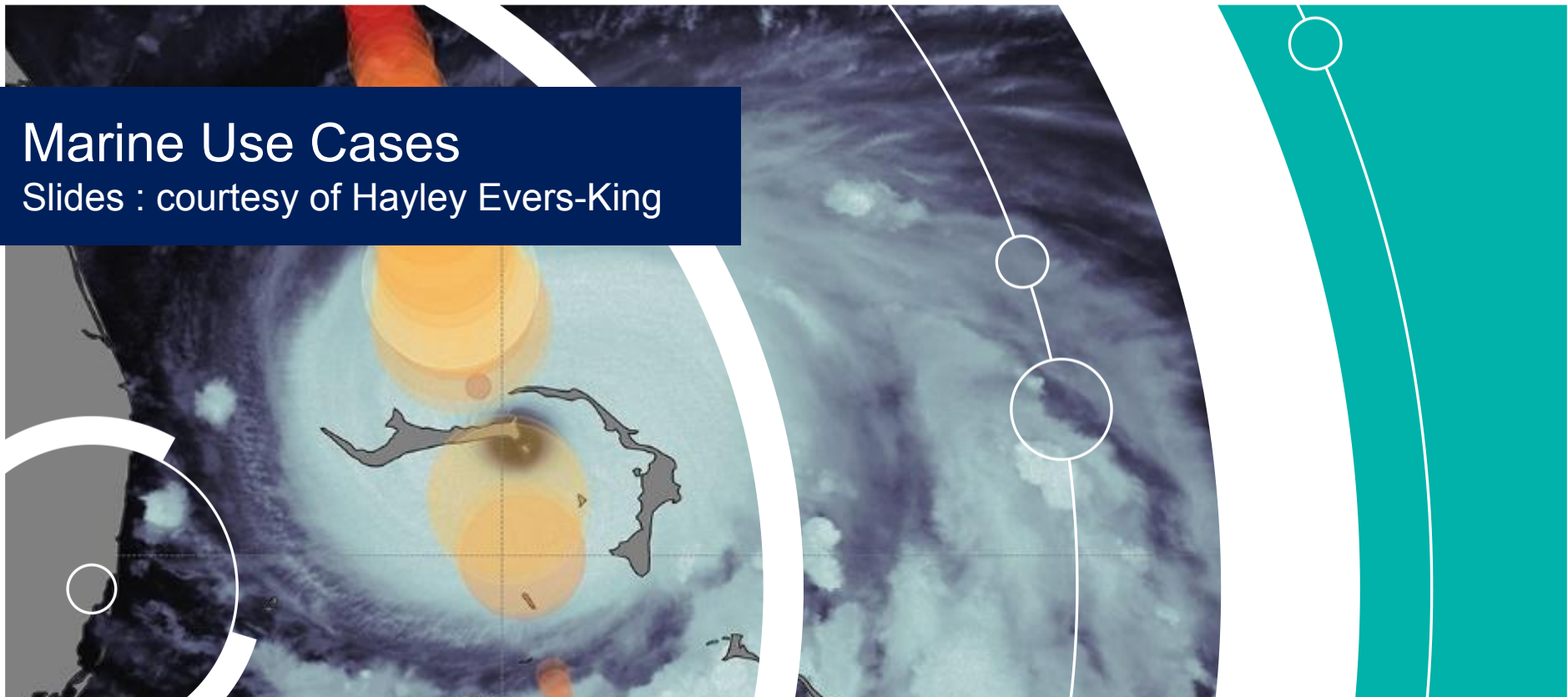
This slide shows links and distribution for **Copernicus marine** data only!



In practice there are many, many more links between EUMETSAT and the Copernicus Services

# Marine Use Cases

Slides : courtesy of Hayley Evers-King



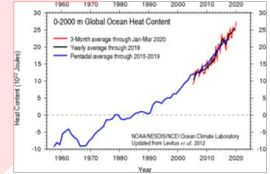
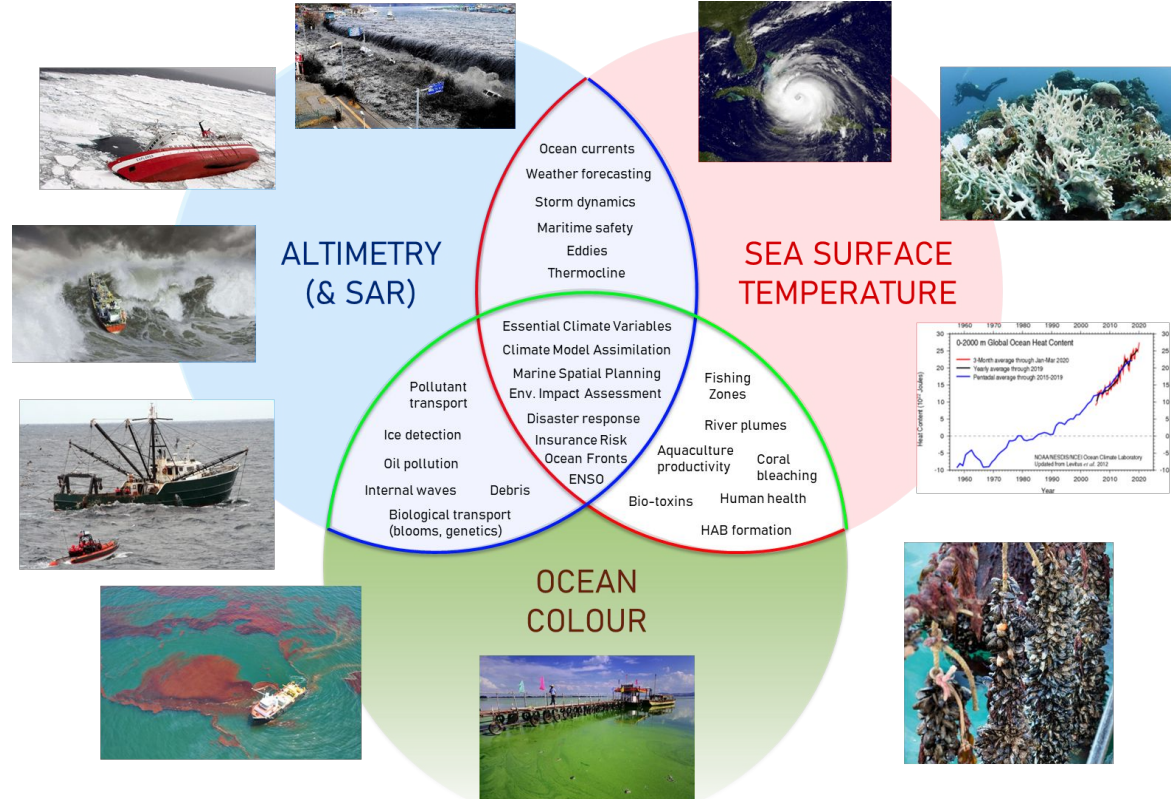


# Marine applications of satellite data

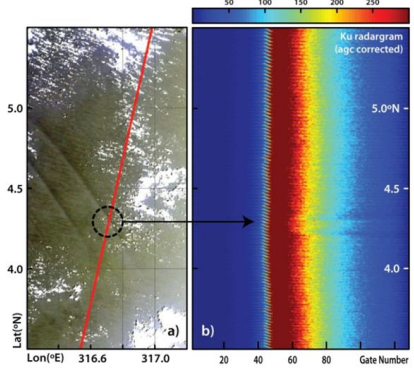
Data from EUMETSAT operated Copernicus satellites (Sentinel-3 and 6) suits applications where rapid availability (within 3 hrs) and highest spatial resolution is key. Synergy applications benefit from multi-sensor platform of Sentinel-3.

Data features heavily in downstream level-3 and 4 products from Copernicus Marine Service.

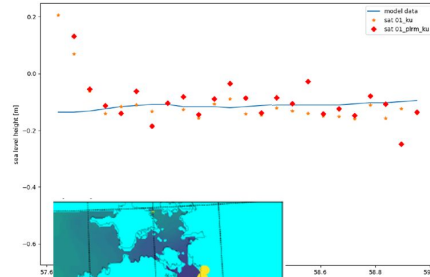
Also used a lot for studies seeking to improve remote sensing measurements and processing



# L1 and L2 scientific research and applications

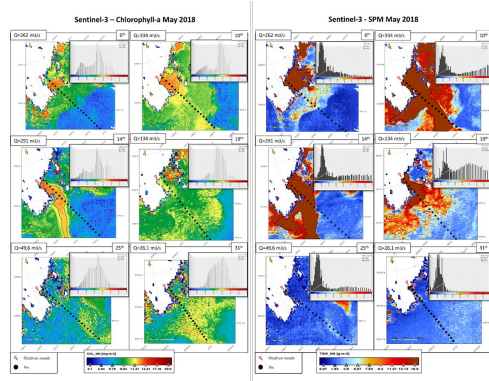
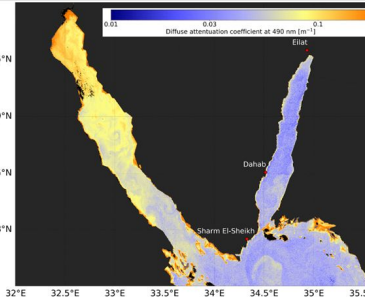
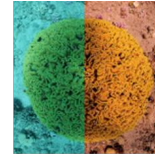


SRAL & OLCI: detection of internal waves (Santos-Ferreira et al., 2018)

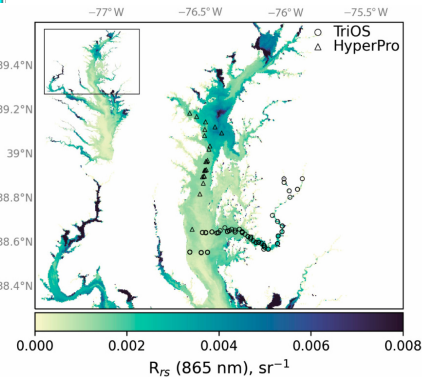


Operational ocean model validation with SRAL SSH in the Gulf of Riga (Vilnis Frishfelds).

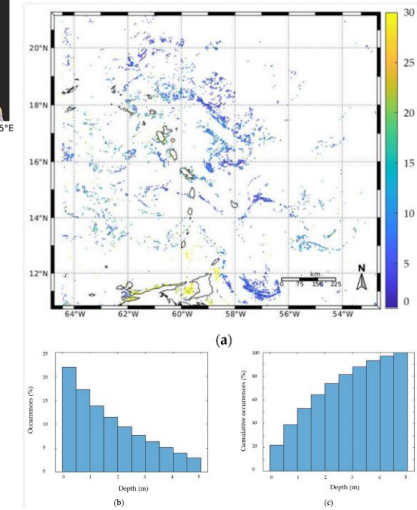
OLCI attenuation data used to correct underwater imagery. (Derya Akkaynak)



Comparing OLCI data with river discharge measurements (Noemi Marsico)



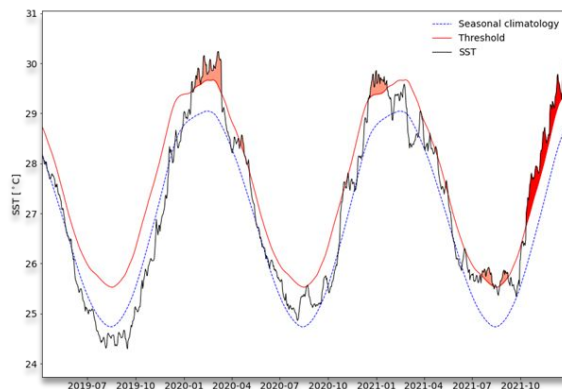
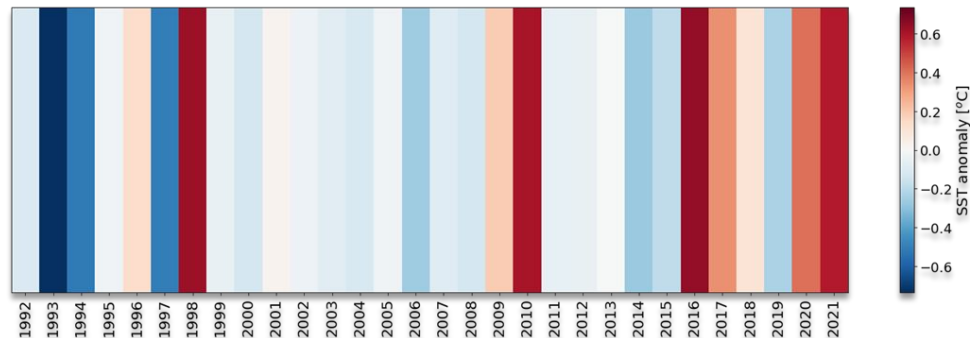
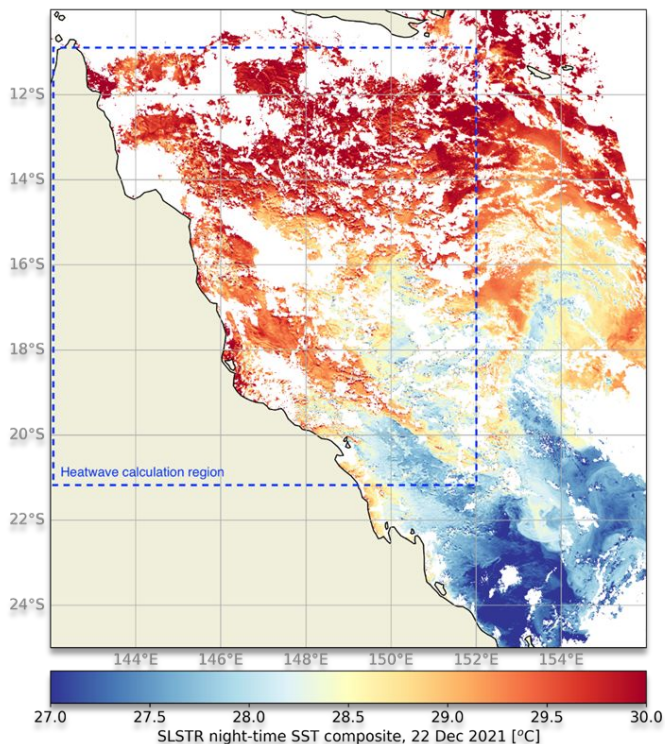
OLCI validation in Chesapeake Bay (Anna Windle)



Detection of submerged sargassum (Lea Schamberger)



## • Marine heatwaves can be monitored from space to inform marine management

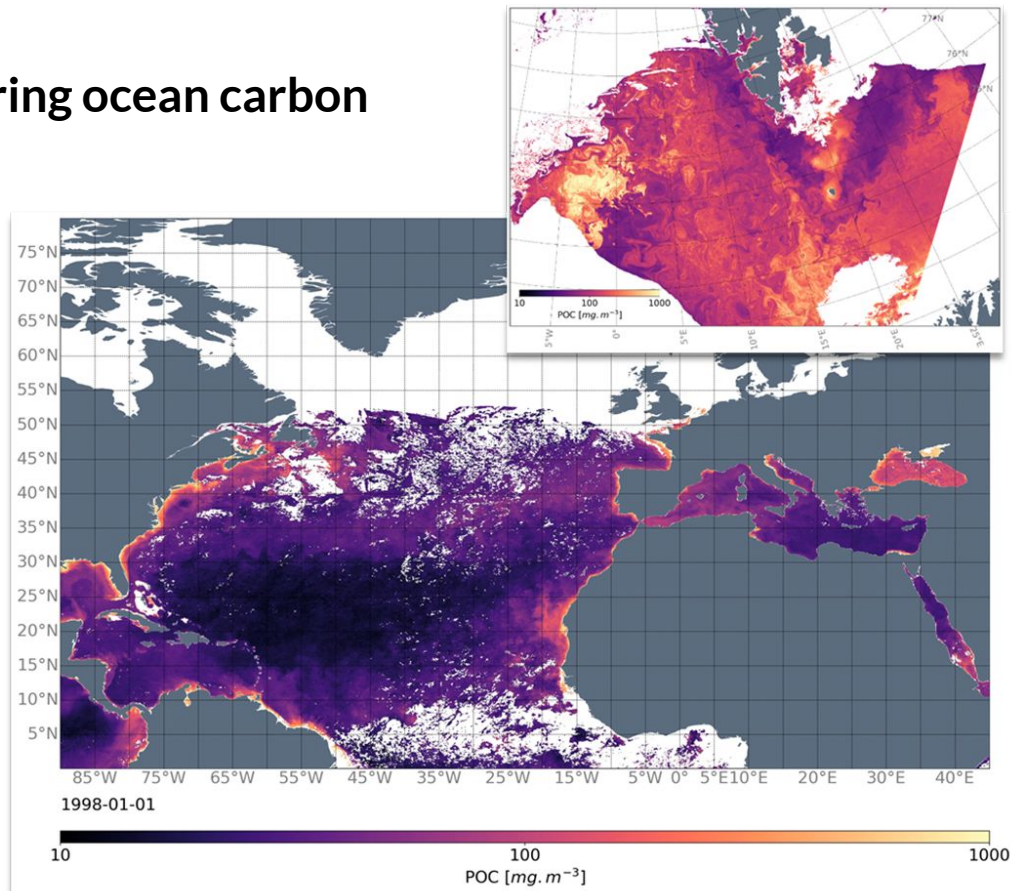


- Need to identify and monitor events relative to historical baselines.
- Impacts on ecosystems and dependent industries.
- Notebook shows how to access NRT data, as well as longer reprocessed series and conduct analysis.



- **Satellite data contributing to monitoring ocean carbon uptake**

- Ocean colour data can be used to derive information about carbon pools e.g. POC, PIC
- Other data can be used towards studies of carbonate system (ocean acidification).
- Data offers insight in to event scale dynamics and long-term trends.
- Notebook shows access to ocean colour data and applications of a simple, published algorithm for POC.

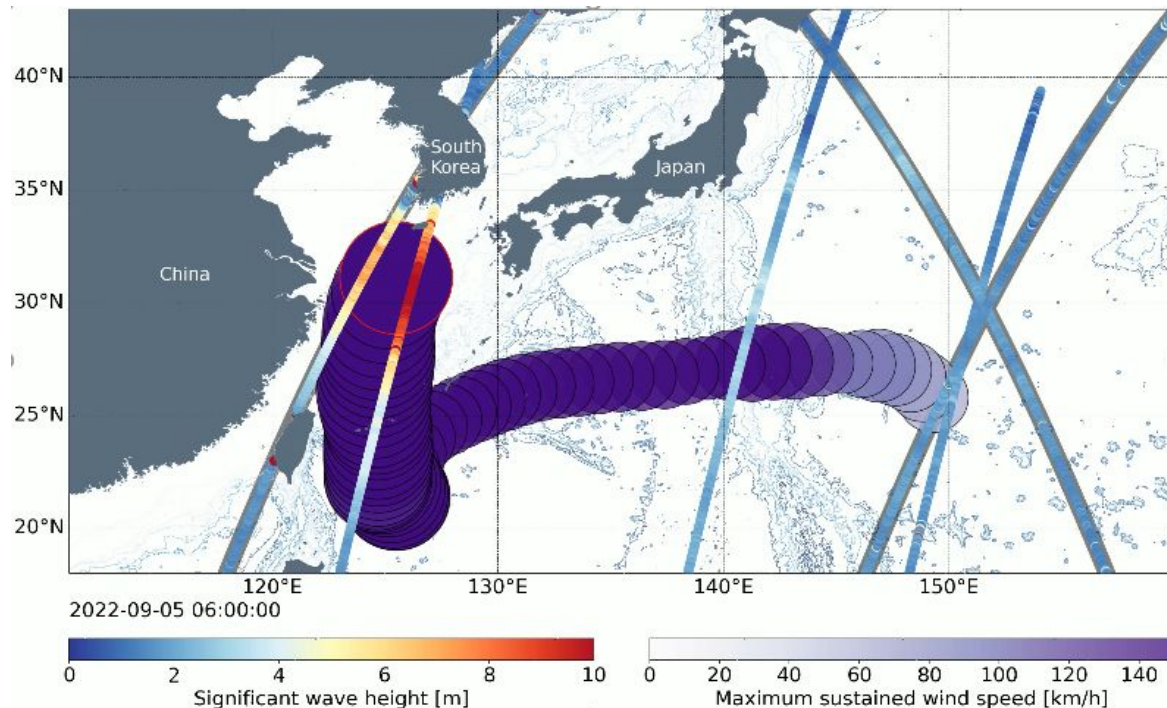






- **Monitoring extreme weather and impacts on oceans and coasts**

- Altimetry data captures the impacts of storms on the ocean and coasts.
- This data feeds in to forecasts and warning systems.
- Notebook shows how users can access this data and follow a storm in NRT.

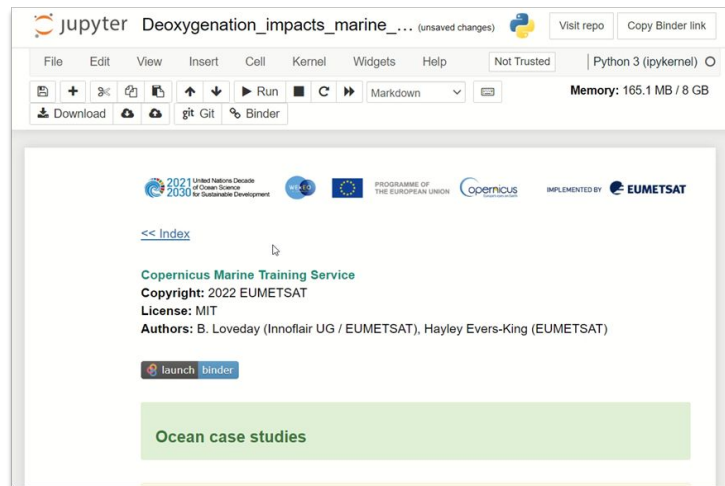
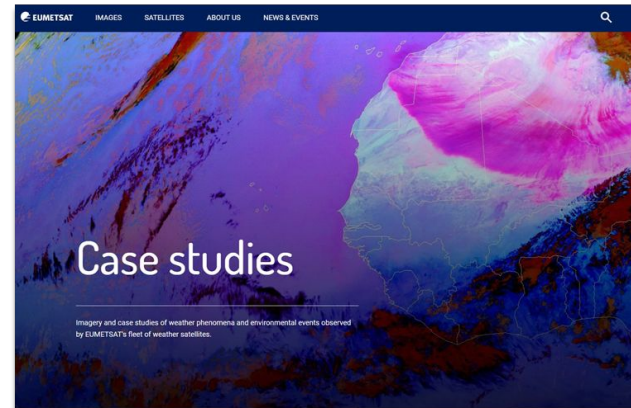


## Case studies:

<https://www.eumetsat.int/case-studies>

**Gitlab:** <https://gitlab.eumetsat.int/eumetlab/oceans/oceantraining/applications/ocean-case-studies>

README contains guidance on running.  
Also compatible with WEkEO JupyterLab and Binder.





GitLab

<https://gitlab.eumetsat.int/eumetlab/oceans>

Ocean Training

Group ID: 851

This group contains various projects where you can learn about ocean satellite data and how to use it.

Subgroups and projects Shared projects Archived projects

A applications

S sensors

learn-olci Repository for all training content associated with the Copernicus Sentinel-3 OLCI s... ★ 0

learn-osi-saf-sea-ice Repository for all training content associated with EUMETSAT Ocean and Sea Ice Sa... ★ 0

learn-osi-saf-sst Repository for all training content associated with EUMETSAT Ocean and Sea Ice Sa... ★ 0

learn-osi-saf-wind Repository for all training content associated with EUMETSAT Ocean and Sea Ice Sa... ★ 0

learn-s6 Repository for all training content associated with the Copernicus Sentinel-6 Posei... ★ 0

learn-slstr Repository for all training content associated with the Copernicus Sentinel-3 SLSTR... ★ 0

learn-sral Repository for all training content associated with the Copernicus Sentinel-3 SRAL ... ★ 0

T tools

<https://osi-saf.eumetsat.int/community/stories/online-training-jupyter-notebooks>

```

in [5]: fig = plt.figure(figsize=(10,9))

# set data projection and request output projection
data_projection=ccrs.Stereographic(central_latitude=90.0, central_longitude=45.0, true_scale_latitude=70.0)
output_projection=ccrs.Stereographic(central_latitude=90.0, central_longitude=45.0, true_scale_latitude=70.0)

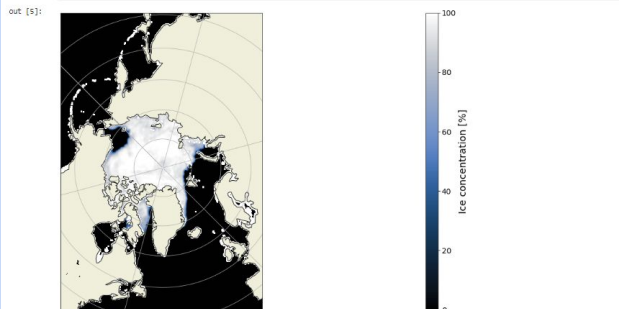
# define plot characteristics
ax = plt.axes([0.05,0.05,0.75,0.85], projection=output_projection)
ax.add_feature(Feature.LAND, zorder=0, edgecolor='black')
ax.gridlines()

# open and plot data
for filename in os.listdir(directory):
    if filename.endswith('.nc'):
        nc = xr.open_dataset(directory + '/' + filename)
        xc = nc.variables['xc'][:]
        yc = nc.variables['yc'][:]
        ice_conc = nc.variables['ice_conc'][:]
        confidence_level = nc.variables['confidence_level'][:]
        nc.close()

# Sea Ice Concentration data is provided in x y coordinates, bounds need to be defined for cartopy
bounds=[xc.min()*1000,xc.max()*1000,yc.min()*1000,yc.max()*1000]

# plotting sea ice
in = ax.imshow(ice_conc[0,:,:], transform=data_projection, extent=bounds, origin='upper', cmap=cmo)

# Adding a colorbar
axc = fig.add_axes([0.85,0.05,0.92,0.85])
cb = plt.colorbar(in, orientation='vertical', cmap=cmo)
cb.set_label('Ice concentration [%]', fontsize=10)
cb.ax.tick_params(labelsize=14)
    
```



```

in [8]: fig = plt.figure(figsize=(10,9))

# set data projection and request output projection
data_projection=ccrs.PlateCarree()
output_projection=ccrs.Orbographic(lon_max=lon_max/2,(lat_max=lat_max/2))

# define plot characteristics
ax = plt.axes([0.05,0.05,0.75,0.85], projection=output_projection)
ax.set_extent([lon_min, lon_max, lat_min, lat_max])
ax.add_feature(Feature.OCEAN, zorder=0)
ax.add_feature(Feature.LAND, zorder=1)
ax.gridlines()
ax.cmap=cmo

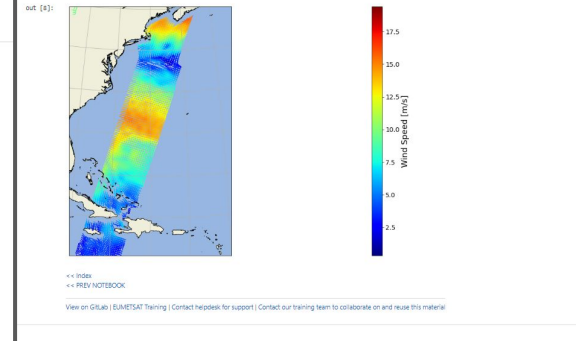
# open and plot sea ice netcdf user files
for filename in os.listdir(directory):
    if filename.endswith('.nc'):
        nc = xr.open_dataset(directory + '/' + filename)
        lat = nc.variables['lat'][:]
        lon = nc.variables['lon'][:]
        replat=lon_numpy()
        replon=lon_numpy()
        wind_speed = nc.variables['wind_speed'][:]
        wind_dir = nc.variables['wind_dir'][:]
        wind_dir_flag = nc.variables['wind_dir_flag'][:]
        nc.close()

# plotting wind bars in cartopy requires u and v components.
u = np.sqrt((replon-180))
v = np.sqrt((lon-180))
[::,] = wind_speed * np.cos(np.radians(90 - wind_dir[::,]))
[::,] = wind_speed * np.sin(np.radians(90 - wind_dir[::,]))
stride = 1

# plotting wind bars
in = ax.barbs(replon::stride,::stride, replat::stride,::stride, u::stride,::stride,
              v::stride,::stride, wind_speed::stride,::stride, transform=data_projection,
              cmap=cmo, linestyle='length')

# Adding a colorbar
axc = fig.add_axes([0.85,0.05,0.92,0.85])
cb = plt.colorbar(in, orientation='vertical', cmap=cmo)
cb.set_label('Wind Speed (m/s)', fontsize=10)
cb.ax.tick_params(labelsize=14)

out [8]:
    
```



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 >> PREVIOUS NOTEBOOK  
 View on GitHub | EUMETSAT Training | Contact helpdesk for support | Contact our training team to collaborate on and reuse this material



## Stories

❖ *Regular news*



## Social Media [@OSISAF](https://twitter.com/OSISAF)

❖ *Twitter feed & user support*



## Newsletter



## Training activities

- ❖ *Webinar & short courses*
- ❖ *Development of notebooks*

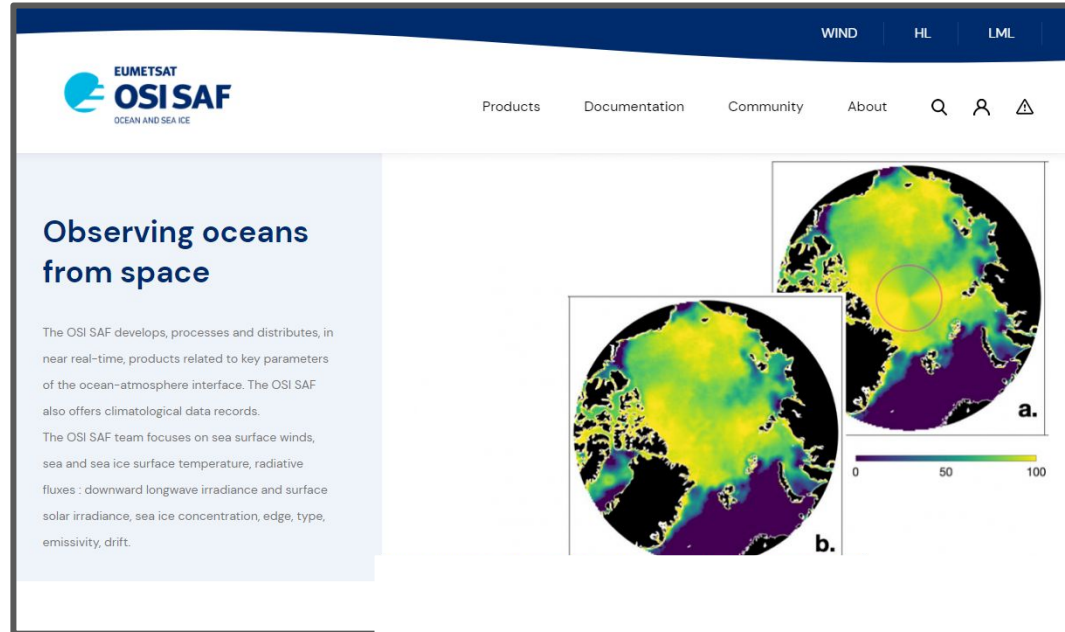
## Contacts

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[osi-saf.helpdesk@meteo.fr](mailto:osi-saf.helpdesk@meteo.fr)



Stay in touch, register

<https://osi-saf.eumetsat.int/>



The screenshot shows the OSI SAF website interface. At the top, there are navigation tabs for 'WIND', 'HL', and 'LML'. The main header includes the EUMETSAT OSISAF logo and navigation links for 'Products', 'Documentation', 'Community', and 'About'. The main content area features the heading 'Observing oceans from space' and a paragraph describing the organization's work: 'The OSI SAF develops, processes and distributes, in near real-time, products related to key parameters of the ocean-atmosphere interface. The OSI SAF also offers climatological data records. The OSI SAF team focuses on sea surface winds, sea and sea ice surface temperature, radiative fluxes : downward longwave irradiance and surface solar irradiance, sea ice concentration, edge, type, emissivity, drift.' To the right, there are two satellite images of the Arctic region, labeled 'a.' and 'b.', with a color scale legend below them ranging from 0 to 100.



Helpdesk: ops@eumetsat.int

## Knowledge Bases



Sentinel-3  
Sentinel-6  
Data access



## Courses



moodle



<https://training.eumetsat.int/>



## Code distribution

CONDA



GitLab



## Video tutorials



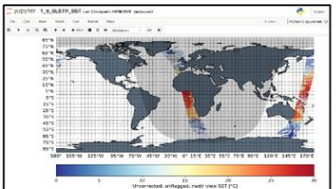
YouTube



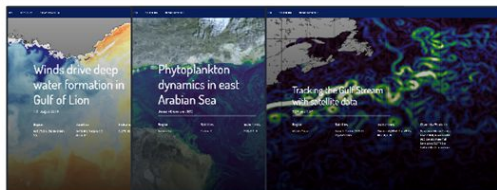
<https://www.youtube.com/eumetsat1>

## Jupyter Notebooks

jupyter

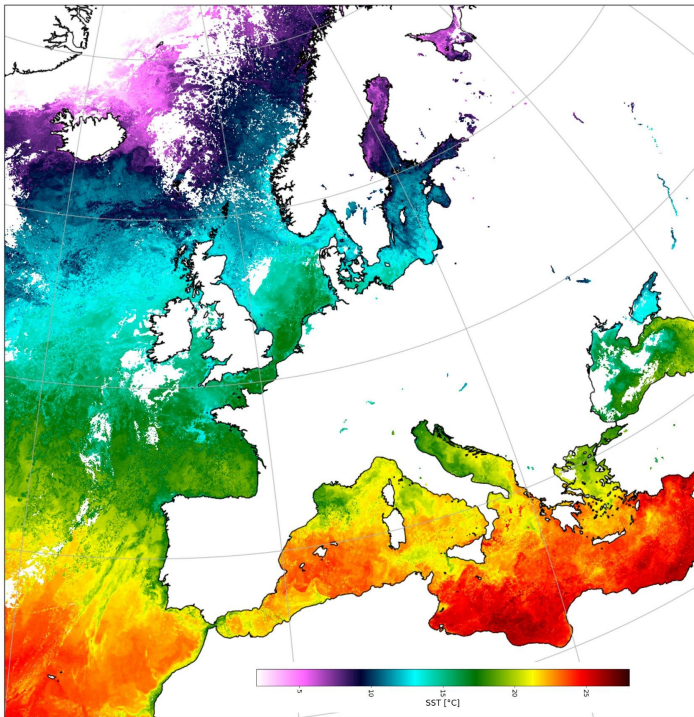


## Case studies



<https://www.eumetsat.int/case-studies>

<https://gitlab.eumetsat.int/eumetlab/oceans>



## Thank you !



Looking forward to hear  
your feedback about  
EUMETSAT marine  
products !