



# Marine Data Literacy Course

## Data Harvesting and Data Harnessing

### Online Data Portals

Dr Adam Gauci  
adam.gauci@um.edu.mt

University of Malta

“

Data is acquired and prepared once to be used by many.

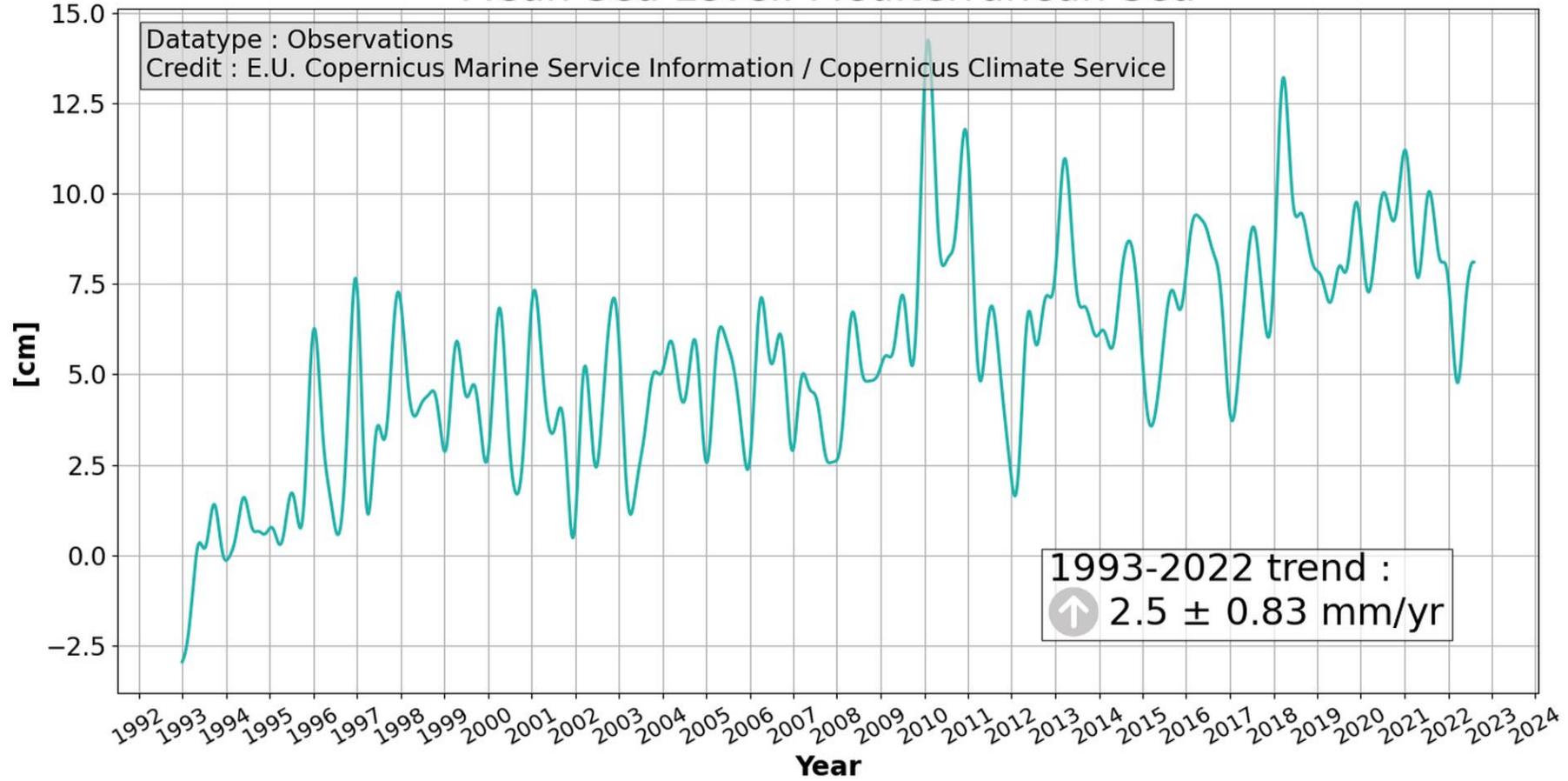
“

You can't manage what you can't measure.

# Mean Sea Level in Med Sea in the last 30 years

increased | decreased | remained the same

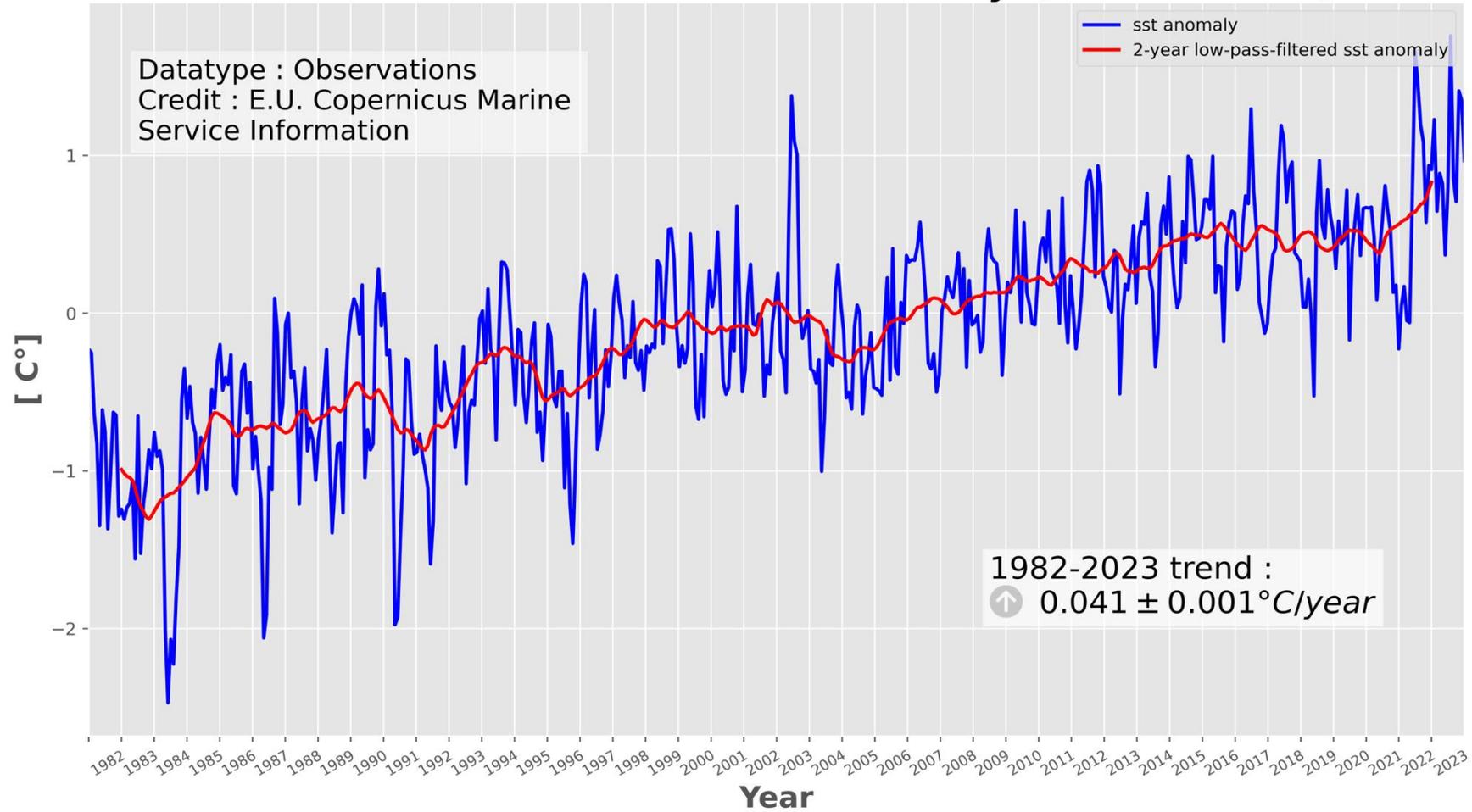
# Mean Sea Level: Mediterranean Sea



# Sea Surface Temperature in Med Sea in the last 30 years

increased | decreased | remained the same

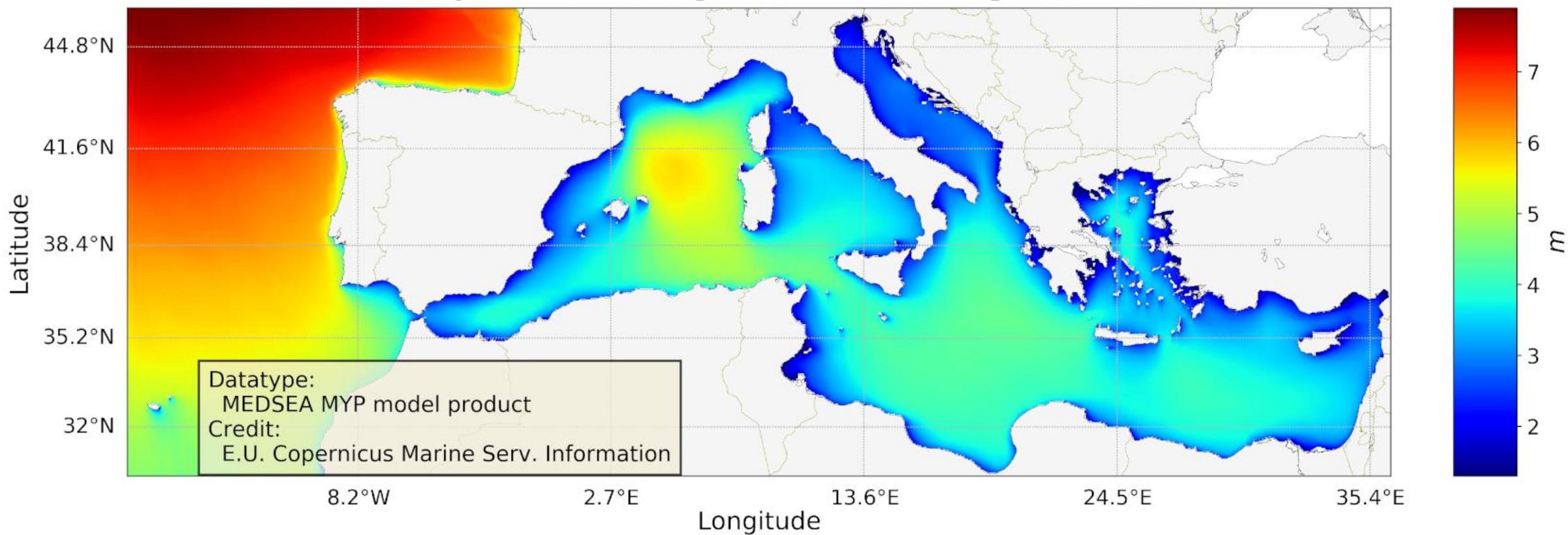
# Mediterranean Sea SST Anomaly (1982-2023)



# Highest Waves in Mediterranean Sea

west | central | east

## Mean 99th percentile of Significant Wave Height (1993-2019)



The background features abstract, overlapping geometric shapes in various shades of blue, ranging from light sky blue to deep navy blue. These shapes are primarily located on the left and right sides of the frame, creating a modern, tech-oriented aesthetic. The central area is a clean, white space where the word 'DATA' is prominently displayed.

**DATA**

# Outline

- ▶ **COPERNICUS Marine Data Portal**
  - ▶ NetCDF
  - ▶ PANOPLY
  - ▶ Matlab scripts
- ▶ **EMODnet**
  - ▶ EMODnet Bathymetry / Human-Activities / Physics / Ingestion
  - ▶ QGIS
- ▶ **The European Space Agency (ESA) Data Hub**
  - ▶ Sentinel Application Platform (SNAP)
  - ▶ Oil spill detection
  - ▶ CHL / TSM
- ▶ **World Ocean Database**
  - ▶ Ocean Data View (ODV)

# Data

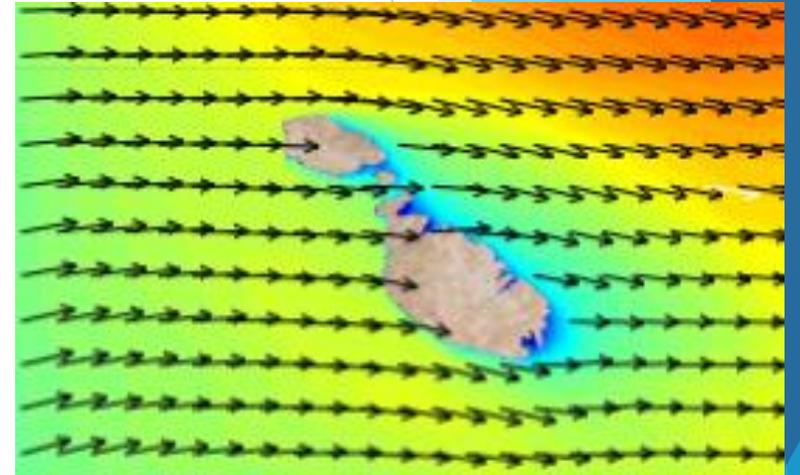
*In-Situ*



Remote Sensing



Models

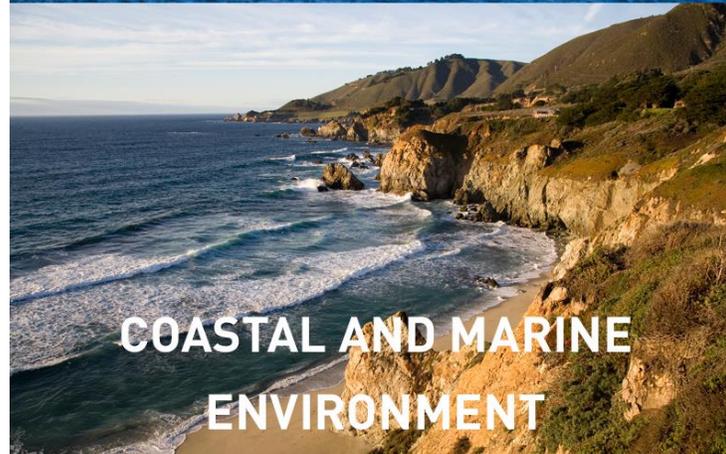


# Copernicus



## Copernicus Marine Environment Monitoring Service (CMEMS)

- ▶ Integrated Service
- ▶ Open and Free
- ▶ Single Catalogue of Products
- ▶ Reliable
- ▶ Sustainable



# Copernicus



Copernicus  
Europe's eyes on Earth

Copernicus  
Marine Service

Services

Opportunities

Access Data

Use Cases

User Corner

About

## Copernicus Marine Service

Providing free and open marine data and services to enable marine policy implementation, support Blue growth and scientific innovation.

Access Data >

DATA

### OCEAN PRODUCTS

A robust ocean data catalogue, to download or visualise data including hindcasts, nowcasts and forecasts.

EXPERTISE

### OCEAN STATE REPORT

Extensive annual analysis on the state of the ocean over nearly 20 years and severe/notable annual events.

TRENDS

### OCEAN MONITORING INDICATORS

Essential variables monitoring the health of the ocean over the past quarter of a century.

EXPLORATION

### OCEAN VISUALISATION

Dive into our 4D digital oceans through our 3 visualisation tools for beginner, intermediate and advanced users

marine.copernicus.eu

COPERNICUS

# OCEAN STATE REPORT

ISSUE 9



Implemented by  
**MERCATOR  
OCEAN**  
INTERNATIONAL

#OceanStateReport

#CopernicusMarine



PROGRAMME OF  
THE EUROPEAN UNION



Copernicus  
Marine Service

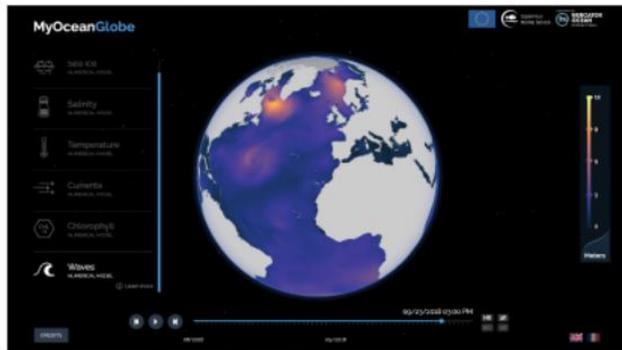
implemented by



**MERCATOR  
OCEAN**  
INTERNATIONAL

# Copernicus [Data Visualising Tools]

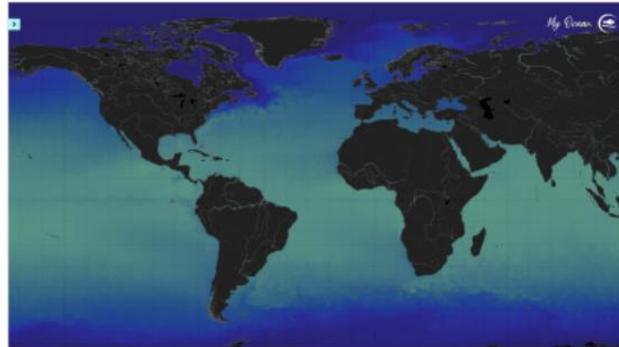
## MYOCEAN LEARN (BEGINNER) GLOBE



Understand key variables

[Explore MyOcean Learn](#)

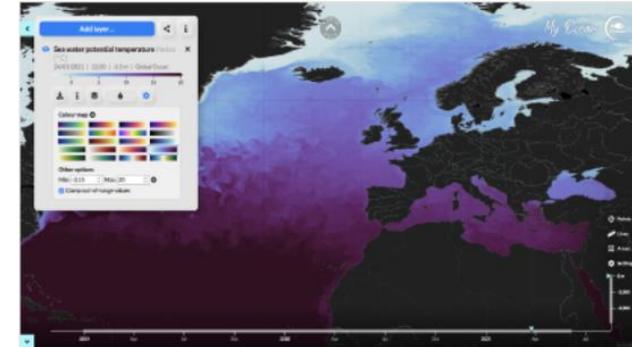
## MYOCEAN LIGHT (INTERMEDIATE) PLANISPHERE



Access key variables

[Explore MyOcean Light](#)

## MYOCEAN PRO (EXPERT) PLANISPHERE



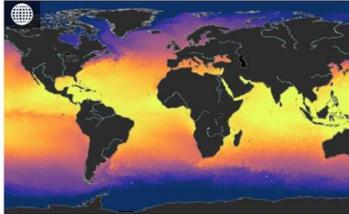
Access full catalogue

[Explore MyOcean Pro](#)

# Copernicus [Ocean Products]

Products 303 

## MOST POPULAR



**Global Ocean Physics Analysis and Forecast**

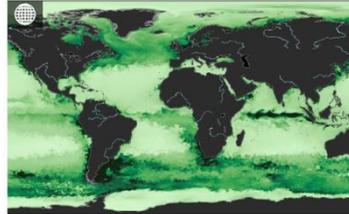
GLOBAL\_ANALYSISFORECAST\_P... 001\_024

Models

Global,  $0.083^\circ \times 0.083^\circ \times 50$  levels

1 Nov 2020 to 26 Mar 2025, hourly, daily,...

Temperature, salinity, sea surface height, velocity, mixed layer thickness, wave, sea ice...



**Global Ocean Biogeochemistry Analysis and Forecast**

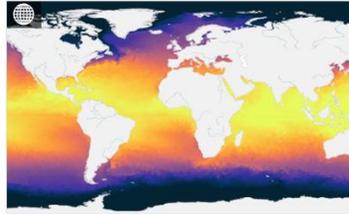
GLOBAL\_ANALYSISFORECAST\_B... 001\_028

Models

Global,  $0.25^\circ \times 0.25^\circ \times 50$  levels

1 Oct 2021 to 21 Mar 2025, daily, monthly

Plankton, nutrients, oxygen, carbonate system, optics



**Global Ocean Physics Reanalysis**

GLOBAL\_MULTIYEAR\_PHY\_001\_030

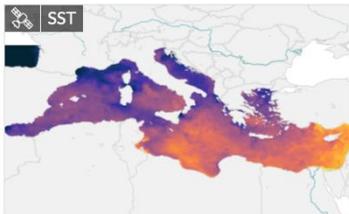
Models

Global,  $0.083^\circ \times 0.083^\circ \times 50$  levels

1 Jan 1993 to 25 Feb 2025, daily, monthly

Temperature, salinity, sea surface height, velocity, mixed layer thickness, sea ice

## RECENTLY VIEWED



**Mediterranean Sea - High Resolution L4 Sea Surface...**

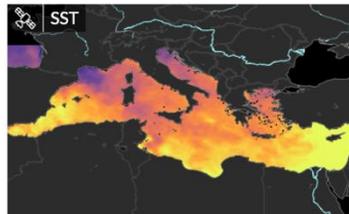
SST\_MED\_SST\_L4\_REP\_OBSERVA... 010\_021

Satellite (L4)

Med Sea,  $0.05^\circ \times 0.05^\circ$

1 Jan 1982 to 14 Feb 2025, daily

Temperature



**Mediterranean Sea High Resolution and Ultra High...**

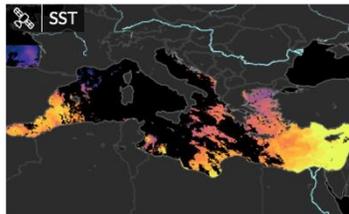
SST\_MED\_SST\_L4\_NRT\_OBSERVA... 010\_004

Satellite (L4)

Med Sea,  $0.01^\circ \times 0.01^\circ$

1 Jan 2008 to 16 Mar 2025, daily

Temperature



**Mediterranean Sea - High Resolution and Ultra High...**

SST\_MED\_SST\_L3S\_NRT\_OBSERV... 010\_012

Satellite (L3)

Med Sea,  $0.01^\circ \times 0.01^\circ$

1 Jan 2008 to 16 Mar 2025, daily

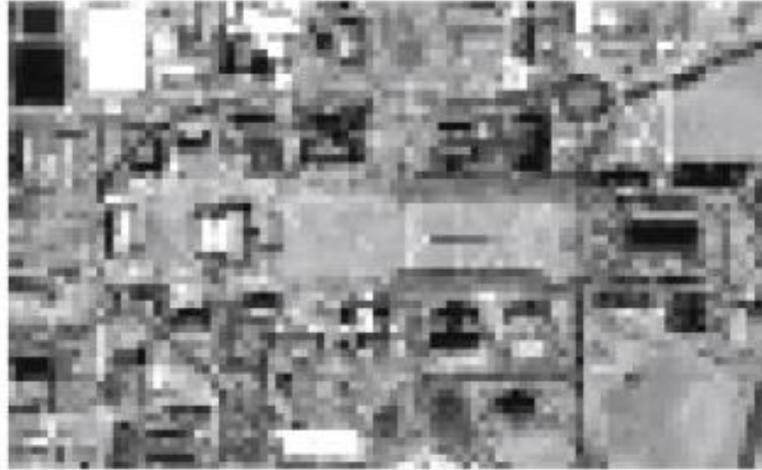
Temperature

# Copernicus [Spatial Resolution]

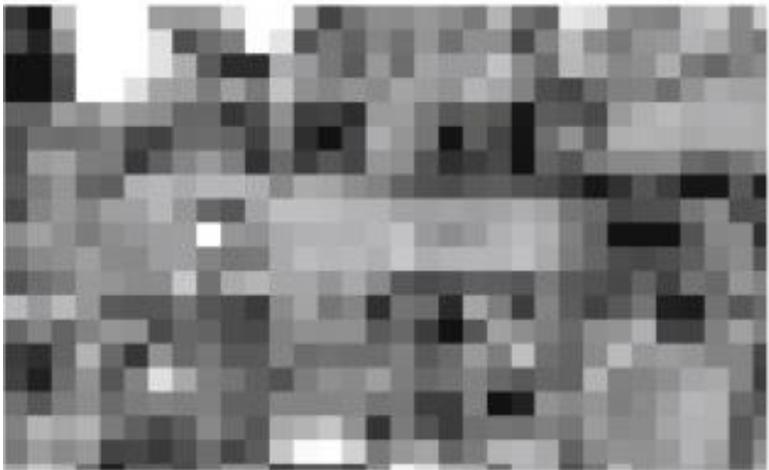
(A) 1 m



(B) 10 m



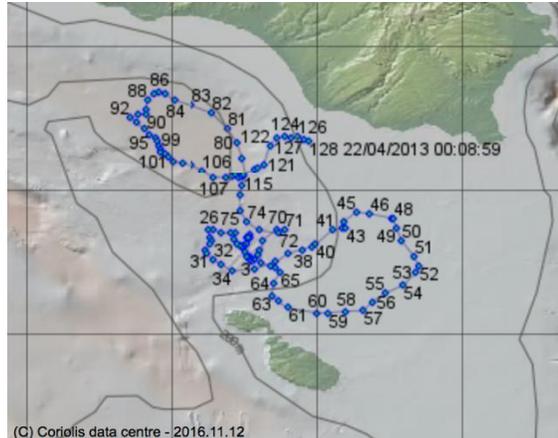
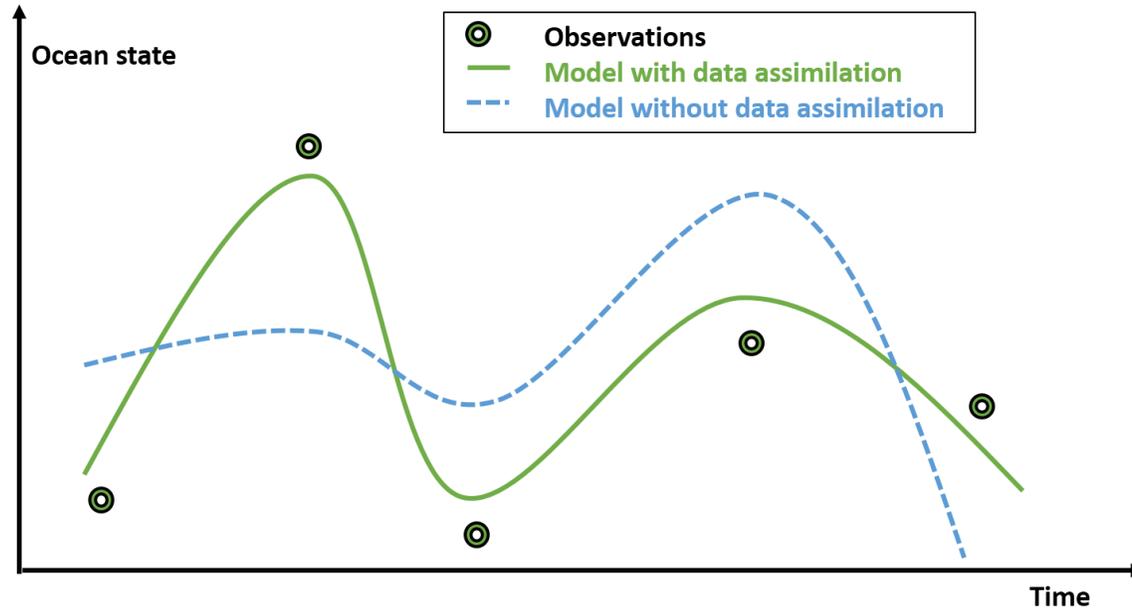
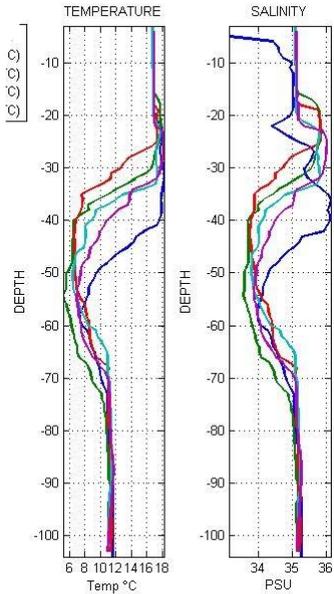
(C) 30 m



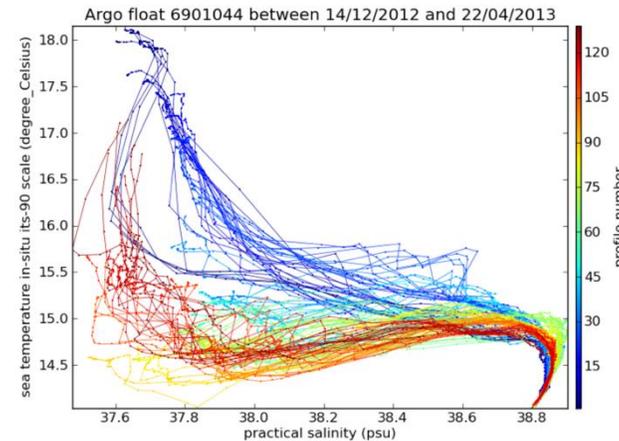
(D) 250 m



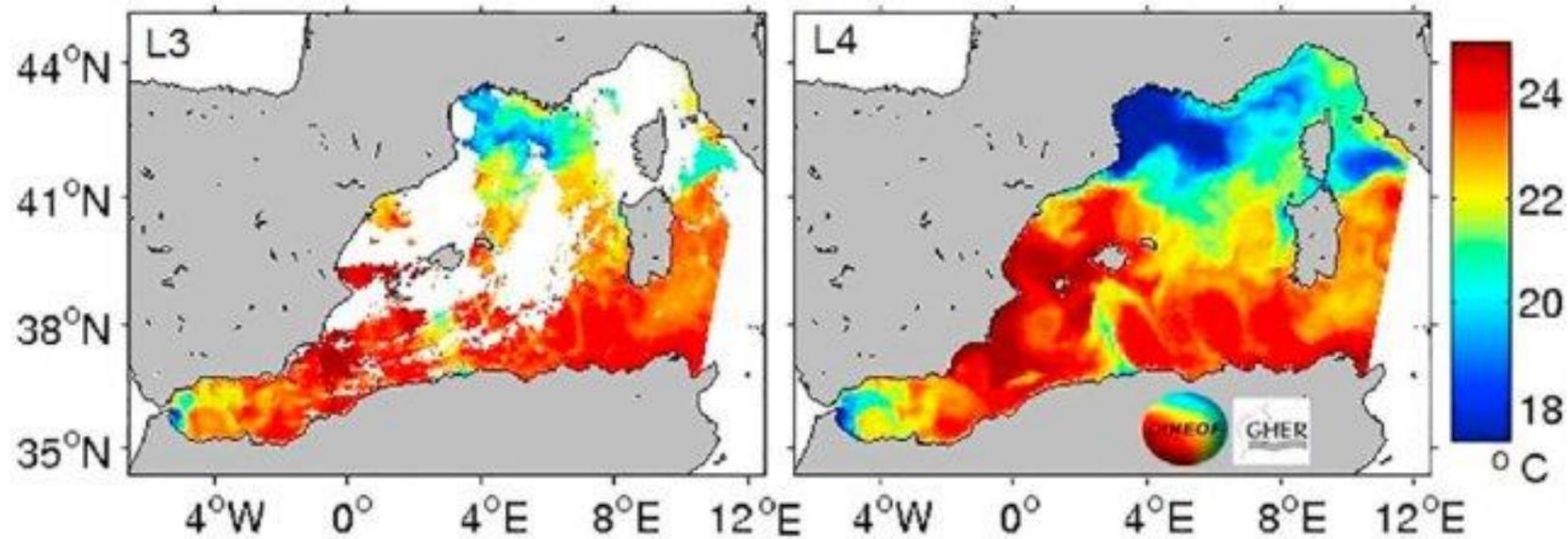
# Copernicus [Data Assimilation]



(C) Coriolis data centre - 2016.11.12



# Copernicus [Satellite Data Levels]



Source: Minnett, P.J., et al., 2019. Half a century of satellite remote sensing of sea-surface temperature. *Remote Sensing of Environment*, 233, p.111366.

# Copernicus [Example]

- ▶ **Mediterranean Sea Physics Reanalysis**  
MEDSEA\_MULTIYEAR\_PHY\_006\_004
- ▶ **Mediterranean Sea High Resolution  
and Ultra High Resolution Sea Surface Temperature Analysis**  
SST\_MED\_SST\_L4\_NRT\_OBSERVATIONS\_010\_004

# Copernicus [Example]

## Data access

MEDSEA\_ANALYSISFORECAST\_PHY\_006\_013

Mediterranean Sea Physics Analysis and Forecast

Dataset selected

## Geographical area

N

W   E

S

## Time range

(Default = Last date available)

Select all dates

Start date

End date

## Depth

(Default = Surface depth)

Select all depths

Start depth

End depth

## Variables

(Default = All variables)

<input checked="" type="checkbox"/>	Name	Description	Standard name	Units
<input checked="" type="checkbox"/>	bottomT	sea floor potential temperature	sea_water_potential_temperatu re_at_sea_floor	degrees_C
<input checked="" type="checkbox"/>	thetao	potential temperature	sea_water_potential_temperatu re	degrees_C

# Copernicus [Example]

## Data access

SST\_MED\_SST\_L4\_NRT\_OBSERVATIONS\_010\_004

Mediterranean Sea High Resolution and Ultra High Resolution Sea Surface Temperature Analysis

Dataset selected

SST\_MED\_SST\_L4\_NRT\_OBSERVATIONS\_010\_004\_c\_V2

## Geographical area

N 40

W 10



E 18

S 33

Reset geographical selection

## Time range

(Default = Last date available)

Select all dates

Start date

2021-10-20 00:00:00

End date

2021-10-22 00:00:00

## Variables

(Default = All variables)

<input checked="" type="checkbox"/>	Name	Description	Standard name	Units
<input checked="" type="checkbox"/>	analysed_sst	analysed sea surface temperature	sea_surface_temperature	kelvin
<input checked="" type="checkbox"/>	analysis_error	estimated error standard deviation of analysed_sst		kelvin

# Panoply

<https://www.giss.nasa.gov/tools/panoply/download/>

**Panoply — Sources**

Create Plot Combine Plot Open Dataset Remove Remove All Hide Info

Datasets Catalogs Bookmarks

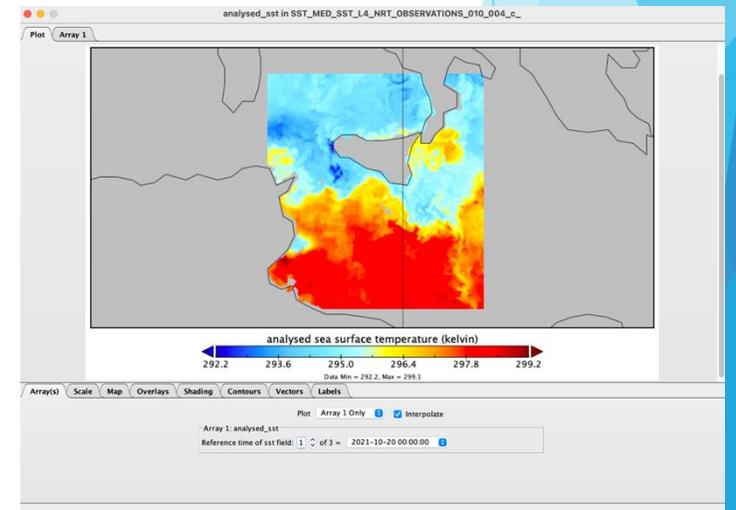
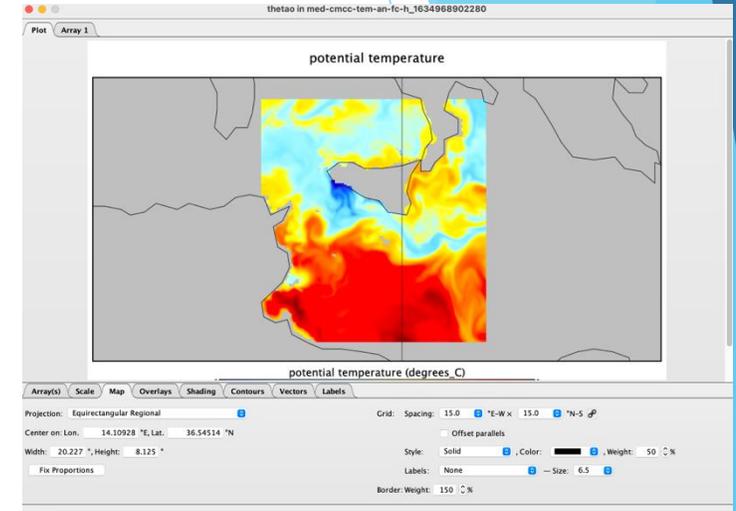
Name	Long Name	Type
med-cmcc-tem-an-fc-...	Potential Temperature (3D) - Ho...	Local File
bottomT	sea floor potential temperature	Geo2D
depth	depth	1D
lat	latitude	1D
lon	longitude	1D
thetao	potential temperature	Geo2D
time	time	1D
SST_MED_SST_L4_NRT_...	Mediterranean SST Analysis, L4, ...	Local File
analysed_sst	analysed sea surface temperature	Geo2D
analysis_error	estimated error standard deviati...	Geo2D
lat	latitude	1D
lon	longitude	1D
time	reference time of sst field	1D

Show: All variables

**File**  
"med-cmcc-tem-an-fc-h\_1634968902280.nc"  
File type: NetCDF-3/CDM

```
netcdf file:/Users/adamgauci/Desktop/Marine%20Dat
dimensions:
  time = 72;
  depth = 74;
  lat = 168;
  lon = 193;
variables:
  float depth(depth=74);
    :units = "m";
    :standard_name = "depth";
    :long_name = "depth";
    :axis = "Z";
    :positive = "down";
    :ChunkSizes = 141; // int
    :_CoordinateAxisType = "Height";
    :_CoordinateZisPositive = "down";
    :valid_min = 1.0182366f; // float
    :valid_max = 1005.1355f; // float

  float thetao(time=72, depth=74, lat=168, lon=
    :_FillValue = 1.0E20f; // float
    :units = "degrees_C";
    :standard_name = "sea_water_potential_tempe
    :long_name = "potential temperature";
```



# Matlab

```
%reading model data
model_filename = 'med-cmcc-tem-an-fc-h_1634968902280.nc';
model_lon = ncread(model_filename, 'lon');
model_lat = ncread(model_filename, 'lat');
model_depth = ncread(model_filename, 'depth');
model_time= ncread(model_filename, 'time');
model_data = ncread(model_filename, 'thetao');

%extracting the first depth level
%for all frames
figure
for h = 1:1:size(model_data, 4)
    model_data_temp = model_data(:,:,1, h);
    pcolor(model_lon, model_lat, model_data_temp);
    box on;
    shading flat;
    title(['Hour = ', num2str(h)]);
    xlabel('Longitude (\circE)');
    ylabel('Latitude (\circN)');
    caxis([19 26]);
    colorbar;
    pause (0.1);
    drawnow;
end
```

```
%extracting all depth levels
%for the first time frame
figure
for d = 1:1:size(model_data, 3)
    model_data_temp = model_data(:,:, d, 1);
    pcolor(model_lon, model_lat, model_data_temp);
    box on;
    shading flat;
    title(['Depth = ', num2str(model_depth(d)), 'm']);
    xlabel('Longitude (\circE)');
    ylabel('Latitude (\circN)');
    colorbar;
    pause (0.1);
    drawnow;
end

%-----

%extracting surface correspondng to 21/10/2021 at 00:30
model_data_temp = model_data(:, :, 1, 25);
figure;
pcolor(model_lon, model_lat, model_data_temp);
box on;
shading flat;
title(['Model Data 21/10/2021 00:30']);
xlabel('Longitude (\circE)');
ylabel('Latitude (\circN)');
caxis([19 26]);
colorbar;
```

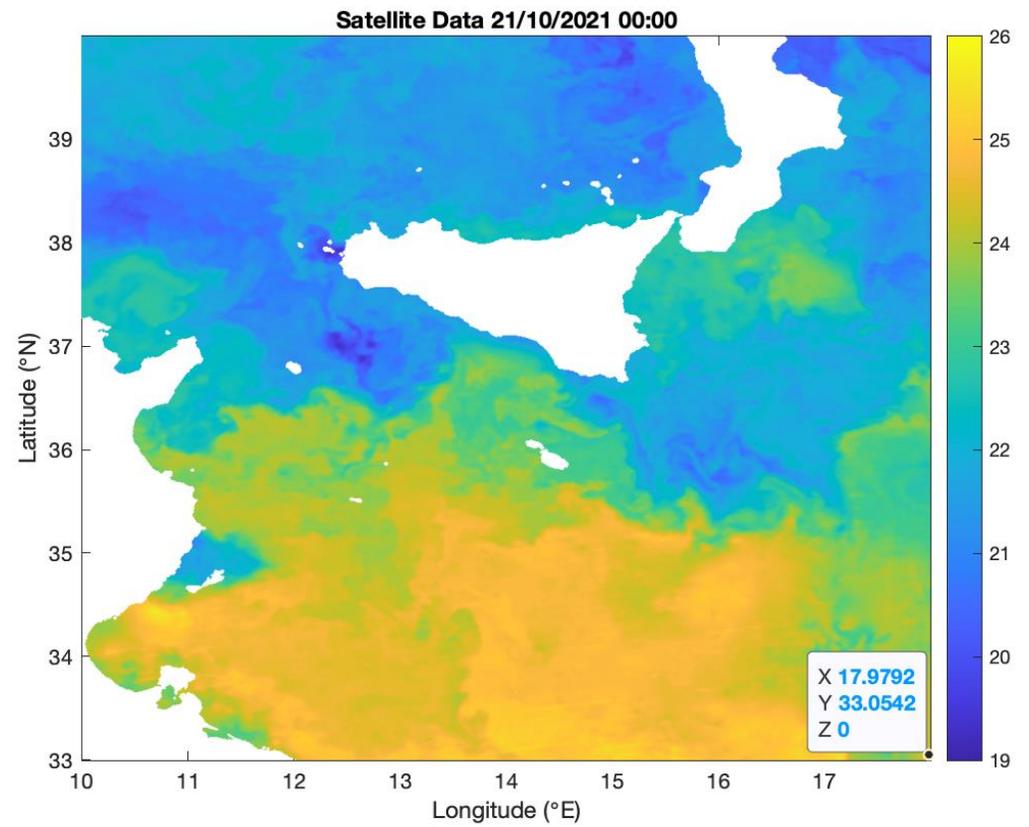
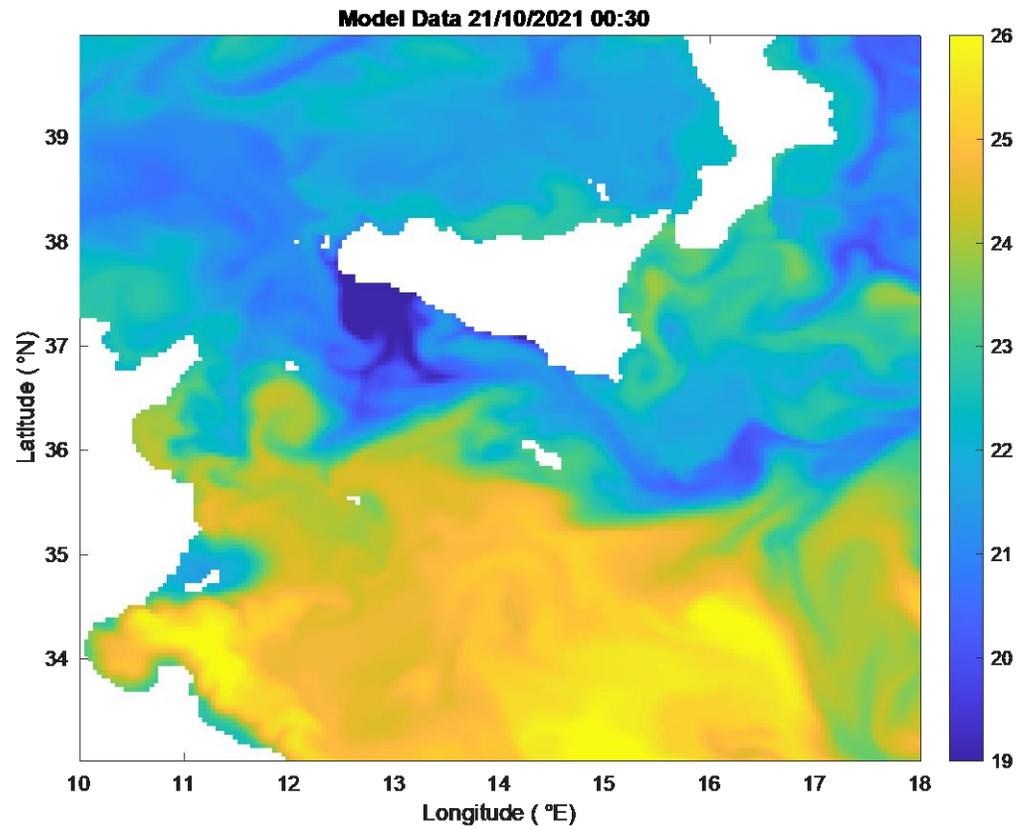
# Matlab

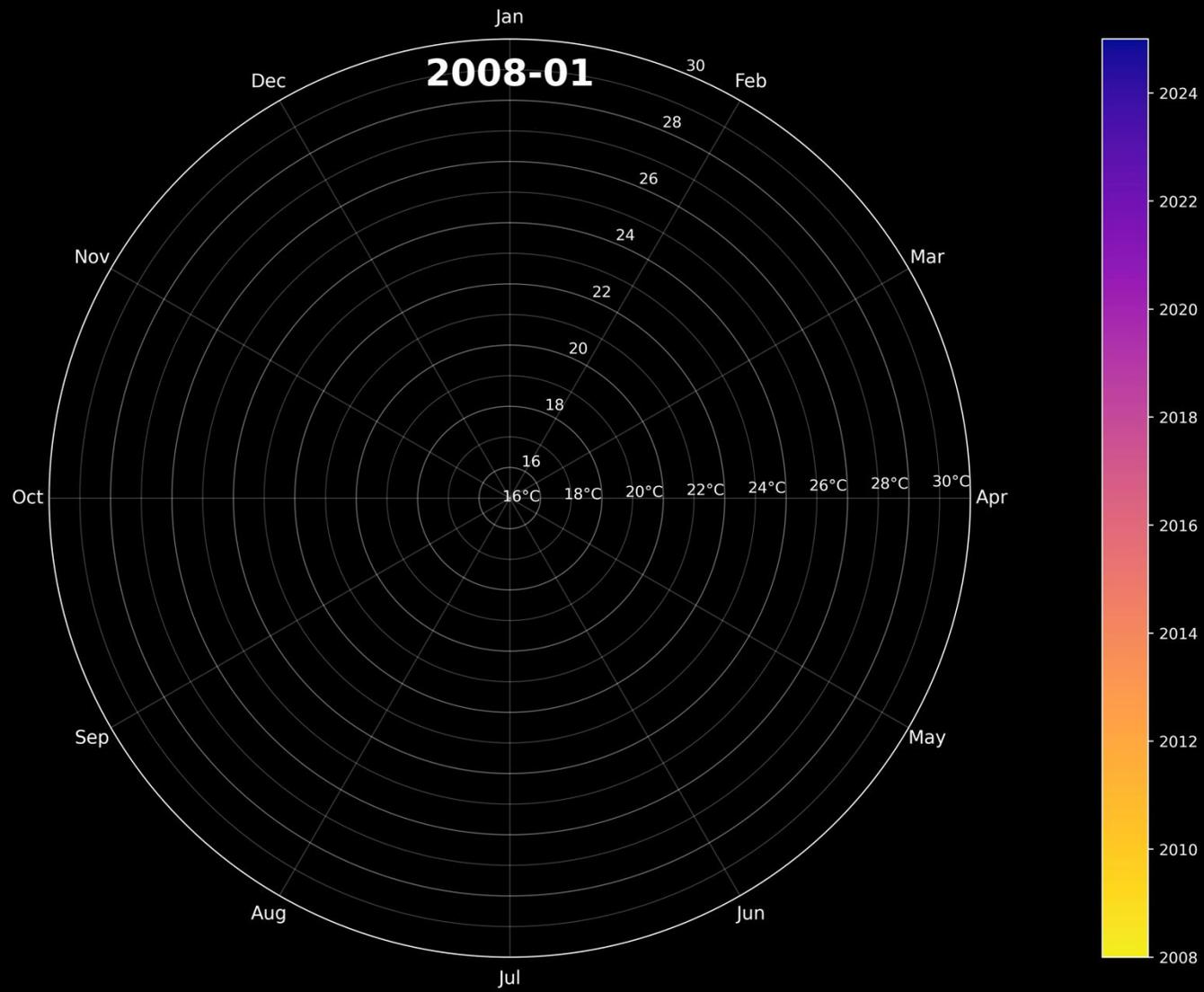
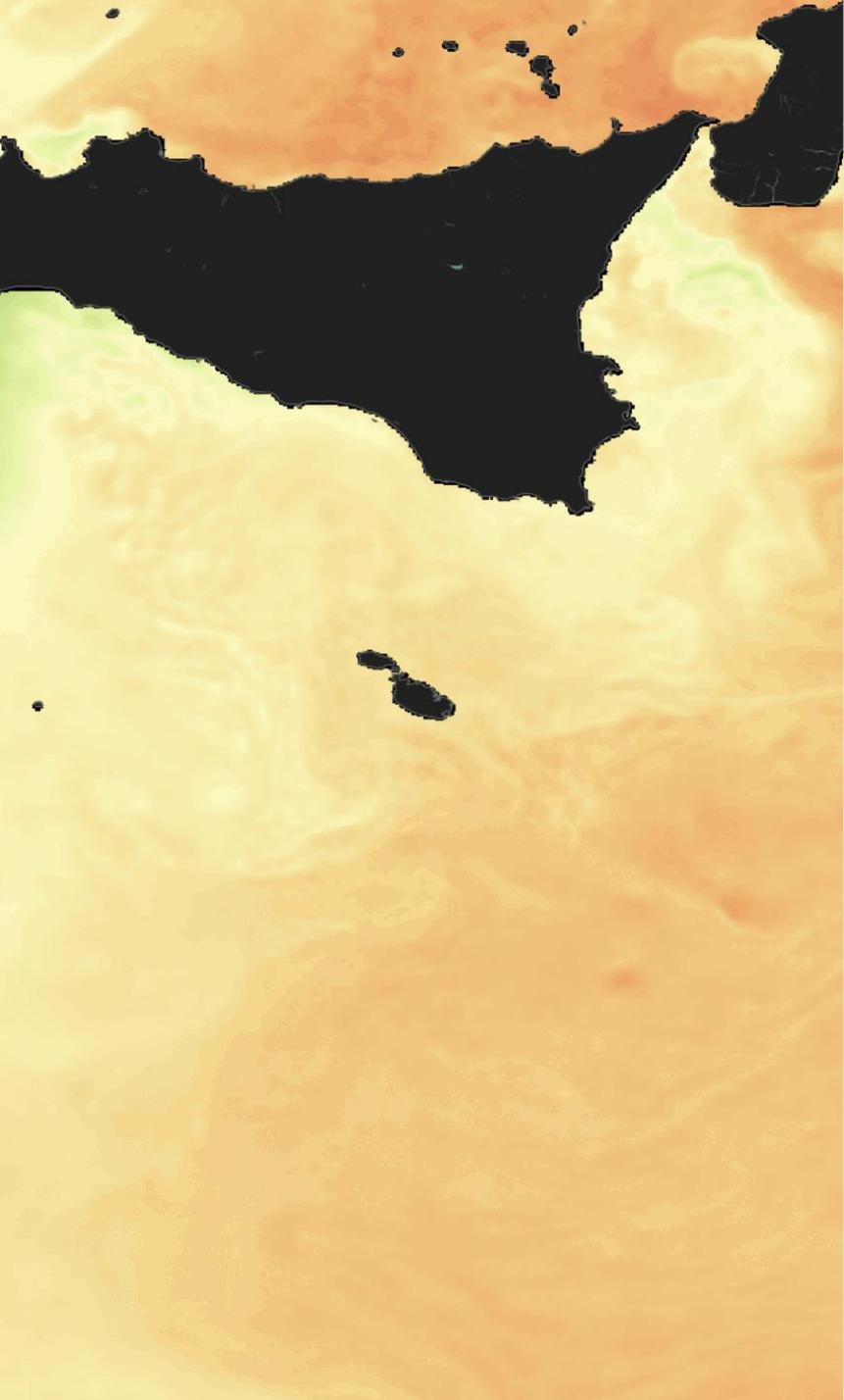
```
reading satellite file
sat_filename = 'SST_MED_SST_L4_NRT_OBSERVATIONS_010_004_c_V2_1634969733519.nc';
sat_lon = ncread(sat_filename, 'lon');
sat_lat = ncread(sat_filename, 'lat');
sat_time = ncread(sat_filename, 'time');
sat_data = ncread(sat_filename, 'analysed_sst');
sat_data = sat_data(:,:,2) - 273.15;
figure;
pcolor(sat_lon, sat_lat, sat_data');
box on;
shading flat;
title(['Satellite Data 21/10/2021 00:00']);
xlabel('Longitude (\circE)');
ylabel('Latitude (\circN)');
caxis([19 26]);
colorbar;

%-----

%mapping satellite data onto grid model
sat_data_interp = CommonGrid(model_lon, model_lat, model_data_temp, sat_lon,
sat_lat, sat_data);
plot(model_data_temp(:,), sat_data_interp(:,), '.');
axis equal;
axis tight;
xlabel('Model Data');
ylabel('Satellite Data');
axis([20 26 20 26]);
```

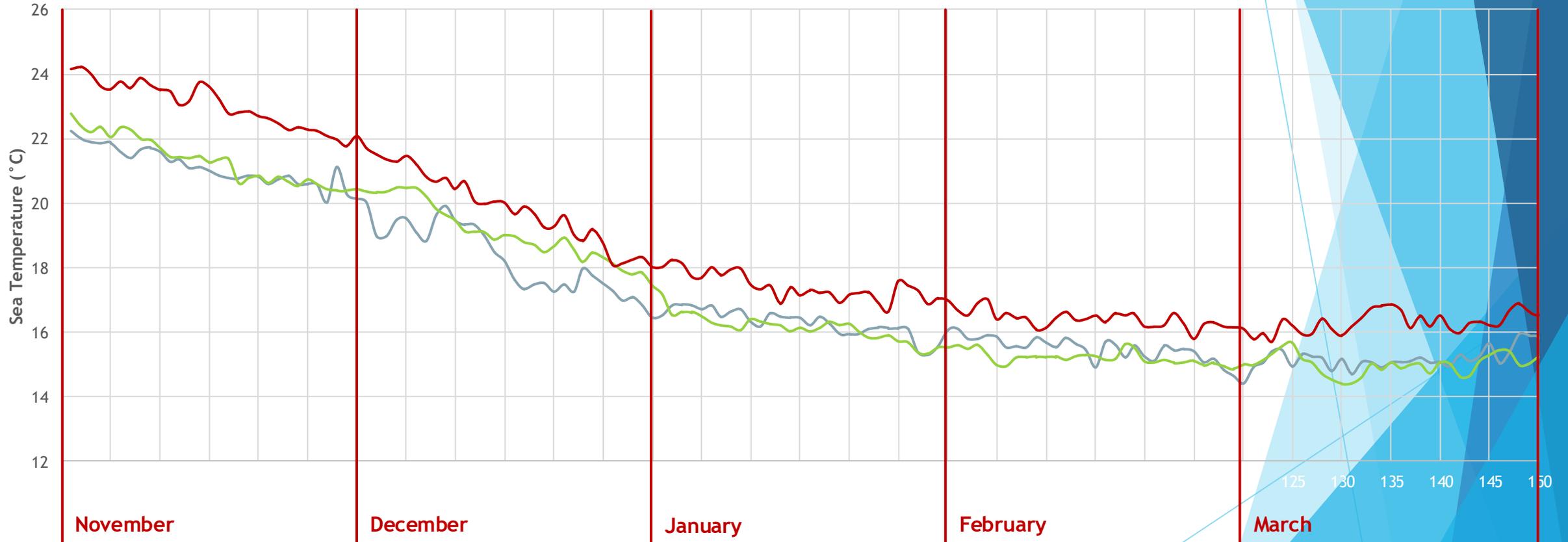
# Matlab



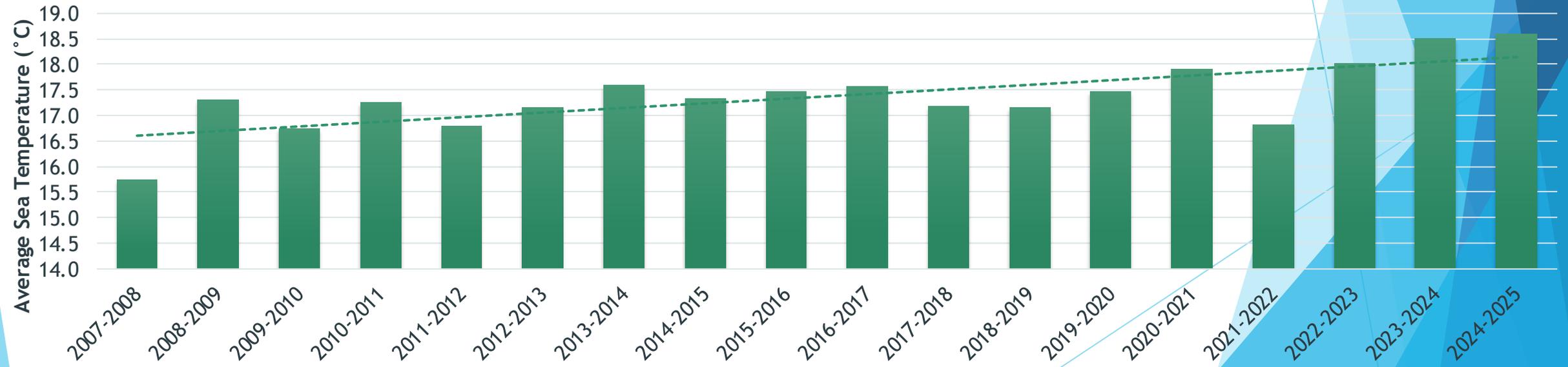
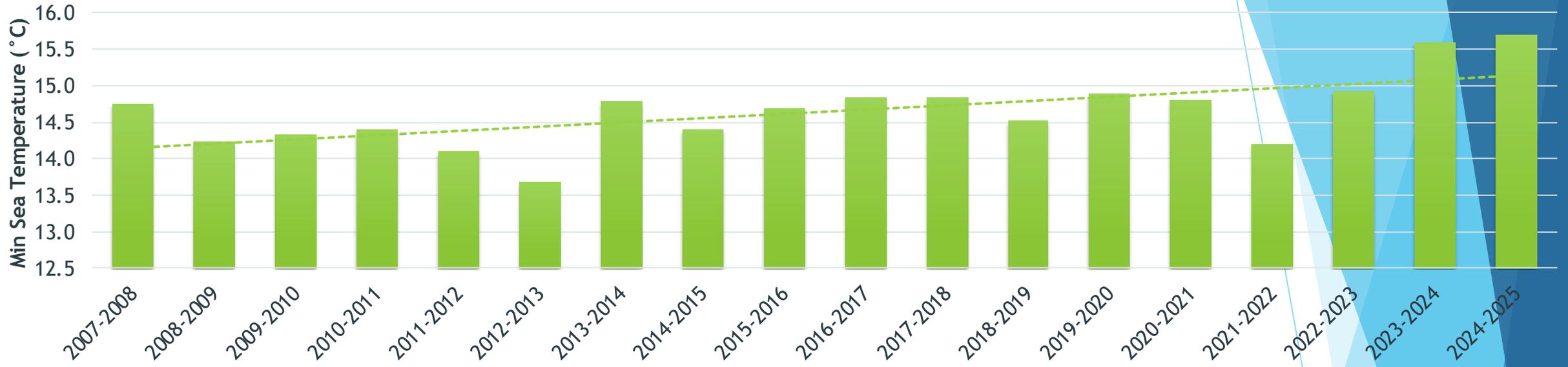


# Daily Sea Surface Temperature November to May

— 2010 - 2011    — 2014 - 2015    — 2024 - 2025

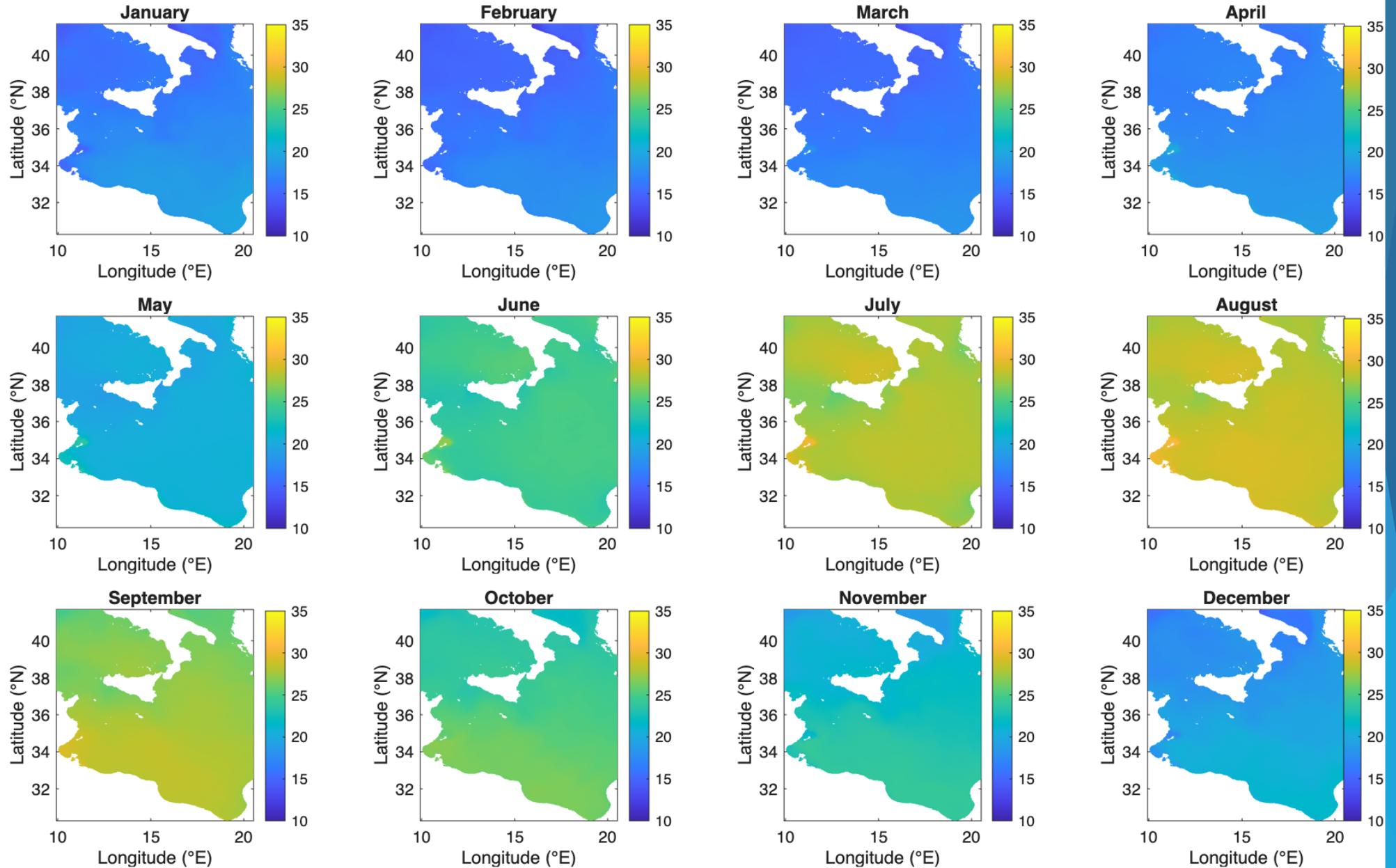


# Winter Months (November - February)

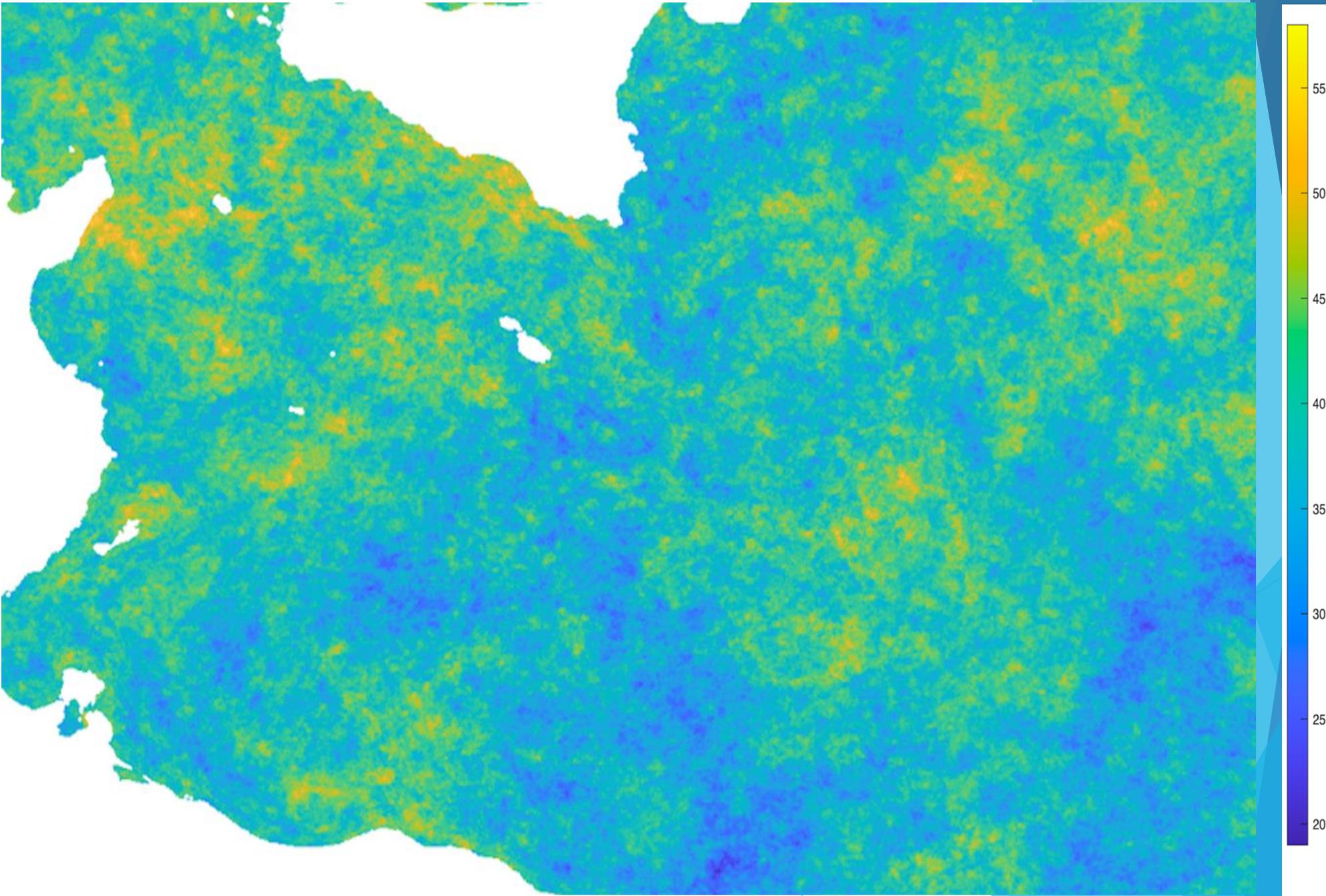


# Climatology 90<sup>th</sup> Percentiles

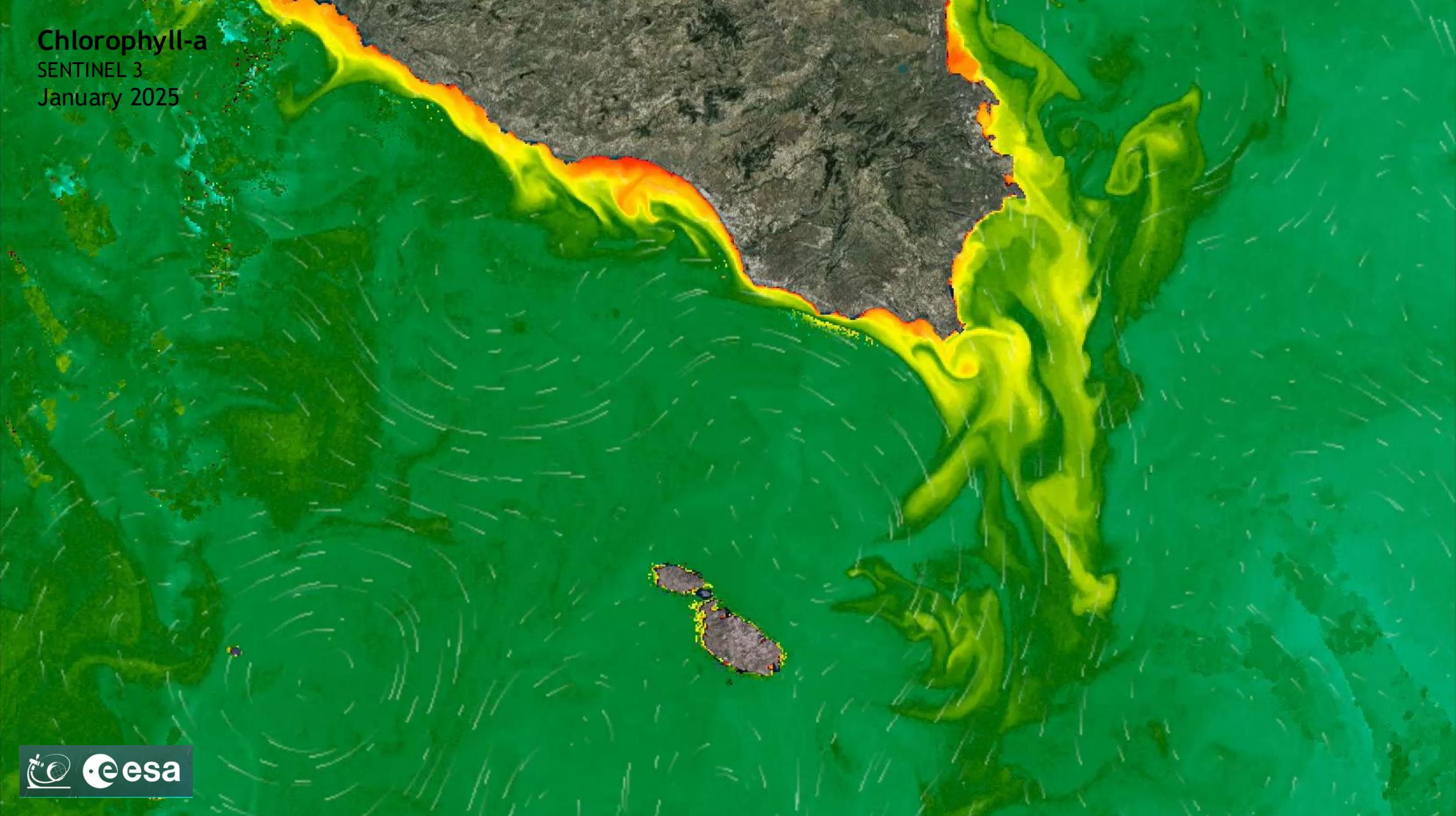
## Monthly Mean 90th-Percentile SST Climatology



**Detected  
Marine  
Heatwaves**



**Chlorophyll-a**  
SENTINEL 3  
January 2025



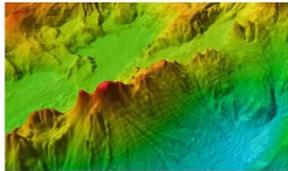
# EMODnet

<https://emodnet.ec.europa.eu/geoviewer/>

European Marine Observation and Data Network (EMODnet)

[About](#) [Data Portals](#) [Data Services](#) [Solutions](#) [News & Events](#) [Atlas of the Seas](#) [EU-China](#)

[Home](#) > [Data Portals](#) > [Data Portals Overview](#)



## Bathymetry

Data on bathymetry (water depth), coastlines, and geographical location of underwater features: wrecks.



## Biology

Data on temporal and spatial distribution of species abundance and biomass from several taxa.



## Chemistry

Data on the concentration of nutrients, organic matter, pesticides, heavy metals, radionuclides and antifoulants in water, sediment and biota.



## Geology

Data on seabed substrate, sea-floor geology, coastal behaviour, geological events, and minerals.



## Human activities

Data on the intensity and spatial extent of human activities at sea.



## Physics

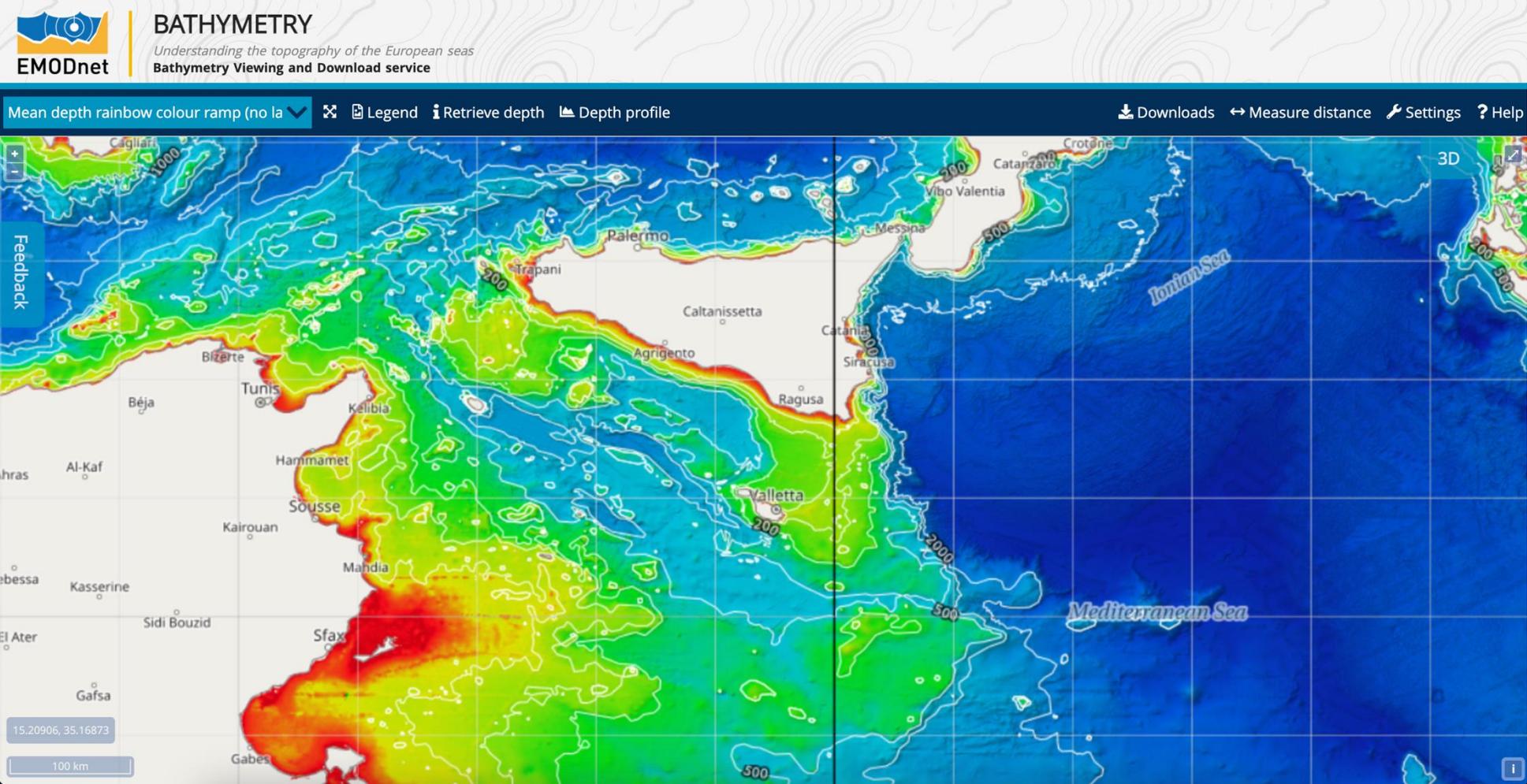
Data on salinity, temperature, waves, currents, sea-level, light attenuation, and FerryBoxes.



## Seabed habitats

Data, maps and models on the spatial distribution and extent of seabed habitats and communities.

# EMODnet [Bathymetry]



# EMODnet [Bathymetry Download]

The image shows the EMODnet Bathymetry web application interface. The main map displays bathymetry data for the Mediterranean Sea region, with a specific tile labeled 'F6' highlighted. The interface includes a top navigation bar with the EMODnet logo and the text 'BATHYMETRY Understanding the topography of the European seas Bathymetry Viewing and Download service'. Below the map, there is a toolbar with options like 'High resolution bathymetry', 'Legend', 'Retrieve depth', and 'Depth profile'. A right-hand sidebar contains 'Dataset type' (DTM Tiles, High resolution areas, Area of interest) and 'DTM version'. A red-bordered pop-up window is overlaid on the right side, displaying a confirmation message: 'Dear Adam, Your requested data files from the EMODnet DTM are now ready for downloading. The download links expire in 12 hours'. Below the message is a table with columns 'Tile' and 'Format', showing 'F6' and 'ESRI ASCII' respectively, with a 'Download now' link.

**EMODnet** | **BATHYMETRY**  
Understanding the topography of the European seas  
Bathymetry Viewing and Download service

High resolution bathymetry | Legend | Retrieve depth | Depth profile | Downloads | Measure distance | Settings | Help

Dataset type  
DTM Tiles | High resolution areas | Area of interest  
DTM version

**EMODnet** | **BATHYMETRY**  
Understanding the topography of the European seas  
Bathymetry Viewing and Download service

**Download**

Dear Adam,

Your requested data files from the EMODnet DTM are now ready for downloading. The download links expire in 12 hours

Tile	Format
<a href="#">F6</a>	<a href="#">ESRI ASCII</a>

[Download now](#)

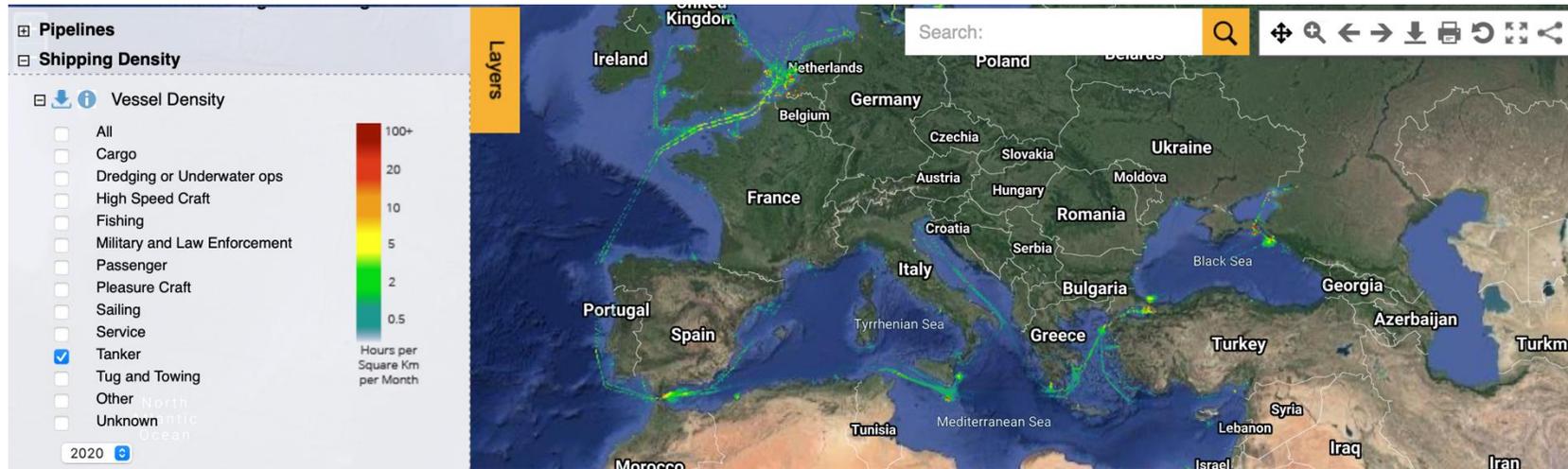
# EMODnet [Human Activities]

The screenshot displays the EMODnet Human Activities web application. At the top, a dark blue navigation bar contains the following menu items: HOME, ABOUT, DATA SERVICES, PUBLICATIONS, BLOG, HELPDESK, and CENTRAL PORTAL. Below this, a breadcrumb trail reads "Home » Data Services » View Data".

The main interface is divided into three primary sections:

- Layers Panel (Left):** A vertical sidebar with a "Layers" header. It contains a list of 20 data layers, each with a checkbox and a question mark icon. The layers are: Aggregate Extraction, Algae Production, Aquaculture, Cables, Cultural Heritage, Dredging, Environment, Fisheries, Main Ports, Maritime Spatial Planning (MSP), Military Areas, Nuclear Power Plants, Ocean Energy Facilities, Oil and Gas, Other Forms of Area Management/Designation, Pipelines, Shipping Density, Waste Disposal, and Wind Farms. A "Database Under Construction" warning is visible at the top of this panel.
- Map (Center):** A satellite-style map of the Mediterranean region and surrounding areas. A search bar is located at the top center of the map area. To the right of the search bar is a toolbar with icons for zooming, panning, and other map functions. A small inset map in the top right corner shows the current view's location within a larger geographical context.
- Map Content:** The map displays various geographical features and data points corresponding to the layers listed in the sidebar. Labeled countries include the United Kingdom, Ireland, France, Spain, Portugal, Italy, Greece, Turkey, Georgia, Azerbaijan, Armenia, Ukraine, Romania, Bulgaria, Serbia, Croatia, Hungary, Slovakia, Czechia, Austria, Poland, Belarus, Moldova, Georgia, Azerbaijan, Turkmenistan, Uzbekistan, Afghanistan, Iran, Iraq, Jordan, Israel, Lebanon, Syria, Saudi Arabia, United Arab Emirates, Oman, Yemen, Eritrea, Sudan, Chad, Niger, Mali, Mauritania, Morocco, Tunisia, Algeria, Libya, Egypt, Sudan, Eritrea, Yemen, Oman, United Arab Emirates, and Saudi Arabia. Bodies of water shown include the Tyrrhenian Sea, Mediterranean Sea, Black Sea, Persian Gulf, Red Sea, and Gulf of Aden.

# EMODnet [Human Activities - Vessel Density]



- All - All types
- 00 - Other
- 01 - Fishing
- 02 - Service
- 03 - Dredging or underwater ops
- 04 - Sailing
- 05 - Pleasure Craft
- 06 - High speed craft
- 07 - Tug and towing
- 08 - Passenger
- 09 - Cargo
- 10 - Tanker
- 11 - Military and Law Enforcement
- 12 - Unknown

# EMODnet [Ingestion]

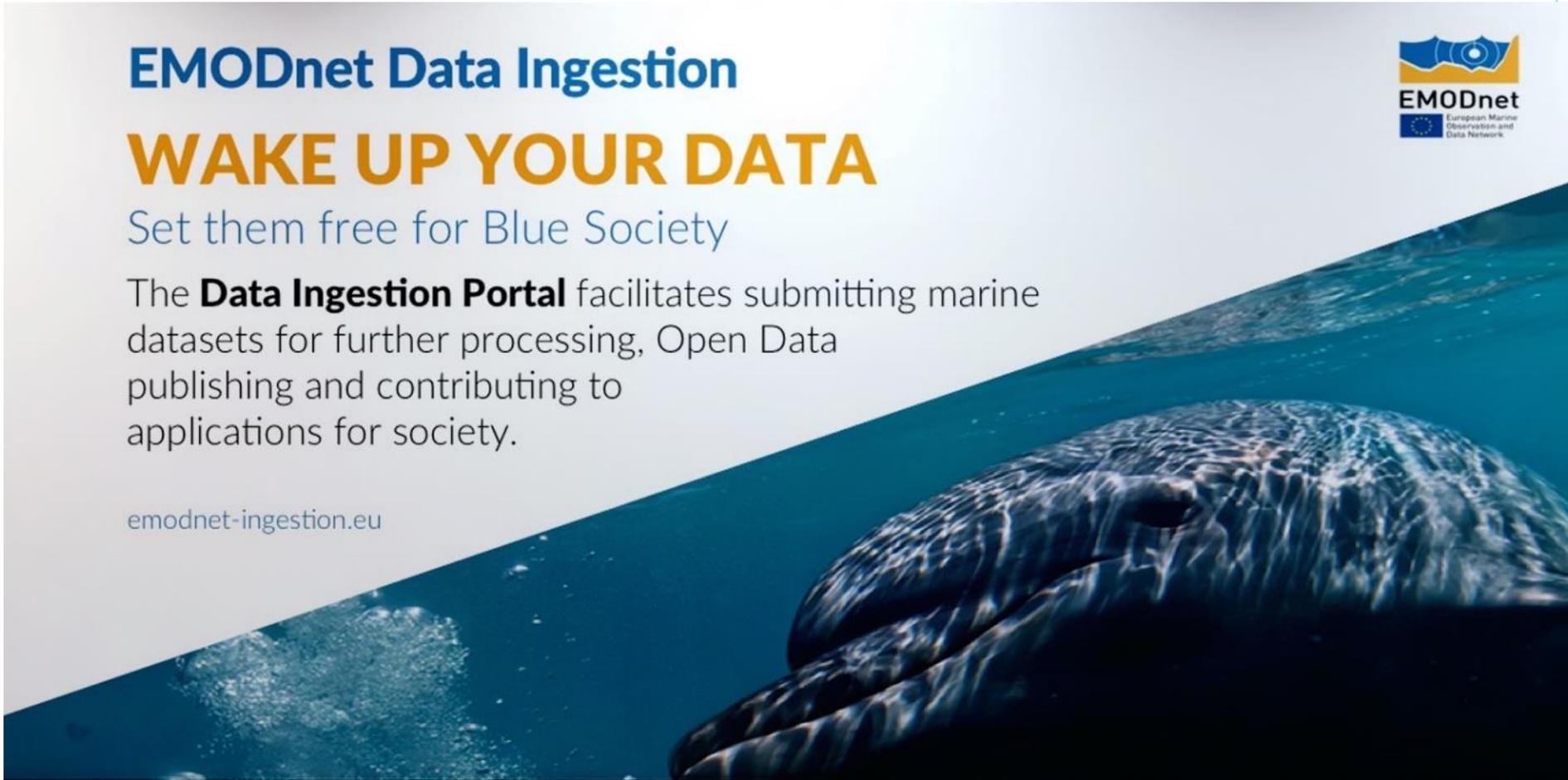
## EMODnet Data Ingestion

### WAKE UP YOUR DATA

Set them free for Blue Society

The **Data Ingestion Portal** facilitates submitting marine datasets for further processing, Open Data publishing and contributing to applications for society.

[emodnet-ingestion.eu](http://emodnet-ingestion.eu)





# QGIS

<https://qgis.org/en/site/>

 3.20.3  
3.16.11 LTR

[DISCOVER QGIS](#) [FOR USERS](#) [GET INVOLVED](#) [DOCUMENTATION](#)

English ▼

## QGIS

A Free and Open Source Geographic Information System



**QGIS 3.20 Odense**  
has been released!

20!  
[or packages](#) for your Operating System and read the [changelog](#).

**QGIS Community**  
Find out more about

Create, edit, visualise, analyse and publish geospatial information on Windows, Mac, Linux, BSD and mobile devices

For your desktop, server, in your web browser and as developer libraries

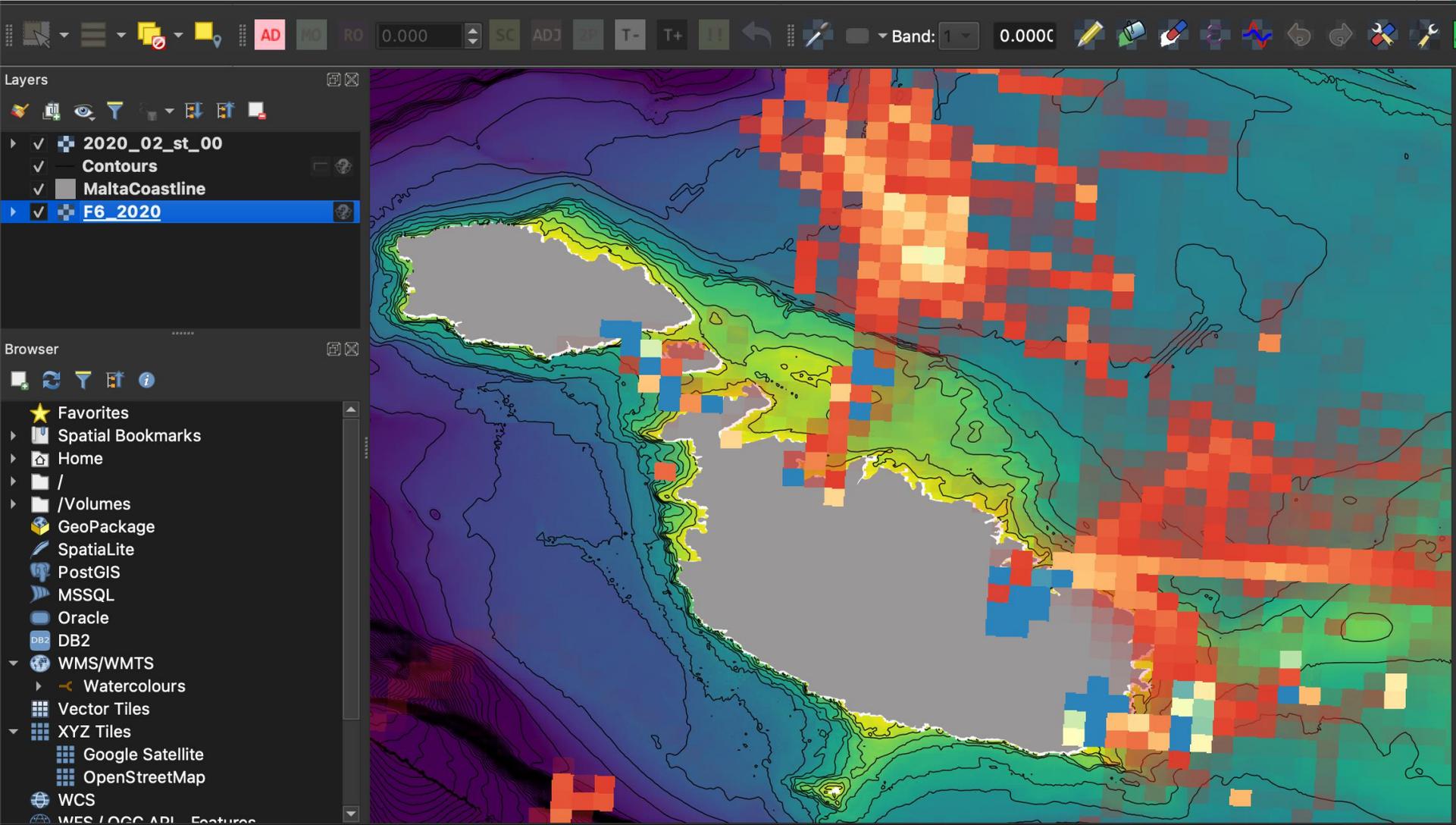
[Download Now](#)

Version 3.20.3  
Version 3.16.11 LTR

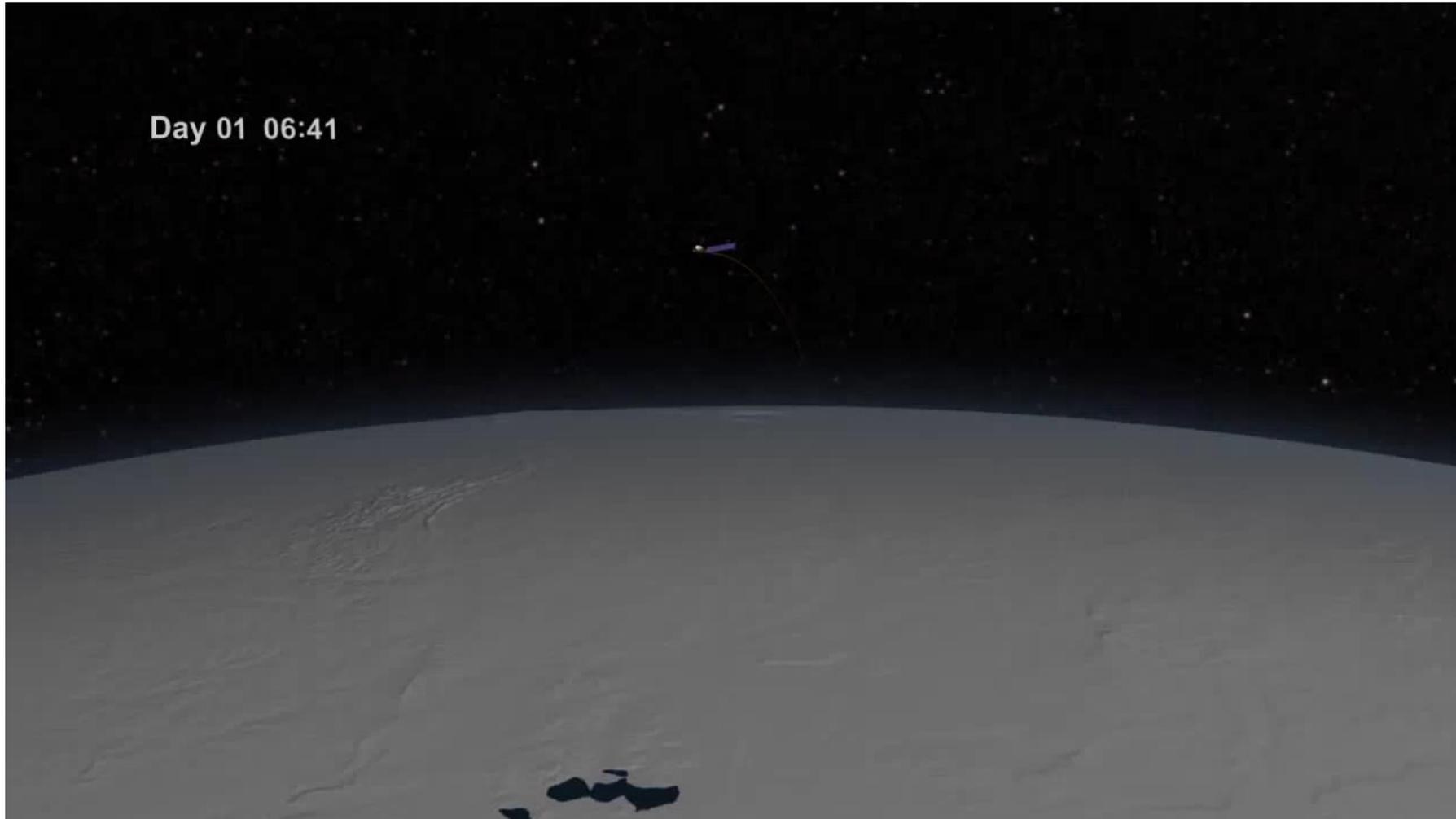
[Support QGIS](#)

Donate now!

# QGIS



# Sentinel Family



# Sentinel Family



# Sentinel Family



OPTICAL

The optical satellite measures the visible part of the spectrum.

The energy scattered off the leaf is dependent on the greenness of the leaf as a function of the amount of chlorophyll, which absorbs the energy that is needed for photosynthesis



RADAR



The radar satellite will measure the microwave part of the spectrum.

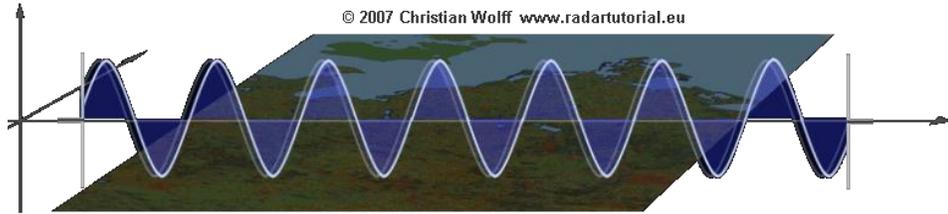
The energy scattered off the leaf is dependent on the size, shape, orientation and dielectric properties.

# Sentinel Family [Optical]

- ▶ SENTINEL-1 has a single C-band SAR instrument operating at a centre frequency of 5.405 GHz.

Sentinel-2 Bands	Central Wavelength ( $\mu\text{m}$ )	Resolution (m)
Band 1 - Coastal aerosol	0.443	60
Band 2 - Blue	0.490	10
Band 3 - Green	0.560	10
Band 4 - Red	0.665	10
Band 5 - Vegetation Red Edge	0.705	20
Band 6 - Vegetation Red Edge	0.740	20
Band 7 - Vegetation Red Edge	0.783	20
Band 8 - NIR	0.842	10
Band 8A - Vegetation Red Edge	0.865	20
Band 9 - Water vapour	0.945	60
Band 10 - SWIR - Cirrus	1.375	60
Band 11 - SWIR	1.610	20
Band 12 - SWIR	2.190	20

# Sentinel Family [SAR]



## Single-polarimetric SAR mode

VV

HH

## Dual-polarimetric coherent mode

HH - HV

VV - VH

## Full-polarimetric mode

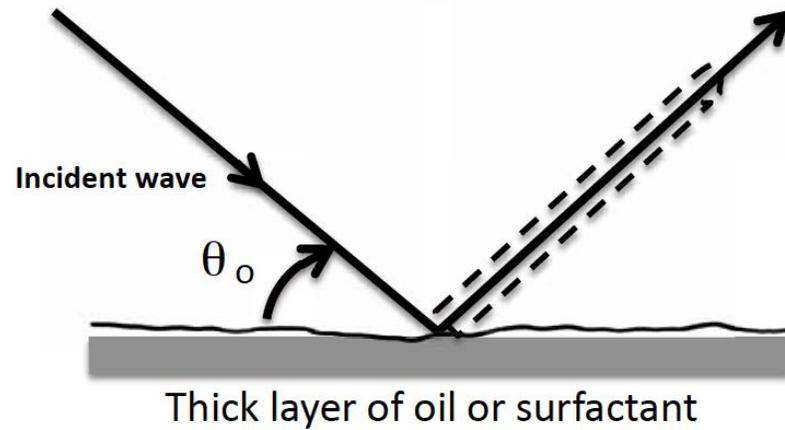
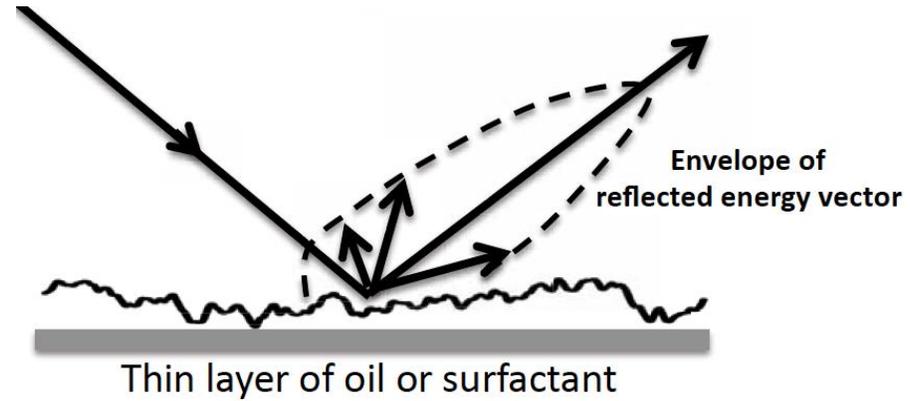
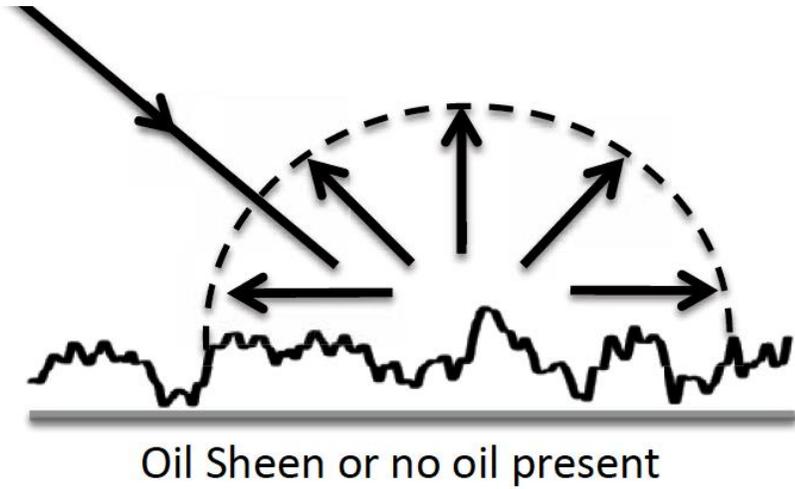
VV

VH

HV

HH

# Sentinel Family [SAR]



# ESA Data Hub

The screenshot displays the Copernicus Browser interface. The top left features the Copernicus logo and 'BROWSER' text, along with language selection (EN) and a 'Login' button. A 'VISUALISE' button is prominent. The main interface is divided into a left sidebar and a central map area. The sidebar includes a 'DATE: SINGLE' section with a date selector (YYYY-MM-DD) and a '30%' cloud cover filter, a 'Show latest date' button, and a 'Find products for current view' link. Below this is a 'CONFIGURATIONS:' section with a 'Default' dropdown. The 'DATA COLLECTIONS:' section shows 'Sentinel-2' selected, with a list of 'Sentinel-2 L1C' and 'Sentinel-2 L2A' (checked). The central map shows a satellite view of Sicily and Malta, with labels for Agrigento, Galtanissetta, Catania, Ragusa, and Siracusa. A search bar at the top right says 'Go to Place'. The bottom right corner shows a scale bar for 30 km and coordinates: Lat: 34.398, Lng: 17.486. The footer includes logos for the European Union, Copernicus, and ESA, along with 'About' and 'Support' links.

<https://browser.dataspace.copernicus.eu/>

# SNAP [Oil Spill Exercise 1]

- Tunisian tanker carrying trucks rammed into an anchored Cypriot container ship north of Corsica in the morning on Sunday 7<sup>th</sup> October 2018.
- Huge hole in the hull of one of the ships caused the fuel spill into the marine reserve created just two years ago.
- Spill created a trail of pollution 12 miles long and several hundred meters wide, heading away from Corsica towards the French and Italian mainland. The spill was pushed by the wind and started to break up.
- An estimated 40 to 200 cubic metres of oil leaked.
- Not clear why crash in clear conditions happened but most likely cause was human error. No-one was injured in the collision.
- Inflatable booms were deployed to stop the spread of a slick.

# SNAP [Oil Spill Exercise 1]



# SNAP [Oil Spill Exercise 1]



# SNAP [Oil Spill Exercise 1]



# SNAP [Oil Spill Exercise 1]



# SNAP [Oil Spill Exercise 1]



© Associated Press Photo

# SNAP [Oil Spill Exercise 1]

