# #MarineData4Asia

QGIS detailed presentation

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now Systems

26 January 2024

Copernicus Marine Service

PROGRAMME OF THE EUROPEAN UNION

Copernicus Europe's eyes on Earth

MERCATOR OCEAN INTERNATIONAL

noLogin

# Outline

- Introduction to QGIS and Copernicus Marnine products
- Discussion on implemented workflow for ocean data analysis using QGIS
- Summary of the main results
- References

#MarineData4Asia

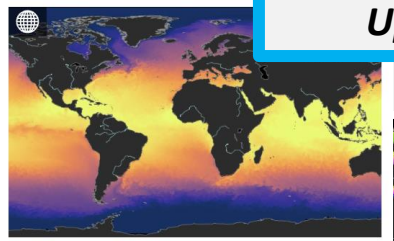
Copernicus Marine Service

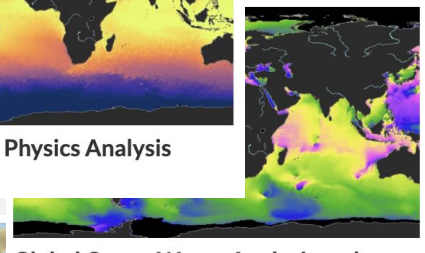
Implemented by MERCATOR OCEAN INTERNATIONAL

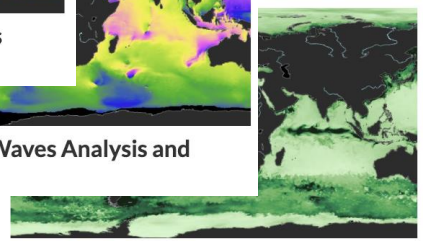

COPERNICUS MARINE REGIONAL OCEAN PRODUCT DIVISIONS

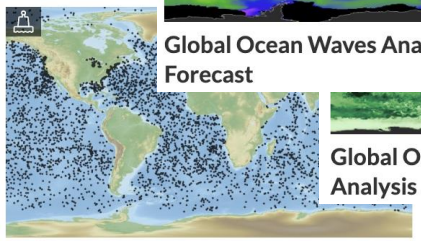
1. Global Ocean
2. Arctic Ocean
3. Baltic Sea
4. European North West Shelf Seas
5. Iberian Biscay Ireland Seas
6. Mediterranean Sea
7. Black Sea

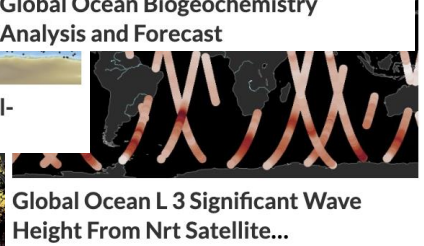
## Upstream Data


Global Ocean Physics Analysis and Forecast

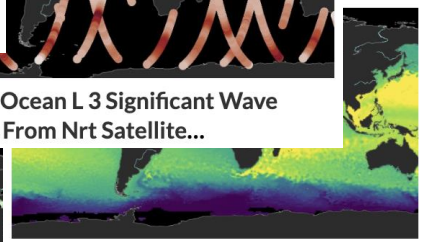

Global Ocean Waves Analysis and Forecast

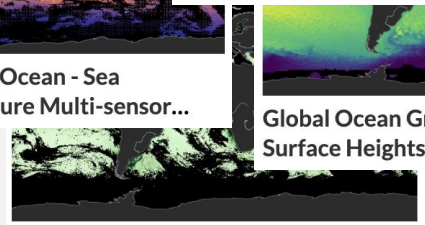

Global Ocean Biogeochemistry Analysis and Forecast


Global Ocean- In-Situ Near-Real-Time Observations


Global Ocean L 3 Significant Wave Height From Nrt Satellite...


ODYSSEA Global Ocean - Sea Surface Temperature Multi-sensor...


Global Ocean Gridded L 4 Sea Surface Heights And Derived...


Global Ocean Colour (Copernicus-GlobColour), Bio-Geo-Chemical, L3...

Source (Mod/Obs)

Essential Ocean Variable

Temporal resolution

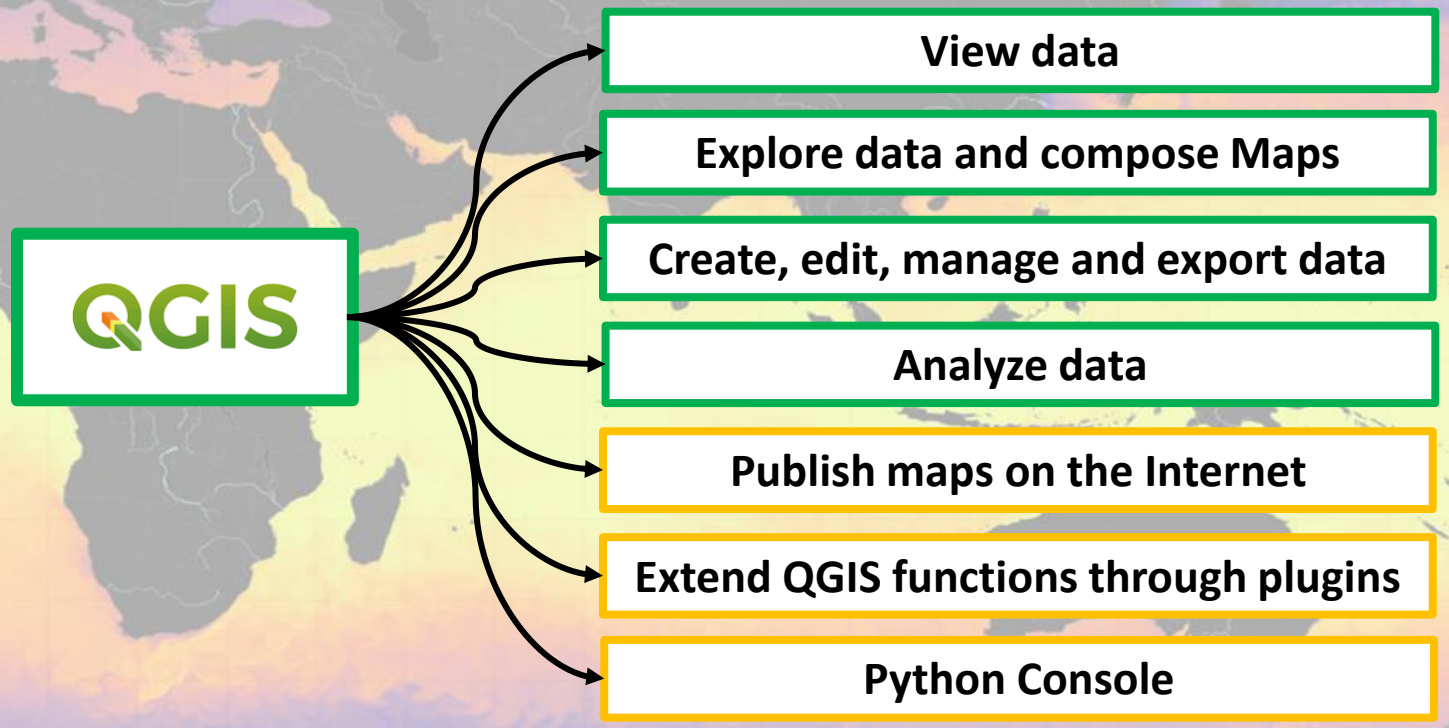
## Search and Discovery

Marine Data Store

MyOcean Pro

QGIS

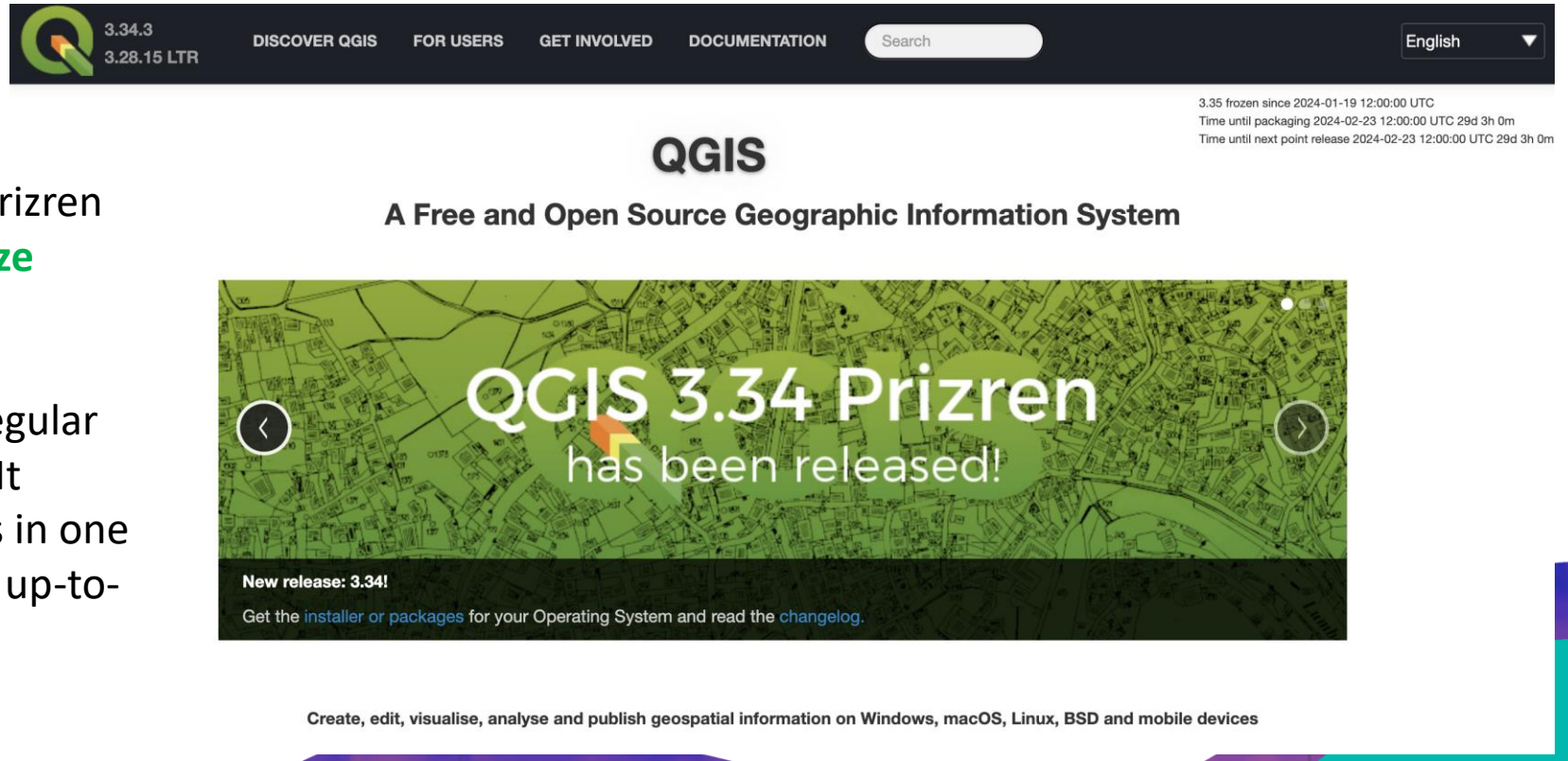
**Basic** and **advanced** functionalities that are helpful for managing and analyzing Copernicus Marine products




**Source:** https://docs.qgis.org/2.18/en/docs/user_manual/preamble/features.html

# QGIS Installation: an introduction

https://qgis.org/en/site/index.html




**Standalone installation:**

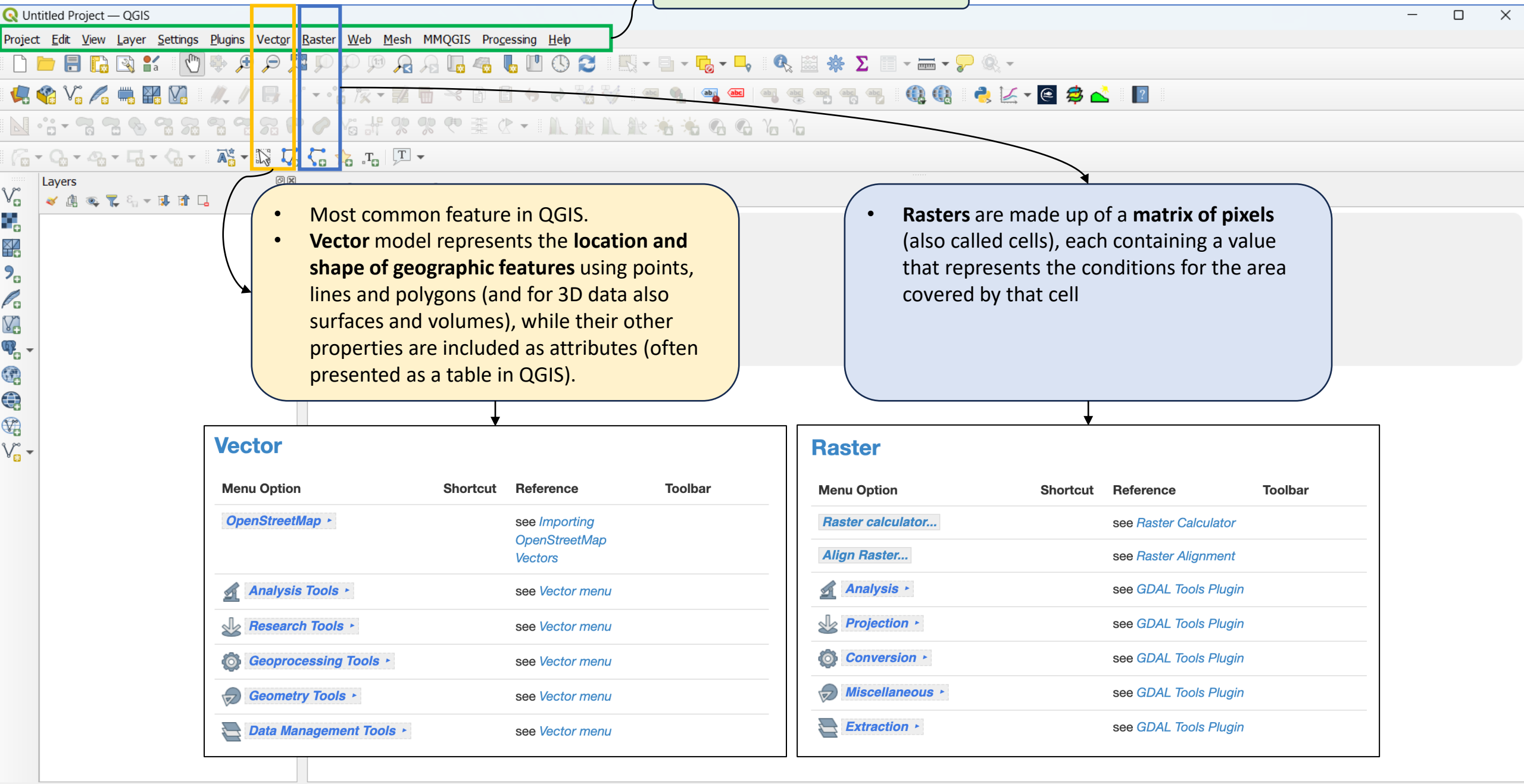
- Last developed version: QGIS 3.34 Prizren
- Long Term Release: **QGIS 3.28 Firenze**

**Advanced installation:**

- OSGeo4W: it is recommended for regular users or organization deployments. It allows to have several QGIS versions in one place, and to keep each component up-to-date individually without having to download the whole package.

**Source:** https://docs.qgis.org/3.28/en/docs/

**Access to QGIS features**




- Most common feature in QGIS.
- **Vector** model represents the **location and shape of geographic features** using points, lines and polygons (and for 3D data also surfaces and volumes), while their other properties are included as attributes (often presented as a table in QGIS).

- **Rasters** are made up of a **matrix of pixels** (also called cells), each containing a value that represents the conditions for the area covered by that cell

## Vector

| Menu Option | Shortcut | Reference | Toolbar |
|---|---|---|---|
| OpenStreetMap | | see *Importing OpenStreetMap Vectors* | |
| Analysis Tools | | see *Vector menu* | |
| Research Tools | | see *Vector menu* | |
| Geoprocessing Tools | | see *Vector menu* | |
| Geometry Tools | | see *Vector menu* | |
| Data Management Tools | | see *Vector menu* | |

## Raster

| Menu Option | Shortcut | Reference | Toolbar |
|---|---|---|---|
| Raster calculator... | | see *Raster Calculator* | |
| Align Raster... | | see *Raster Alignment* | |
| Analysis | | see *GDAL Tools Plugin* | |
| Projection | | see *GDAL Tools Plugin* | |
| Conversion | | see *GDAL Tools Plugin* | |
| Miscellaneous | | see *GDAL Tools Plugin* | |
| Extraction | | see *GDAL Tools Plugin* | |

**Source: https://events.marine.copernicus.eu/marinedata4asia-2024/content/qgis**

## E-Learning Materials

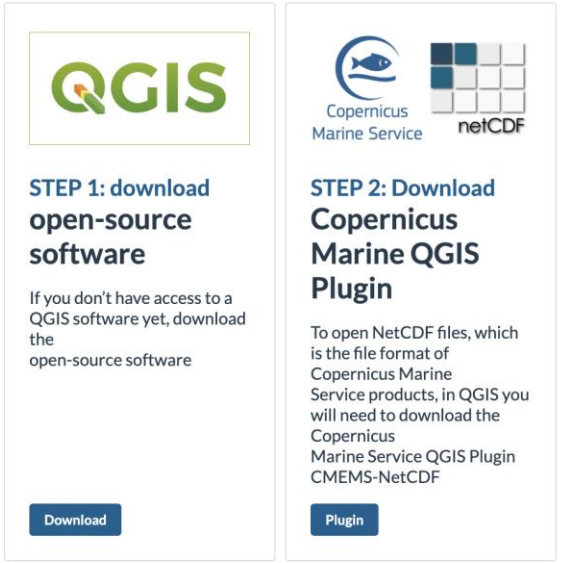
Access our tutorials online, accompanied by videos, code, and more.

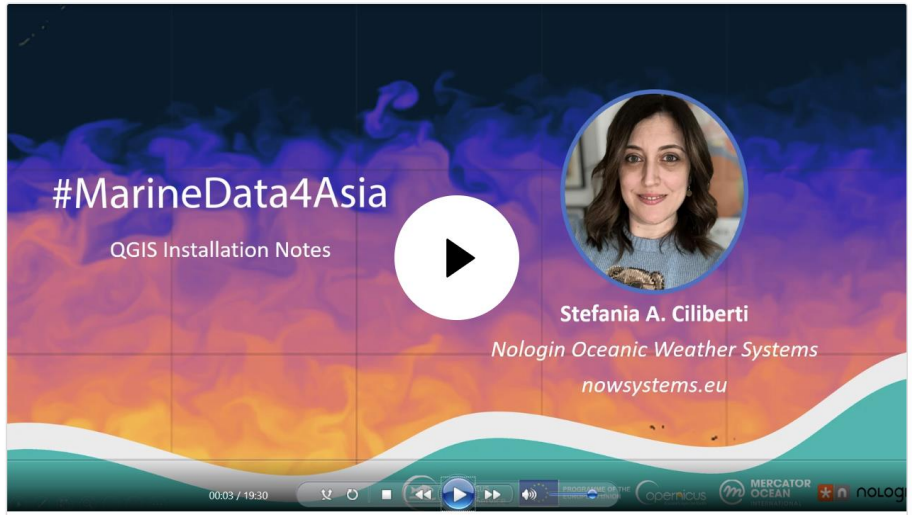


### Practical Session Guidelines

This guide includes a few steps you will need to take to start your QGIS practice!

Guidelines



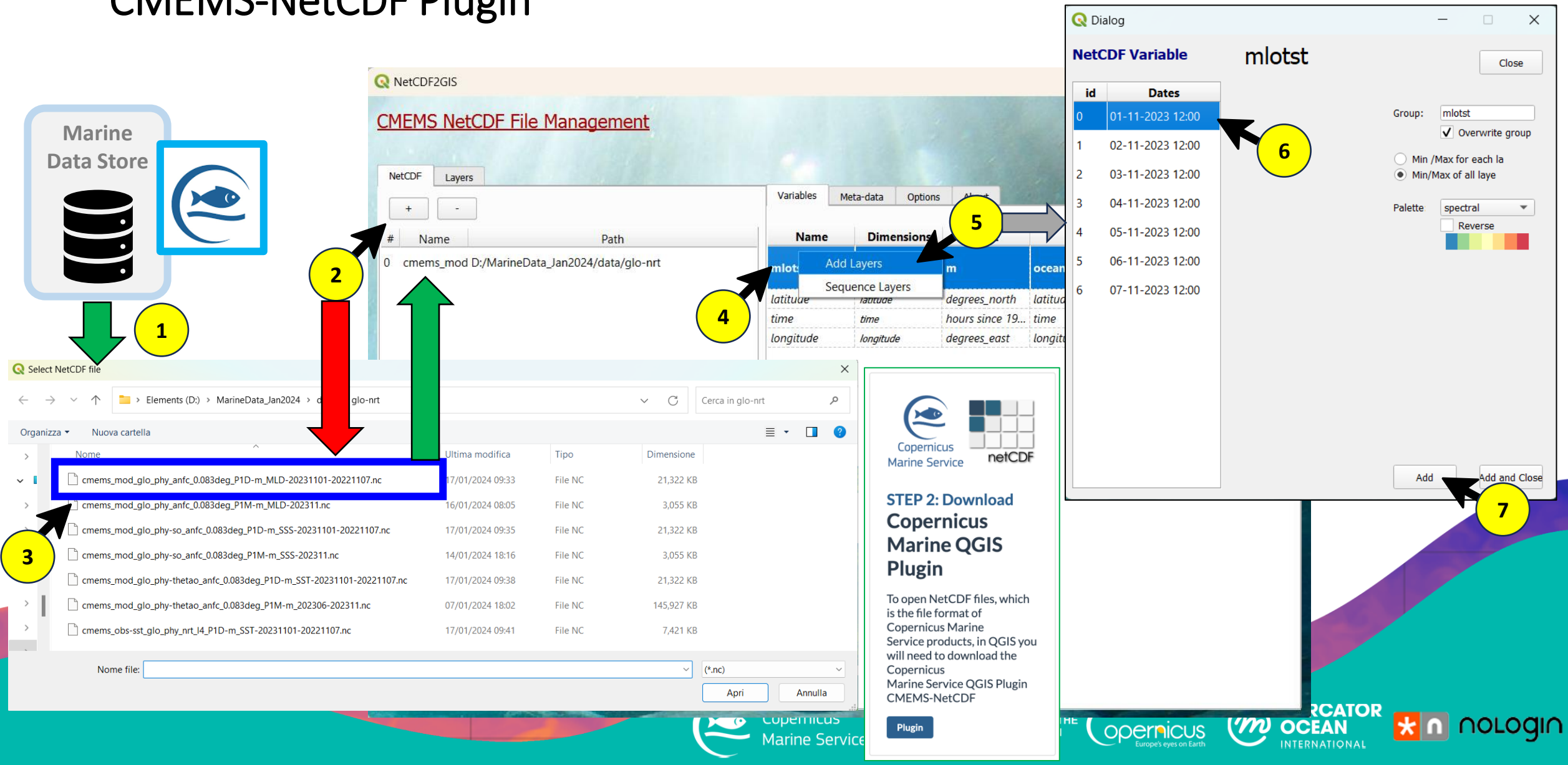




### QGIS
### Installation notes

This video presents basic steps on how to download and install QGIS in your computer using the standalone installer and the OSGeo4W advanced one. Examples are given for Windows OS. You can also download the PDF by clicking on the following button:

Download PDF

# CMEMS-NetCDF Plugin

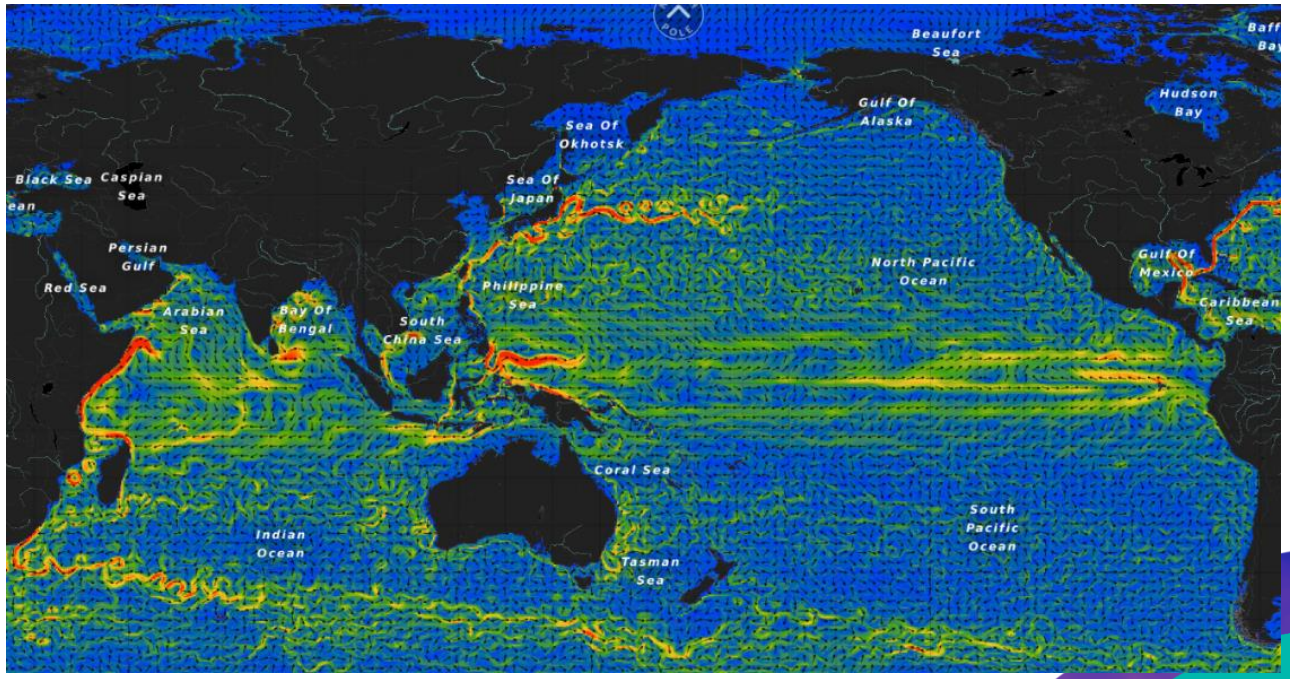


# Additional plugins

- **QuickMapService**: it is used to add basemaps and geoservices
- **DataPloty**: it is a tool, developed in Python, that allows for the plotting of charts

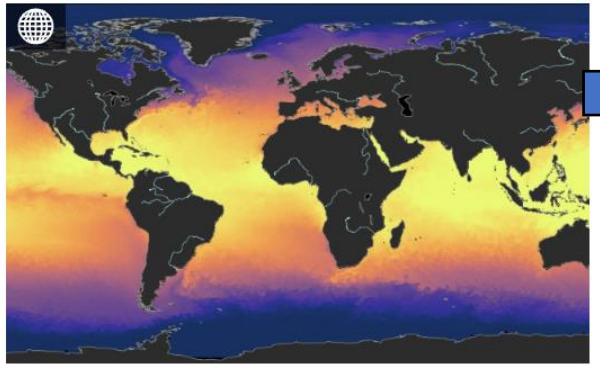
# Scope of the training session

- Monitor the El Niño (and La Niña) event by computing **SST anomalies** to visualize the relevant pattern in the Pacific Ocean and for computing metrics in the Niño3.4 region.
- **Visualize the Copernicus Marine** products in the Indian Ocean, extracting EOV values in same specific locations.
- **Interpolate SST values in a specific grid** at given resolution to support additional data analysis (e.g., validation).



# Upstream Data

Global Ocean Analysis and Forecasting System for the Physics (GLO-PHY NRT), produced by Copernicus Marine **GLO-MFC** (Mercator Ocean International, France)



**Global Ocean Physics Analysis and Forecast**

GLOBAL_ANALYSISFORECAST_P... 001_024

Models

Global, 0.083° × 0.083° × 50 levels

1 Nov 2020 to 4 Feb 2024, hourly, daily,...

Mixed layer thickness, salinity, sea ice, sea surface height, temperature, velocity, wave...

**Dataset ID**

cmems_mod_glo_phy-cur_anfc_0.083deg_PT6H-i

cmems_mod_glo_phy-cur_anfc_0.083deg_P1D-m

cmems_mod_glo_phy-cur_anfc_0.083deg_P1M-m

cmems_mod_glo_phy-so_anfc_0.083deg_PT6H-i

cmems_mod_glo_phy-so_anfc_0.083deg_P1D-m

cmems_mod_glo_phy-so_anfc_0.083deg_P1M-m

cmems_mod_glo_phy-thetao_anfc_0.083deg_PT6H-i

cmems_mod_glo_phy-thetao_anfc_0.083deg_P1D-m

cmems_mod_glo_phy-thetao_anfc_0.083deg_P1M-m

cmems_mod_glo_phy-wcur_anfc_0.083deg_P1D-m

cmems_mod_glo_phy-wcur_anfc_0.083deg_P1M-m

cmems_mod_glo_phy_anfc_0.083deg_P1D-m

cmems_mod_glo_phy_anfc_0.083deg_P1M-m

cmems_mod_glo_phy_anfc_0.083deg_PT1H-m

cmems_mod_glo_phy_anfc_merged-uv_PT1H-i

cmems_mod_glo_phy_anfc_0.083deg-climatology-uncertainty_P1M-m

cmems_mod_glo_phy_anfc_0.083deg_static – *bathy*

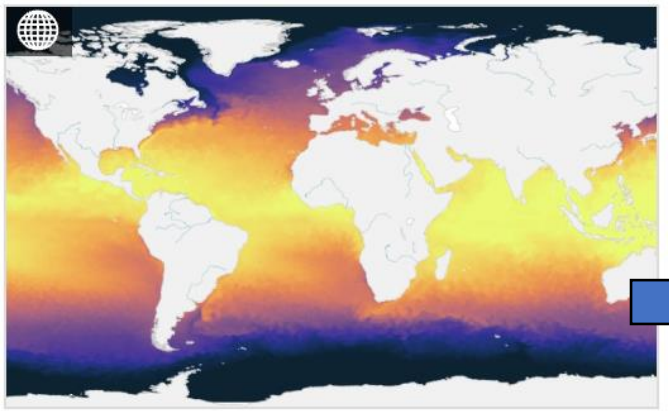
cmems_mod_glo_phy_anfc_0.083deg_static – *coords*

cmems_mod_glo_phy_anfc_0.083deg_static – *mdt*

- Daily mean (P1D) 3D temperature (thetao) and salinity (so):
  - Temporal period: 01-07/11/2023
  - Depth: 0.5 m (only one lavel)
  - Area: Indian Ocean
- Daily mean (P1D) 2D mixed layer depth (mlotst):
  - Temporal period: 01-07/11/2023
  - Area: Indian Ocean
- Monthly mean (P1M) temperature (thetao):
  - Temporal period: Jun to Nov 2023
  - Depth: 0.5 m (only one level)
  - Area: Global Ocean

# Upstream Data

Global Ocean Reanalysis for the Physics (GLO-PHY MY), produced by Copernicus Marine **GLO-MFC** (Mercator Ocean International, France)



**Global Ocean Physics Reanalysis**

GLOBAL_MULTIYEAR_PHY_001_030
Models
Global, 0.083° × 0.083° × 50 levels
1 Jan 1993 to 24 Oct 2023, daily, monthly
Mixed layer thickness, salinity, sea ice, sea surface height, temperature, velocity

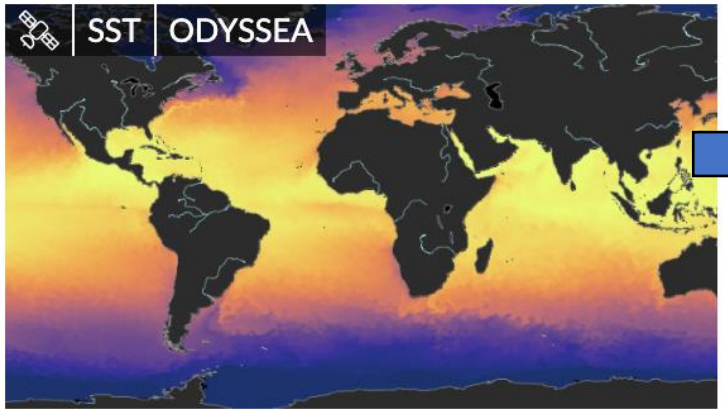
**Dataset ID**

cmems_mod_glo_phy_my_0.083_P1D-m
cmems_mod_glo_phy_my_0.083_P1M-m
cmems_mod_glo_phy_my_0.083deg_P1D-m
cmems_mod_glo_phy_my_0.083deg_P1M-m
cmems_mod_glo_phy_myint_0.083deg_P1D-m
cmems_mod_glo_phy_myint_0.083deg_P1M-m
**cmems_mod_glo_phy_my_0.083-climatology_P1M-m**
cmems_mod_glo_phy_my_0.083deg-climatology_P1M-m
cmems_mod_glo_phy_my_0.083deg_static — *bathy*
cmems_mod_glo_phy_my_0.083deg_static — *coords*
cmems_mod_glo_phy_my_0.083deg_static — *mdt*

- Monthly climatology (climatology_P1M) 3D temperature (thetao):
  - Temporal period: Jun to Nov
  - Depth: 0.5 m (only one lavel)
  - Area: Global Ocean

# Upstream Data

Sea Surface Temperature satellite observations (SST-OBS), as provided by the Copernicus **SST-TAC** (Ifremer, France)




**ODYSSEA Global Sea Surface Temperature Gridded Level 4 Daily...**

SST_GLO_PHY_L4_NRT_010_043
Satellite (L4)
Global, 0.1° × 0.1°
1 Jan 2021 to 3 Dec 2023, daily
Temperature

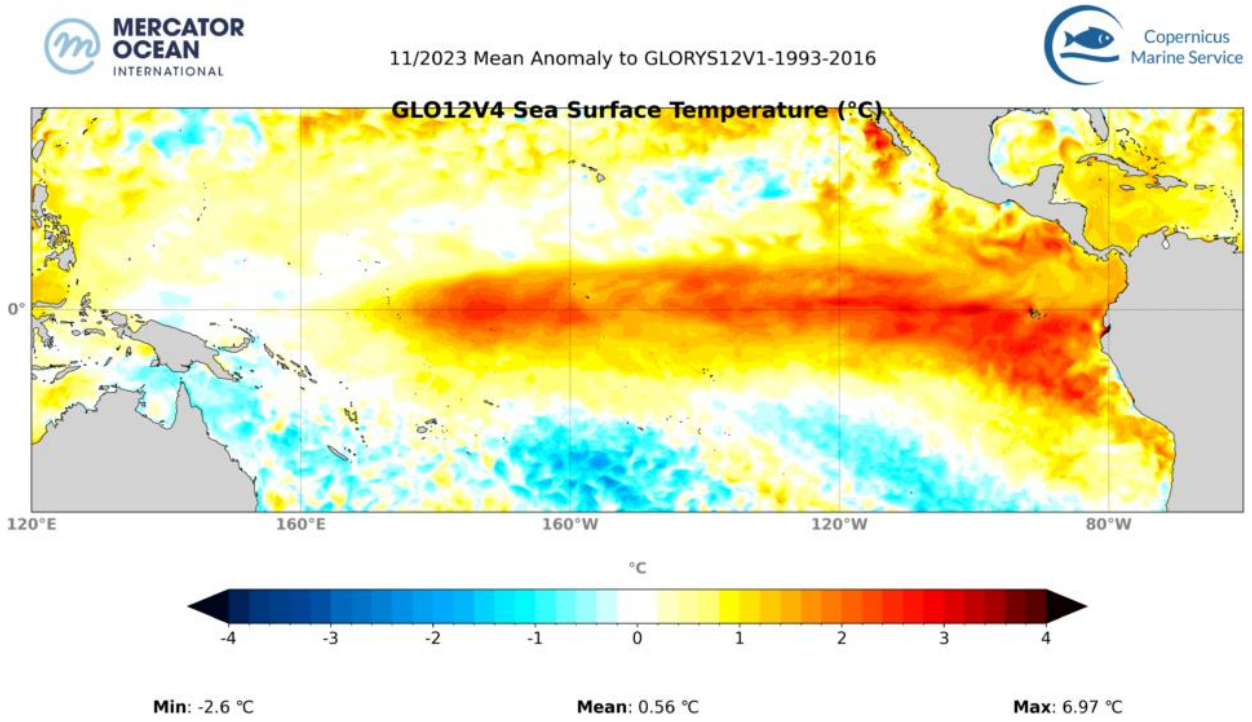
**Dataset ID**

cmems_obs-sst_glo_phy_nrt_l4_P1D-m

- Daily (P1D) satellite (obs) L4 Sea Surface Temperature (sst):
  - Temporal period: 01-07/11/2023
  - Area: Indian Ocean

# El Niño event in 2023

- An El Niño event has been underway since spring 2023.
- Conditions have been gaining strength, and as of mid-November, these are still observed in the tropical Pacific Ocean.
- The evolution of El Niño remains uncertain, but it is likely that it will shortly peak and end in the coming Northern Hemisphere spring.




Sea Surface Temperature anomalies (°C) in the Pacific for November 2023. Axis are longitude and latitude. Positive (or negative) anomalies mean actual conditions are warmer (or colder) than regular conditions at the same time of the year. Analysis: GLO12 and GLORYS12. Latest update 29 November 2023

Source: https://www.mercator-ocean.eu/actualites/el-nino-update-november-2023/

Source: https://docs.qgis.org/3.28/en/docs/user_manual

# Calculating SST anomalies to monitor El Niño event

***Workflow***

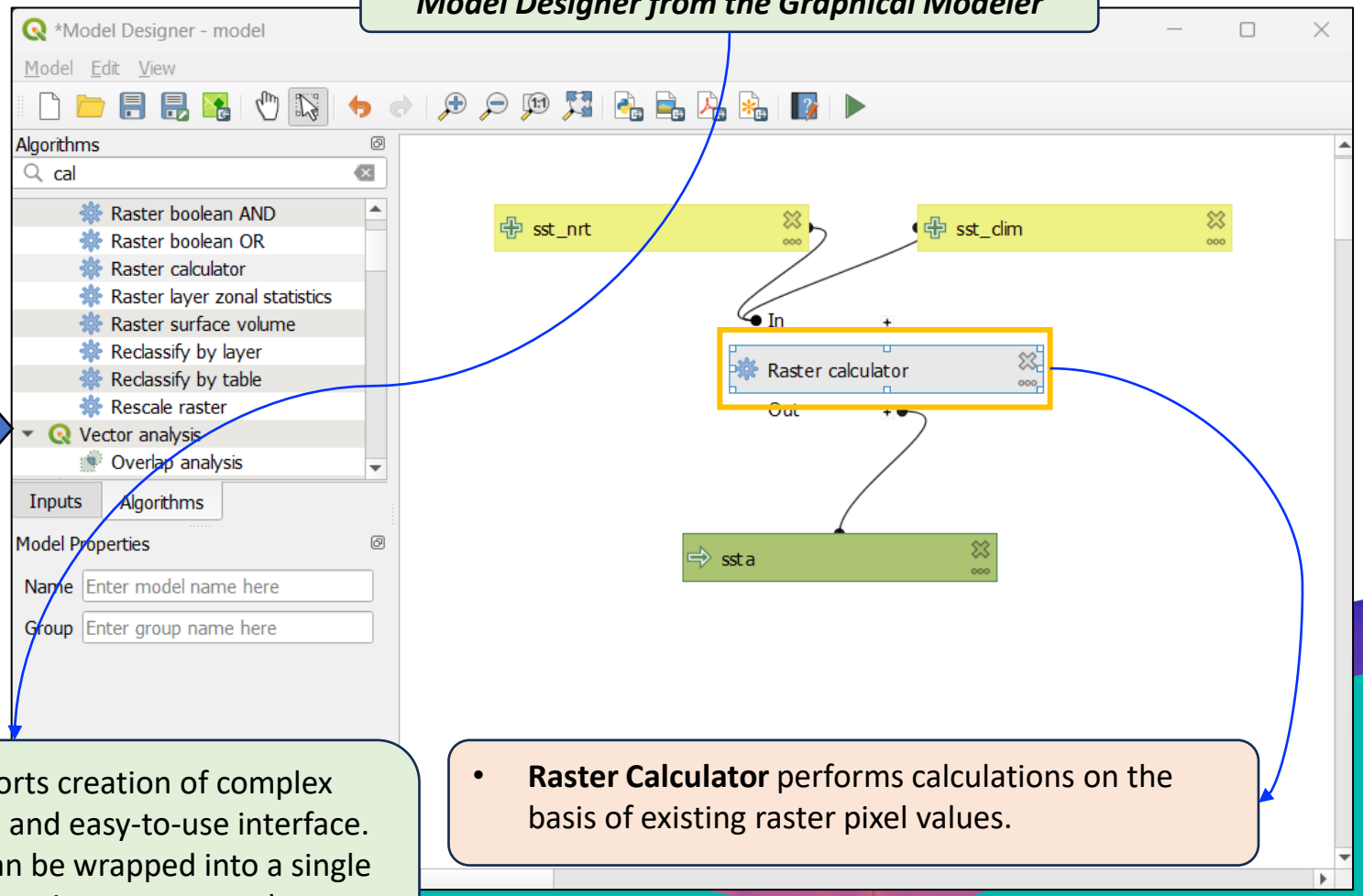
SST monthly mean from GLO-PHY NRT ***SST_monthly***

SST monthly climatology from GLO-PHY MY ***SST_clim***

***diff (SST_monthly , SST_clim)***

**SST GLO-PHY NRT monthly anomaly *SST_anomal***

***Model Designer from the Graphical Modeler***

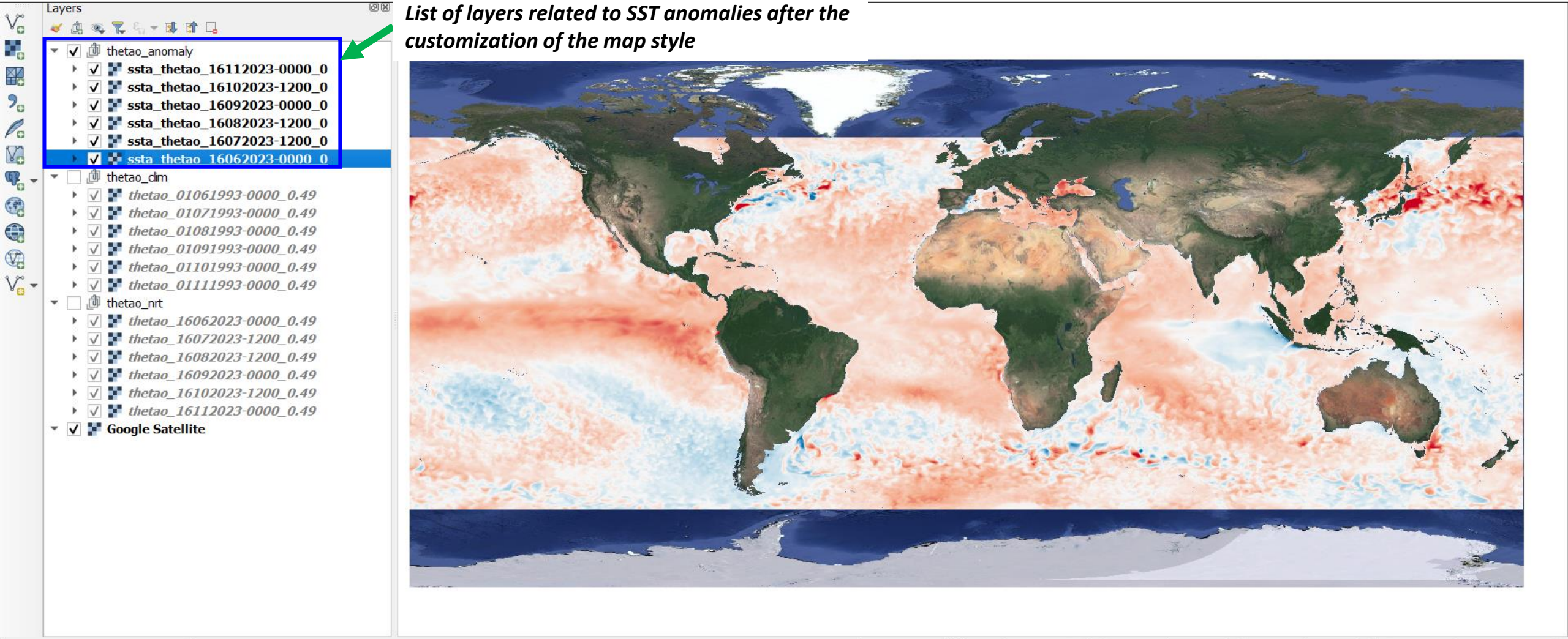



- **Model Designer** supports creation of complex models using a simple and easy-to-use interface.
- Chain of operations can be wrapped into a single process, making it convenient to execute later with a different set of input.

- **Raster Calculator** performs calculations on the basis of existing raster pixel values.

# Calculating SST anomalies to monitor El Niño event

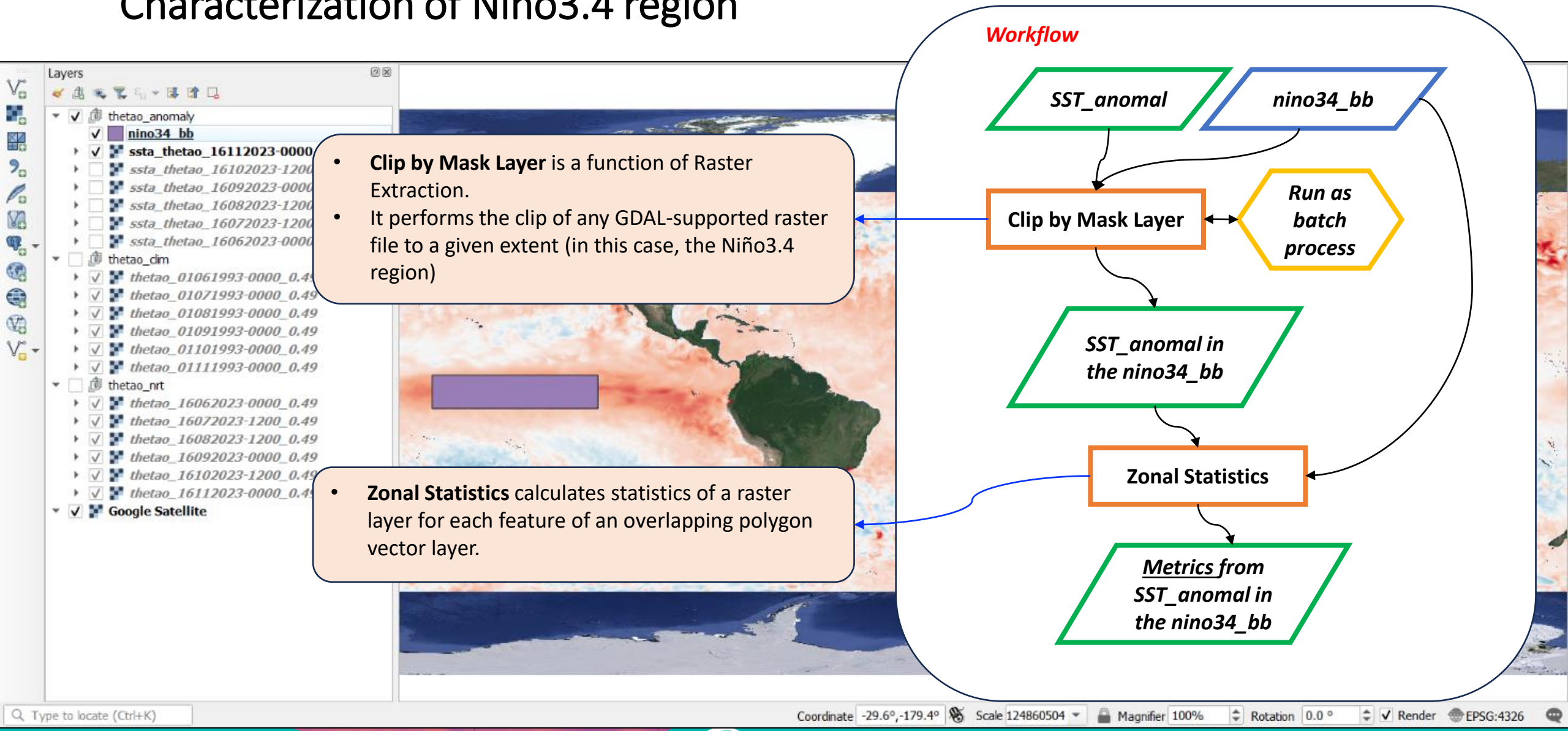
***List of layers related to SST anomalies after the customization of the map style***



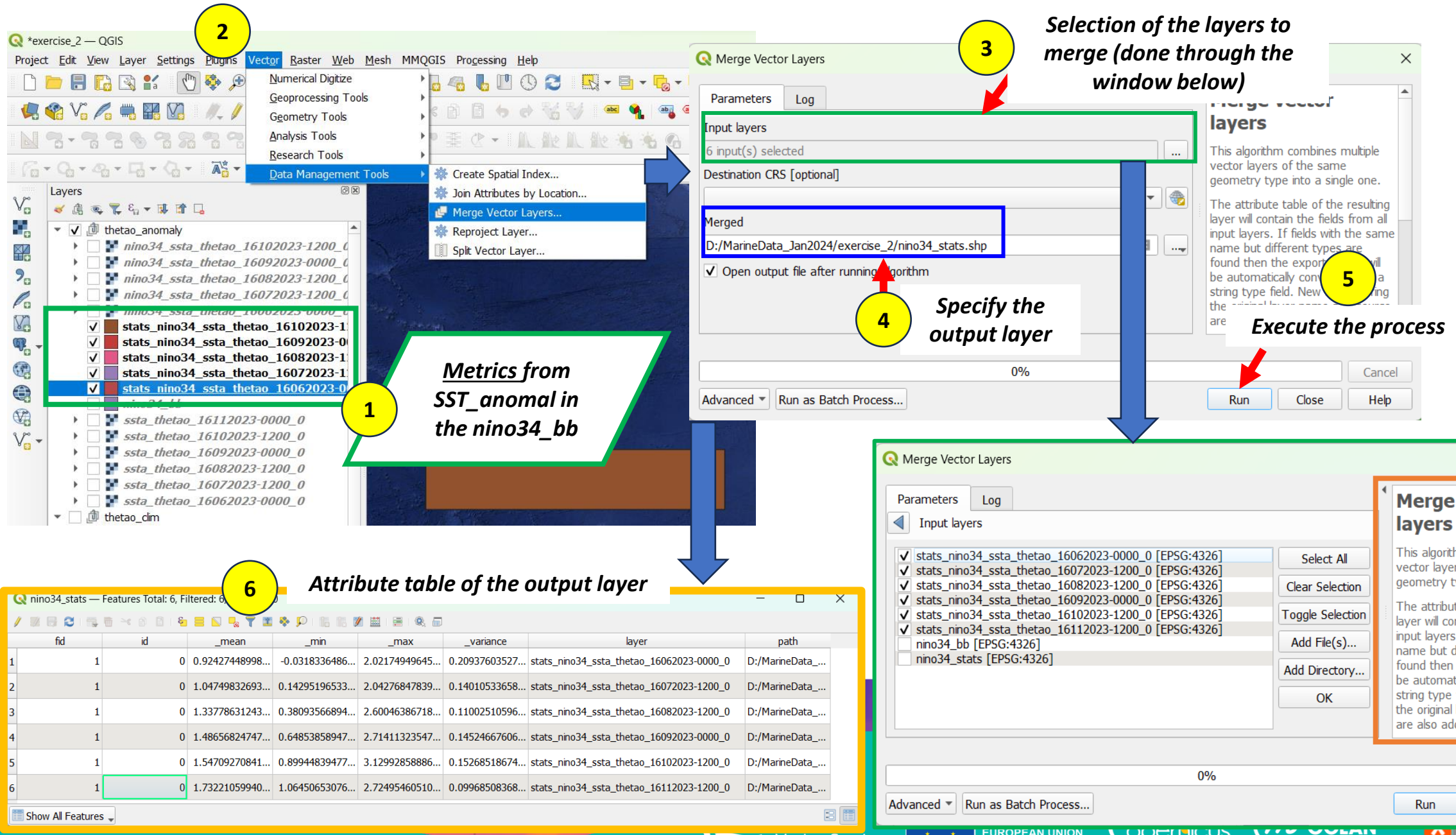
# Characterization of Niño3.4 region

- **Clip by Mask Layer** is a function of Raster Extraction.
- It performs the clip of any GDAL-supported raster file to a given extent (in this case, the Niño3.4 region)

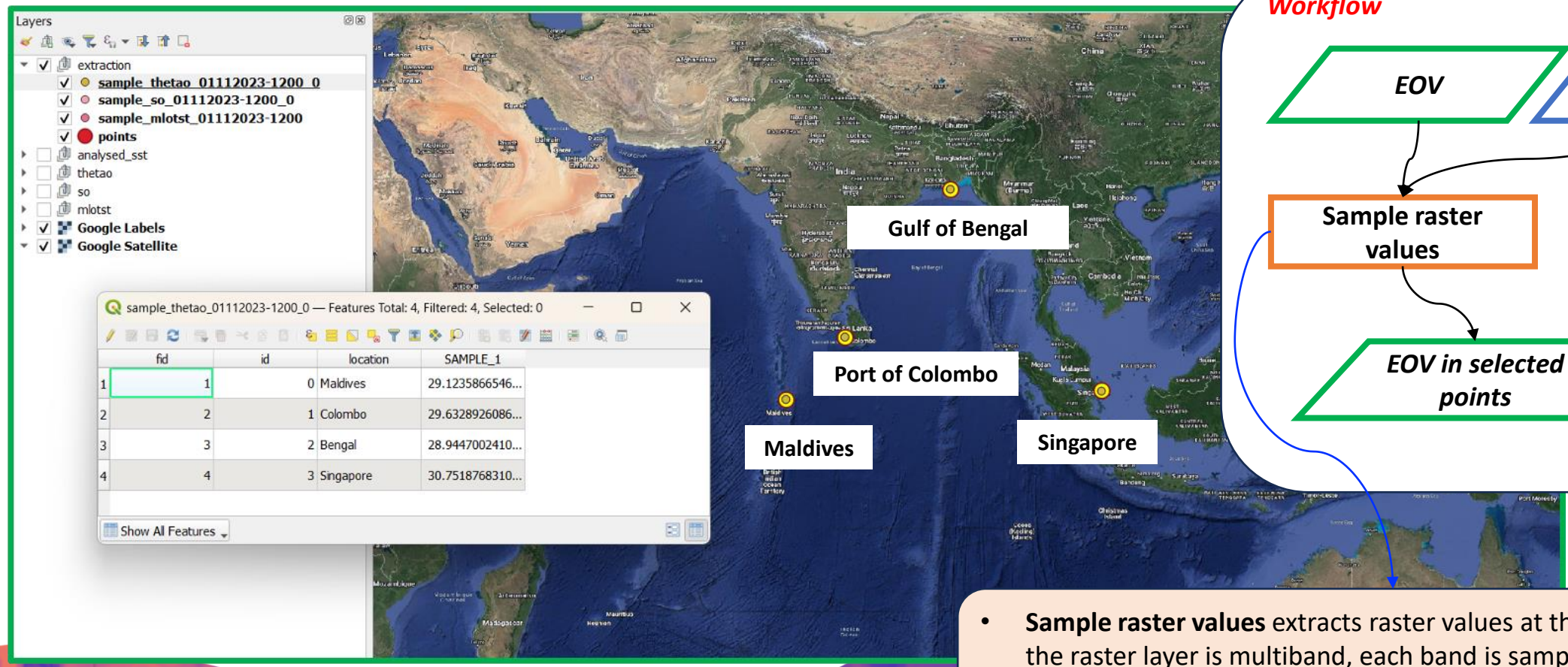
- **Zonal Statistics** calculates statistics of a raster layer for each feature of an overlapping polygon vector layer.

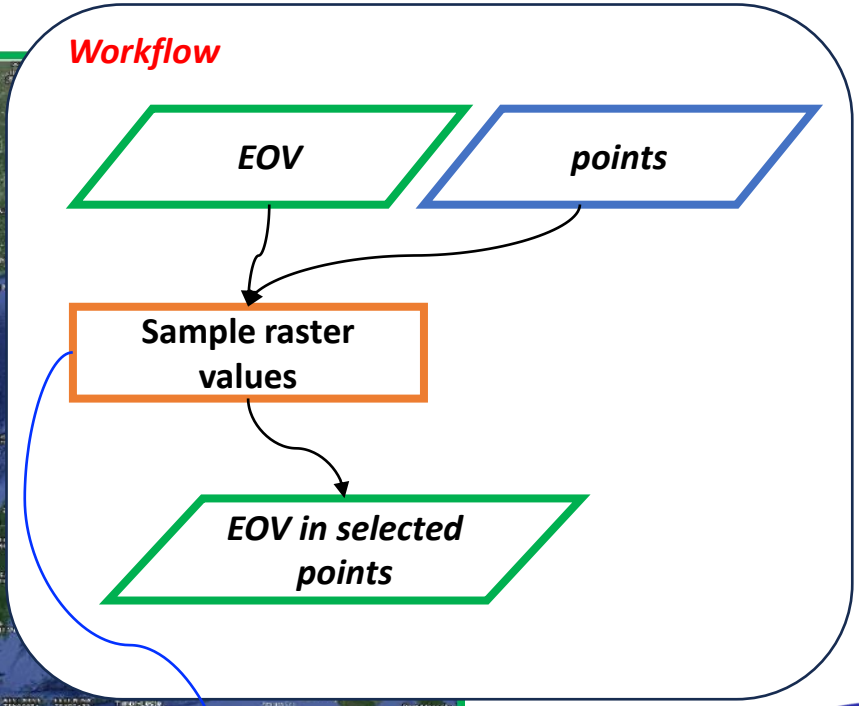



Source: https://docs.qgis.org/3.28/en/docs/user_manual


2
*exercise_2 — QGIS
Project Edit View Layer Settings Plugins Vector Raster Web Mesh MMQGIS Processing Help
Numerical Digitize
Geoprocessing Tools
Geometry Tools
Analysis Tools
Research Tools
Data Management Tools
Create Spatial Index...
Join Attributes by Location...
Merge Vector Layers...
Reproject Layer...
Split Vector Layer...
Layers
thetao_anomaly
stats_nino34_ssta_thetao_16102023-1
stats_nino34_ssta_thetao_16092023-0
stats_nino34_ssta_thetao_16082023-1
stats_nino34_ssta_thetao_16072023-1
stats_nino34_ssta_thetao_16062023-0
ssta_thetao_16112023-0000_0
ssta_thetao_16102023-1200_0
ssta_thetao_16092023-0000_0
ssta_thetao_16082023-1200_0
ssta_thetao_16072023-1200_0
ssta_thetao_16062023-0000_0
thetao_clim
1
Metrics from SST_anomal in the nino34_bb
3
Selection of the layers to merge (done through the window below)
Merge Vector Layers
Parameters
Log
Input layers
6 input(s) selected
Destination CRS [optional]
Merged
D:/MarineData_Jan2024/exercise_2/nino34_stats.shp
Open output file after running algorithm
4
Specify the output layer
Merge vector layers
This algorithm combines multiple vector layers of the same geometry type into a single one.
The attribute table of the resulting layer will contain the fields from all input layers. If fields with the same name but different types are found then the export will be automatically converted into a string type field. New fields storing the original layer name and source are also added.
5
Execute the process
0%
Cancel
Advanced
Run as Batch Process...
Run
Close
Help
Merge Vector Layers
Parameters
Log
Input layers
stats_nino34_ssta_thetao_16062023-0000_0 [EPSG:4326]
stats_nino34_ssta_thetao_16072023-1200_0 [EPSG:4326]
stats_nino34_ssta_thetao_16082023-1200_0 [EPSG:4326]
stats_nino34_ssta_thetao_16092023-0000_0 [EPSG:4326]
stats_nino34_ssta_thetao_16102023-1200_0 [EPSG:4326]
stats_nino34_ssta_thetao_16112023-1200_0 [EPSG:4326]
nino34_bb [EPSG:4326]
nino34_stats [EPSG:4326]
Select All
Clear Selection
Toggle Selection
Add File(s)...
Add Directory...
OK
Merge vector layers
This algorithm combines multiple vector layers of the same geometry type into a single one.
The attribute table of the resulting layer will contain the fields from all input layers. If fields with the same name but different types are found then the exported field will be automatically converted into a string type field. New fields storing the original layer name and source are also added.
0%
Cancel
Advanced
Run as Batch Process...
Run
Close
Help
6
Attribute table of the output layer
nino34_stats — Features Total: 6, Filtered: 6
fid id _mean _min _max _variance layer path
1 1 0 0.92427448998... -0.0318336486... 2.02174949645... 0.20937603527... stats_nino34_ssta_thetao_16062023-0000_0 D:/MarineData_...
2 1 0 1.04749832693... 0.14295196533... 2.04276847839... 0.14010533658... stats_nino34_ssta_thetao_16072023-1200_0 D:/MarineData_...
3 1 0 1.33778631243... 0.38093566894... 2.60046386718... 0.11002510596... stats_nino34_ssta_thetao_16082023-1200_0 D:/MarineData_...
4 1 0 1.48656824747... 0.64853858947... 2.71411323547... 0.14524667606... stats_nino34_ssta_thetao_16092023-0000_0 D:/MarineData_...
5 1 0 1.54709270841... 0.89944839477... 3.12992858886... 0.15268518674... stats_nino34_ssta_thetao_16102023-1200_0 D:/MarineData_...
6 1 0 1.73221059940... 1.06450653076... 2.72495460510... 0.09968508368... stats_nino34_ssta_thetao_16112023-1200_0 D:/MarineData_...
Show All Features

# Selection of locations where to extract EOVs: example with SST



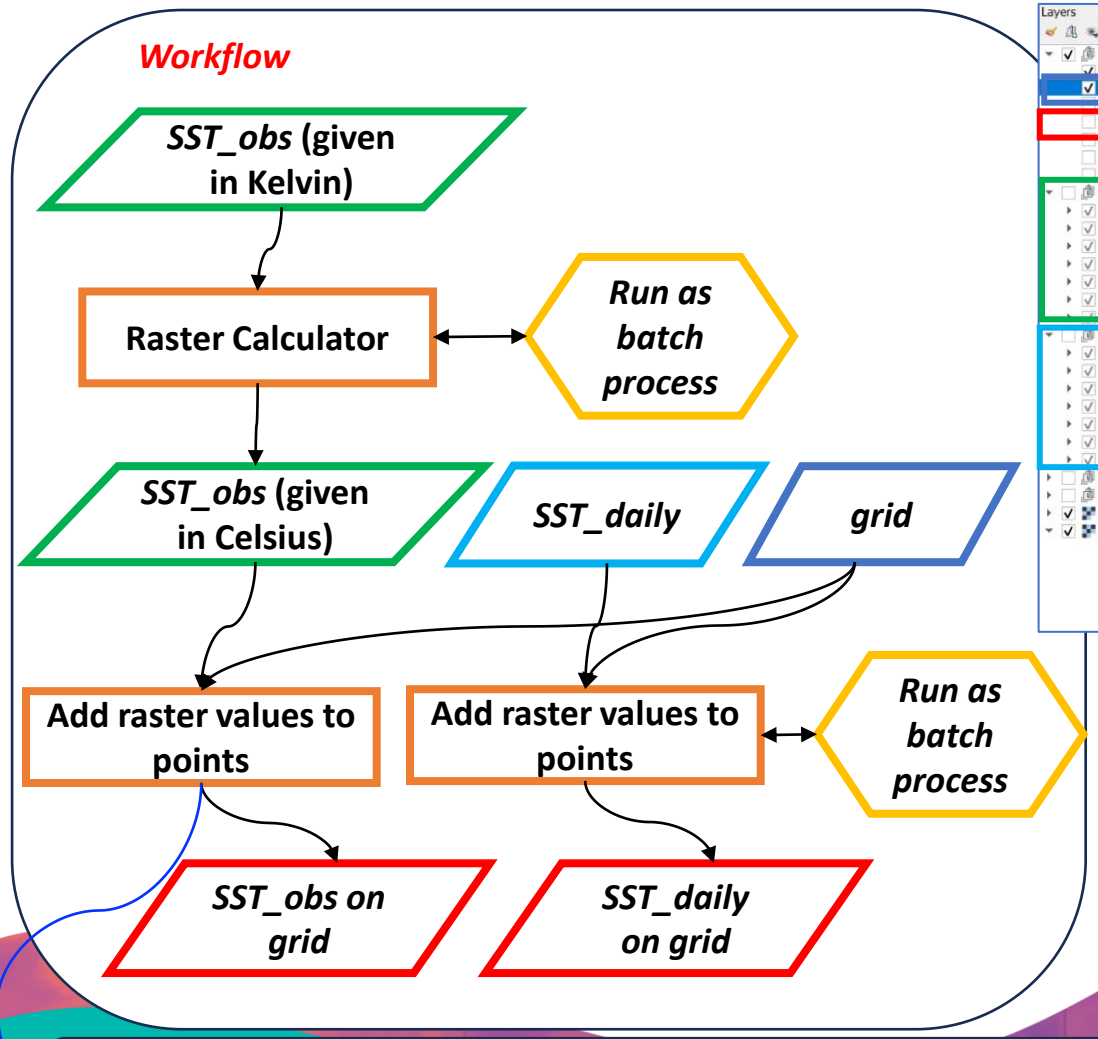



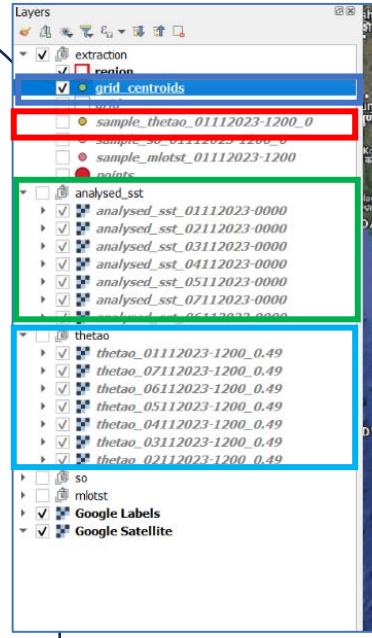

- **Sample raster values** extracts raster values at the point locations. If the raster layer is multiband, each band is sampled.
- The attribute table of the resulting layer will have as many new columns as there are bands in the raster layer.

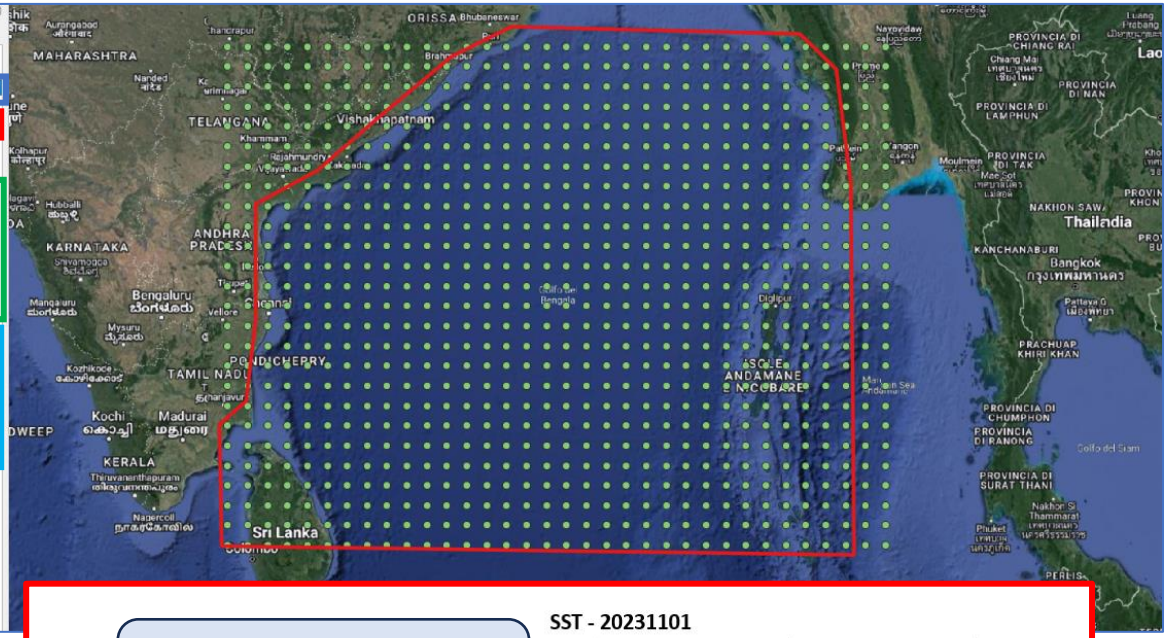
**Source:** https://docs.qgis.org/3.28/en/docs/user_manual

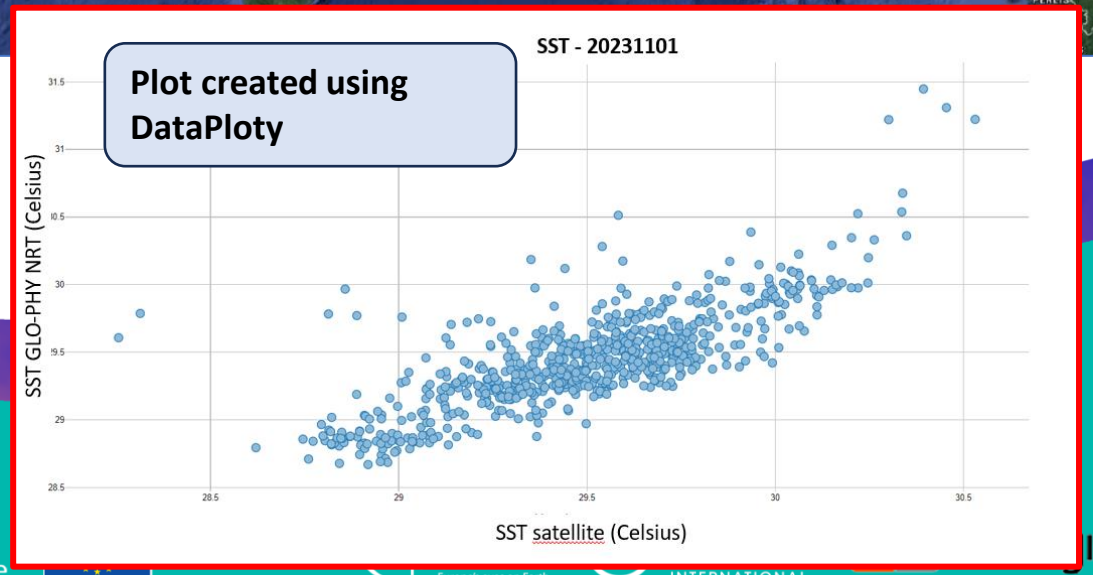
# Evaluation of SST in the Bay of Bengal

**Workflow**




- **Add raster values to points** performs the interpolation of raster values over a grid characterized by grid points (centroids).

**Source:** https://events.marine.copernicus.eu/marinedata4asia-2024/content/qgis

## E-Learning Materials

Access our tutorials online, accompanied by videos, code, and more.



### Practical Session Guidelines

This guide includes a few steps you will need to take to start your QGIS practice!

Guidelines

### STEP 1: download open-source software

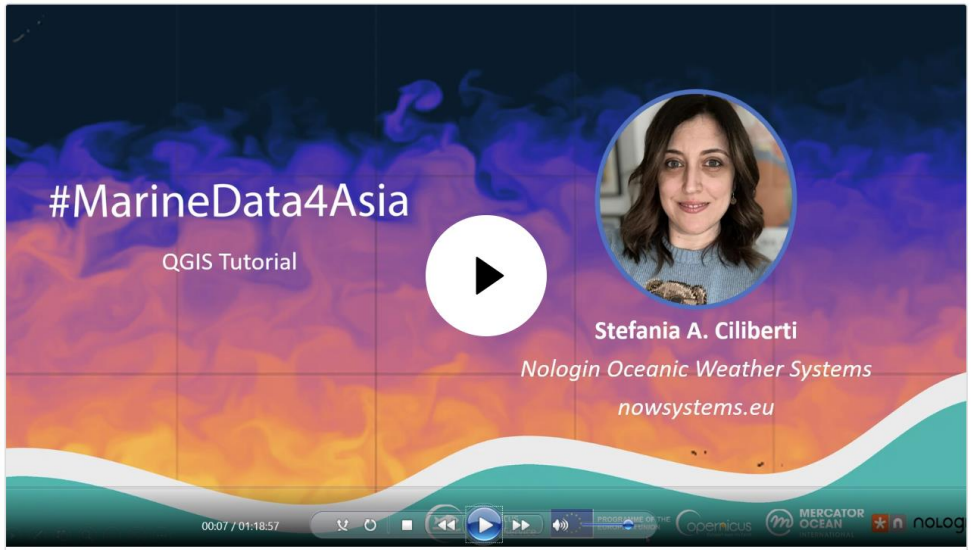
If you don't have access to a QGIS software yet, download the open-source software

Download

### STEP 2: Download Copernicus Marine QGIS Plugin

To open NetCDF files, which is the file format of Copernicus Marine Service products, in QGIS you will need to download the Copernicus Marine Service QGIS Plugin CMEMS-NetCDF

Plugin




### QGIS Tutorial

This video illustrates how to use QGIS functionalities for tracking and monitoring El Nino event occurred in 2023 in the tropical Pacific Ocean region and impacts in the Indian Ocean, using Global Ocean Products (both models and satellite observations). You can also download the PDF by clicking on the following button:

Download PDF

# Summary of the main outcomes

- QGIS offers capacity for **geospatial analysis of Copernicus Marine products**.
- Functions like ”Raster Calculator” and “Graphical Modeler” offer the possibility to **execute automatically numerical algorithms**:
  - Calculating SST anomalies over a given period.
  - Converting temperature from Kelvin to Celsius.
- It has been shown how to **extract raster values over an assigned shapefile** (polygon, points):
  - Extracting SST anomalies over Niño3.4 region.
  - Extracting EOV (i.e., temperature, salinity, mixed layer depth) over selected points.
- By creating an object “Grid” with given resolution, it is possible to perform **geospatial interpolation of EOV fields** in a selected region by using the extraction tools:
  - Bilinear interpolation of the SST daily mean from GLO-PHY and SST daily satellite observations in the Bay of Bengal.

# References uses in this presentation

- QGIS: https://docs.qgis.org/3.28/en/docs/index.html
- Copernicus Marine Service: https://marine.copernicus.eu/
- Copernicus Marine E-Learning Material: https://marine.copernicus.eu/services/user-learning-services/tutorials
- Copernicus Marine QGIS plugin installation: https://marine.copernicus.eu/services/user-learning-services/qgis-plugin-cmems-netcdf
- Copernicus Marine Toolbox: https://help.marine.copernicus.eu/en/collections/4060068-copernicus-marine-toolbox
- Copernicus Marine YouTube Channel: https://www.youtube.com/@copernicusmarineservice1453
- Copernicus Webinar - MarineData4Asia:
  - https://events.marine.copernicus.eu/marinedata4asia-2024#bl-7d0b3f5b-c3a6-4b40-8749-390d707a7040
  - https://marine.copernicus.eu/events/webinar-marine-data-4-asia
- CF Conventions: https://cfconventions.org/
- NetCDF: https://www.unidata.ucar.edu/software/netcdf

# #MarineData4Asia

QGIS detailed presentation

**Thank you all!**

Copernicus Marine Service

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