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CoAStal and marine waters integrated monitoring systems for ecosystems proteCtion AnD managemEnt

CASCADE

Project ID: 10255941

Priority Axis: Environment and cultural heritage

Specific objective: Improve the environmental quality conditions of the sea and coastal area by
use of sustainable and innovative technologies and approaches

D4.3.1

Information platform implemented and
available, with the contribution of relevant PPs

PP in charge: PP1 – CMCC

Final version

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Chapter 1 - Aims and content of the document

The aim of the 4.3.1 Deliverable is to describe the “data repository” and “web platform” components of the Cascade Information System, and its implementation.

The document is organized as follows:

- **chapter 2** gives a rough picture of the data repository architecture;
- **chapter 3** introduces ERDDAP, an open source data server, and describes how it has been leveraged to build the data repository, providing some additional implementation details;
- **chapter 4** provides the list of nodes composing the distributed data repository, and the most relevant datasets (modelling and observational);
- **chapter 5** is dedicated to the implementation phase of the CASCADE web platform, providing an overview of the key aspects, requirements, methodologies, and technologies used to bring this platform to life.
- **chapter 6** provides the data visualization features and components in CASCADE, emphasizing their role in empowering users to gain insights from the presented information.

Chapter 2 - The data repository

Since activities are performed in almost all the coastal regions of the Programme area (both on the Italian and the Croatian sides), an efficient access to datasets and a distributed approach has been considered.

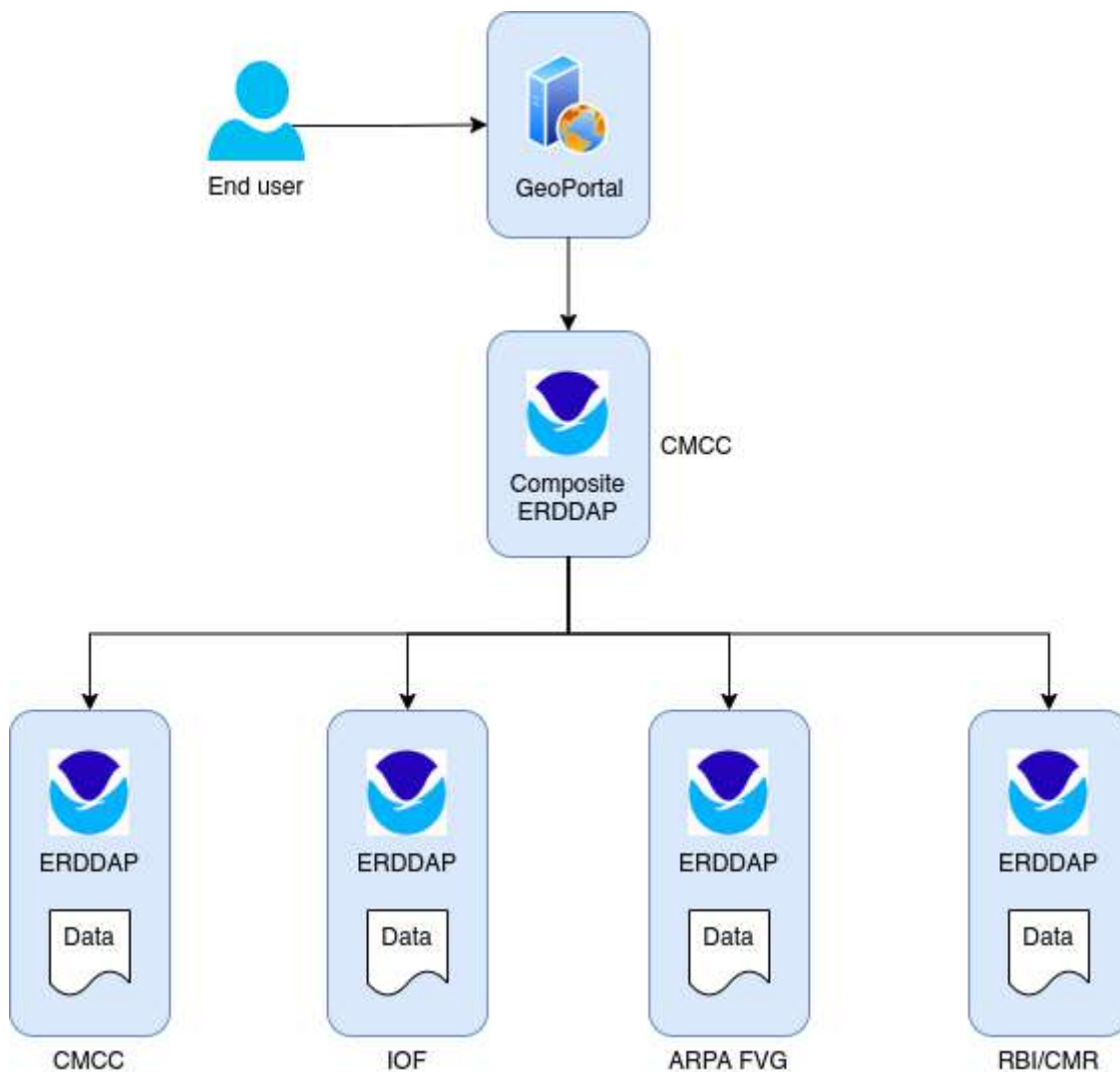
The architecture is based on a federated data management system, where nodes of data are held and controlled at a remote location. The principles of federation keep a single data source for each partner’s data and remove the need to keep multiple replicated sources synchronized.

Instead of a single partner hosting the sum total of the project output data (this generally would involve significant duplication of data and a significant monetary cost), the use of a federation of nodes, deployed at each partner data center, guarantees that each contributing organization maintains full control of their data while also contributing to the whole dataset, which is not dependent on any single partner to keep publicly available.

When a user searches for specific data on the GeoPortal, the latter interacts with a “central” node that only stores metadata, routing queries to remote nodes which actually contain the data.

As described in the next session, the architecture is based on ERDDAP, the tool used to store, visualize, and download the datasets.

The following diagram depicts a high-level architecture of the distributed data repository.



The way how to do that and some different scenarios are explained in the next chapter.

Chapter 3 - Implementation via-ERDDAP

What is ERDDAP

ERDDAP is a free and open-source data server written in Java and developed by NOAA that provides a simple, consistent way to visualize and download subsets of gridded and tabular scientific datasets in common file formats, acting as a “middleman” between the end users and the various - local and remote - data sources.

It supports temporal and spatial subsetting or, for tabular data, via other constraints.

A variety of data types can be distributed on ERDDAP: in situ, satellite, or model data among others.

The data can be downloaded in different formats (NetCDF, CSV, ESRIcsv, JSON, text and more).

ERDDAP also allows users to create customizable maps and graphs, and then to generate images in PNG format, transparent PNG, PDF and more.

ERDDAP is not only a web application, but also a RESTful web service: indeed, for every web page with a form, there is a corresponding ERDDAP web service that is designed to be easy for other applications to use. In this way, it can return user-interface results as a table of data in different - computer-program friendly - file types, the most common of which are:

- CSV;
- JSON;
- mat;
- NetCDF-3 binary;
- htmlTable (an HTML web page with the data in a table);
- Google Earth kml.

Additionally, ERDDAP is compatible with the current WMS 1.3.0 standard (GetCapabilities, GetMap - opaque, GetMap - transparent), and then it is able to provide a basic WMS service for each dataset configured.

It also offers RSS and email/URL subscriptions services.

In the following image, the “griddap” service is shown. It allows requests for a data subset, graph, or map from a gridded dataset (for example, sea surface temperature data from satellite), via a specially formed URL. It uses the OPeNDAP Data Access Protocol (DAP) and its projection constraints.

ERDDAP > griddap > Make A Graph

Dataset Title: **Cascade | NiN | Wave Height** 

Institution: UNIZG (Dataset ID: NiN_a53b_0a4f_28bd)

Information: [Summary](#) | [License](#) | [FGDC](#) | [ISO 19115](#) | [Metadata](#) | [Background](#) | [Data Access Form](#) | [Files](#)

Graph Type:

X Axis:

Y Axis:

Color:

Dimensions

time (UTC)

Start specify just 1 value --

Stop

latitude (degrees_north)

longitude (degrees_east)

Graph Settings

Color Bar:

Continuity:

Scale:

Minimum:

Maximum:

N Sections:

Draw land mask:

Y Axis Minimum:

Maximum:

Ascending

Redraw the Graph

(Please be patient. It may take a while to get the data.)

Optional:

Then set the File Type: (File Type information)

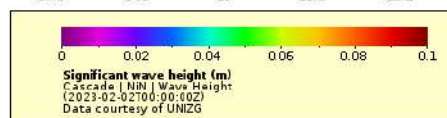
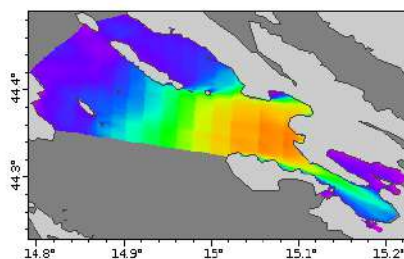
and [Download the Data or an Image](#)

or view the URL: https://erddap-cascade.cmcc-opa.eu/erddap/griddap/NiN_a53b_0a4f_28bd.html

([Documentation](#) | [Bypass this form](#))

Click on the map to specify a new center point.

Zoom:



In this case the dataset is related to the “Wave Height” variable, historical data of Miljašić Jaruga river mouth, Nin Bay (HR), coming from University of Zagreb.

Types of datasets in ERDDAP

There are two main categories of datasets in ERDDAP: EDDGrid datasets handle gridded data, and EDDTable datasets handle tabular data.

In EDDGrid datasets, data variables are multi-dimensional arrays of data (for example, for satellite data and model data).

There must be an axis variable for each dimension, and axis variables must be specified in the order that the data variables use them. All data variables must use all the axis variables. Each dimension must be in sorted order (ascending or descending) and can be irregularly spaced.

The main EDDGrid dataset types are:

- EDDGridFromAudioFiles, aggregating data from a group of local audio files;
- EDDGridFromDap, handling gridded data from DAP servers;
- EDDGridFromEDDTable lets you convert a tabular dataset into a gridded dataset;
- EDDGridFromErddap, handling gridded data from a remote ERDDAP;
- EDDGridFromNcFiles, aggregating data from a group of local NetCDF (v3 or v4) .nc and related files;
- EDDGridCopy can make a local copy of another EDDGrid's data and serves data from the local copy.

In EDDTable datasets, tabular data can be represented as a database-like table with rows and columns. Each column (a data variable) has a name, a set of attributes, and stores just one type of data. Each row has an observation (or group of related values). Examples of tabular data are in-situ buoy, station, and trajectory data.

The main EDDTable dataset types are:

- EDDTableFromAsciiFiles, aggregating data from comma-, tab-, semicolon-, or space-separated tabular ASCII data files;
- EDDTableFromAudioFiles, aggregating data from a group of local audio files;
- EDDTableFromAwsXmlFiles, aggregating data from a set of Automatic Weather Station (AWS) XML files;
- EDDTableFromCassandra, handling tabular data from one Cassandra table;
- EDDTableFromDatabase, handling tabular data from one database table;
- EDDTableFromEDDGrid lets you create an EDDTable dataset from an EDDGrid dataset;
- EDDTableFromErddap, handling tabular data from a remote ERDDAP;
- EDDTableFromHttpGet is ERDDAP's only system for data import as well as data export;
- EDDTableFromJsonIcsvFiles aggregates data from JSON Lines CSV files;
- EDDTableFromMultidimNcFiles aggregates data from NetCDF (v3 or v4) .nc files with several variables with shared dimensions;
- EDDTableAggregateRows can make an EDDTable dataset from a group of EDDTable datasets;
- EDDTableCopy can make a local copy of many types of EDDTable datasets and then re-serve the data quickly from the local copy.

ERDDAP federations

“ERDDAP federation” is the built-in feature used to set up the distributed data repository: in this way it is possible to avoid data duplication and to minimize costs, while each partner still manages its own data in its own data center.

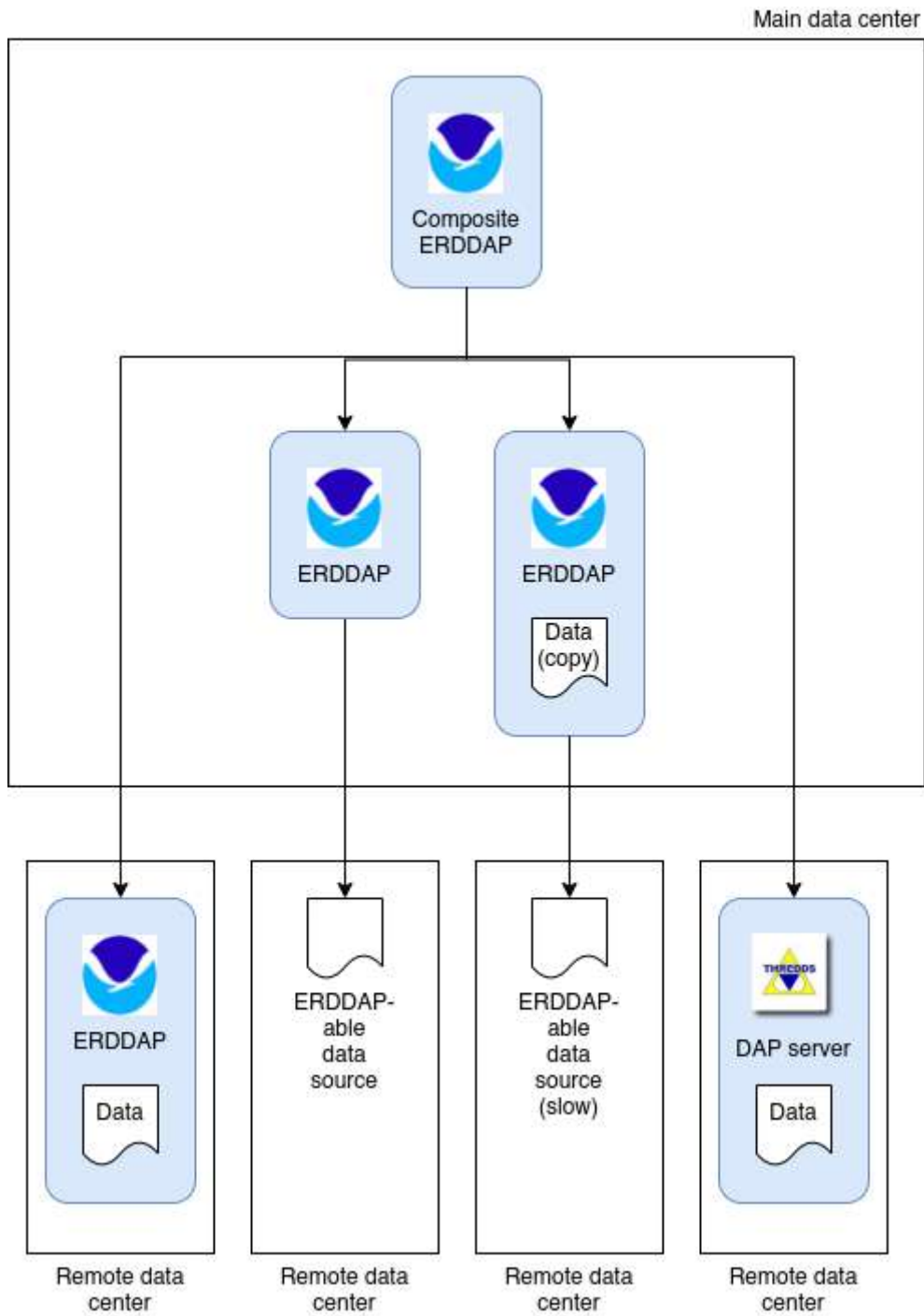
ERDDAP is designed to work well within a federation of “ERDDAPs”. Instead of moving all the datasets from different locations to a centralized data server, ERDDAP's design works with the world as it is: each data center which produces data can continue to maintain, curate, and serve their data, and yet, with ERDDAP, the data can also be instantly available from a centralized ERDDAP, without the need for transmitting the data to the centralized ERDDAP or storing duplicate copies of the data.

An ERDDAP federation therefore consists of the following components, some of them are optional:

- a centralized “composite” ERDDAP (in some cases more than one in high availability, for fault tolerance);
- remote ERDDAP/(Open)DAP servers;
- non-ERDDAP but “ERDDAP-able” remote data sources;
- slow ERDDAP-able remote data sources, for which a copy of the datasets is required.

The composite ERDDAP is a regular ERDDAP except that it just serves data from other ERDDAPs. When it receives a request for data, it redirects the data request to the remote ERDDAP server actually hosting that data. The redirect is transparent to the user regardless of the client software.

Remote ERDDAP and (Open)DAP servers can be directly connected to the central composite node through EDDGridFromErddap or EDDTableFromERDDAP dataset types. If the remote server is some other type of DAP server (THREDDS, Hyrax, or GrADS), it can be connected via-EDDGridFromDap dataset type.



An ERDDAP-able data source is a data source from which ERDDAP can read data. In this case, it is possible to set up another ERDDAP in the grid which is responsible for serving the data from this data source.

If the ERDDAP-able data source is delivered by a slow service or over a slow network, another ERDDAP can be deployed, storing a copy of the dataset through EDDGridCopy and/or EDDTableCopy dataset types.

Chapter 4 - Data repository nodes and datasets

Based on “ERDDAP federation” feature, the data repository network consists of the central composite node hosted on CMCC infrastructure, equipped as follows:

- Processors: 2 CPUs, 4 vCPUs
- Memory: 6GB RAM
- Storage: 16GB for operating system, the datasets are actually stored on remote nodes
- OS: Ubuntu 20.04 LTS
- ERDDAP v2.22, deployed as a Docker container

and the following remote nodes:

- CMCC (8 vCPUs, 14GB RAM, 512GB for ERDDAP data - the “bigParentDirectory” in ERDDAP terminology -, Ubuntu 20.04 LTS, ERDDAP v2.22 deployed as Docker container)
- IOF
- ARPA FVG
- RBI/CMR

Overall, the datasets provided and available via-ERDDAP are:

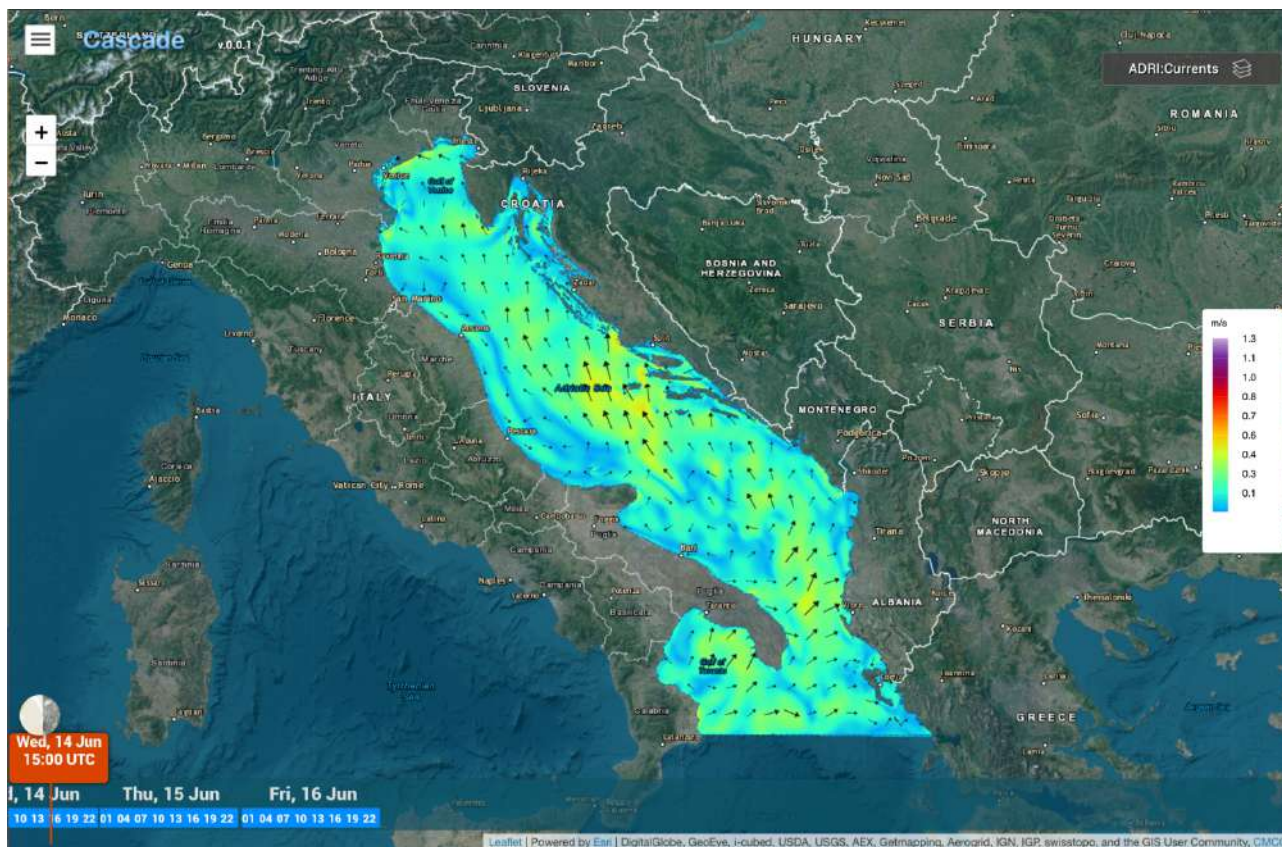
- EMODnet Physics - Arctic Sea Surface Temperature Climatology (1900-2014) - GridSeriesObservation - based on the SeaDataNet aggregated dataset
- EMODnet Physics - Atlantic Sea Surface Temperature Climatology (1900-2014) - GridSeriesObservation - based on the SeaDataNet aggregated dataset
- EMODnet Physics - Collection of (POTENTIAL_TEMP) TimeSeries Min/Max/Mean - MultiPointTimeSeriesObservation
- EMODnet Physics - Collection of (TEMP) TimeSeries Min/Max/Mean - MultiPointTimeSeriesObservation
- EMODnet Physics - Collection of (TEMP_DOXY) TimeSeries Min/Max/Mean - MultiPointTimeSeriesObservation
- EMODnet Physics - Collection of Sea Potential Temperature (POTENTIAL_TEMP) Profiles - MultiPointProfileObservation

- EMODnet Physics - Collection of Sea Potential Temperature (POTENTIAL_TEMP) TimeSeries - MultiPointTimeSeriesObservation
- EMODnet Physics - Collection of Sea Temperature (TEMP) Profiles - MultiPointProfileObservation
- EMODnet Physics - Collection of Sea Temperature (TEMP) Profiles from Argo/Profilers - MultiPointProfileObservation
- EMODnet Physics - Collection of Sea Temperature (TEMP) Profiles from Gliders - MultiPointProfileObservation
- EMODnet Physics - Collection of Sea Temperature (TEMP) Profiles from Mooring - MultiPointProfileObservation
- EMODnet Physics - Collection of Sea Temperature (TEMP) Profiles from XBT - MultiPointProfileObservation
- EMODnet Physics - Collection of Sea Temperature (TEMP) TimeSeries - MultiPointTimeSeriesObservation
- EMODnet Physics - Collection of Sea Temperature From Oxygen Sensor (TEMP_DOXY) Profiles - MultiPointProfileObservation
- EMODnet Physics - Collection of Sea Temperature From Oxygen Sensor (TEMP_DOXY) TimeSeries - MultiPointTimeSeriesObservation
- Mediterranean SST Analysis, L4, 1km daily
- Historical data of MiljašićJaruga river mouth, Nin bay (HR): Wave Direction, Wave Height, Wave Period
- Grado and Marano Lagoon, and Gulf of Trieste (ARPA FVG)
- Sacca di Goro (ARPAE): Currents, Currents Vector, Salinity, Sea Surface Height, Temperature
- Tegnùe di Chioggia (IUAV)
- Adriatic Hydrodynamics and Wave modelling output (AdriFS, CMCC)
- Apulia Region High resolution Hydrodynamics modelling output for Adriatic Sea (SOAP, CMCC)
- Mediterranean Hydrodynamics modelling output (MedFS, CMCC)
- In-situ buoy for Torre Guaceto area (CMCC)

Chapter 5 - Implementation of Web platform

Introduction

This chapter focuses on the implementation phase of the web platform for CASCADE, outlining the key aspects, requirements, methodologies, and technologies employed to bring this platform to life. The web platform of CASCADE is a comprehensive system that aims to facilitate the visualization of diverse observations and forecasting model products with data contribution provided by all relevant project partners. The web platform demonstrates the integration and assessment of monitoring (observations and models) components information for each model. By offering a centralized platform for data sharing and collaborative analysis, the web platform enhances the understanding and utilization of these valuable scientific resources. The web application is available at the following url: <https://cascade.cmcc-opa.eu>. It was presented to users in the framework of 1st Workshop on Observing and Predicting the Global Coastal Ocean of UN Decade Programme PredictOnTime, held on 11-13 May at the CMCC headquarters in Lecce, Italy.



Cascade webapp at landing time

Technology

The implementation of the web platform for CASCADE relied on a combination of technologies to ensure a robust and efficient solution. This section provides an overview of the key technologies utilized, including **Ionic, Node.js, and JavaScript**.

Ionic offers a cross-platform development approach, enabling the creation of mobile-friendly and responsive web applications using web technologies such as HTML, CSS, and JavaScript. The use of Ionic allowed for a consistent user experience across multiple devices and operating systems.

Then for the backend, we use Node Js that facilitates efficient data processing, integration with external APIs, and seamless communication between the client and server components of the web platform.

Additionally, the web platform leveraged a range of supporting technologies and tools, including but not limited to

- *Data repository* - ERDDAP and MapServer are the data repositories from where the web portal gets the data which is processed to be displayed in the map.
- *RESTful API's* - To facilitate communication between the web platform and data sources
- *Data Visualization Libraries* - JavaScript-based data visualization libraries, such as Chart.js, Leaflet.js, were integrated to create interactive and visually compelling charts, graphs, and map layers within the CASCADE web platform.
- *Version Control System* - A version control system like Git was utilized to ensure collaboration, code management, and easy deployment of updates to the web platform.

User Interface Design

The CASCADE web platform adopted a clean and minimalist design to focus the user's attention on the core components. The layout consisted of a map as the central element, occupying a significant portion of the screen, accompanied by a left menu and a right menu. The layout ensured that users could easily interact with the map and access additional functionality through the menus.

- *Map* - The map served as the central element of the user interface, providing a visual representation of the data layers. It allowed users to explore patterns and relationships by zooming, panning, and interacting with map markers. On clicking over the map the user could see the charts representing the statistics of the data at the clicked coordinates.
- *Left Menu* - The left menu provided users with access to different models coming from different partners of projects. It allowed users to navigate and select specific layers of interest, focusing on a particular model or data source.
- *Right Menu* - The right menu complemented the left menu by providing additional functionality that was dependent on the selection made in the left menu. The content of the right menu dynamically updated based on the user's selection, providing relevant options, filters, or settings specific to the chosen data layer.

- *Time Series* - The bottom of the page featured a time series component, allowing users to visualize temporal trends or variations in the data. The slider component provided a compact representation of data over time, offering users insights into temporal patterns and facilitating comparisons across different time intervals. Its placement at the bottom of the page ensured it was easily accessible while not obstructing the main map view.
- *Colour Palette* - The CASCADE web platform employs a well-defined and consistent colour palette to represent different data attributes or categories. This enabled users to interpret the displayed data more effectively and make informed observations.

The user interface design of the CASCADE web platform aimed to provide users with a seamless and intuitive experience for visualizing and exploring data. By employing a basic design with a map, left menu, right menu, timeseries, and a colour palette, the user interface promoted efficient data navigation, layer selection, and analysis.

Data Integration and Management

The integration and management of data within the CASCADE web platform presented two types of data sources: **modeling** data for forecasting and **observation** data from satellites and buoys. This section discusses the strategies and challenges encountered during the processing and standardization of these diverse data formats.

- *Data Sources and Formats* - The modeling forecasting data were obtained from various project partners. Each partner might have utilized different data formats, structures, and conventions for their datasets. The datasets were provided in the following formats: netcdf, csv, geotiff, etc.
- *Data Acquisition and Preprocessing* - This involved retrieving data from the project partners' sources through APIs, FTP, or other means. The acquired data underwent post processing steps (if required) such as data cleaning, filtering, and transformation to ensure consistency and compatibility with the platform's requirements. The processed data was then finally uploaded to ERDDAP.
- *Standardization and Harmonization* - Standardizing the data from different sources was a significant challenge. Each project partner might have used their own data standards, variable names, or coordinate systems. To address this, a data standardization and harmonization process was implemented. This involved mapping and aligning the data attributes, units, and metadata to a common format or schema. Tools and techniques like data mapping tables, transformation scripts, or data conversion libraries were utilized to achieve consistency and interoperability.

Deployment

The front-end of the CASCADE web platform, developed using the Ionic framework, was deployed on an Ionic server. The Ionic server facilitated the hosting and serving of the web application's user

interface to the end-users. It handled the delivery of static assets, including HTML, CSS, and JavaScript files, enabling users to access and interact with the platform through their web browsers.

The back-end of the CASCADE web platform, built using Node.js, was deployed on VMs to handle server-side operations and manage data processing tasks. Node.js provided a scalable, event-driven architecture, allowing for efficient handling of concurrent requests and real-time data updates. The deployment of Node.js on VMs ensured optimal performance and resource allocation for the back-end components of the web platform.

The deployment of the CASCADE web platform on VMs provided a reliable infrastructure for hosting and delivering the application to end-users. By leveraging the Ionic server and Node.js on the VMs of CMCC, the platform's front-end and back-end components were efficiently deployed, enabling users to access and utilize the functionality of the web platform.

Version History

The version history of the CASCADE web platform encompasses the updates and changes made to the application over time. Significant updates and modifications were implemented, primarily focusing on the data side, specifically the WMS layers, and the introduction of the left and right menu connection. This section provides an overview of the main changes introduced in each version.

Version 0.0.1: Initial Release

The initial release of the CASCADE web platform, marked as version 0.0.1, laid the foundation for the subsequent developments. The key features and functionalities included:

- *Map Visualization* - The platform provided a map interface for visualizing the available data layers, allowing users to explore and interact with the spatial data.
- *WMS Layers* - The initial version included a selection of WMS layers, providing access to modeling data for forecasting and observation data from satellites and buoys.

Version 1.0.0 (Data-side Updates): Connection between Left and Right Menu

Version 1.0.0 witnessed significant updates on the data side and the introduction of a connection between the left and right menu. The key changes incorporated were:

- *Left Menu Introduction* - The left menu was introduced to enhance user navigation and data selection capabilities. Users could now browse and choose from different categories or groups of data layers.
- *Right Menu Enhancement* - The right menu was modified to dynamically update based on the selection made in the left menu. This connection between the left and right menu allowed users to access layer-specific options, filters, or settings relevant to their selected data layer.

- *WMS Layer Updates* - The available WMS layers were expanded and updated to include new datasets, additional variables, or refined data sources. These updates provided users with an extended range of modeling data and observation data to explore and visualize
- *Bug Fixes and Performance Enhancements* - The version update also included bug fixes and performance enhancements, addressing any reported issues and optimizing the overall user experience.

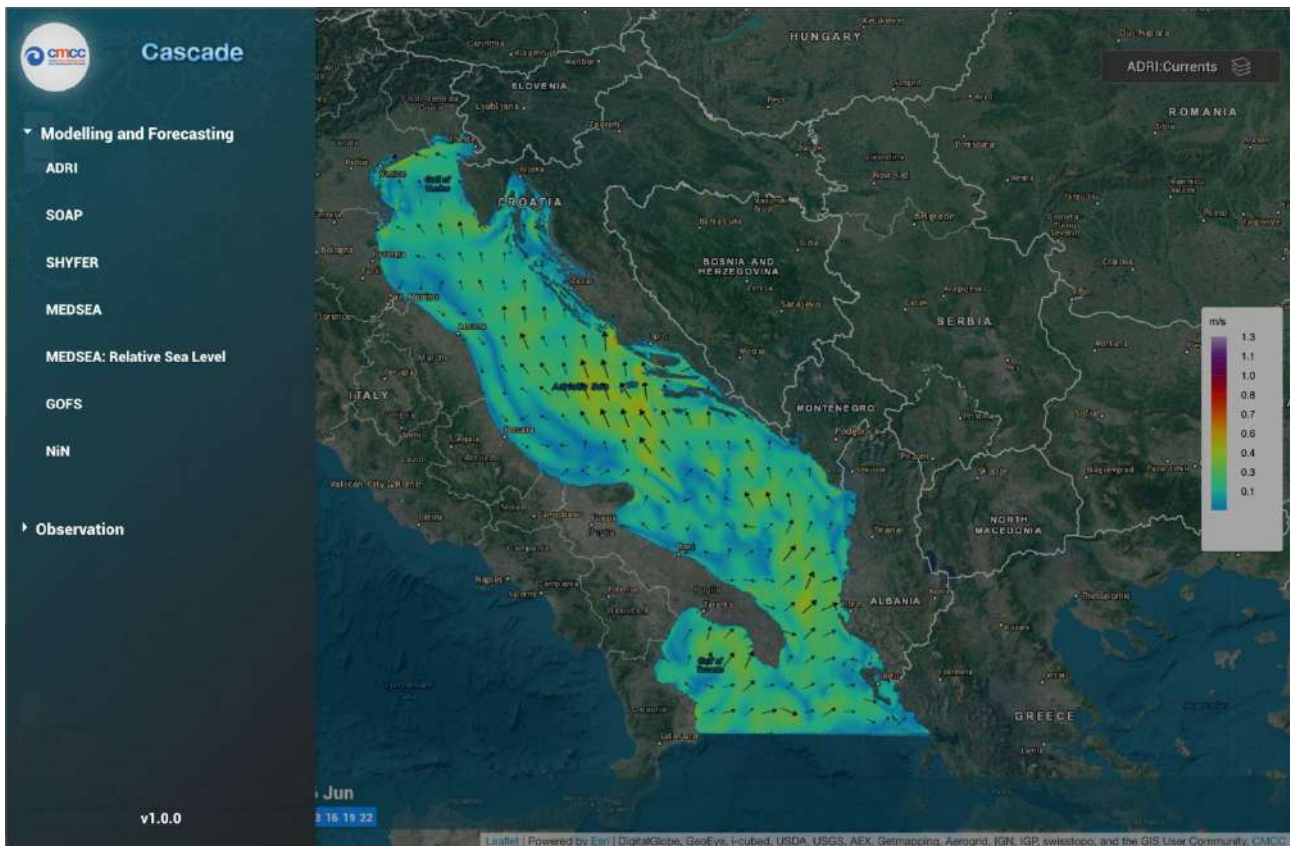
Chapter 6 - Data visualization

Introduction

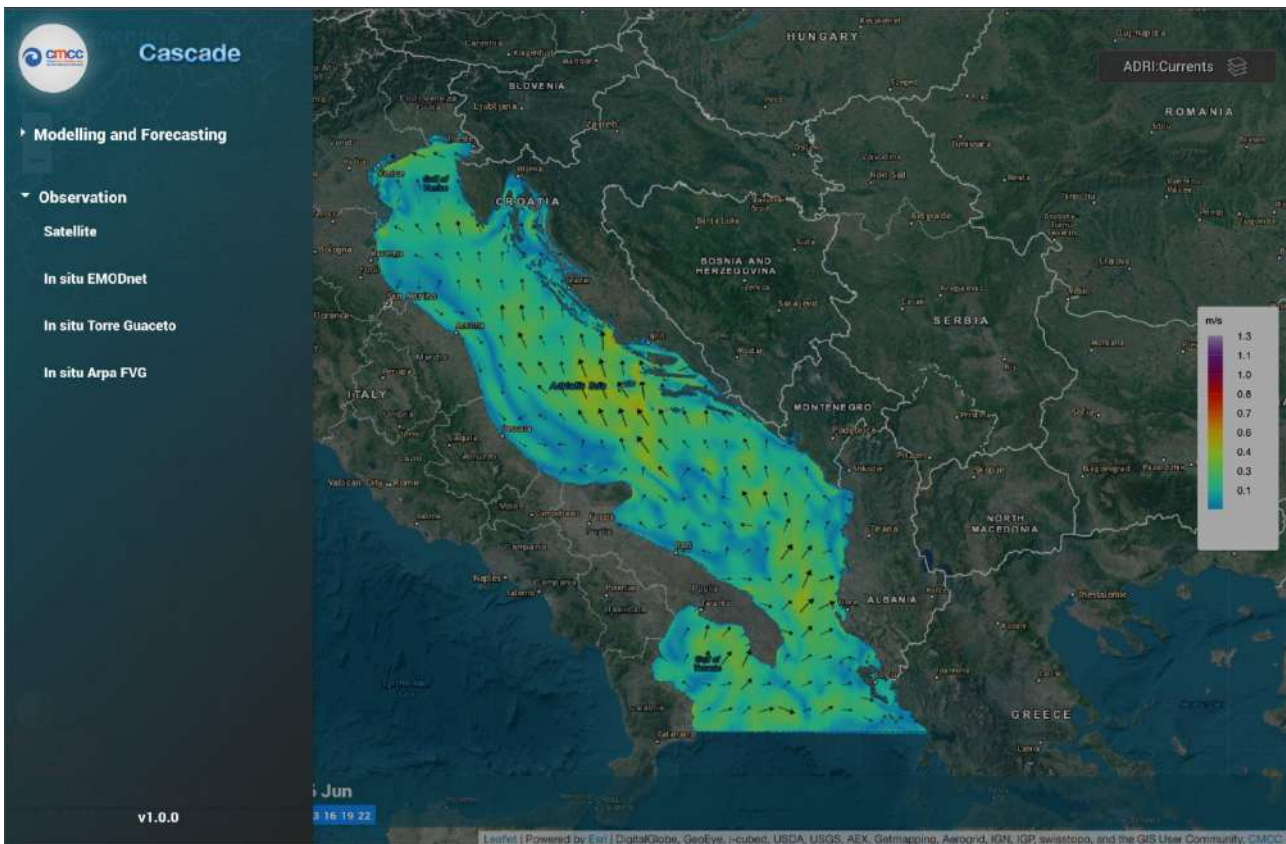
The data visualization capabilities of the CASCADE web platform enable users to explore and analyse a wide range of spatial and temporal data. This section introduces the data visualization features and components within CASCADE, highlighting the key elements that empower users to gain insights from the displayed information.

- *WMS Layers on the Map* - The CASCADE web platform incorporates various Web Map Service (WMS) layers, which are dynamically displayed on the map interface. These layers represent different types of data, including modeling data for forecasting and observation data obtained from satellites and buoys. By visualizing these layers on the map, users can gain a comprehensive understanding of the spatial distribution and patterns of the displayed data.
- *Interactive Charts on Map Click* - The map interface allows users to interact with the displayed data. When users click on specific locations on the map, interactive charts are generated, providing detailed insights into the selected data point. This interactive feature enables users to explore data at a granular level and extract valuable information through visual representations.
- *Left Menu for Model and Observation Selection* - The left menu in the CASCADE web platform represents the available forecasting models from project partners and observation data collected from satellites and buoys. Users can utilize the left menu to select specific models or observations of interest. This selection narrows down the displayed data, focusing on the chosen modeling outputs or observational datasets.
- *Right Menu for Variable and Environment Selection* - Upon selecting a model or observation from the left menu, the right menu dynamically updates to present the available variables or environmental fields associated with the chosen model or observation. Users can customize their data exploration by selecting specific variables such as current, temperature, salinity, and more.
- *Timeline at the Bottom* - The CASCADE web platform incorporates a timeline component positioned at the bottom of the interface. This feature allows users to observe and analyse temporal changes in the displayed data. By interacting with the timeseries, users can explore how various data attributes evolve over time, identifying trends, patterns, or anomalies that may be crucial for their analysis.

- *Colour Palette as a Legend* - To aid data interpretation, CASCADE employs a colour palette as a legend. The colour palette corresponds to the different values or categories represented in the WMS layers displayed on the map. This visual representation enhances the understanding of data attributes by associating specific colours with corresponding values, making it easier for users to interpret the displayed information accurately.



Left menu, “Modelling and Forecasting” products



Left Menu, “Observation” products

Mapping Technologies

The key mapping technologies and tools employed in CASCADE are:

Leaflet: Leaflet is a popular open-source JavaScript library used for interactive web mapping. It provides a lightweight and versatile platform for displaying maps, markers, layers, and other spatial elements on the web. Leaflet offers a user-friendly interface, supports various tile providers, and allows for customization and interactivity. Its integration within CASCADE enables the rendering and manipulation of maps, enhancing the overall user experience.

Web Map Service (WMS): The Web Map Service (WMS) is a standard protocol that enables the retrieval and portrayal of map layers over the internet. It allows users to access and visualize geospatial data from different sources. In the context of CASCADE, WMS is utilized to retrieve and display the modeling data for forecasting and observation data from satellites and buoys. WMS layers are dynamically added to the map, providing users with an interactive and comprehensive view of the spatial information.

Layering and Styling

WMS layers, representing different types of data such as modeling outputs and observation data, are visualized on the map with distinct colours. Colour selection is typically based on the nature of the data and its intended interpretation. The use of colours helps to differentiate and highlight various spatial patterns or attributes present in the data, enabling users to visually analyse and understand the information at a glance. In certain cases, data layers within CASCADE may involve directional information, such as ocean currents. To represent these directions effectively, arrows can be used as visual indicators. The direction of the arrow indicates the flow or movement. When representing data layers involving magnitudes, such as current velocity, the size of the arrows can be utilized to convey the magnitude information. Larger arrows correspond to higher magnitudes, indicating stronger currents.

The colour palette used to represent data layers in CASCADE is often dynamically calculated based on the minimum and maximum values of the dataset being visualized. This dynamic range ensures that the colour representation is optimized and scaled appropriately to the data, taking into account the full range of values present. By dynamically adjusting the colour palette, users can observe subtle variations and detect extremes in the data, enhancing their ability to interpret and analyse the information effectively.

The use of distinct colours for WMS layers, the utilization of arrows to represent direction, sizing of arrows to reflect magnitude, and the dynamic range of the colour palette, contributes to the comprehensive and visually informative representation of spatial data within the CASCADE web platform. These techniques aid in effectively conveying complex spatial information, empowering users to gain meaningful insights and make informed decisions based on the displayed data.

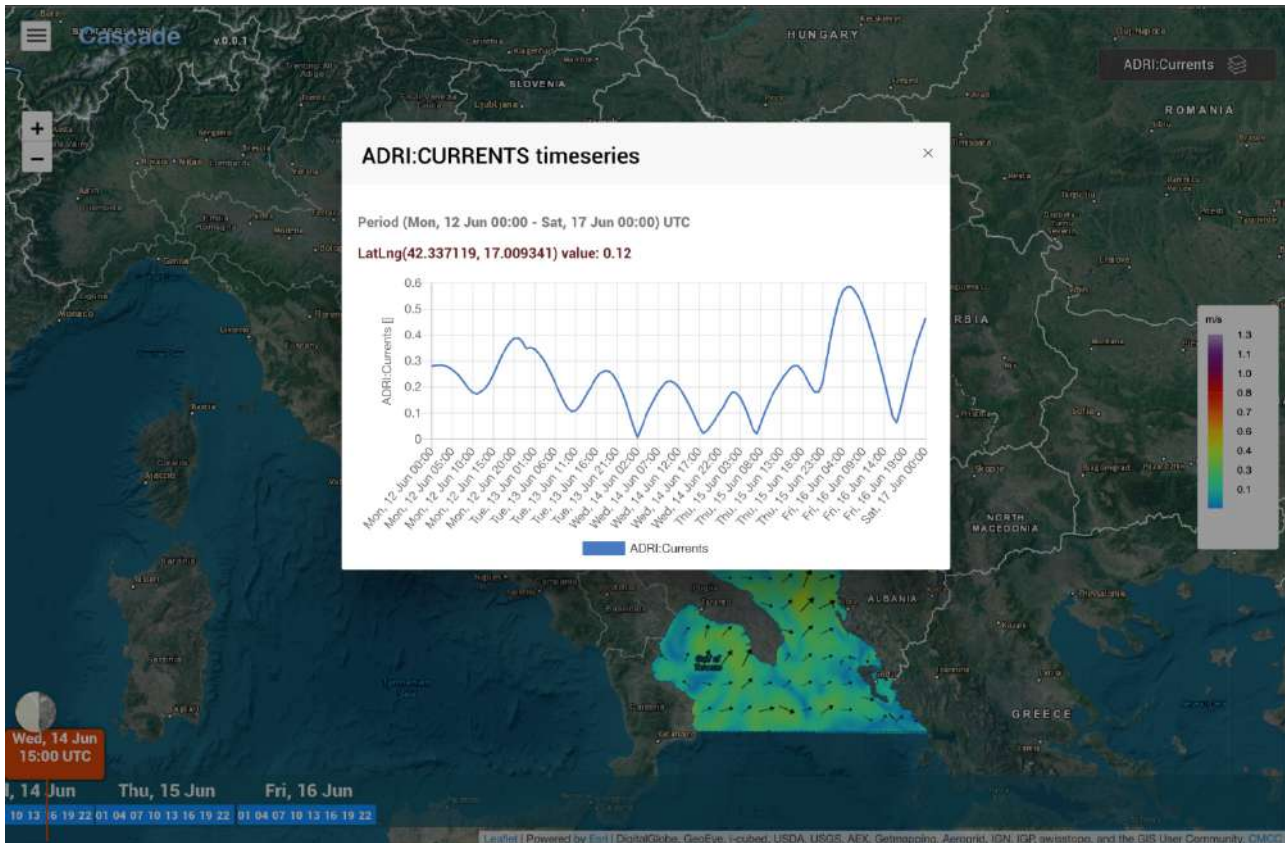
Interactivity and User Controls

The platform incorporates various interactive features and user controls to facilitate data exploration and analysis.

The *menu* within CASCADE allows users to select different models or observations and variables/environment fields respectively. Upon selection, the layers displayed on the map dynamically update to reflect the chosen model or observation. This interactive feature enables users to switch between different datasets or scenarios, facilitating comparative analysis and exploration of the available data. By default, the top choice in both the left and right menus is selected when users first access the CASCADE web platform. This default selection provides users with an initial dataset to explore. However, they have the flexibility to change their selections based on their specific interests and requirements.

When users click on a specific location on the map, interactive *charts* are generated, providing detailed insights into the selected data point. These charts may display additional information related to the clicked location, such as variable values, trends, or comparisons. This feature enables users to perform in-depth analysis and examine specific data attributes associated with the chosen

location. To enhance the clarity and understanding of the displayed charts, tooltips are implemented. These tooltips provide additional information when users hover over specific data points or elements within the chart.



Example of timeseries

It also incorporates a *time controller* component positioned at the bottom of the interface. This time controller is represented as a slider that users can interact with. The slider displays time information, allowing users to select a specific time or range of time to observe the corresponding data changes. By adjusting the slider, users can analyse the temporal evolution of the data and gain insights into trends, patterns, or anomalies over time. automatically selects the nearest available time to the current date as the default. This default selection provides users with the most recent data for modeling scenarios or historical observations.

Chapter 7 - Conclusions

The main aspect of Cascade portal lies in its pioneering approach as the first platform that seamlessly integrates and visualizes data from multiple sources. By offering a consolidated and comprehensive view of different datasets, it provides a new tool to the users that can access,

analyse, and gain insights from such information. This innovative solution eliminates the need for users to navigate through multiple platforms or manually consolidate data, providing an efficient experience for exploring and harnessing the collective information of disparate datasets.