



## **Project of Strategic Interest NEXTDATA**

### **Deliverable D2.2.4**

## **Design and implementation of the alpha and beta archive reanalysis with comprehensive viewing and catalogue service**

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## Executive summary

The NextData Reconstruction-Reanalysis (RR) Geoportal has been constructed and implemented on the INGV server. The Geoportal is an example of an INSPIRE compliant service for spatial data sets search, view and download.

## 1. Introduction

During the third year, WP2.2 activity focused on the completion of the NextData-INGV Geoportal to discover and visualize the Reconstruction-Reanalyses (hereafter RR) data for the Mediterranean Sea covering the period from 1955 to 2012.

After the definition of user requirements for the Geoportal and the software selection, the three Geoportal components (Data, Presentation and Application layers) were implemented and tests were performed to verify that all the components are working and fully integrated.

## 2. Geoportal structure

Following the user requirements and the indications given by the Project (see D2.2.3), each layer has been developed using open source software or software delivered under GPL Licence.

### 2.1 Data Layer

The Data layer contains the RR outputs. All data are available in netCDF format and are provided from Thredds Data Server (TDS). The TDS catalog describes the inventory of the datasets: this catalog allows a simple hierarchical structure for specific collection of datasets with a human understandable name and a simple access procedure.

The TDS provides two services:

- An OpenDAP service, for external users who can download directly.
- A Web Map Service (WMS) service, which is published for external users and is used by NextData webportal to implement the viewing service.

The available datasets are organized in catalog trees as follow:

```
<NextData Catalog/>
  <NextData_RR/>
    <daily Dataset/> ----- <dataset ssh>
                                ----- <dataset sal>
                                ----- <dataset cur>
                                ----- <dataset tem>

    <hourly Dataset/> ----- <dataset sal>
                                ----- <dataset tem>
                                ----- <dataset cur>
                                ----- <dataset wflux>
                                ----- <dataset hflux>
                                ----- <dataset mflux>

  <MyOcean_NextData_Reanalysis/>
    <monthly Dataset/> ----- <dataset ssh>
                                ----- <dataset sal>
                                ----- <dataset cur>
```

----- <dataset tem>

----- <dataset flx>

Each level of a catalog tree is described in a dataset element in which the lower levels are embedded (as dataset element as well).

## 2.2 Presentation Layer

The Presentation layer contains the general contents of the Project portal and the link to the Application. In order to develop the Presentation layer, a Content Management System has been implemented to facilitate the update of the portal contents and the links of the needed applications. The chosen CMS is WordPress, which has the advantage to be free.

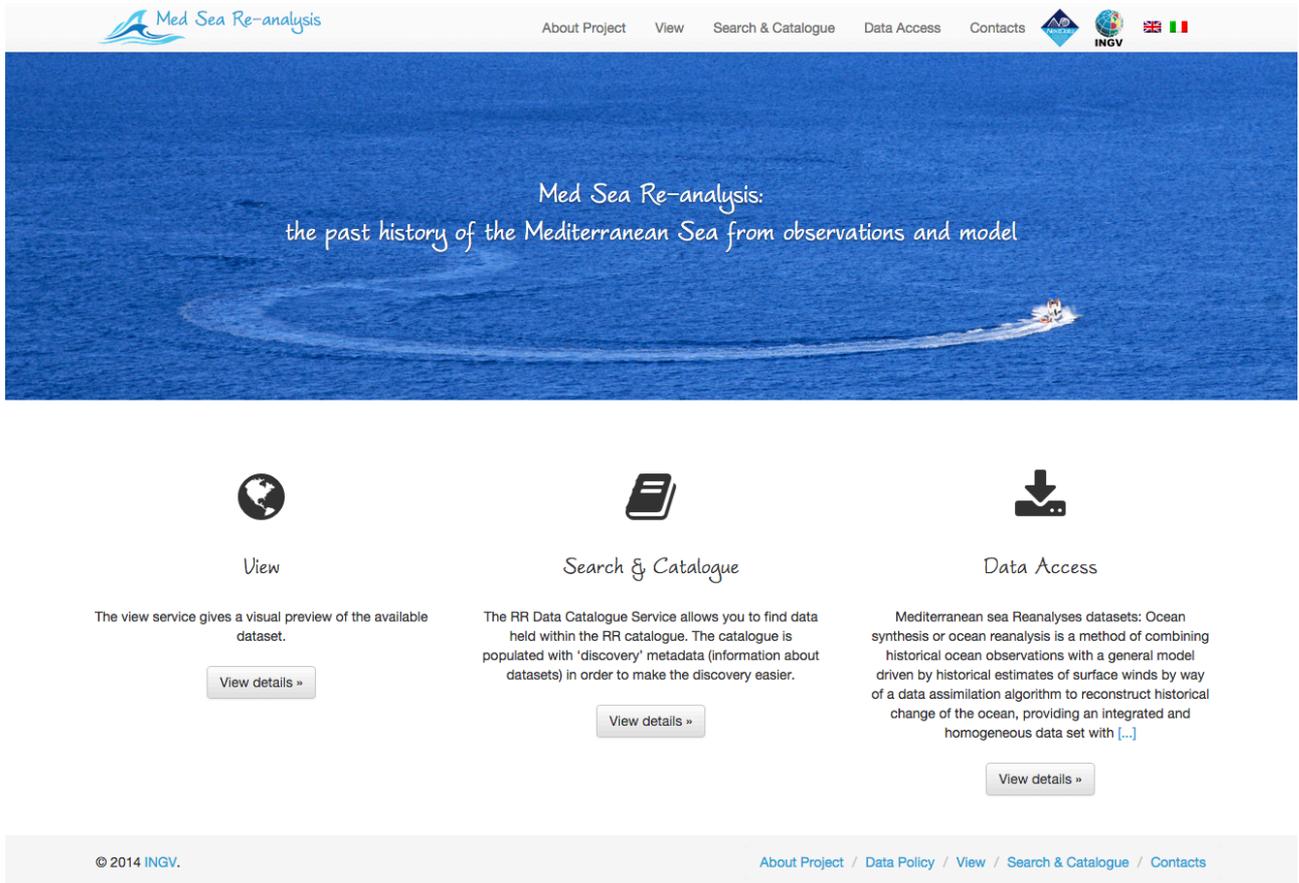
A new logo has been designed for the portal (Fig.).



**Fig.1. The Med Sea reanalysis logo.**

WordPress has a web template system using a template processor (Theme). The Theme of the graphic layout has been developed accordingly to the Portal logo. The layout is structured as follows (Fig. 2):

- the header: this includes Portal logo, Main Menu, supporting organization and the language switcher (Italian-English);
- the photo banner: an image of the sea landscape has been inserted and the Portal title is visible above the image;
- main text area: shows the links to the Applications: view, search & catalog and data access;
- footer: this includes copyrights, Data Policy and the replication of the main menu.



**Fig. 2. Web Portal Layout.**

The layout changes in the different pages:

- About page: the header, the content of the page and the footer are visible (Fig. 3);
- All the Application: the header, the content of the page and the footer are visible.

## About Project

Nextdata project aims to foster the implementation of measurements networks and the creation of a national system for the retrieval, storage, access and diffusion of environmental and climate data from mountain and marine remote areas, which can be easily used by both researchers and public and private users, including the manufacturing and commercial sectors. Access to quantitative information on remote regions, both mountain and marine, is crucial in order to understanding the climate and its changes.

### Funded by

- Ministry of Education, University and Research (MIUR)

Duration 3 years from 02/01/2012 to 31/12/2015

### Coordinating organization

- Department of Earth System Science and Environmental Technologies, National Research Council of Italy

### INGV Role

- Leader of Work Package 1.3 e 2.2

## INGV Activities

The Operational Group for Oceanography of the INGV is leader of two work packages:

- WP1.3 : Marine observation systems and climate reconstructions
- WP2.2 : Archive of marine observations networks and climate reconstructions

Time series for reanalysis and reconstructions are currently required by different research and institutional users (research institutions, ENI, NATO, meteorological centres, regional environmental agencies, etc.) and private companies (environmental consultancies, coastal engineering, and maritime transport companies, etc.) for the management of the marine environment, risk assessment and sustainable exploitation of marine resources.

In order to reconstruct the climate signal from all existing in situ and satellite measurements, recent years have seen the development of reanalysis techniques, which optimally combine models and observations.

The result is a climate reconstruction for the recent past, reflecting the best of existing scientific and technological knowledge and offer a continuous time series.

Historical marine data for the Mediterranean Sea over the past hundred years are available in European databases, continuously updated by EU member countries, thanks to infrastructural projects such as SeaDataNet, EMODNET and GMES-MyOcean.

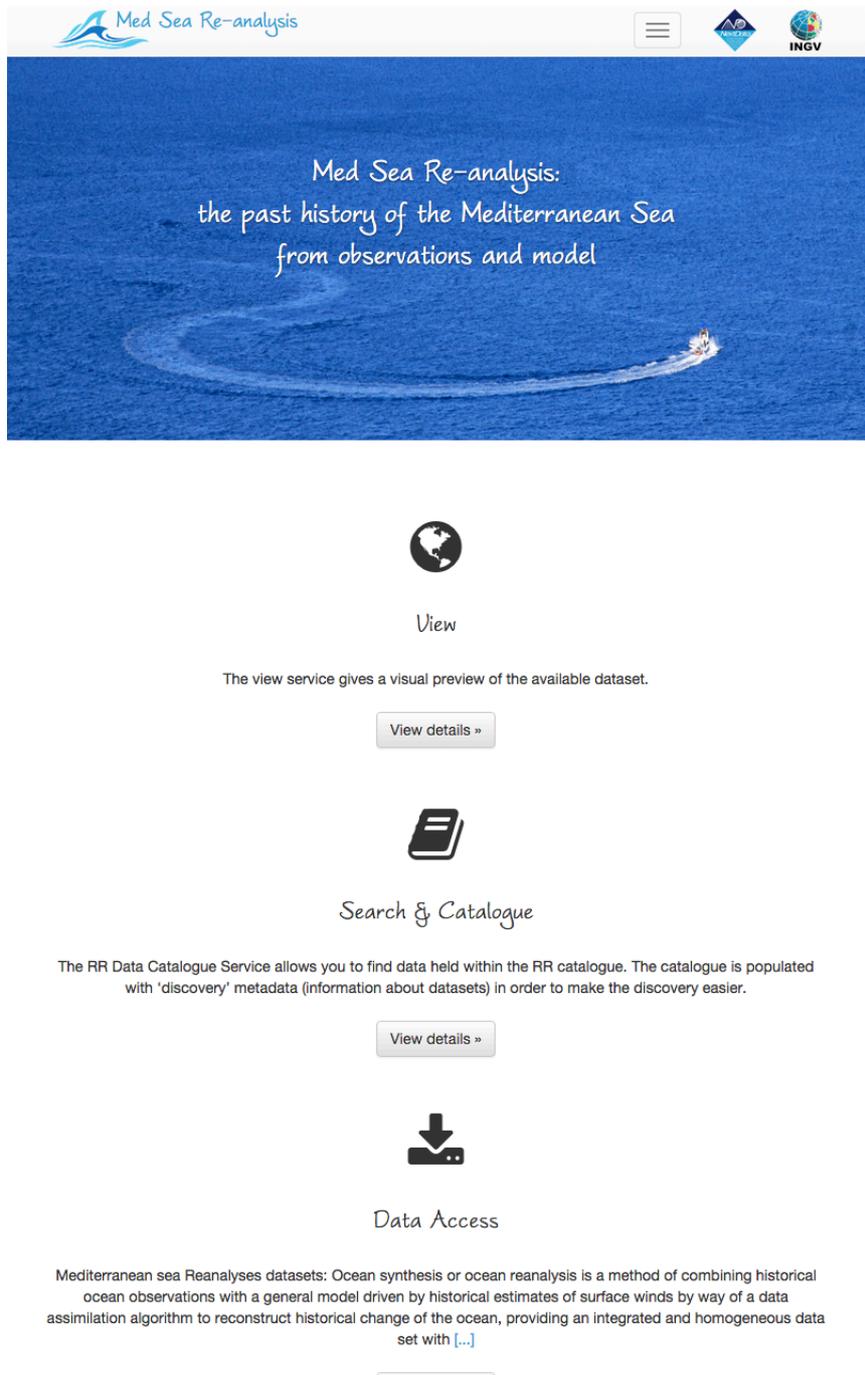
What it is missing, however, is a reanalysis of these data in order to produce a complete map and high-resolution spatial and temporal climate variability in the Mediterranean.

The Operational Group for Oceanography of the INGV, on the basis of past experience in the development of first prototypes of reanalysis for the past twenty years, aims to study the feasibility of and realize the first high-resolution time-space climate reconstruction of the Mediterranean Sea for the past 60 years. At the same time it aims to realize a computer system that makes it available to the scientific community and institutional, as well as to private.



**Fig. 3: About page layout.**

The layout of the portal is responsive: this means that the portal provides an optimal viewing experience easy reading and navigation with a minimum of resizing, panning and scrolling-across a wide range of device (from mobile phones to desktop computer monitors) (Fig. 4). A site designed with RWD adapts the layout to the viewing environment by using fluid, proportion-based grids, flexible images and CSS3 media queries.



**Fig. 4. Resize of Web Portal page.**

The Web Portal structure is organized as follows:

- Home.
- About: the description of the Project.
- View.
- Search & Catalogue.
- Contacts: an email form to the Project contact (Fig. 5).
- Data Policy: The Data policy page shows the data policy for NextData-INGV data and the text has been taken from NextData website.

## Contacts

Your Name (required)

Your Email (required)

Subject

Your Message

Avoid antispam

1+1=?

Send

© 2014 INGV.

[About Project](#) / [Data Policy](#) / [View](#) / [Search & Catalogue](#) / [Contacts](#)

**Fig. 5. Contact page.**

The portal is available in two languages: Italian and English. The switching between the two languages can be done clicking on the flags in the main menu.

## 2.3 Application Layer

The Application Layer contains the Visualization, Discovery and Download services and the links to the Presentation Layer.

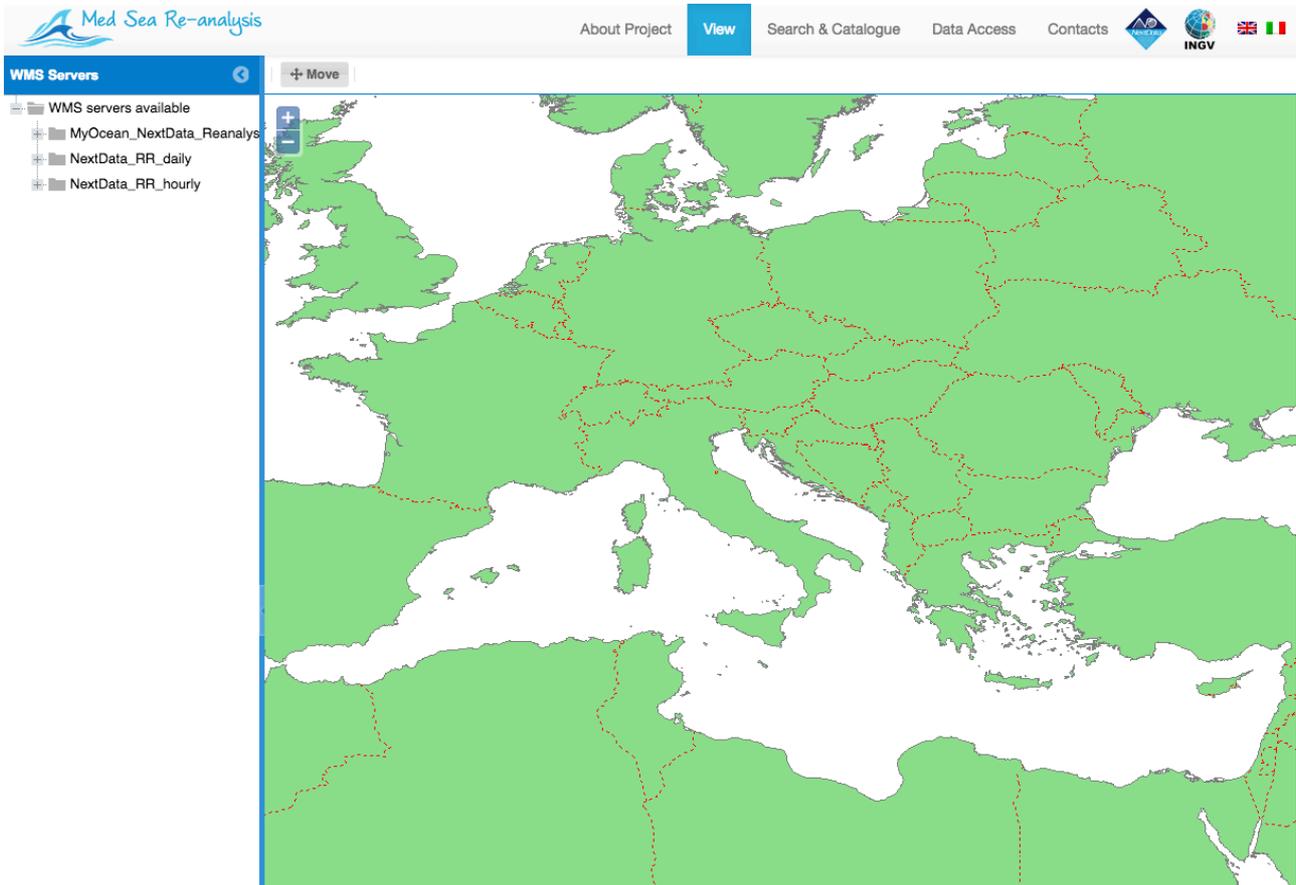
The Application Layer consists in three different parts:

- Viewing Service
- Search and Catalogue Service
- Data Access Service.

### 2.3.1 Viewing Service

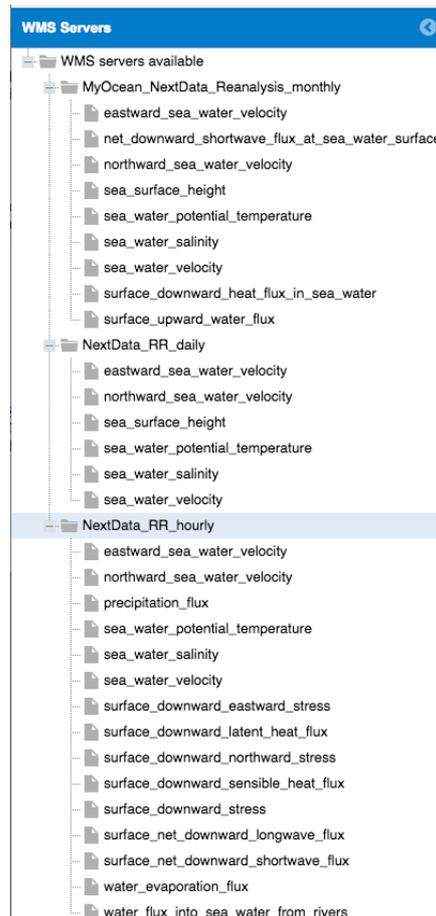
The Viewing Service is reachable clicking on the “View” link from the home page of the Portal at the following link: [http://medsearr.bo.ingv.it/?page\\_id=34](http://medsearr.bo.ingv.it/?page_id=34). (Fig. 6).

The View layout is composed by a left menu to select the data to be visualized and a right part to visualize the map of the Mediterranean Sea and plot the selected data.



**Fig. 6. View Service layout.**

The left menu lists the datasets available through the Data Layer (Fig. 7):



**Fig. 7. List of available datasets.**

Clicking on each dataset the list of the available variables is visualized.

Clicking on each variable name the View Service, which is based on WMS service, plots the image of the left area.

The Visualization Service includes several tools:

1. Selection tools to choose:
  - Year
  - Month
  - Day
  - Hours (if any)
2. Palette configuration (Palette Manager): it is possible to change styles, number of colours, scale range and opacity of each plotted map.
3. The default map results (the most recent date among the available).
4. The palette related to the current map.

Maps are zoomable and interactive.

### 2.3.2 Search and Catalogue Service

The Search and Catalogue Service allows the users to find the data following search criteria. It is reachable clicking on “Search and Catalogue” link from the home page of the Portal at the following link [http://medsearr.bo.ingv.it/?page\\_id=26](http://medsearr.bo.ingv.it/?page_id=26).

The interface shows the search parameter box on the left side of the page while the results of the queries are shown in the right part. The search can be done as free search or choosing variable, date range, coordinates or selecting on the map (Fig. 8). The search is performed on a list of xml files INSPIRE compliant. Each xml contains the full description of the catalogue.

**Search params**

Search:

Variables: precipitation\_flux

▲ Date Range

Start:

End:

Reset

▲ Coordinates

Nord: 47

East: 37

South: 30

West: -8

**Catalog Items**

**Mediterranean Sea Reconstruction-Reanalysis**

○ From: 1955-01-01 To: 2012-12-31

■ precipitation\_flux, water\_flux\_into\_sea\_water\_from\_rivers, water\_evaporation\_flux

▼ 45.9375, -6, 30.1875, 36.25

**Short description:**

The Mediterranean Sea Reconstruction-Reanalysis is a first high-resolution time-space climate reconstruction of the Mediterranean Sea for the past sixty years. The hydrodynamics are supplied by the Nucleos for European Modelling of the Ocean (NEMO) with a variational data assimilation schema (OceanVar) thanks to which salinity and temperature profiles and satellite Sea Level Anomaly along track data are jointly assimilated to estimate the initial conditions for numerical ocean model. The model horizontal grid resolution is 1/16° (ca. 6-7 km) and the unevenly spaced vertical levels are 72.

**Detailed description:**

The OGCM (Ocean General Circulation Model) code is NEMO-OPA (Nucleus for European Modelling of the Ocean-Ocean Parallelise) version 3.2 (Madec et al 2008). The code is developed and maintained by the NEMO-consortium. The model is primitive equation in spherical coordinates. NEMO has been implemented in the Mediterranean at 1/16deg. x 1/16deg. horizontal resolution and 72 unevenly spaced vertical levels (Oddo et al., 2009). The model is located in the Mediterranean Basin and also extend into the Atlantic in order to better resolve the exchanges with the Atlantic Ocean at the Strait of Gibraltar. The NEMO model is nested, in the Atlantic, within the monthly mean climatological fields computed from ten years of daily output of the 1/4° x 1/4° degrees global model (Drevillon et al., 2008). Details on the nesting technique and major impacts on the model results are in Oddo et al., 2009. The model uses vertical partial cells to fit the bottom depth shape. The model is forced by momentum, water and heat fluxes interactively computed by bulk formulae using the 12-h, 1.125° horizontal-resolution AMIP fields (Cherchi and Navarra, 2007) and the model predicted surface temperatures (details of the air-sea physics are in Tonani et al., 2008). The water balance is computed as Evaporation minus Precipitation and Runoff. The evaporation is derived from the latent heat flux while precipitation and the runoff are provided by monthly mean datasets: the Climate Prediction Centre Merged Analysis of Precipitation (CMAP) Data (Xie and Arkin, 1997); the Global Runoff Data Centre dataset (Fekete et al., 1999) for the Ebro, Nile and Rhone and the dataset from Raichich (Raichich, 1996) for the Adriatic rivers (Po, Vjosë, Seman and Bojana). The Dardanelles inflow is parameterized as a river and the climatological net inflow rates are taken from Kourafalou and Barbopoulos (2003). The data assimilation system is an updated version of the OCEANVAR scheme developed by Dobricic and Pinardi (2008). The background error correlation matrix is estimated from the temporal variability of parameters in a historical model simulation. Background error correlation matrices vary seasonally and in 13 regions of the Mediterranean Sea, which have different physical characteristics (Dobricic et al 2006). The mean dynamic topography used for the assimilation of SLA (Sea Level Anomaly) has been computed by Dobricic et al. (2005). The assimilated data include: sea level anomaly, sea surface temperature, in situ temperature profiles by VOS XBTs (Voluntary Observing Ship-eXpandable Bathythermograph), in situ temperature and salinity profiles by argo floats, and in situ temperature and salinity profiles from CTD (Conductivity-Temperature-Depth), Met Office Hadley Centre SST data set (HadSST1) (Rayner et al., 2003) is used for the correction of surface heat fluxes with the relaxation constant of 60 W/m2K1.

**Processing information:**

The Reconstruction-Reanalysis have been initialized with a gridded climatology for Temperature and Salinity computed from in-situ data sampled before 1987 (PRE-TREANSIENT climatology) from SeaDataNet FP6 project. The model has been initialized at the 1st January 1953. The assimilation of the available satellite and in situ data is done since January 1st 1953 too. Two year of spin-up are considered, thus the available data starts in 1955.

**References:**

Adani M., Dobricic, S. Pinardi N., 2011: Quality Assessment of a 1985–2007 Mediterranean Sea Reanalysis. *J. Atmos. Oceanic Technol.*, 28, 569–589. doi: <http://dx.doi.org/10.1175/2010JTECHO798.1>.

Cherchi, A. and A. Navarra, 2007: Sensitivity of the Asian summer monsoon to the horizontal resolution: differences between AMIP-type and coupled model experiments, *Climate Dynamics*, 28, 2, 273-290, doi:10.1007/s00382-006-0183-z.

Fig. 8. Search and Catalogue layout.

### 2.3.3 Data Access Service

The Data Access Service is reachable clicking on the “Data Access” link from the Portal home page at the following link: [http://medsearr.bo.ingv.it/?page\\_id=126](http://medsearr.bo.ingv.it/?page_id=126).

The page contains a description of the available data and link to the Data Component. All the products are stored using the NetCDF format and are openly and freely accessible by any user through OPENDAP links (Fig. 9).

## Data Access

### Mediterranean sea Reanalyses datasets:

Ocean synthesis or ocean reanalysis is a method of combining historical ocean observations with a general model driven by historical estimates of surface winds by way of a data assimilation algorithm to reconstruct historical change of the ocean, providing an integrated and homogeneous data set with high temporal and spatial resolution.

For the Mediterranean sea, the products disseminated here are:

- **MyOcean\_NextData\_Reanalysis** : This dataset, derived from Mediterranean Sea physics reanalysis ([www.myocean.eu](http://www.myocean.eu)), is composed by 3D monthly mean fields of Temperature, Salinity, Zonal and Meridional velocity, and by 2D monthly mean fields of Sea Surface Hight, Heat, Water and Momentum fluxes, Temperature, Salinity, Zonal and Meridional velocity for the period 1987-2012.

Variable	Geographical coverage	Spatial resolution	Number of levels	Temporal resolution	Temporal coverage
Temperature	6° W - 36.25° E 30.19° N - 45.94° N	0.0625°	33 (JODE levels)	Monthly average fields	1987-2012
Salinity	6° W - 36.25° E 30.19° N - 45.94° N	0.0625°	33 (JODE levels)	Monthly average fields	1987-2012
Sea Surface Height	6° W - 36.25° E 30.19° N - 45.94° N	0.0625°	1	Monthly average fields	1987-2012
Horizontal velocity	6° W - 36.25° E 30.19° N - 45.94° N	0.0625°	33 (JODE levels)	Monthly average fields	1987-2012
Surface heat, water and momentum flux	6° W - 36.25° E 30.19° N - 45.94° N	0.0625°	1	Monthly average fields	1987-2012
Surface salinity, temperature and currents	6° W - 36.25° E 30.19° N - 45.94° N	0.0625°	1	Monthly average fields	1987-2012

- **NextData\_RR** : This is the nominal dataset for NextData sixty years ocean reanalysis for the Mediterranean Sea, composed by 3D, daily and monthly mean fields of Temperature, Salinity, Zonal and Meridional Velocity, by 2D, daily and monthly means of Sea Surface Height and by 2D, 6hr snapshot and monthly mean fields of Heat, Water and Momentum fluxes, Temperature, Salinity, Zonal and Meridional velocity for the period 1955-2012.

Variable	Geographical coverage	Spatial resolution	Number of levels	Temporal resolution	Temporal coverage
Temperature	6° W - 36.25° E 30.19° N - 45.94° N	0.0625°	33 (JODE levels)	24hr average fields, Monthly average fields	1955-2012
Salinity	6° W - 36.25° E 30.19° N - 45.94° N	0.0625°	33 (JODE levels)	24hr average fields, Monthly average fields	1955-2012
Sea Surface Height	6° W - 36.25° E 30.19° N - 45.94° N	0.0625°	1	24hr average fields, Monthly average fields	1955-2012
Horizontal velocity	6° W - 36.25° E 30.19° N - 45.94° N	0.0625°	33 (JODE levels)	24hr average fields, Monthly average fields	1955-2012
Surface heat, water and momentum flux	6° W - 36.25° E 30.19° N - 45.94° N	0.0625°	1	6hr snapshot, Monthly average fields	1955-2012
Surface salinity, temperature and currents	6° W - 36.25° E 30.19° N - 45.94° N	0.0625°	1	6hr snapshot, Monthly average fields	1955-2012

All the products are stored using the NetCDF format.

The data are openly and freely accessible through the following OPENDAP links:

**Fig. 9. Data Access layout.**