EMODnet Data Ingestion and safe-keeping of marine data

Pilot for (Near) Real Time oceanographic data exchange using Sensor Web Enablement standards and services

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Contents

1 Introduction

EMODnet - the European Marine Observation and Data network – is a long term marine data initiative from the European Commission Directorate-General for Maritime Affairs and Fisheries (DG MARE) involving and networking more than 150 organizations for assembling marine data, products, and metadata. The data infrastructure has been developed through a stepwise approach in 3 major phases by running 8 thematic portals, 6 regional check points and a Data Ingestion facility.

EMODnet Physics (www.emodnet-physics.eu), one of the thematic portals, is developing a combined array of services and functionalities such as facility for viewing and downloading, dashboard reporting and machine-to-machine communication services, to obtain, free of charge data, meta-data and data products on the physical conditions of the ocean from many different distributed data sets.

The EMODnet Data Ingestion portal seeks to identify and to reach out to other potential providers in order to make their data sets also part of the total offer. It aims at streamlining the data ingestion process so that data holders from public and private sectors that are not yet connected to the existing marine data management infrastructures can easily release their data for safekeeping and subsequent distribution through EMODnet. This will enrich the total offer for all types of users and conform to the EMODnet motto 'collect data once and use it many times'.

EMODnet Physics and EMODnet Ingestion together have developed a Pilot for Real Time Oceanographic Data Exchange using Sensor Web Enablement (SWE) standards and services.

This document is an introductory guide to users of the EMODnet Real Time Oceanographic Data Client and its features. EMODnet Real Time is a web application that shows how NRT data can be automatically ingested in the EMODnet Physics loop.

2 EMODnet Real Time

The EMODnet Real time Portal (**http://www.emodnet-physics.eu/realtime**) is a web application that is able to provide (N)RT data and metadata from marine data centres that offer a machine to machine interface based on the Sensor Observation Service (SOS) standard of the Open Geospatial Consortium (OGC). Its goal is to offer a simple point of access to distributed (N)RT data in a transparent way: users can add and/or remove available sensor systems to/from the portal and thus access their data.

The following figure shows the logical architecture behind the portal:

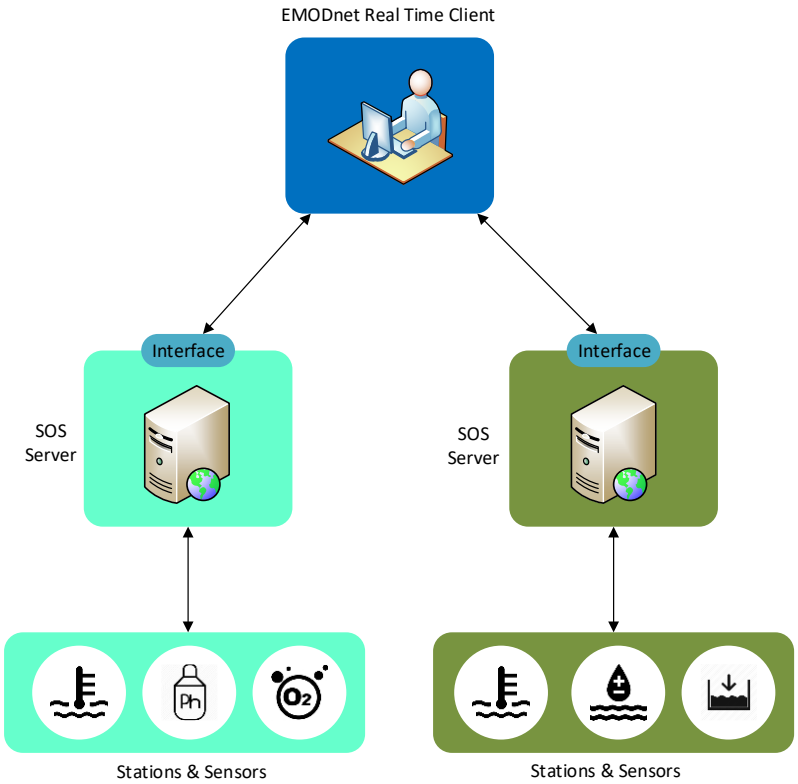

Figure 1: EMODnet Real Time System Architecture

EMODnet Real Time is based on the Helgoland client that is freely available on Github at https://github.com/52North/js-sensorweb-client.

2.1 Helgoland

Helgoland is a software client for visual exploration and analysis of sensor web data developed by 52° North (https://52north.org). It is a lightweight web application that enables the exploration, analysis and visualization of sensor web data in various fields of use, e.g. hydrology, meteorology, environmental monitoring, traffic management. Using this application, users can easily explore stations or mobile sensor platforms in a map, select time series data by a list selection, visualize time series, trajectory or profile data and explore their metadata.

The application is based on HTML, JavaScript and CSS and can connect to different Sensor Web endpoints (REST-APIs). These Sensor Web REST-APIs provide a thin access layer to sensor data via RESTful Web binding with different output formats (e.g. proxy solution is available that allows to encapsulate existing XML-based SOS severs for integration into the Helgoland client).

The main features provide by Helgoland are:

- Access to SOS instances (through the proxy solution SOS 1.0.0 and 2.0 as well as specific extensions such as those required by the INSPIRE technical guidance on Download Services are supported)
- Diagram view of multiple time series, profiles, temporal zooming and panning, etc.
- Data export (PDF, Excel, CSV).

2.2 Sensor Observation Service

The Helgoland client gives users simple access to SOS instances. SOS – Sensor Observation Service, provides a standardized interface for managing and retrieving metadata and observations from heterogeneous sensor systems. The OGC SOS standard defines a Web service interface that allows querying observations, sensor metadata, as well as representations of observed features. For connecting the Helgoland client to SOS servers, usually these servers need to provide at least the following basic "core" operations:

- GetCapabilities: returns a service description with information about the interface (offered operations and endpoints) as well as the available sensor data, such as the period for which sensor data is available, sensors that produce the measured values, or phenomena that are observed.
- DescribeSensor: metadata on the registered probes and sensors. The sensor description can contain information about the sensor in general, the identifier and classification, position and observed phenomena.
- GetObservations: allows pull-based querying of observed values, including their metadata stored in the SOS database.

In addition the GetDataAvailability operation, as defined by the INSPIRE Technical Guidance on Download Services, may be used for determining in more detail the available data sets offered by an SOS server. To encode observations, the ISO/OGC Observations & Measurements (O&M) standard is used. To encode sensor descriptions, the OGC Sensor Model Language (SensorML) is used.

2.3 Technologies

Different technologies have been used to develop Helgoland:

- *Angular.js*: it is a client side JavaScript MVC framework to develop a dynamic web application. AngularJS was originally started as a project in Google but it is now an open source framework. AngularJS is entirely based on HTML and JavaScript and it changes static HTML to dynamic HTML. It extends the ability of HTML by adding built-in attributes and components and also provides an ability to create custom attributes using simple JavaScript. The AngularJS framework works by first reading the HTML page, which has additional custom tag attributes embedded into it. Angular interprets those attributes as directives to bind input or output parts of the page to a model that is represented by standard JavaScript variables. The values of those JavaScript variables can be manually set within the code, or retrieved from static or dynamic JSON resources. AngularJS is the frontend part of the MEAN stack, consisting of MongoDB database, Express.js web application server framework, Angular.js itself, and the Node.js server runtime environment.
- *Leaflet*: Leaflet is a widely used open source JavaScript library used to build web mapping applications. It supports most mobile and desktop platforms, supporting HTML5 and CSS3. Along with OpenLayers, and the Google Maps API, it is one of the most popular JavaScript mapping libraries and is used by major web sites such as FourSquare, Pinterest and Flickr. Leaflet allows developers without a GIS background to very easily display tiled web maps

hosted on a public server, with optional tiled overlays. It can load feature data from GeoJSON files, style it and create interactive layers, such as markers with popups when clicked.

- *Bootstrap*: Bootstrap is a free front-end framework for faster and easier web development. It includes HTML and CSS based design templates for typography, forms, buttons, tables, navigation, modals, image carousels and many other, as well as optional JavaScript plugins. Is also used to provide features to easily create responsive design applications.
- *MomentJS*: it is a JavaScript code for manipulating dates and time, without other dependencies provided; it is a powerful tool for parsing, validating and displaying dates. Supporting internationalization and time zone it is very useful when dates should be displayed in a localized format provided by user location.
- *Flot*: Flot is a pure JavaScript plotting library for jQuery, with a focus on simple usage, attractive looks and interactive features.

3 EMODnet Real Time Features

The EMODnet Real Time client (**http://www.emodnet-physics.eu/realtime**) is a software client based on the Helgoland application that, in its current beta version, gives the user the opportunity to explore, analyse and download real time data and metadata from existing data servers that provides OGC SOS interoperability. In particular, four SOS servers are connected in the present release:

- **OGS-NODC**: http://nodc.ogs.trieste.it/sos/api/v1/
- **IFREMER Oceanotron**: http://151.1.245.87/ifremerproxy/api/services/?expanded=true&locale=en&valueTypes=all
- **NeXOS SOS Server**: http://nexos.demo.52north.org/52n-sos-nexos-test/api/
- **BODC**: http://linkedsystems.uk/52n-sos-webapp/api/v1/ fixed observatory data from historic ANIMATE project.

OGS-NODC provides data and metadata from six fixed monitoring stations located in the Adriatic Sea that provides information on sea physical parameters. The Oceanotron SOS provides data from IFREMER and, in particular, the ArgoNetCDFToProfile dataset that comprises temperature, salinity and conductivity vertical profiles acquired by floats related to the ARGO network. The NeXOS SOS Server offers data acquired by different mobile platforms. BODC offers access to datasets in the form of links, which currently cannot be displayed in the Client, but will be included in one of new updates. The URLs lead to ODV and netCDF files e.g.:

https://www.bodc.ac.uk/data/open_download/series/1225957/odvnc/

The following table shows a summary of the information provided:

Table 1: EMODnet RT observations

	OGS-NODC	OCEANOTRON	NeXos	BODC
Name	My timeseries service	ArgoNetCDFToProfile	NeXos Test SOS Server	BODC

Stations	12	1	12	1
Types	Time series	Profiles	Mobile Platforms	Time Series
Datasets	73	294	14	45*

Since EMODnet RT is an open client, it is possible to update the list of the SOS servers handled by the client. This can be done by adding the SOS rest API url in the settings.json file located in the <tomcat folder>/webapps/client/ folder.

```
  },
  "restApiUrls": {
    "http://ll.linkedsystems.uk/52n-sos-webapp/api/v1/":"bodc",
    "http://nodc.ogs.trieste.it/sos/api/v1/":"trieste",
    "http://151.1.245.87/ifremerproxy/api/":"ifremer",
    "http://nexos.demo.52north.org/52n-sos-nexos-test/api/":"53north"
  },
  "chartOptions": {
    "yaxis": {
      "tickDecimals": 2
    }
  },
  "supportedLanguages": [{
      "code": "de",
      "label": "Deutsch"
```

Figure 1: Settings.json configuration file

All the data can be managed by the EMODnet Real Time interface that allows users to navigate the data, from the selection of the provider to the download of a specific time series/profile. The following paragraph will introduce the different features of the application and an example of a procedure to access data.

3.1 Main Window menu

The main window menu allows the user to select the features of interest, in particular different kind of data (time series, profiles, and trajectories), favourites and settings. Selecting a “data type” item, opens a second menu that provides tools for loading, harvesting and browsing data from different data providers (i.e. SOS servers) (see next paragraphs for full details).

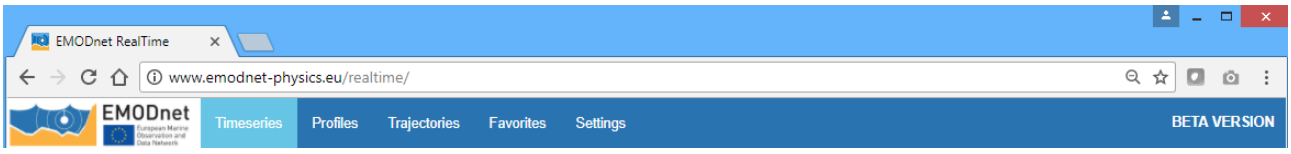

Figure 2: EMODnet Real Time Menu

3.2 Timeseries

The timeseries item opens the custom menu for browsing timeseries data types with different features:

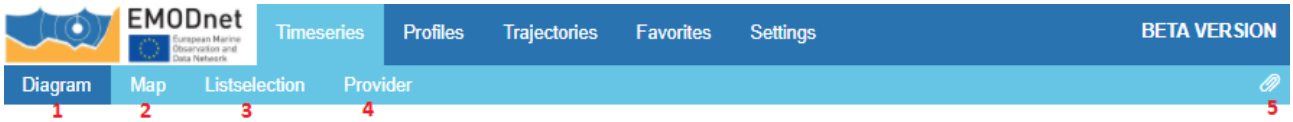

Figure 3: Time Series Menu

1. *Diagram*: this page shows the time series selected by the user in the List Selection page.

Figure 4: Time Series - Diagram page

The Diagram page is basically divided in 3 parts:

- Chart section: the data selected are shown in the chart. When moving the mouse on the plot, a tooltip appears with details on the values. Multiple plots can be loaded simultaneously and by clicking on the y-axis legend the related chart is highlighted.
- Time Bar: the time bar is used to change the time scale of the chart and change the visualization from chart to data table.
- Legend section: this section provides metadata on the plots (station, phenomenon, sensor) and features for interaction with the data:

Table 1: Time Series – Diagram Legend

Icon	Description
	Enable/disable the visualization of the plot
	Shows a mini map with the station location

	Change the style and colour of the plot
	Shows first data, latest data and link to download the time series in CSV format
	Remove the current time series from the view

2. *Map*: the map shows the stations provided by the selected providers. Clicking on a station brings up a popup with all the phenomena available for that station that can be selected for visualization and data download. In the right part of the page there is a list of all the phenomena provided by the platforms. This list can be used to filter the stations visualized in the map

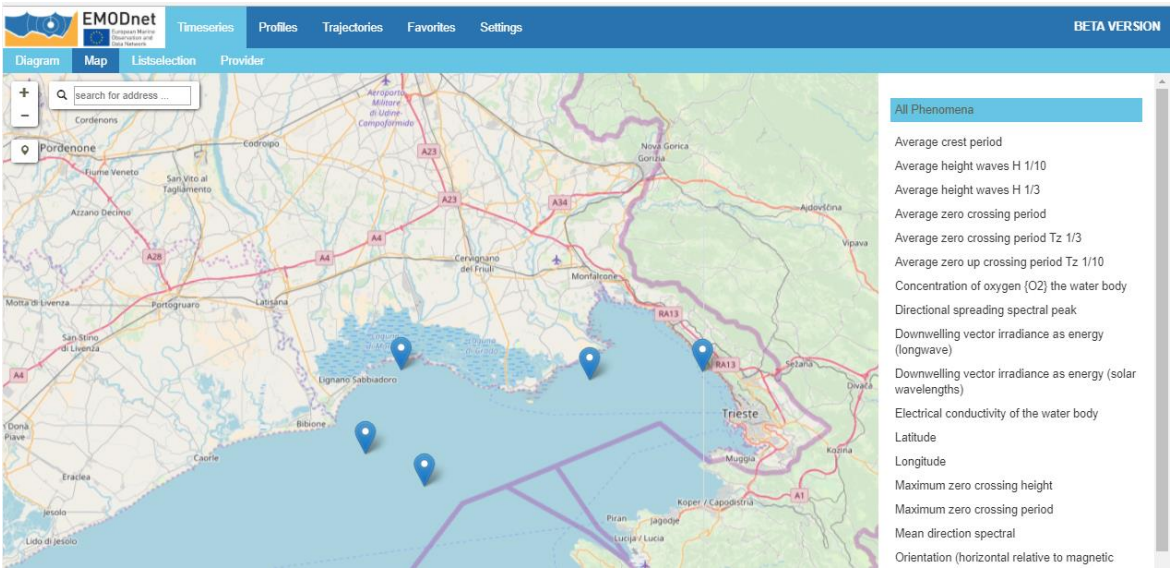

Figure 5: Time Series - Map page

3. *ListSelection*: this page allows the user to select the timeseries to view in the diagram page. Using a menu list that shows all the information provided by the selected SOS in terms of category, station name, phenomenon and sensor.

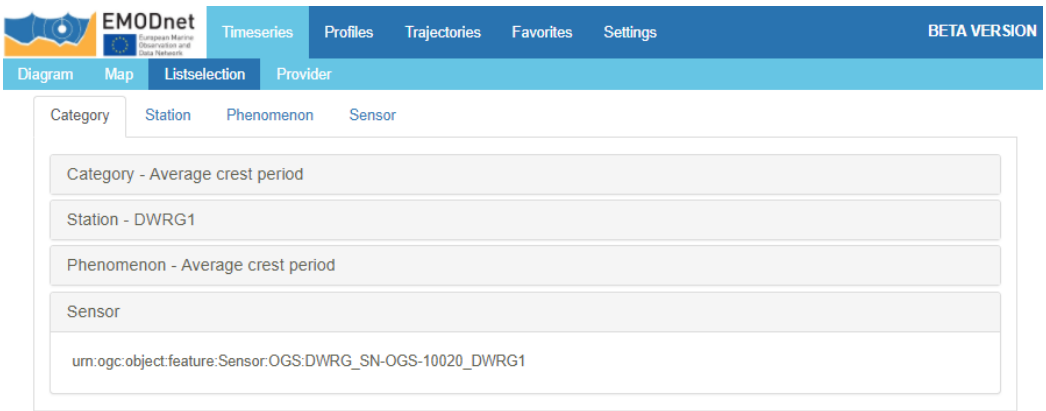

Figure 6: List Selection page

Once the selection process is completed, the selected time series is opened in the diagram page

4. *Provider*: offers a list of SOS Data Centers that provide timeseries. By clicking on an item, the system queries the SOS interface and retrieve its capabilities, thus allowing the users to navigate its data.

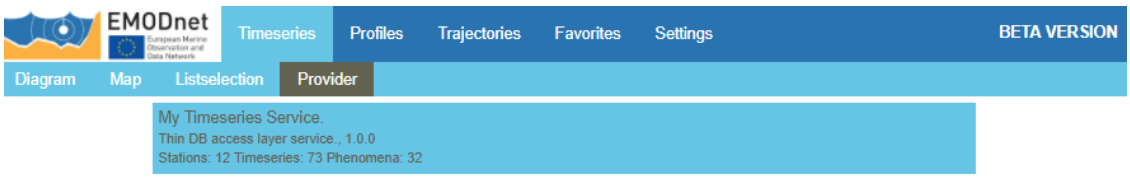

Figure 7: Timeseries – Provider page

5. *Permalink*: creation of a permanent link for the current view. This link can be sent to other users so that they can open the same view.

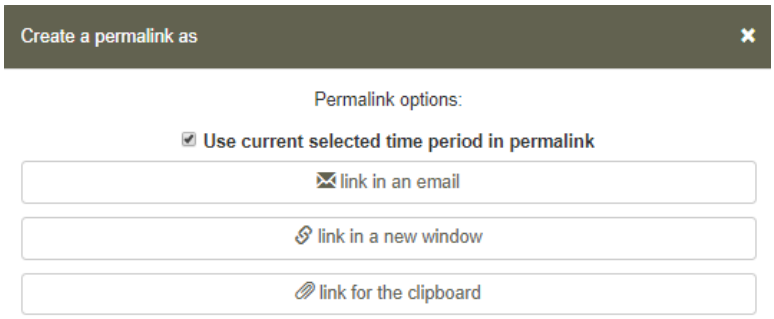

Figure 8: Permalink creation

3.3 Profiles

The profile section provides features to harvest and view profile data. In the current version of EMODnet Real Time data from the Argo network are available through the OCEANOTRON SOS provided by IFREMER.

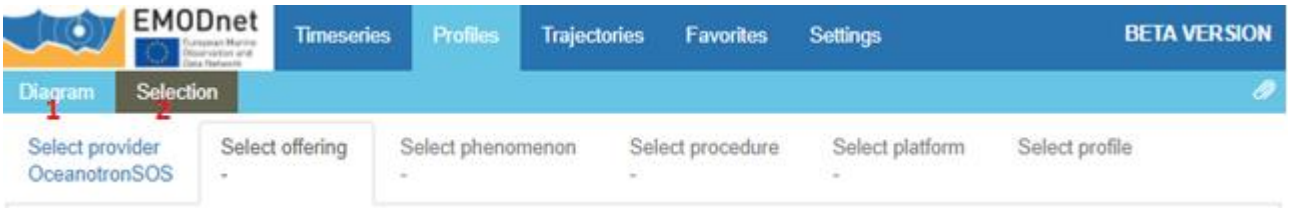

Figure 9: Profiles menu

The Profiles section menu provides two item:

1. *Diagram*: this page shows the profiles selected by the user in the Selection page:

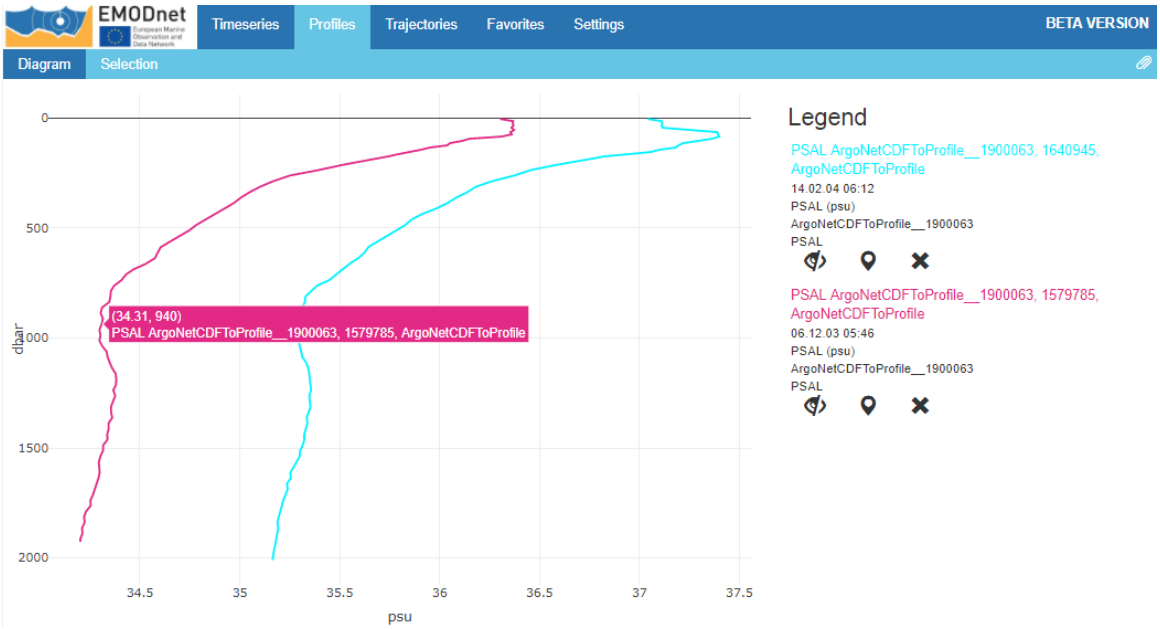

Figure 10: Profiles - Diagram page

The Diagram page is divided in 2 parts:

- Chart section: the data selected are shown in the chart. When moving the mouse on the plot, a tooltip appears with details on the values. Multiple profiles can be loaded simultaneously.
- Legend section: this section provides metadata on the plots (station, phenomenon, sensor) and features for interaction with the data:

Table 2: Profiles – Diagram Legend

Icon	Description
	Enable/disable the visualization of the plot
	Shows a mini map with the location of the profile
	Delete the current profile

2. *Selection*: this section allows the user to select profiles to be shown in the diagram page. The user is guided by the interface in a selection process that includes:
   - Selection of an offering (a particular test)
   - Selection of a phenomenon (the physical parameter to observe – temperature, salinity, conductivity)
   - Selection of the procedure (the dataset)
   - Platform selection: could be a stationary or a mobile platform. The system allows the user to select the station directly from a map:

Figure 11: Profiles – Platform selection

- Selection of the time stamp of the profile.

Once the selection process is completed the data is automatically opened in the Diagram page.

3.4 Trajectories

The trajectories item opens the custom menu for browsing trajectories data types with different features:

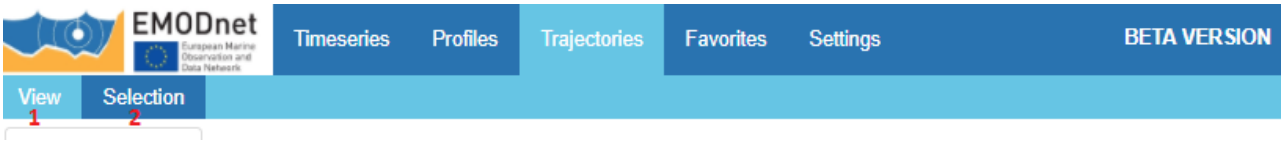

Figure 12: Trajectories Menu

The Profiles section menu provides two item:

1. View: this page shows a map with the trajectories selected in the Selection page and a diagram with the data associated with that trajectory. By moving the mouse on the trajectories in the map, the correspondent data on the chart is highlighted.

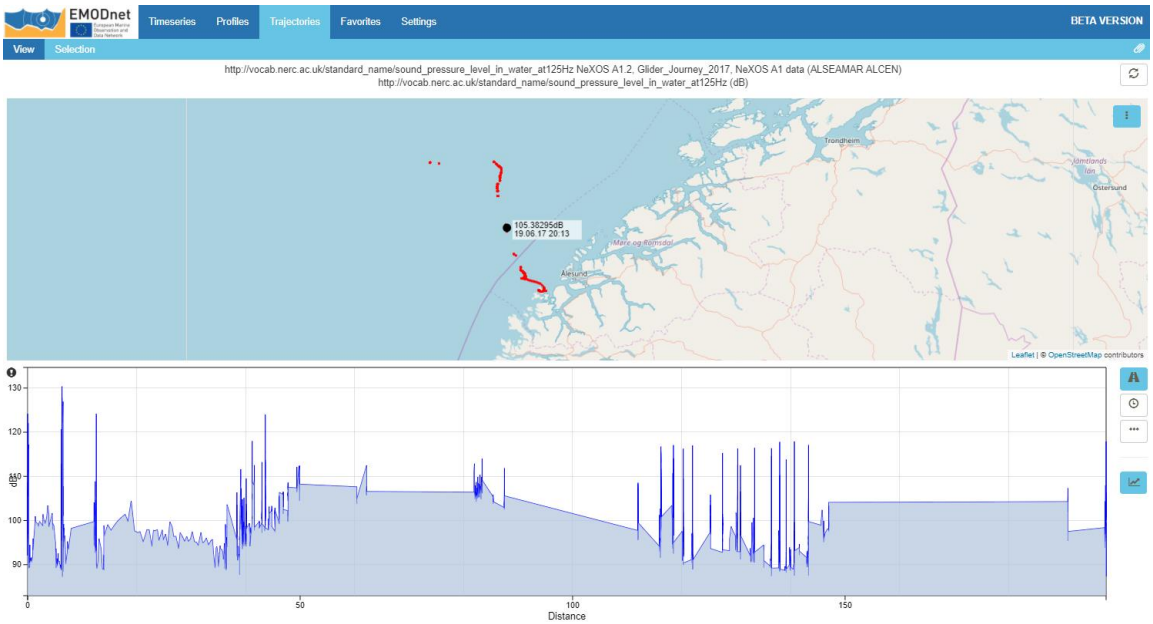

Figure 13: Trajectories – View Page

2. Selection: this section allows the user to select the trajectories to be shown in the map page. The user is guided by the interface in a selection process that includes:
   - Selection of the provider
   - Selection of the platform
   - Selection of the phenomenon

Once the selection process is completed the data is automatically open in the View page.

3.5 Favourites

The star icon within the *Legend* area of the timeseries view, users can mark their favorite timeseries so that the client remembers these timeseries for faster access. When opening the *Favorites* menu, users can view an overview of the marked timeseries with their current values.

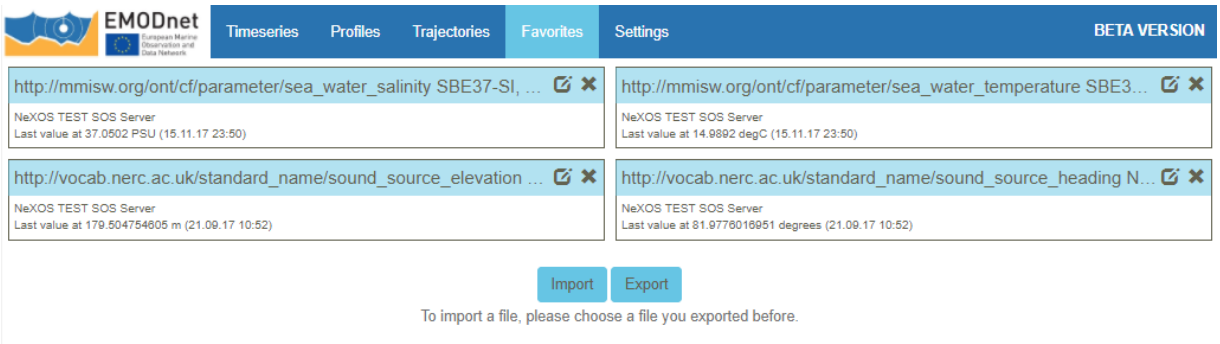

Figure 14: Favorites Page

As the list of favorites is stored in the local storage of the browser, these favorites will get lost if the local storage/cache of the browser is emptied. For this purpose, the Helgoland viewer offers in this

menu functionality for exporting and importing previously created lists a favorites. Furthermore, this functionality can be used for transferring lists of favorites to other computers.

3.6 Settings

The setting page allows users set some configuration parameters of the application:

- Save/Reset Environment: selections made in the sessions are saved/reset for the next session.
- Switch language: change the language of the application
- Generalize data: In case of high-resolution time series data, the amount of data points in a timeseries may be magnitudes higher than the number of pixels available for visualizing the time series. Thus, if the Generalization option is activated, the client is able to request from its underlying REST API timeseries data in a lower resolution that matches the resolution of the display. This reduces the data volume which is transmitted to the browser (especially useful for mobile connections)
- Imprint: general information on Helgoland

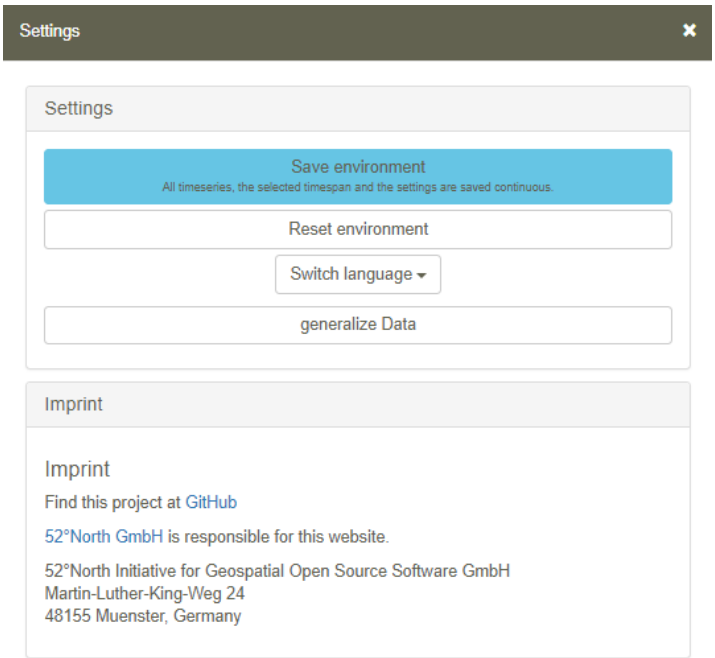

Figure 15: Settings page

3.7 SWE Marine Templates

A range of SWE profiles has been formulated and can be found under: **https://odip.github.io/MarineProfilesForSWE/**

This site includes a story that narrates how projects, people, technologies and vocabularies were brought together to formulate meaningful and semantically rich profiles for the marine domain. The related EU-projects that have funded this effort are listed under the above mentioned URL.

Two of the partners, OGS and BODC, have implemented demonstrators that implement the SWE marine profiles which can be found at:

http://nodc.ogs.trieste.it/sos/client, where OGS publish marine observatories acquiring meteo-oceanographic data in (near) real time

and

http://linkedsystems.uk/52n-sos-webapp/, where BODC publish historic ANIMATE project data as a demonstrator from placing fixed observatory data on an SOS server.

In order to support new and existing partners to implement the above mentioned profiles, BODC and OGS have also created specific URLs with working examples of sensors described with SensorML following the SWE Marine profiles and can be found at:

- A model of an Aanderaa oxygen optode:
  http://linkedsystems.uk/system/prototype/TOOL0969 /current/
- An instance of an oxygen optode:
  http://linkedsystems.uk/system/instance/TOOL0969_prospect/current/
- An instance of a Wind Monitor-JR:
  http://europa.ogs.trieste.it/OGS_SOS/SensorML_3_0/Sensor_V3_E2M3A_WIND.xml
- An instance of SBE 37-SMP-ODO MicroCAT high-accuracy conductivity and temperature recorder:
  http://europa.ogs.trieste.it/OGS_SOS/SensorML_3_0/Sensor_V3_E2M3A_CT.xml