



EMODnet



European Marine
Observation and
Data Network

EMODnet Ingestion and safe-keeping of marine data n.2

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**EMODnet Data Ingestion –
D3.4 - SWE Demonstrator expanded with new Services
September 2020**

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Document info

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1. Introduction

The European The European Marine Observation and Data Network, EMODnet, is a long-term marine initiative implementing mechanism of the European Commission's Marine Knowledge 2020 strategy^{1,2} to unlock the potential of Europe's wealth of marine data. Based on the principle of collecting data once and using it many times for many purposes, EMODnet is a network of organizations supported by the EU's Integrated Maritime Policy linked by a data management structure. These organizations work together to facilitate the discovery and access to marine data and data products representing the following seven main themes: bathymetry, biology, chemistry, geology, human activities, physics, and seabed habitats; six regional check points and a Data Ingestion facility. EMODnet provides a gateway to those marine data accompanied by their metadata and data products through a number of thematic portals and a central portal (www.emodnet.eu).

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'.

The EMODnet Real time Portal (<http://www.emodnet-physics.eu/realtime>) is a web application that is able to provide NRT data and metadata from marine data centers 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 NRT data in a transparent way: users can add and/or remove available sensor systems to/from the portal and thus access their data.

This document is an introductory guide to users on how to exchange EMODnet Real Time (RT) Data using the Sensor Web Enablement (SWE) Sensor Observation Service (SOS). In particular, this document presents an overview on the functioning of the SWE Demonstrator expanded with new stations related to SOS Server in the reporting period.

¹ European Commission (2010). Marine Knowledge 2020 Marine Data and Observation for Smart and Sustainable Growth. Commission Communication COM (2010) 461, Publications Office of the European Union.

² European Commission (2012). Marine Knowledge 2020 from Seabed Mapping to Ocean Forecasting. Green Paper, Publications Office of the European Union, Luxembourg.

2. Sensor Web Enablement

A brief intro of the Sensor Web Enablement (SWE)

The Sensor Web Enablement framework developed by the Open Geospatial Consortium (OGC) aims to develop and maintain standards for the interoperable integration of sensors and their observation data into Web-based (spatial) data infrastructures (Bröring et al., 2011). There exist several document types within the OGC, representing the maturity of a specification (e.g. discussion paper, best practice paper or standard).

A specification can be understood as a technical definition for a web service or data model (independent of the grade of maturity) while a standard is the document that has been officially adopted by the OGC.

The OGC Sensor Observation Service (SOS) interface allows pull-based access to observation data as well as sensor metadata. This means that the SOS acts as a mediator between clients and a measurement archive (e.g. database) or sensor system.

Through the SOS, it is possible for clients to query observation data of heterogeneous sources via a standardized interface.

On the one hand the SOS standard defines a set of operations and their parameters and on the other hand it relies of the data model/encoding standards of the SWE framework to provide standardised outputs.

The core operations of the SOS interface are:

- GetCapabilities: Retrieve metadata about a SOS server (e.g. supported operations and available data sets)
- DescribeSensor: Access metadata about the sensors or processes which have generated the observation data offered by the SOS server
- GetObservation: Retrieval of observation data/measurements

An important extension of the SOS interface is a group of transactional operations (InsertSensor and InsertObservation) for publishing new sensors and observations data on a SOS server.

Another important operation is the GetFeatureOfInterest operation which allows the retrieval of the geometric features to which observations are associated. It provides the required spatial context, by serving e.g. point or polygon features of the feature that is being observed.

Figure 1 illustrates the four interface methods and their corresponding response formats.

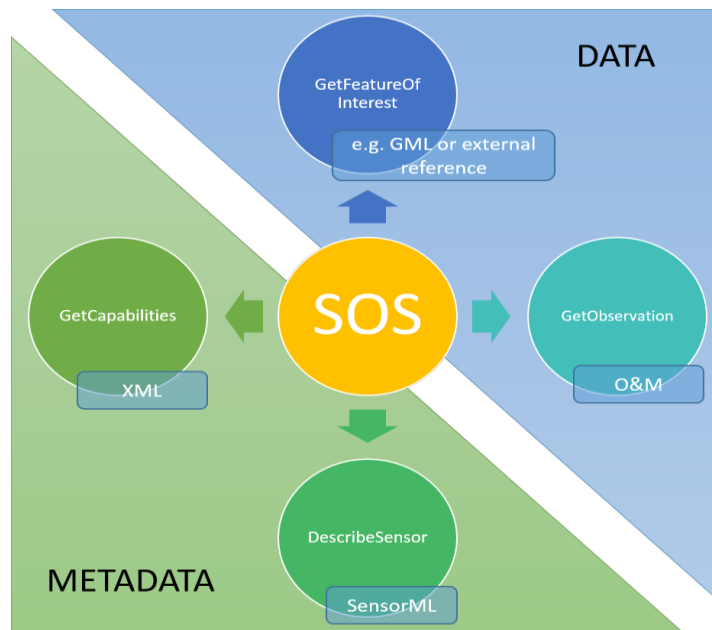


Figure 1. SOS Interface Method Overview

Increasingly, marine data will be collected by smart sensors and platforms. Several developments are ongoing in this field of developing new sensors for an expanding range of parameters, and new platforms that can carry a payload of multiple sensors and operate efficiently for long durations. These developments need to be anticipated, also with respect to data management and data flow.

For that purpose, adoption of Sensor Web Enablement (SWE) standards holds great promise as it facilitates to streamline data from platforms in real-time to receivers, and to document many relevant aspects of the sensors, platforms, and observations using marine SWE profiles and vocabularies, thus enriching the available metadata from observations at their origin, which will contribute to improving the FAIRness of data sets and documenting the provenance of observed data.

The SeaDataNet consortium, has also made great progress in building upon the SWE standards to support the interoperable sharing of near-real time and real-time observation data streams. This methodology has already tested to streamline data flow into EMODnet Physics and EMODnet Data Intestion is going to uptake and exted futher the system.

This comprises especially a component, which have been developed led by 52North, the 52N SOS Service. The 52°North Sensor Observation Service 4.x3 implements the OGC SOS standard versions 1.0.0 and 2.0. The implementation comprises all extensions defined in the specification.

³ www.52north.org/sos

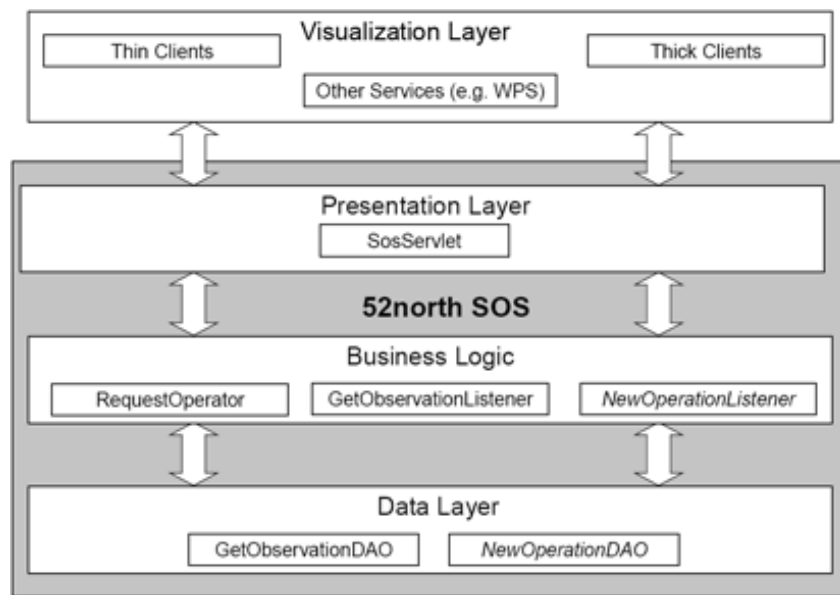


Figure 2. Layered architecture of the 52°North Sensor Observation Service

With its layered architecture, shown in Figure 2 the SOS server can be flexibly connected to different data sources ranging from file-based approaches to different database systems. By default, PostGIS is used as the Database Management System (DBMS). By customizing the Business Logic layer, new functionality may be added. Thereby, new encoders and decoders can be added in a plug and play fashion. For example, prototypical support for an EXI encoding for SOS messages, O&M as well as SensorML has already been implemented in the European research project NeXOS⁴.

A new extension of the 52°North SOS implementation is the support of the OGC SensorThings API Sensing profile. Currently a first beta version of the implementation of the core profile of this specification is available. Further extensions of this module are currently work in progress. The aim of this component is to support sensor operators, researchers and data owners to ingest data and SWE metadata from operational observing platforms and sensors into a local storage system and to publish (selected) data streams from this database by means of SOS services to receiving servers. This facilitates operators to publish streams of near-real time and real-time observation data via SOS servers by first describing the structure of the observation network and data stream and then enabling an automated data ingestion, storage, and publication process. The 52N suite also comprises a SWE Viewing Services, based on the Helgoland Sensor Web Viewer, that is an application for exploring and visualising data streams from operational sensors and platforms. This tool is also available to partner that are joining the data sharing methodology as a complementary tool to self-check the correctness of system configuration and provide the users with a further data exploring and access tool. These components are available as open source software via GitHub⁵.

⁴ <http://www.nexosproject.eu/>

⁵ More information about these solutions, background, SWE profiles, how to apply, and GitHub locations, can be found at <https://www.seadatanet.org/Software/Sensor-Web-Viewer/Documentation>

3. Demonstrator Concept

Background of the SWE demonstrator

Increasingly, marine data will be collected by smart sensors and platforms. Several developments are ongoing in this field of developing new sensors for an expanding range of parameters, and new platforms that can carry a payload of multiple sensors and operate efficiently for long durations. These developments need to be anticipated, also with respect to data management and data flow. For that purpose, adoption of **Sensor Web Enablement (SWE)** standards holds great promise as it facilitates to streamline data from platforms in real-time to receivers, and to document many relevant aspects of the sensors, platforms, and observations using marine SWE profiles and vocabularies, thus enriching the available metadata from observations at their origin, which will contribute to improving the FAIRness of data sets and documenting the provenance of observed data.

Integrating the **online Sensor Web Enablement (SWE)** for ingesting near real time data sets from operational oceanography sensor networks has several benefit/reasons:

- The SWE software is open source and widely adopted
- It can be easily adopted and configured by the operators (e.g. NODCs)
- The model can be used to set up dedicated pipelines by operators
- Close the gap between RT, NRT and DM data
- Facilitate streamlining the data and metadata transfer from operational networks to a database buffer from which assigned (SDN) data centres can pick up the data timeseries for further elaboration and later population into the CDI service

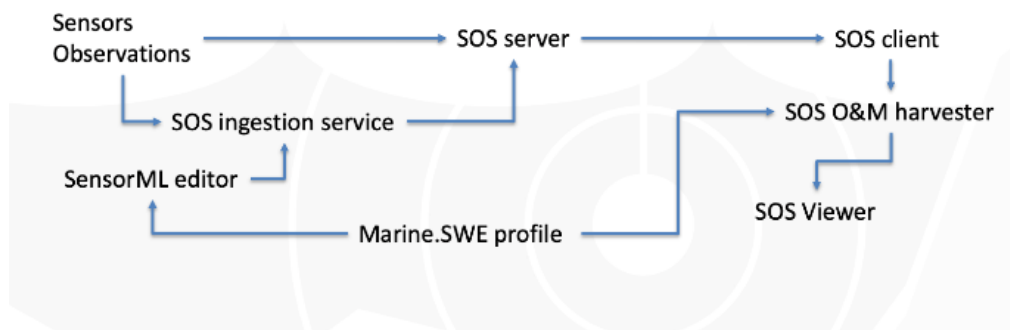


Figure 3. SWE demonstrator concept

Starting from the progresses made by the SeaDataNet community, in building upon the SWE standards to support the interoperable sharing of near-real time and real-time observation data streams, EMODnet Data Ingestion and EMODnet Physics designed and implemented a EMODnet SWE demonstrator consisting in:

- Back End tools for the operators
- Guidelines on tools and standards (e.g. this document)
- Front End tools for EMODnet users

Back end Tools for operators

Backend tools support the collection of data from different sources, the interpretation and conversion into an internal data model (based on the ISO/OGC Observation and Measurements (O&M) standard, as well as the publication of the collected data into the database of an interoperable OGC Sensor Observation Service (SOS) instance. They consists of the following components:

- SWE SOS server. SOS – Sensor Observation Service provides a standardized interface for managing and retrieving metadata and observations from heterogeneous sensor systems.
- SWE Ingestion Service: The aim of this component is to support sensor operators, researchers and data owners to ingest data and SWE metadata from operational observing platforms and sensors into a local storage system and to publish (selected) data streams from this database by means of SOS services to receiving servers. This facilitates operators to publish streams of near-real time and real-time observation data via SOS servers by first describing the structure of the observation network and data stream and then enabling an automated data ingestion, storage, and publication process;
- SWE Viewing Services, based on the Helgoland Sensor Web Viewer, is an application for exploring and visualising data streams from operational sensors and platforms.

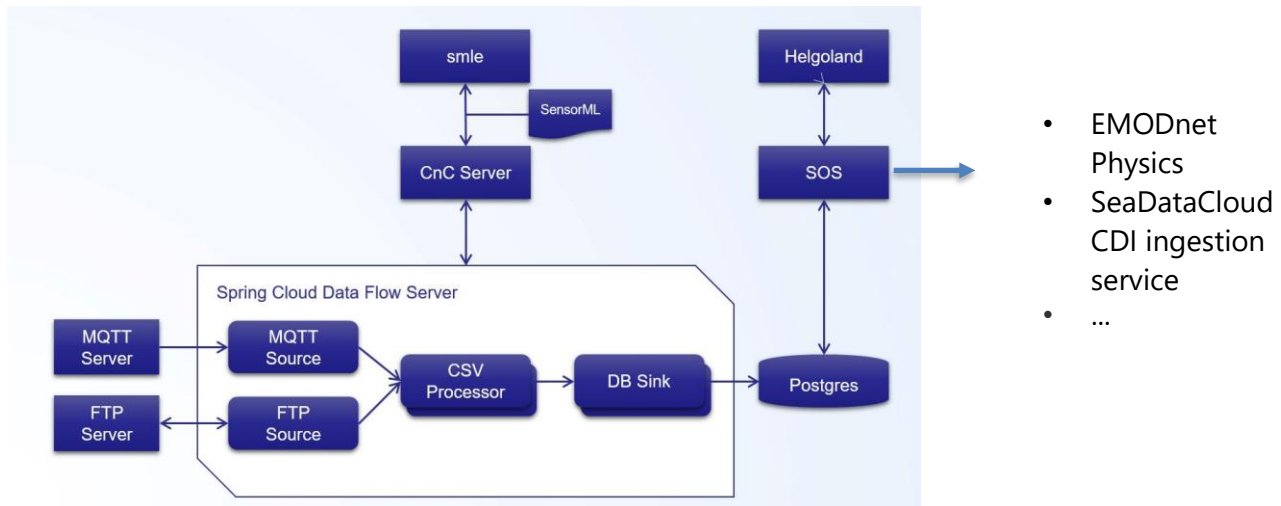


Figure 4. SWE Ingestion service

Sensor Observation Service

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.

Deliverable 3.3 provides instruction on how to install and implement a SOS Server.

Viewing Service - 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 servers for integration into the Helgoland client).

The main features provided 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).

Guidelines and documentation

Information about these solutions, background, SWE profiles, how to apply, and GitHub locations, can be found at: <https://www.seadatanet.org/Software/Sensor-Web-Viewer/Documentation>

Software components can be found at GitHub resources:

- Spring Cloud software and SWE Ingestion service at:
<https://github.com/52North/SWE-Ingestion-Service>
- Helgoland sensor web viewer at:
<https://github.com/52North/helgoland/tree/feature/sea-data-cloud>
- SWE SOS importer:
<https://github.com/52North/sos-importer>
- SMLE editor:
<https://github.com/52North/smle>
- SWE Profiles:
<https://odip.github.io/MarineProfilesForSWE/>

Once installed, the deployed platforms and sensors should be described using the SMLE editor, which allows to configure SWE profiles and to make use of SeaDataNet vocabularies for most metadata elements.

Technologies adopted for implementing the tools

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.

4. SWE Demonstrator

EMODnet Physics viewer for the SWE Demonstrator

The EMODnet Real time Portal (<http://www.emodnet-physics.eu/realtime>) is a web application that is able to provide NRT 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 NRT data in a transparent way: users can add and/or remove available sensor systems to/from the portal and thus access their data.

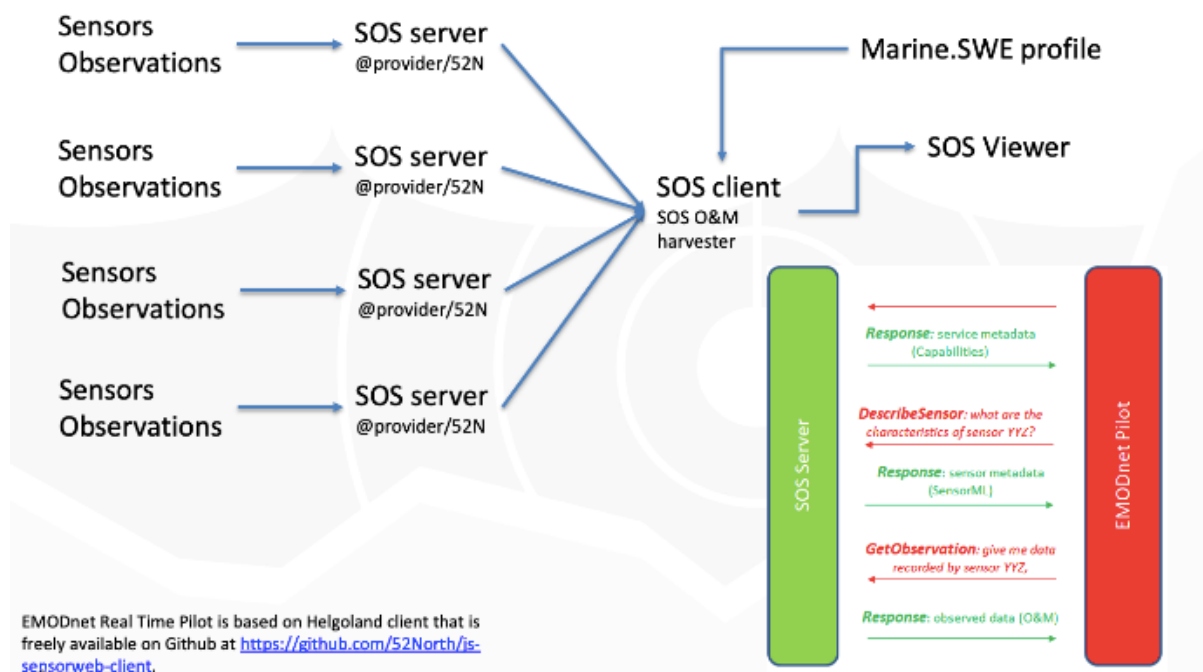


Figure 5. RT data flow with SWE implementation

The following figure shows the logical architecture behind the portal:

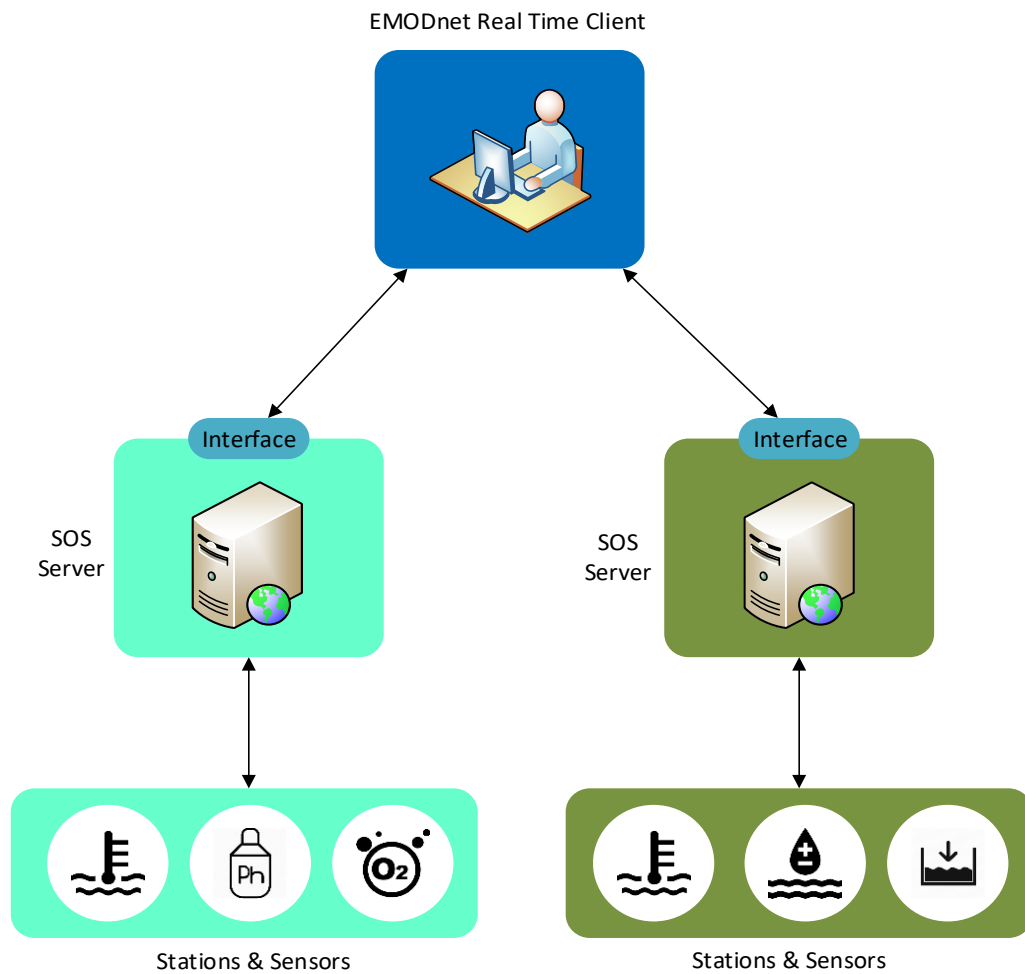


Figure 6. EMODnet Real Time Pilot System Architecture

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

5. Services related to the SOS Server

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, eleven services are connected to SOS server in the present release.

- OGS-NODC: <http://nodc.ogs.trieste.it/sos/api/v1/>
- NeXOS SOS Server: <http://nexos.demo.52north.org/52n-sos-nexos-test/api/>
- IRCEL – CELINE: <https://geo.irceline.be/sos/api/v1/>
- OBSEA: <http://sos.obsea.es/sos/api/>
- PIM: <https://www.pim-liguria.it/52n-sos-webapp/api/>
- ARPA Emilia-Romagna: <http://arpa-er.geodab.eu/emodnet-restful/api/v1//>
- HZG: <https://codm.hzg.de/52n-sos-webapp/api/v1/>
- SMHI: <https://shair.smhi.se/52North/api/v1/>
- INOGS: <https://nodc.inogs.it/sos/api/>
- MONALISA DATA SERVICE: <http://monalisasos.eurac.edu/sos/api/v1/>
- FLUGGS: <https://www.fluggs.de/sos2/api/v1/>

OGS-NODC provides data and metadata from six fixed monitoring stations located in the Adriatic Sea that provides information on sea physical parameters. The NeXOS SOS Server offers data acquired by different mobile platforms. IRCEL-CELINE offers access to air quality data collected by different stations based in Belgium.

Among the new added observations, OBSEA provides data from underwater noise in the area of Barcelona (Spain). PIM provides physical data from fixed sensors in the area of the Ligurian Sea (Italy). ARPA E-R provides physical marine and river data (Discharge, Precipitation, Temperature, Water Level) from Emilia Romagna Region (Italy). HZG provides physical marine data collected through Ferrybox stations from Europe and beyond. SMHI provides physical data (weather and climate) from Sweden; INOGS offers physical marine data from the Adriatic Sea; MONALISA DATA SERVICE collects environmental physical data that offers information on the conditions of the Alpes (Bolzano, Italy). Ultimately, FluGGS provides physical data from the in situ stations based in the Wupper River (Germany).

The following tables show a summary of the information provided:

OGS-NODC		NEXOS	IRCEL - CELINE
Name	My timeseries service	NeXos Test SOS Server	IRCEL - CELINE: timeseries-api (SOS 2.0)
Stations	12	12	111
Types	Time series	Mobile Platforms	Time series
Datasets	73	14	598

Table 1: EMODnet RT observations present before the reporting period

OBSEA PIM			CNR + HZG ARPA ER	SMHI	INOGS	MONALISA DATA SERVICE	FLUGGS	
Name	Restful SOS Service	RESTful Dataset Service	EMODnet broker	HZG FerryBox data	SwedischEPA, SHMI	My RESTful Dataset Service	My Timeseries Service	Wupperverband Zeitreihen Dienst
Stations	2	5	669	569	2825	15	31	83
Types	Time series	Time series	Time series	Time series	Time series	Time Series	Time Series	Time Series
Datasets	17	15	4	327585	4591	64	353	212

Table 2: EMODnet RT observations (added) in the reporting period

6. Real Time Data Exchange User Guide

This paragraph describes the Guidelines for Real Time Data Exchange using the EMODnet Real Time Portal. Therefore, it will introduce the different features of the application and an example of a procedure to access data.

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).

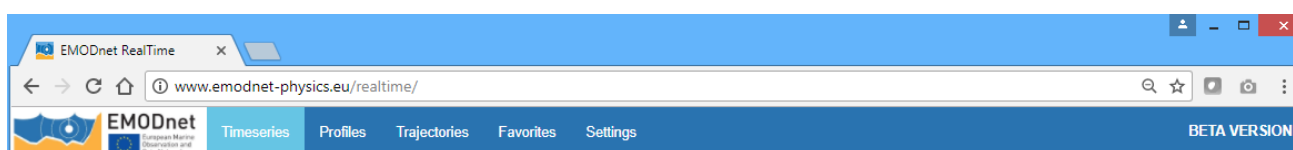


Figure 7. EMODnet Real Time Menu

Timeseries

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

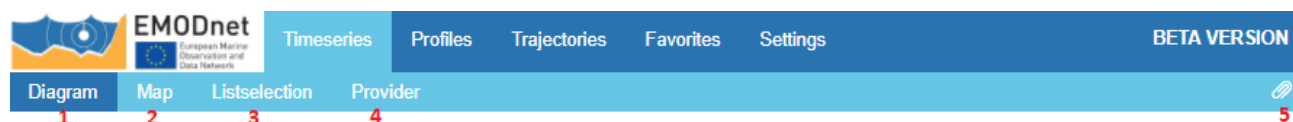


Figure 8. Time Series Menu

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



Figure 9. 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, as shown below:

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

Table 3: Time Series – Diagram Legend

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

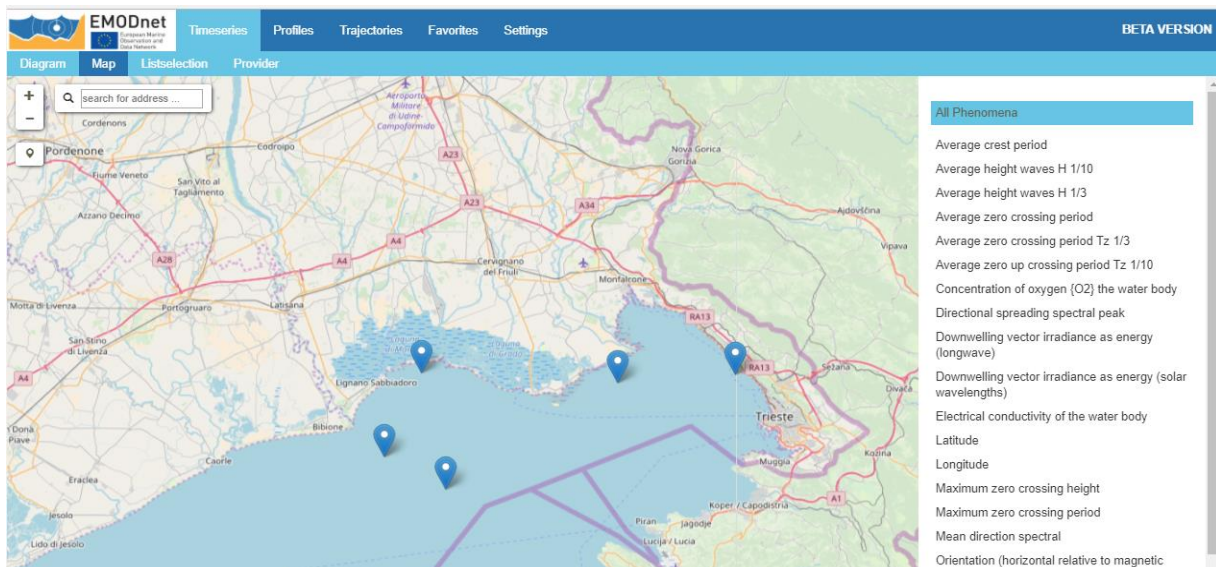


Figure 10. Time Series - Map page

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.

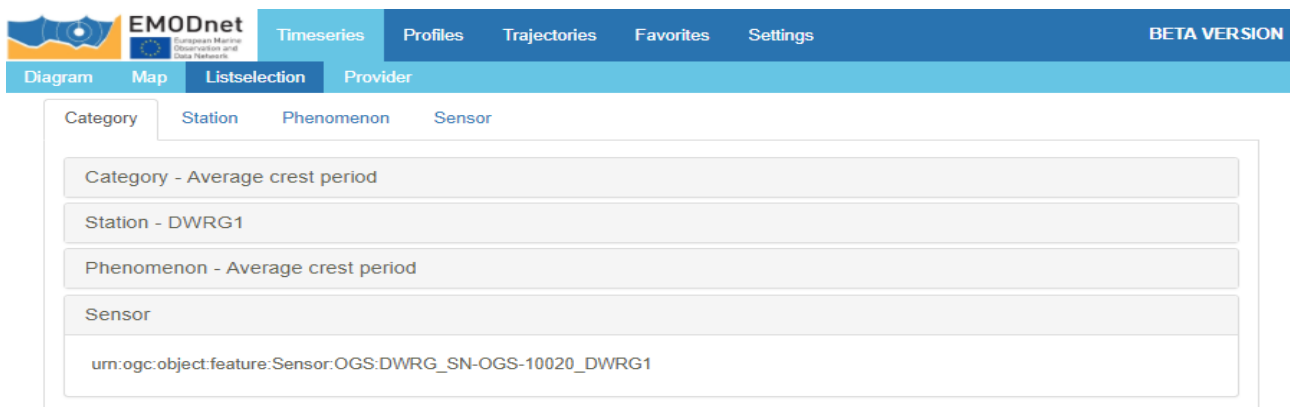


Figure 11. List Selection page

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.

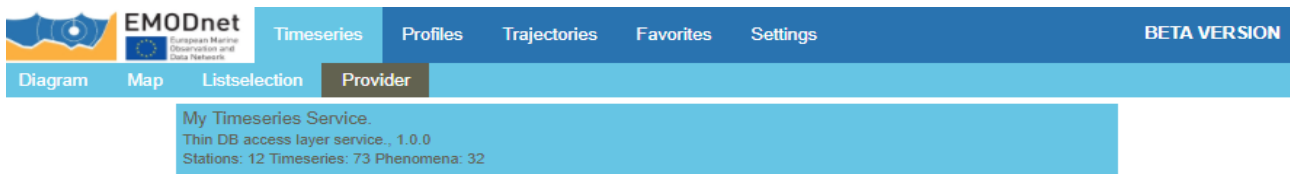


Figure 12. Timeseries – Provider page

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.

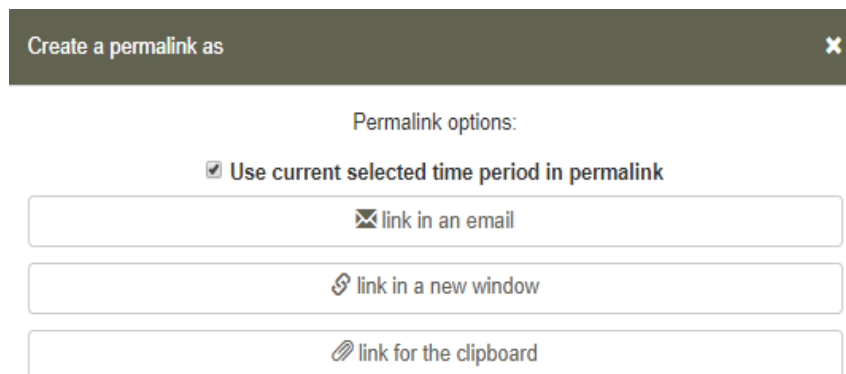


Figure 13. Permalink creation

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.

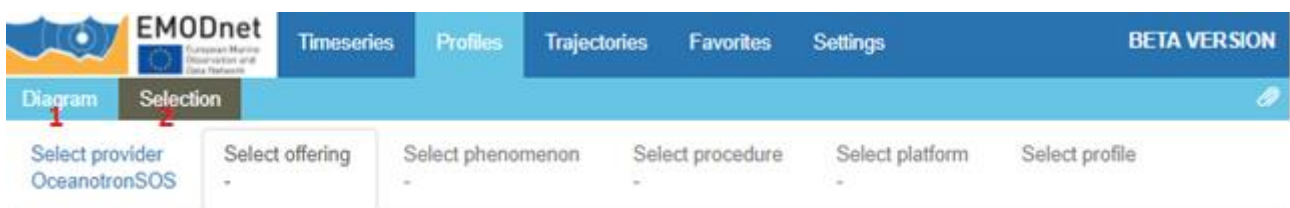


Figure 14. Profiles menu

The Profiles section menu provides two item:

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

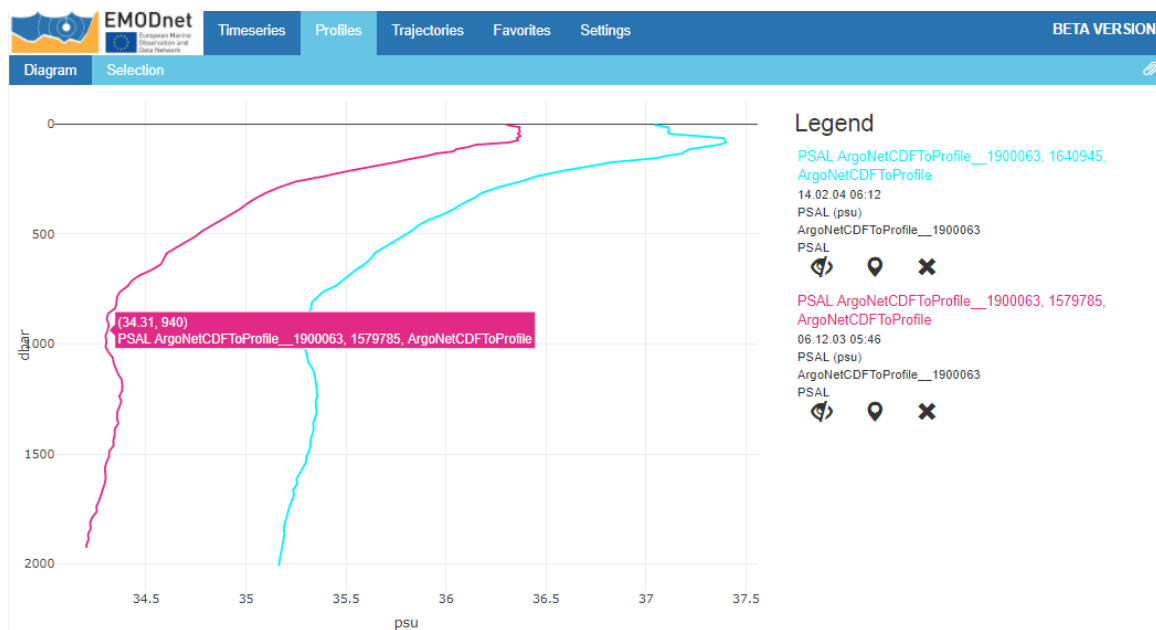


Figure 15. Profiles - Diagram page

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:




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

Table 4: Profiles – Diagram Legend

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:
 - Selection of the time stamp of the profile.



Figure 16. Profiles – Platform selection

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

Trajectories

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

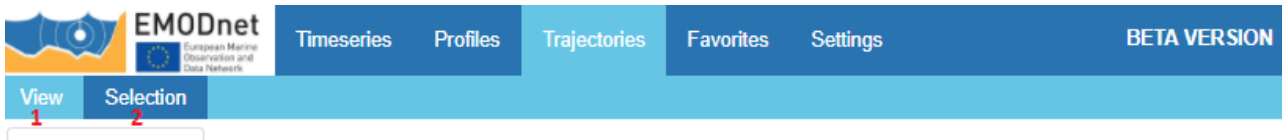


Figure 17. Trajectories Menu

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.

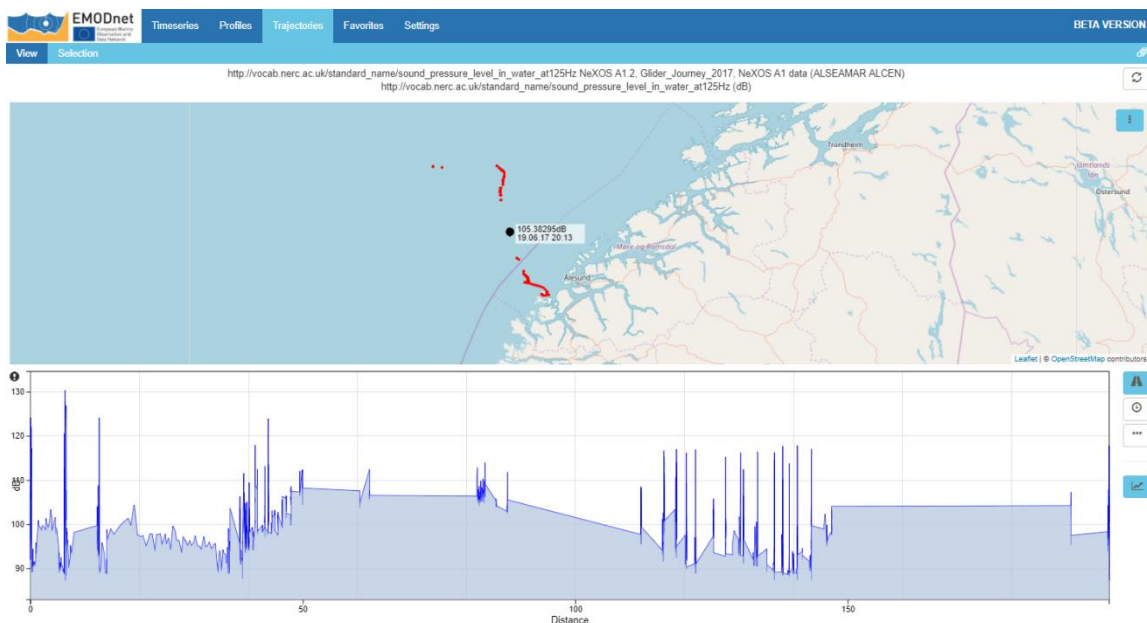


Figure 18. Trajectories – View Page

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.

Favorites

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.

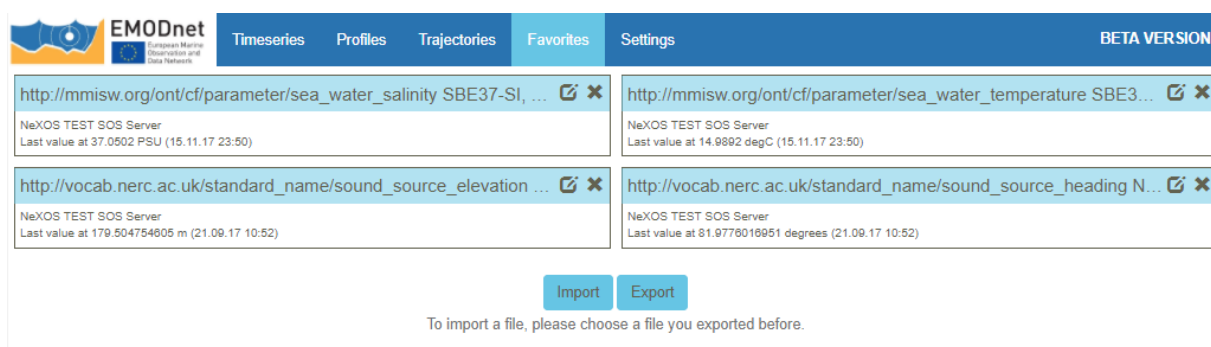


Figure 19. Favorites Page

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.

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

Settings

Settings

Save environment

All timeseries, the selected timespan and the settings are saved continuous.

Reset environment

Switch language ▾

generalize Data

Imprint

Imprint

Find this project at [GitHub](#)

52°North GmbH is responsible for this website.

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Figure 20. Settings page

7. References

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