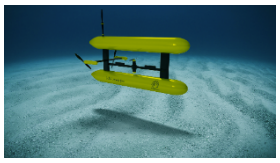
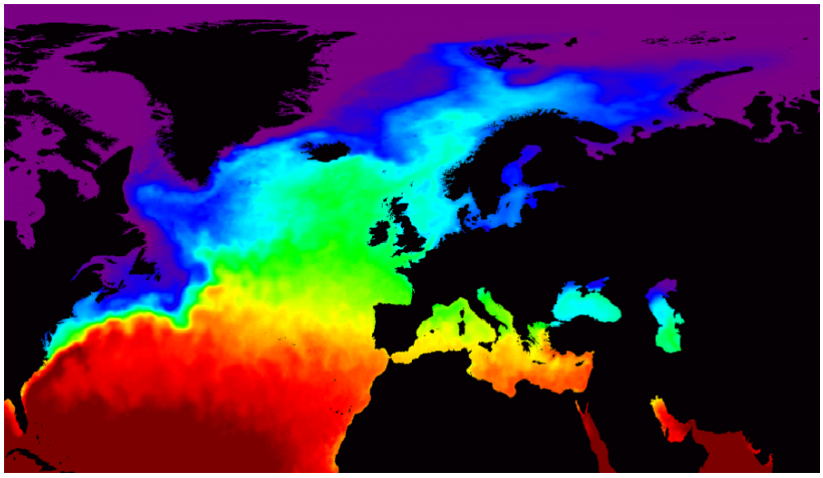
+atlantic

WP5 - Creation of a web-based Services to Support Ocean Industry





https://oomvisor.arditi.pt

Table of Contents

1 Introduction 3

2 Features 8

2.1 Forecast 9

2.2 Offshore renewable energy atlas 11

2.3 HF Radar 13

2.4 Wave Buoy Data 14

2.5 Fisheries Aquaculture 15

2.6 Biodiversity 16

2.7 Marine Mammals 17

2.8 Shipping 18

3 Future Developments 19

1 Introduction

One of the main *PROJECT +atlantic* objectives was the creation of a Communication Platform based on suitable information and communication technologies (ICT) for offshore industry in the Atlantic, the characterization of the dynamics of offshore related industries, identification, analysis, and promotion of most appropriate offshore technologies and methods for inspection and maintenance of subsea systems; integrated ocean observing systems merging in-situ and remote sensing data with high resolution 3D forecast models and the prevention monitoring and mitigation of environmental risks. The web-based data Interactive visor developed is complementary to the objectives.

Web-based Interactive mapping/data involves using maps that allow zooming in and out, panning around, identifying specific features, querying underlying data such as by topic, generating reports and other means of using or visualizing select information in the map. Working in a system of layers, the different levels of geographical information are placed on top of each other. Unlike static maps, interactive maps have the advantage of a number of features designed to improve the display of a large amount of complex data. Some of these features include:

1. The ability to create layers of information that can be shown or hidden at the click of a button;
2. Addition of text boxes to data points that show up when clicked to give a quick summary or description;
3. Zoom functions that allow users to focus on either the details of a particular region, or to gain a quick overview of a wider area;
4. Data can be quickly updated, and these updates made transparent to users;
5. Points on a map can be linked to external supporting documents, such as images, video, or graphs.

These feature results in the follow advantages:

1. Easy to demonstrate how an issue affects different populations and geographic areas;
2. The ability to choose which data to display on an interactive map allows the examination of individual variables;
3. Can be used in the design, implementation and evaluation of interventions, providing evidence that can be used in planning and implementation decisions;
4. Can show change over time, highlighting the temporal evaluation of a problem or a phenomena.
5. Interactive maps are powerful tools for presentation;
6. Powerful at representing conditions in an area, interactive maps can help policy makers understand issues more clearly, and lead to policies that address reality in rational ways.

A web-based Interactive data visor (https://oomvisor.arditi.pt), was built based on R, it is a language and environment for statistical computing and graphics. It is a GNU project which is similar to the S language and environment which was developed at Bell Laboratories (formerly AT&T, now Lucent Technologies) by John Chambers and colleagues. R can be considered as a different implementation of S. There are some important differences, but much code written for S runs unaltered under R.

R provides a wide variety of statistical (linear and nonlinear modelling, classical statistical tests, time-series analysis, classification, clustering, …) and graphical techniques, and is highly extensible. The S language is often the vehicle of choice for research in statistical methodology, and R provides an Open Source route to participation in that activity.

One of R's strengths is the ease with which well-designed publication-quality plots can be produced, including mathematical symbols and formulae where needed. Great care has been taken over the defaults for the minor design choices in graphics, but the user retains full control.

R is available as Free Software under the terms of the Free Software Foundation's GNU General Public License in source code form. It compiles and runs on a wide variety of UNIX platforms and similar systems (including FreeBSD and Linux), Windows and MacOS.

The R environment is an integrated suite of software facilities for data manipulation, calculation and graphical display. It includes:

- Effective data handling and storage facility;
- A suite of operators for calculations on arrays, in particular matrices;
- A large, coherent, integrated collection of intermediate tools for data analysis; graphical facilities for data analysis and display either on-screen or on hardcopy;
- A well-developed, simple and effective programming language which includes conditionals, loops, user-defined recursive functions and input and output facilities.

The term "environment" is intended to characterize it as a fully planned and coherent system, rather than an incremental accretion of very specific and inflexible tools, as is frequently the case with other data analysis software.

Is designed around a true computer language, and it allows users to add additional functionality by defining new functions. Much of the system is itself written in the R dialect of S, which makes it easy for users to follow the algorithmic choices made. For computationally-intensive tasks, C, C++ and FORTRAN code can be linked and called at run time. Advanced users can write C code to manipulate R objects directly.

R has its own LaTeX-like documentation format, which is used to supply comprehensive documentation, both on-line in a number of formats and in hardcopy.

There are about eight packages supplied with the R distribution and many more are available through the CRAN family of Internet sites covering a very wide range of modern statistics. R can be extended (easily) via packages, the most important used packages in this project are:

1) Shiny - Is a new package from RStudio that makes it incredibly easy to build interactive web applications with R. Can host standalone apps on a webpage or embed them in R Markdown documents or build dashboards. Can also extend your Shiny apps with CSS themes, html widgets, and JavaScript actions. It combines the computational power of R with the interactivity of the modern web. Shiny makes the power of R to visualize and manipulate data by users in a comprehensive / interactive and simple manner. It has the next Features:

a) Build useful web applications with only a few lines of code—no JavaScript required.
b) Shiny applications are automatically "live" in the same way that spreadsheets are live. Outputs change instantly as users modify inputs, without requiring a reload of the browser.
c) Shiny user interfaces can be built entirely using R, or can be written directly in HTML, CSS, and JavaScript for more flexibility.
d) Works in any R environment (Console R, Rgui for Windows or Mac, ESS, StatET, RStudio, etc.).
e) Attractive default UI theme based on Bootstrap.
f) A highly customizable slider widget with built-in support for animation.
g) Prebuilt output widgets for displaying plots, tables, and printed output of R objects.
h) Fast bidirectional communication between the web browser and R using the httpuv package.
i) Uses a reactive programming model that eliminates messy event handling code, so you can focus on the code that really matters.
j) Develop and redistribute your own Shiny widgets that other developers can easily drop into their own applications.

2) Leaflet - is one of the most popular open-source JavaScript libraries for interactive maps. It's used by websites ranging from The New York Times and The Washington Post to GitHub and Flickr, as well as GIS specialists like OpenStreetMap, Mapbox, and CartoDB. This R package makes it easy to integrate and control Leaflet maps in R. Features:
   a) Interactive panning/zooming;
   b) Compose maps using arbitrary combinations of:
      i) Map tiles;
      ii) Markers;
      iii) Polygons;
      iv) Lines;
      v) Popups;
      vi) GeoJSON.
   c) Create maps right from the R console or RStudio;
   d) Embed maps in knitr/R Markdown documents and Shiny apps;
   e) Easily render spatial objects from the sp or sf packages, or data frames with latitude/longitude columns;
   f) Use map bounds and mouse events to drive Shiny logic;
   g) Display maps in non-spherical Mercator projections;
   h) Augment map features using chosen plugins from leaflet plugins repository.
3) Highcharter is a R wrapper for Highcharts javascript libray and its modules. Highcharts is very mature and flexible javascript charting library and it has a great and powerful API. The main features of this package are:
   a) Various chart type with the same style: scatters, bubble, line, time series, heatmaps, treemap, bar charts, networks;
   b) Chart various R object with one function. With hchart(x) you can chart: data.frames, numeric, histogram, character, density, factors, ts, mts, xts, stl, ohlc, acf, forecast, mforecast, ets, igraph, dist, dendrogram, phylo, survfit classes;
   c) Support Highstock charts. You can create a candlestick charts in 2 lines of code. Support xts objects from the quantmod package;
   d) Support Highmaps charts. It's easy to create choropleths or add information in geojson format;

e) Piping styling;
f) Themes: you configure your chart in multiples ways. There are implemented themes like economist, financial times, google, 538 among others;
g) Plugins: motion, drag points, fontawesome, url-pattern, annotations.

Dashboards created from Shiny are an excellent interactive tool for visualizing raw data, aggregated information, and analytical results. In addition to the basic development features of R and shiny for dashboards, there are thousands of R packages serving this purpose (e.g., the used Leaflet and Highcharter) - with users from a wide range of fields. Both simple and fast-to-develop applications, as well as complex interactive apps with custom CSS and JavaScript elements, are possible to create. So, the use of shiny dashboards is attractive for companies of all sizes.

A few principles followed when developing web-based data visor dashboards:

1. Push as much of the calculations of the dashboard back to the database - The time it takes for a dashboard to load, and respond, will become the most important aspect of its design. For dashboards, the expected time to load and response is a few seconds;
2. Give the end-user with “train of thought” paths - These paths are commonly provided by way of a drill down from within the dashboard. These paths allow the end-user to quickly answer questions they currently have;
3. Make data driven inputs - It is easy to “hard code” the values that will be available in an input, such as a drop down. This may become a problem later on if the possible values change over time. An ancillary principle is to always use a look up table to obtain the list of values, when available. It is not ideal to obtain a list of possible values by grouping and summarizing a large column.

As a case study web-based products and services were implemented for the Madeira island region considering the layout described in the following flowchart.

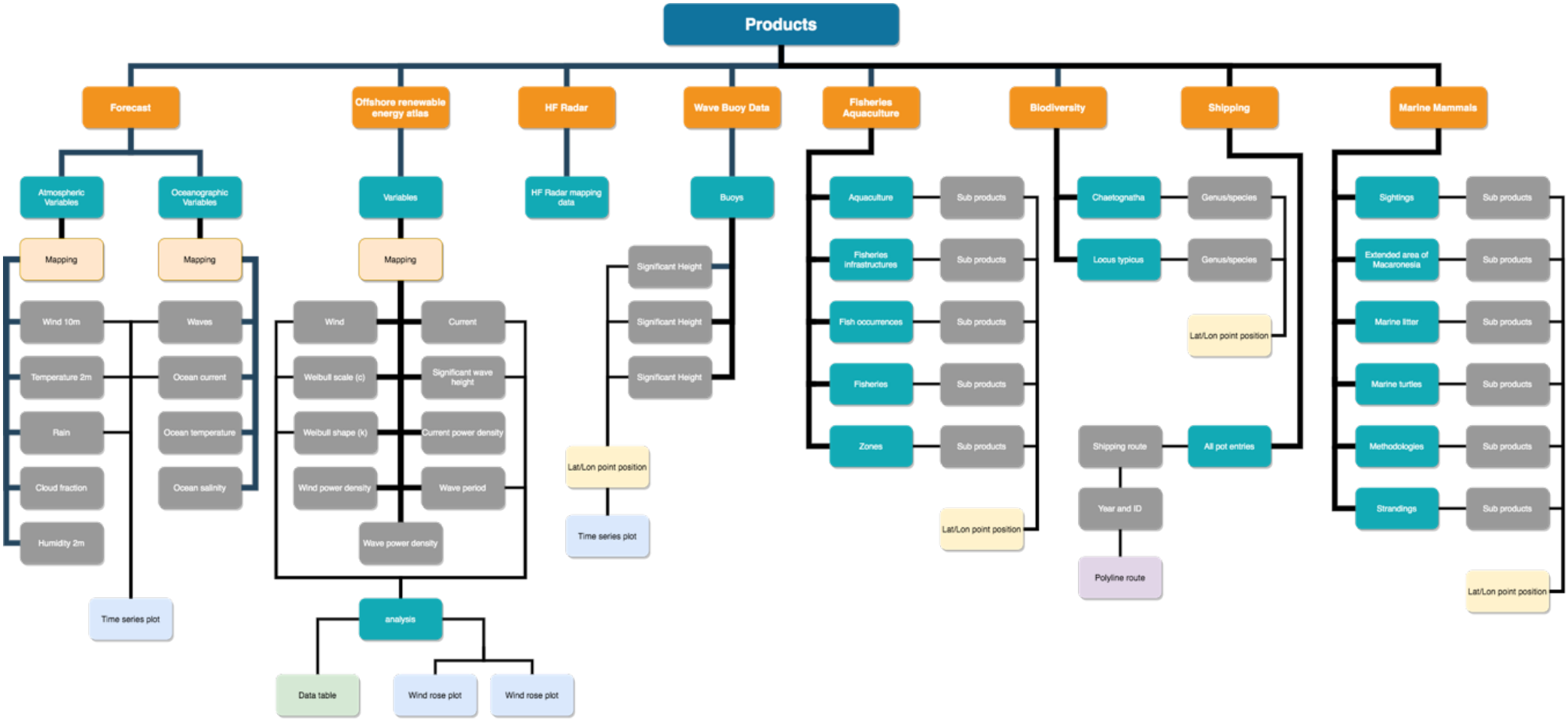


Figure 1 - Web-based products and services implemented for Madeira island region

2 Features

The web-based visor has multiple products available, which can be selected using the **Product** tab.

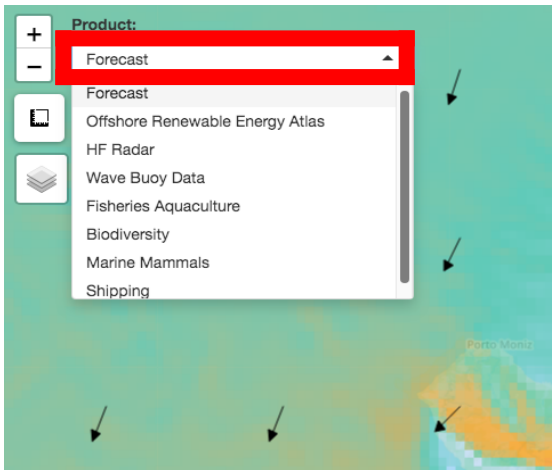


Figure 2 - Available products

There is available:

1. Atmospheric and oceanographic forecasts with time-series when user select a point in the map;
2. Offshore renewable energy atlas. User can select a point in the map in order to access wind rose and histogram plots, also there is available a tab to download selected point data;
3. HF radar data;
4. Wave buoy data time-series;
5. Fisheries aquaculture;
6. Biodiversity;
7. Marine mammals;
8. Shipping.

At the left top of the visor is present some simple tools, such a zoom in and out buttons, measuring tool (can measure distances and areas).

At bottom part, there is the legend and a button to toggle Fullscreen.

Figure 3 - Available tools

2.1 Forecast

Forecast were achieved using 3 coupled models (atmospheric and oceanic). For the atmosphere the WRF computes displayed variables wind 10m, temperature 2m, rain, cloud fraction and humidity 2m, can be selected in **Variable** tab.

Regard to oceanographic variable waves it is computed by WAVEWATCH-III and current, temperature and salinity are computed by ROMS and are represented at surface, 50, 100, 200, 500 and 1000 m of depth.

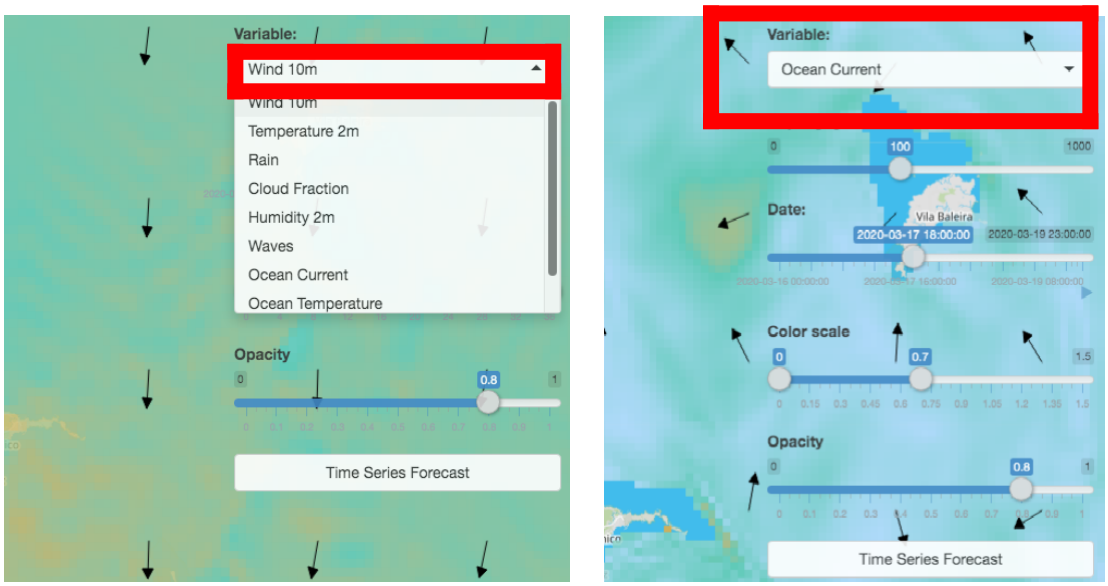


Figure 4 - Forecast controls

When user select a point in map **Time Series Forecast** tab will be available. Inside that tab is presented two plots, one with atmospheric forecast time series data and other with oceanographic atmospheric forecast time series data.

There is available a user set color scale. Here user has the freedom to change data colorbar data range. User can also change data mapping opacity.

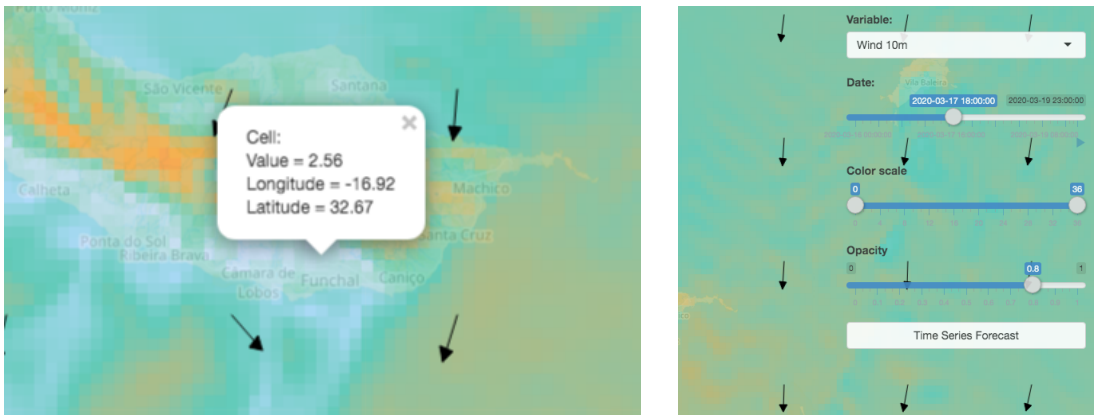


Figure 5 - Example of selected point

Figure 6 - Time-series forecast for selected point

2.2 Offshore renewable energy atlas

In **Variable** tab you can select the variables calculated by models:

1. Wind;
2. Weibull shape (k);
3. Weibull scale (c);
4. Wind power density;
5. Current;
6. Current power density;
7. Significant wave height;
8. Wave period;
9. Wave power density.

Figure 7 - Variable selector for offshore renewable energy atlas

In **Analysis** tab you can select TMY (represent the typical meteorological year periods), MAX (represent the periods with highest average) and MIN (represent the periods with lowest average). For wind, current, significant wave height and wave period variables you can observe calculated monthly average in TMY, MAX and MIN, and hourly values in TMY month values, MAX month values and MIN month values. Weibull, and annual power density calculations are presented in TMY, MAX and MIN, and monthly calculations in TMY month values, MAX month values and MIN month values.

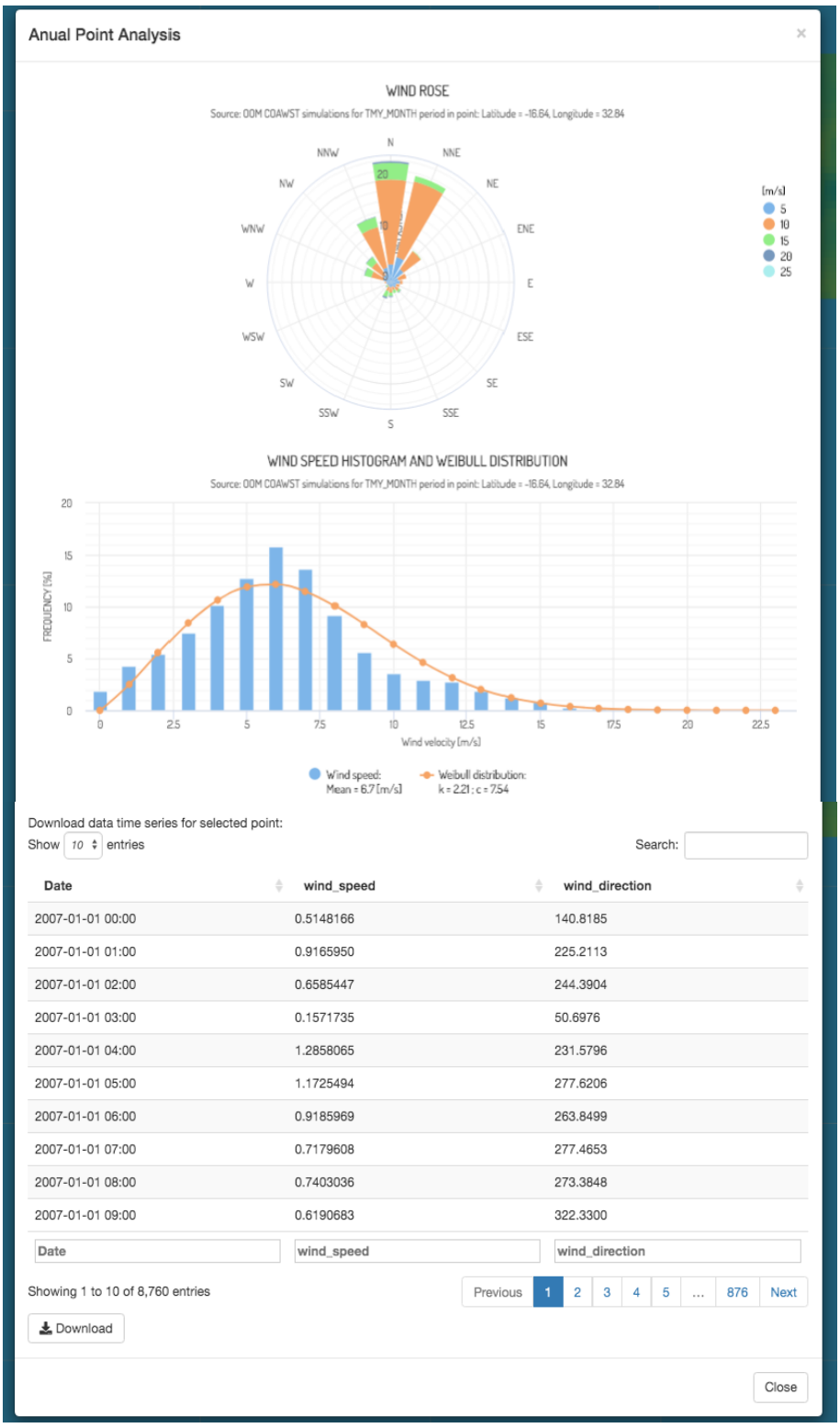


Figure 8 - Detailed information presented in Analysis

To see the value of a single cell user must select/click in any point inside the mapping area. When a cell is selected by user, **Point plots and table** tab is accessible and inside are the annual point analysis. There is present a wind rose, wind speed histogram and Weibull distribution and a table of the data at the bottom. That data will be available for download in the **Download** tab above.

2.3 HF Radar

This is a product obtained from 2 HF radar systems installed in south of Madeira island. In this product user can select mapping data by date in **Date** slider.

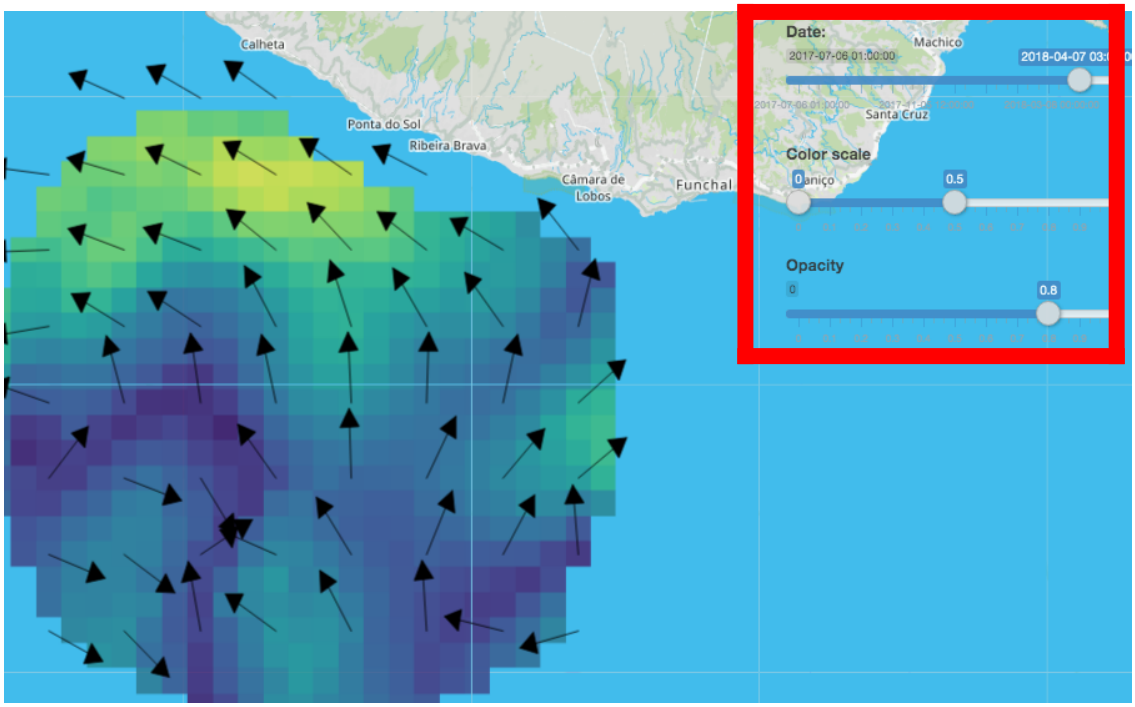


Figure 9 - HF Radar data example

2.4 Wave Buoy Data

This product is the historical data measured by buoys, only one at south of Funchal until present time. Measured variables are Significant Height, Maximum Height, Average direction and Peak Period.

When user select the buoy, a small description is present and a button named **Buoys Data** is available with a time series plot, date range can be changed by user.

Figure 10 - Wave Buoy data example

2.5 Fisheries Aquaculture

Is a product with multiple available sub products:

1. Aquaculture sites;
2. Fisheries infrastructures;
3. Fish occurrences;
4. Fisheries;
5. Zones.

Each sub products appear in the map by user a multiselecting. Each ID has particular information that can be accessed by user click on ID icon.

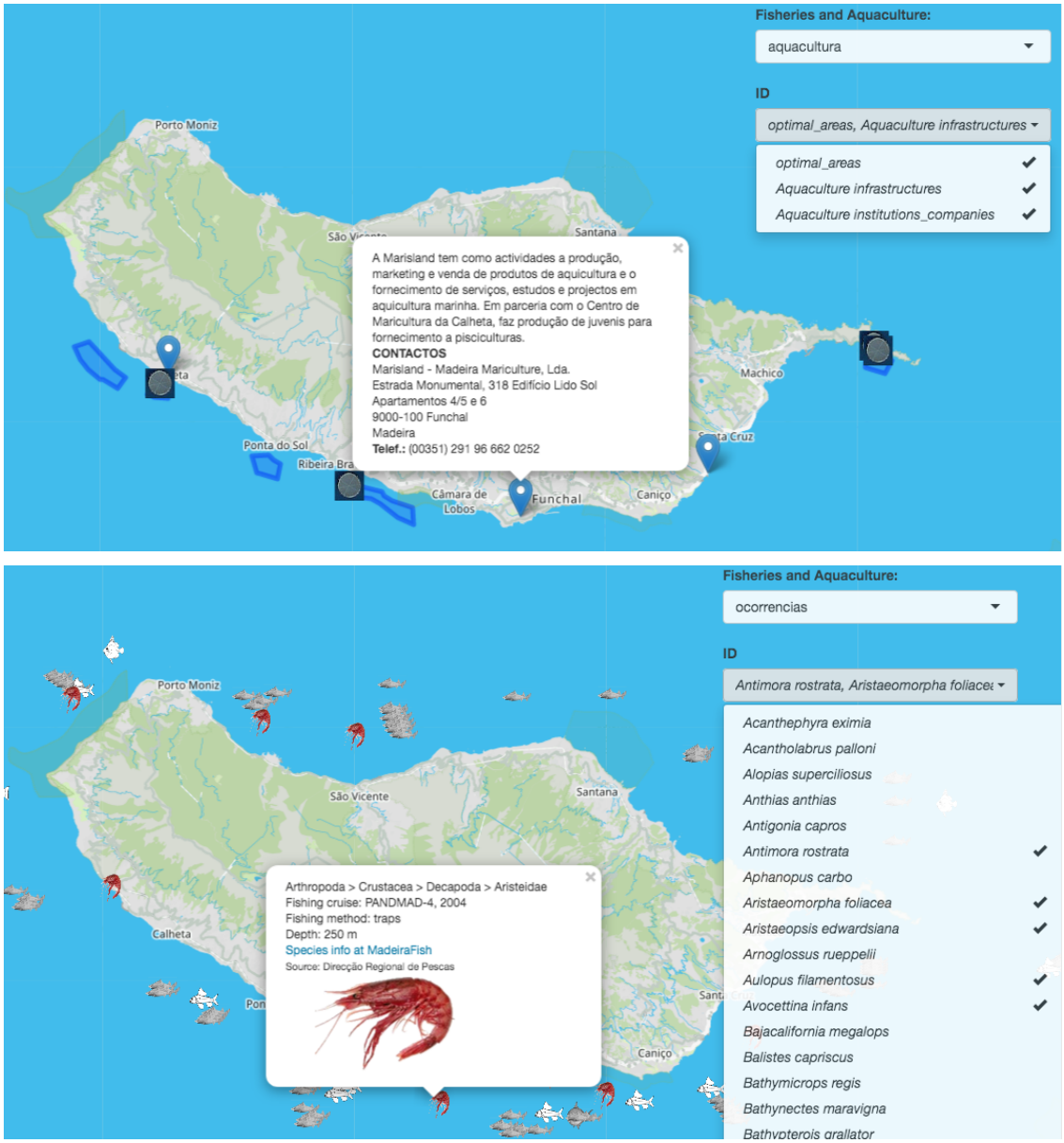


Figure 11 - Fisheries and aquaculture georeferenced data example

2.6 Biodiversity

This product is a biodiversity catalogue for Madeira island. Each species/product appears in the map by user a multiselecting. When user select species on the map a popup appears on the screen with detailed information of that species.

Figure 12 - Biodiversity georeferenced data example

2.7 Marine Mammals

Is a compilation of the geographic distribution of marine mammals observations / occurrences:

1. Sightings;
2. Extended area of Macaronesia;
3. Marine litter;
4. Marine turtles;
5. Methodologies;
6. Strandings.

Each product appears in the map by user a multiselecting. When user select species on the map a popup appears on the screen with detailed information of that species

Figure 13 - Marine Mammals georeferenced data example

2.8 Shipping

This is a record compilation of shipping from all Madeira ports since 1960.

Each shipping track appears in the map by user a multiselecting. When user select a track on the map a popup appears on the screen with the detailed information.

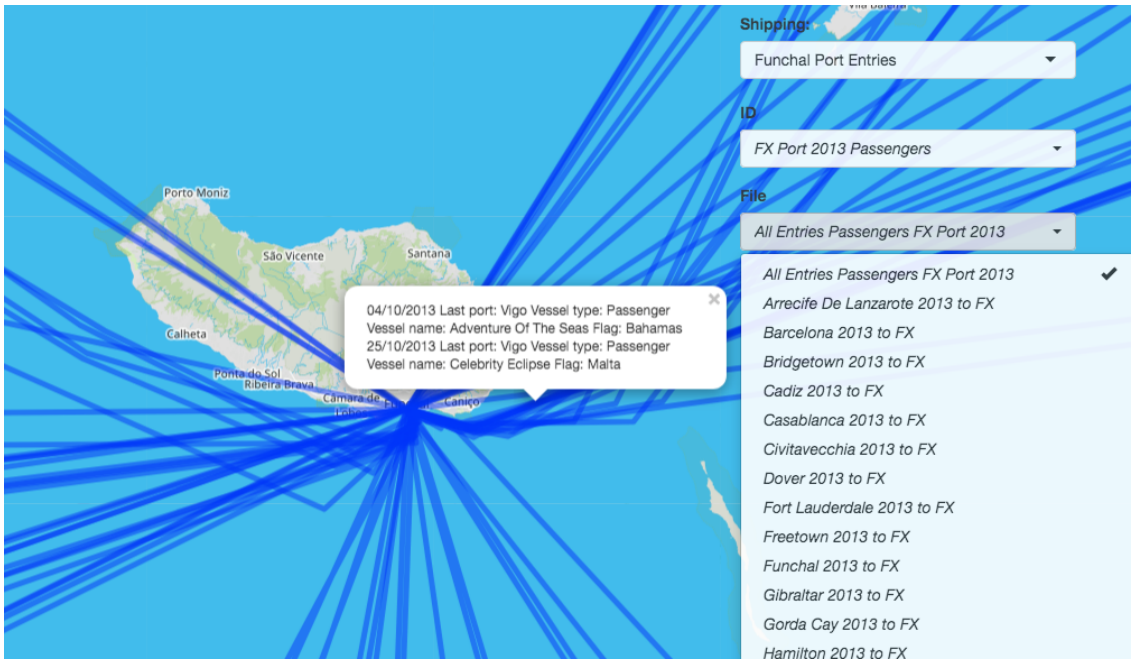


Figure 14 - Shipping track data example

3 Future Developments

Implementation of active tools such as the Lagrangian tracking of particles, pollution, in the ocean and in the atmosphere. High resolution annual, seasonal and monthly ocean climatology mapping for the Atlantic.

Project +atlantic

Instituto Superior Técnico – Maretec

Secção de Ambiente e Energia – Dpto de Mecânica

Av. Rovisco Pais, 1049-001, Lisboa, Portugal

Contact: +351 218419427

Email: maisatlantico@maretec.org

Funded Developers

Self Funded Developers

Other Contributors

+atlantic is funded by CMU-Portugal under agreement FCT CMUP-ERI/TIC/0045/2014