Report on new products

Ref.: D7.14_V1.1

Date: 21/12/2021

Euro-Argo Research Infrastructure Sustainability and Enhancement Project (EA RISE Project) – 824131

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Document Reference

Project	**Euro-Argo RISE - 824131**
Deliverable number	**D7.14**
Deliverable title	**Report on new products**
Description	**The new products developed to enhance Euro-Argo visibility: communication and dissemination towards user's community**
Work Package number	**WP7**
Work Package title	**Euro-Argo RISE visibility: communication and dissemination towards user's community**
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Submission date	**21 December 2021**
Due date	**[M36] – 31 December 2021**
Comments	-
Accepted by	**Claire Gourcuff**

Document History

Version	Issue Date	Author	Comments
1.0	09/12/2021	Thierry Carval – Ifremer	Initial version
1.1	21/12/2021	Thierry Carval – Ifremer	Final version including partners inputs

Executive summary

This report is dedicated to the description of 7 new products developed within Euro-Argo RISE in order to i) enhance services to Euro-Argo users and operators and ii) improve Euro-Argo visibility.

- The Argo data selection web interface allow to discover, select, subset and download Argo data

- New products have been developed to enhance services to existing Argo data users:

  o The BGC-Argo synthetic profiles combine core-Argo (P,T,S) and BGC-Argo distinct profiles into a simple NetCDF well aligned data table. The BGC (bio-geo-chemical) users have an efficient and simplified access to data.

  o The Argo currents product is a daily updated operational product for deep-ocean currents and surface currents calculated from Argo floats trajectories.

- Two tools dedicated to Argo floats operators have also been developed:

  o Argo floats recovery web service: an interactive web page dedicated to oceanographic cruises recovering Argo floats.

  o WMOP currents: the results of the Western Mediterranean OPerational forecasting system (WMOP) for floats operation in coastal areas

- Finally, the report describes the Wesstiti serious game created for young college apprentice Argo oceanographers and the "Argo smartphone app", a simple web interface to discover Argo floats and data from a smartphone.

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1. New web interface for Argo data access

As part of Euro-Argo RISE, Ifremer has developed the "Argo data selection" web interface which proposes discovery, sub-setting and downloading of Argo data.

The web GUI[1] is developed in a very responsive Angular-JS environment. The facets allow you to select and refine in a very interactive way the 2 billion observations from more than 16,000 Argo floats.

The selected data are freely downloadable in 3 possible formats: Ascii-csv, Argo original NetCDF, Copernicus Marine NetCDF.

The web GUI uses the Argo metadata and data API[2]s developed in the EU H2020 ENVRI-FAIR project.

The APIs query Argo big-data: metadata is indexed in Elasticsearch (a search engine), data is queried in Cassandra tables (a noSQL database). These APIs are extremely responsive, instantly displaying metadata (16,000 floats) and data (2 billion observations).
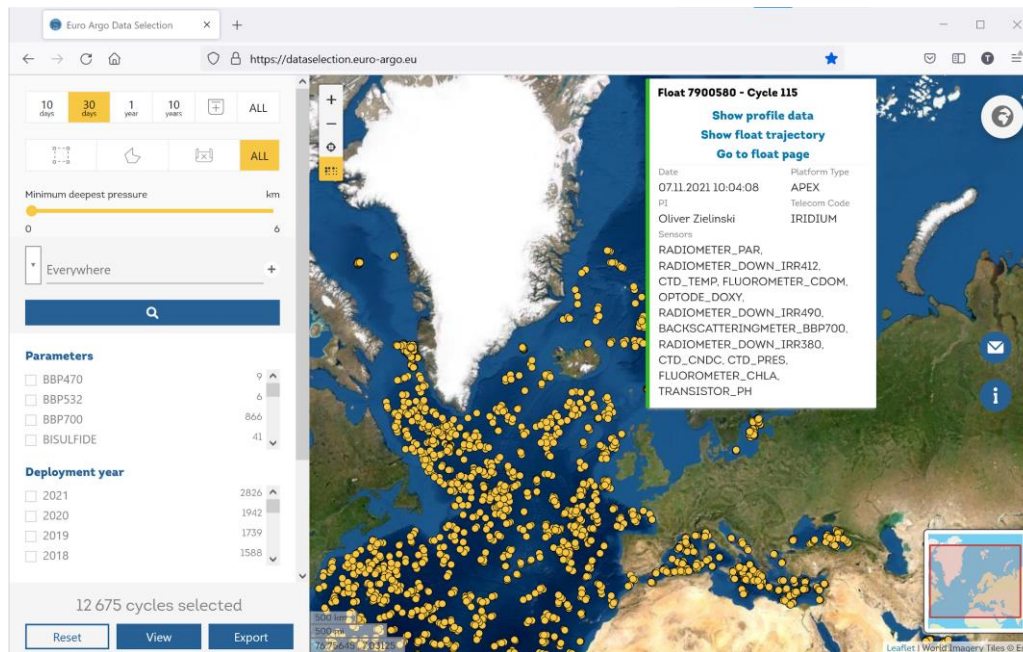

Figure 1 : "Argo data selection" https://dataselection.euro-argo.eu

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[1] Web GUI : Graphic User Interface

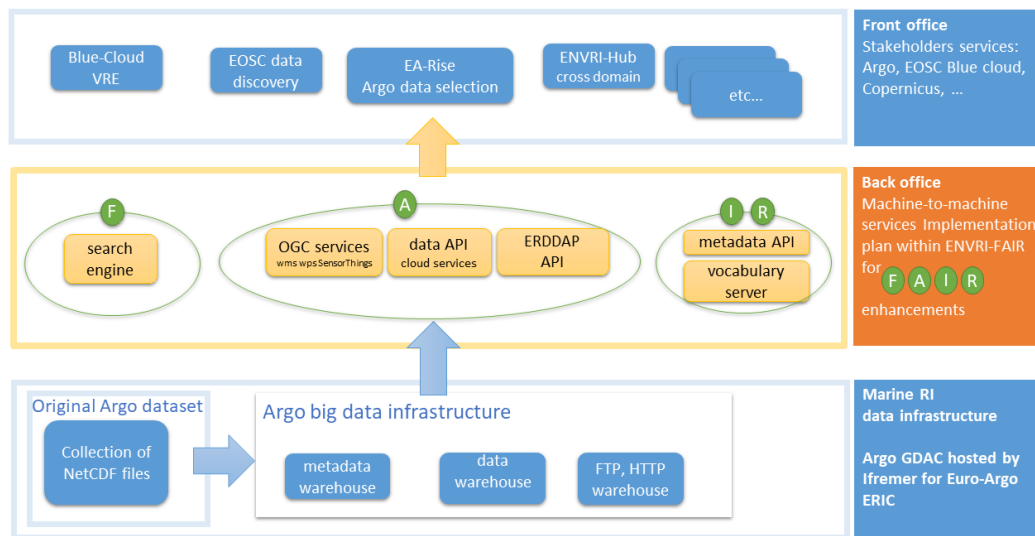[2] API : Application Programming Interface

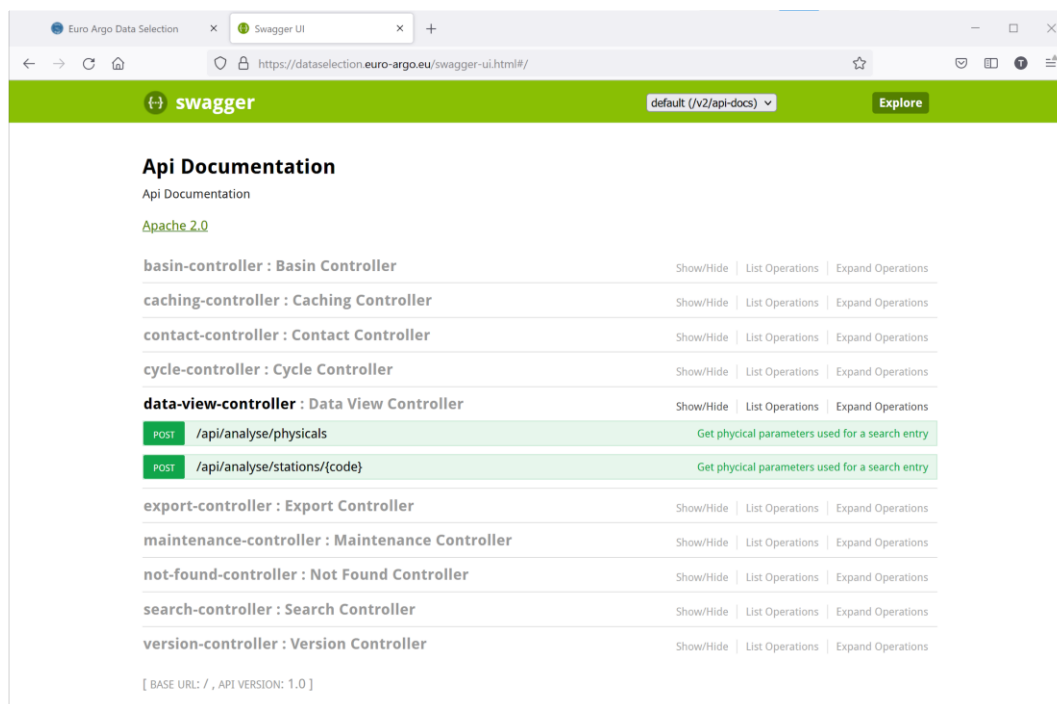*Figure 2: **the web GUI (Euro-Argo RISE) queries the FAIR data APIs (ENVRI-FAIR) on top of Argo GDAC (Euro-Argo)***

*Figure 3: **the data and metadata APIs are public on Internet, queried by "Argo data selection" web interface (Euro-Argo RISE)** https://dataselection.euro-argo.eu/swagger-ui.html*

2. New products for Argo data users

2.1. BGC-Argo synthetic profiles

To facilitate the use of BGC[3]-Argo profiles, Ifremer (as Coriolis Argo GDAC[4]) developed and implemented the generation of Argo floats synthetic profiles. The development is based on the detailed specification published in:

Bittig Henry, Wong Annie, Plant Josh, Coriolis Argo Data Management Team (2019). **BGC-Argo synthetic profile file processing and format on Coriolis GDAC***. https://doi.org/10.13155/55637*

When a float is equipped with BGC sensors in addition to the classical CTD sensor, measurements from multiple sensors are not aligned during onboard processing by the floats, and each parameter is recorded in its raw pressure location. This makes it difficult to study these BGC parameters as co-located measurements, since some data manipulation to align them needs to be done before scientific studies can be carried out. Moreover, because the Argo file format requires that all parameters have dimensions (N_PROF, N_LEVELS), where N_LEVELS = maximum number of vertical levels, the files are large in file size and are mostly filled with white space. The goal of a simplified synthetic profile is then to co-locate as many BGC observations as possible together with the core parameters (pressure, temperature and salinity) while preserving the character of the sampling pattern, i.e., sample interval, number of samples, and approximate pressure locations. No intermediate BGC parameters are included. The synthetic pressure axis is constructed from the BGC sampling levels from each cycle. This means that there is no fixed vertical grid for all floats and all cycles.

The synthetic cycle profiles are distributed on Coriolis GDAC from the existing core and BGC Argo profiles. For each cycle, the existing Argo NetCDF V3.1 profile file contains one or more core-Argo profiles (pressure, temperature, salinity) and one or more additional BGC profiles (oxygen, chlorophyll, etc…).

Data are stored into two or more arrays (N_PROF >= 2).

The index of BGC-Argo synthetic profile files is available on:

- ftp://ftp.ifremer.fr/ifremer/argo/argo_synthetic-profile_index.txt

On Figure 4, an example of a float with multiple BGC sensors (WMO 6901472, first 20 cycles) is shown for two depth ranges. Left panels give the profile information returned from the BGC float, right panels the synthetic profile.

The illustrations Figure 5, Figure 6 and Figure 7 show the global spatial coverage of Argo BGC profiles as available within Copernicus Marine in situ TAC, as presented in BGC-Argo – Copernicus Marine joint meeting in October 2021.

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[3] BGC-Argo : Argo floats that perform Bio-Geo-Chemical observations such as oxygen, chlorophyll, nitrate

[4] Argo GDAC : Global Data Assembly Centre for Argo profiling floats
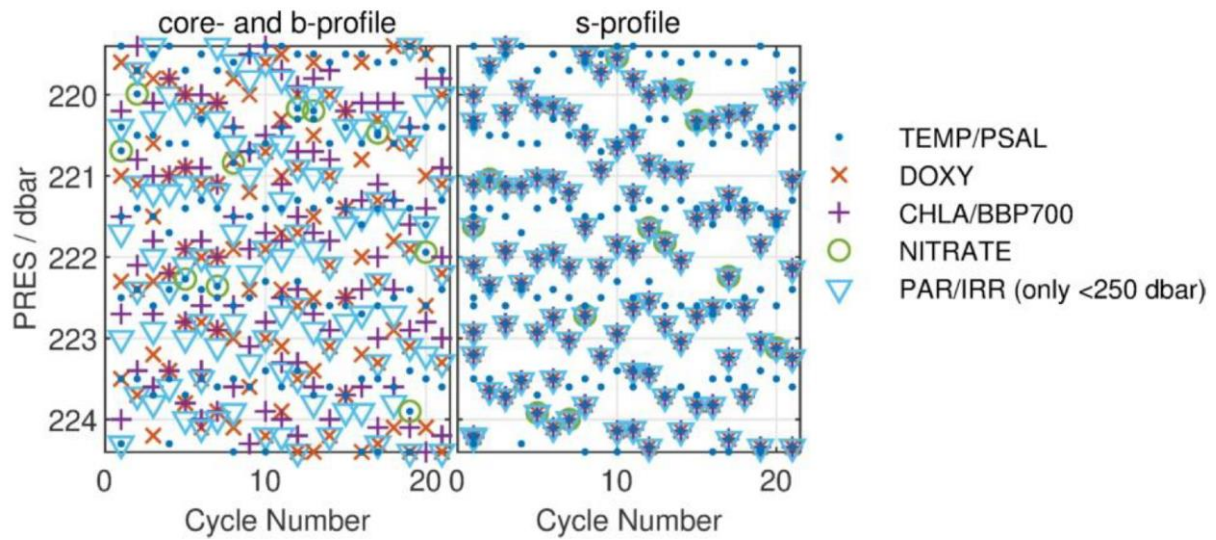
Figure 4 : ***the first 20 cycles from float 6901472 between 220 – 224 dbar***
In the synthetic profile (s-profile), all parameters are aligned on pressure levels (a much simpler use of BGC data for Argo users)
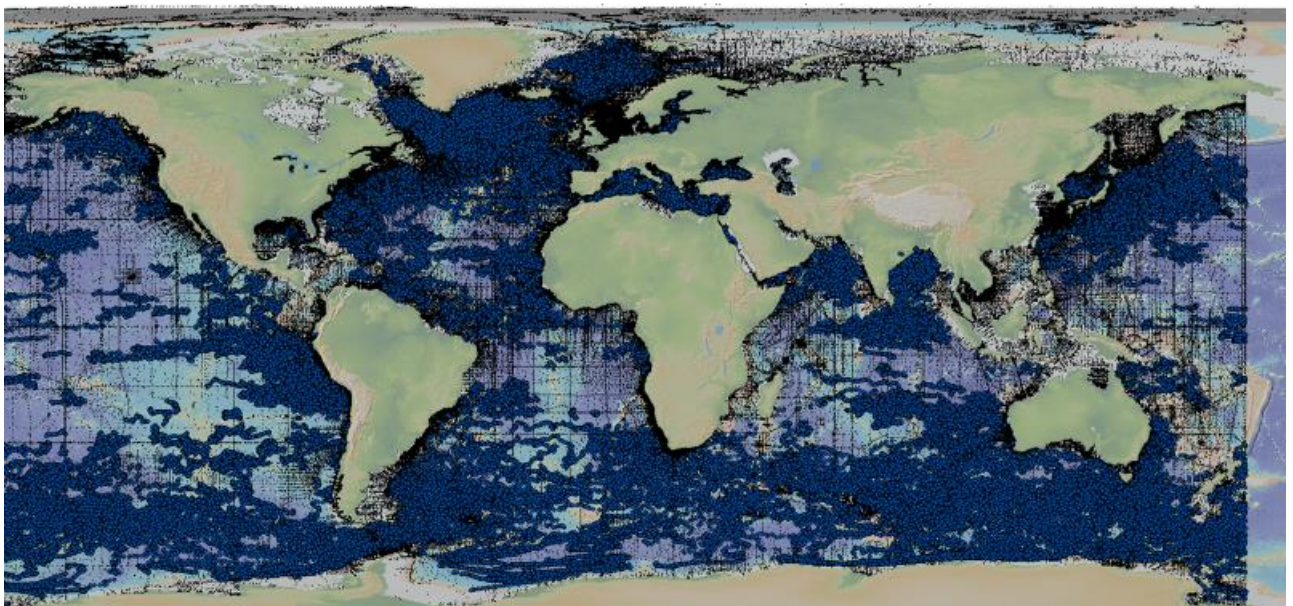

*Figure 5 : **BGC-Argo oxygen profiles among Copernicus Marine BGC profiles***

Copernicus chlorophyll profiles: 0,53 million including 95.000 BGC-Argo profiles

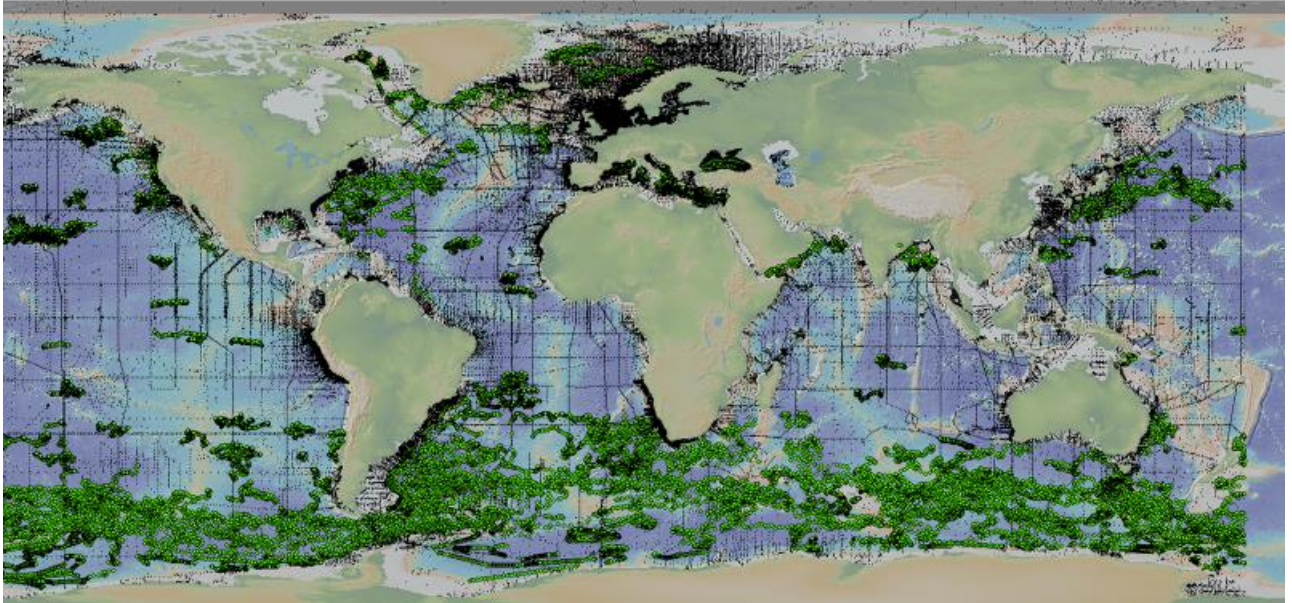16/10/2021 BGC-Argo: green dots, other chlorophyll profiles: black dots

*Figure 6 : **BGC-Argo chlorophyll profiles among Copernicus Marine BGC profiles***

Copernicus nitrate profiles: 0,5 million including 50.000 BGC-Argo profiles

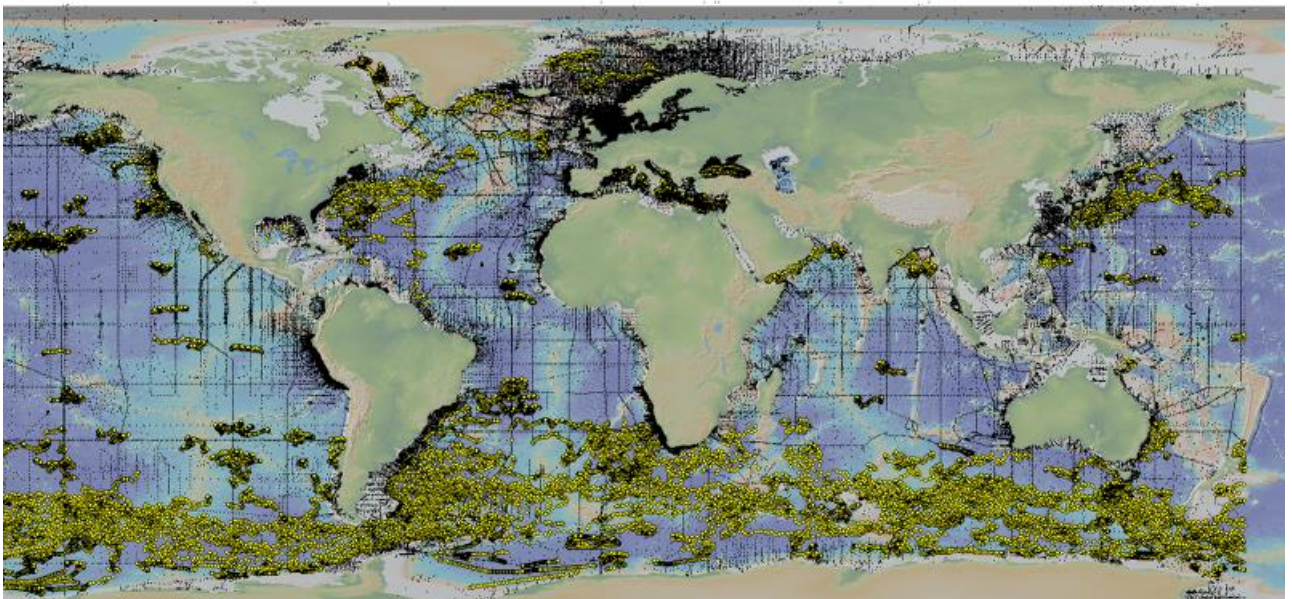16/10/2021 BGC-Argo: yellow dots, other nitrate profiles: black dots

*Figure 7: **BGC-Argo nitrate profiles among Copernicus Marine BGC profiles***

2.2. Argo currents

Within EA-RISE, Ifremer developed a new operational product for Argo floats currents: deep-ocean currents and surface currents.

It is now available from Copernicus Marine service catalogue:

- https://resources.marine.copernicus.eu/product-detail/INSITU_GLO_UV_NRT_OBSERVATIONS_013_048/INFORMATION

This product is derived from the original trajectory data of Argo GDAC (Global Data Assembly Center). In 2021, the GDAC distributes data from more than 16,000 Argo floats. Deep ocean current is calculated from floats drift at parking depth. Surface current is calculated from float surface drift.

A specific real-time quality control is applied on Argo floats currents.

An Argo float drifts freely in the global ocean, performing regular observation cycles of the water column by changing its buoyancy (Figure 11).

An observation cycle usually spreads over 10 days and consists of:

- a descent from the surface to a parking depth (generally 1500 meters deep)
- a 10-day drift at this parking depth
- an ascent to the surface (vertical profile)
- A short surface drift for data transmission

The data transmitted at each cycle contain temperature, salinity observations (and additional biogeochemical parameters if applicable), positions (gps or argos), technical data.
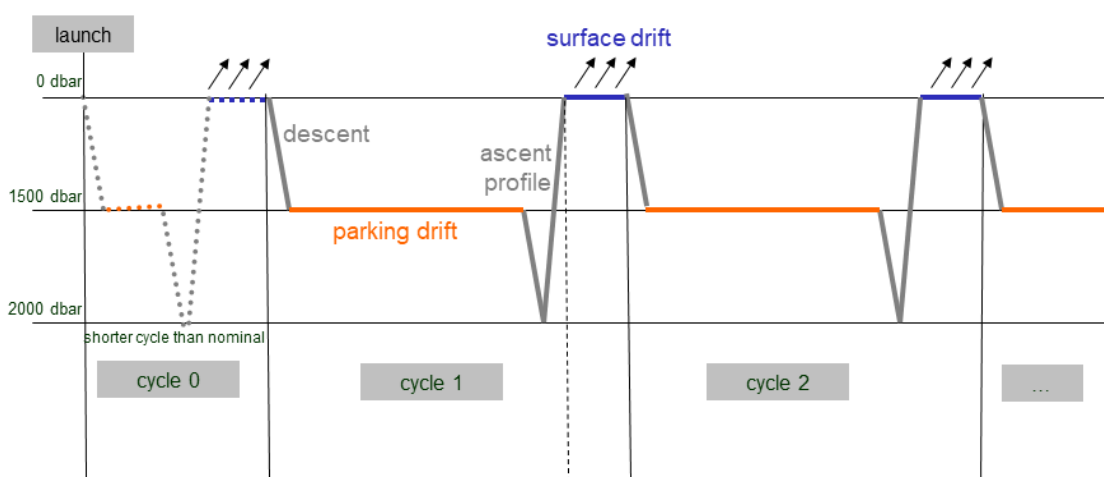

Figure 8: ***the cycles of an Argo float***

The ocean current product contains a NetCDF file for each Argo float. It is updated daily in real time by automated processes. For each cycle it contains the surface and deep current variables (see Figure 9).
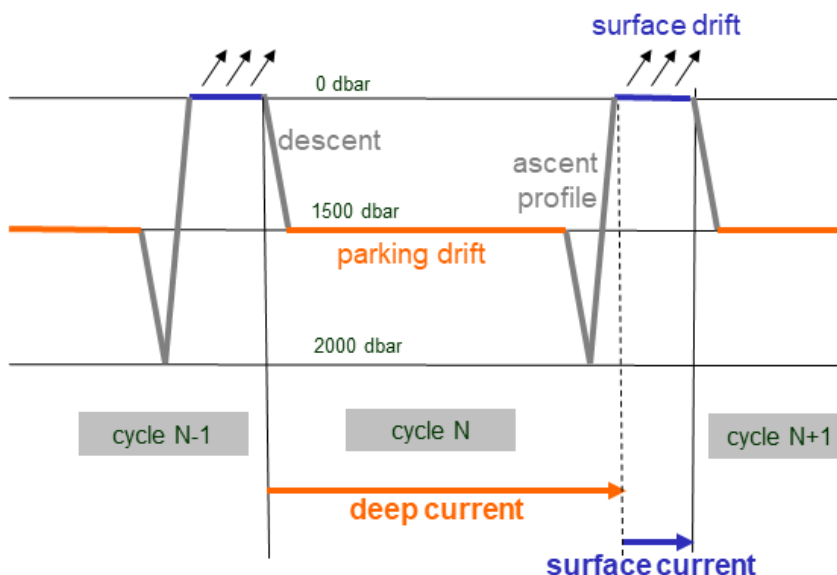
Figure 9: deep and surface current for a cycle of an Argo float

The Argo current dataset contains variables listed in Table 1.

Variable name	Description	Units
TIME	Date of the data	days since 1950-01-01T00:00:00Z
PRES	Representative pressure of the current observation	decibar
LATITUDE	Latitude of the data position	Degree North
LONGITUDE	Longitude of the data position	Degree East
EWCT	West-East sea water velocity at the representative pressure	m.s-1
NSCT	South-North sea water velocity at the representative pressure	m.s-1
TIME_INTERVAL	Time interval of the current variable (measured between two locations)	day
PLATFORM_CODE	The float platform code	n/a
GROUNDED	Indicates the best estimate of whether the float touched the ground for that cycle. The conventions are described in Argo reference table 20.	n/a

Table 1 : list of the available variables for Argo current dataset.

Positions and dates have a QC[5] 1 (good data). Positions and dates that do not have a QC 1 are ignored. The positions are measured during the surface drift (Argos or GPS positioning).

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[5] QC : Quality Control flag used in Argo data files, QC 1 is for good data

For the deep current of cycle N, we take the last good position of cycle N-1 and the first good position of cycle N.

For the surface current of cycle N, we take the first and last good position of the N cycle. The current vector is positioned and dated at the last position of the N-1 cycle.

Four automated real-time quality controls are applied:

- Bathymetry test (pressure is above GEBCO 2020 bathymetry)
- Global range speed test (current speed is less than 3 m/s)
- Positive pressure (pressure is >= 0 decibar)
- If the cycle's "GROUNDED" flag is set ("Y"), the current is flagged false.

The Quality Control (QC) flags of the values which fail the test are set to "bad data" (QC = 4).
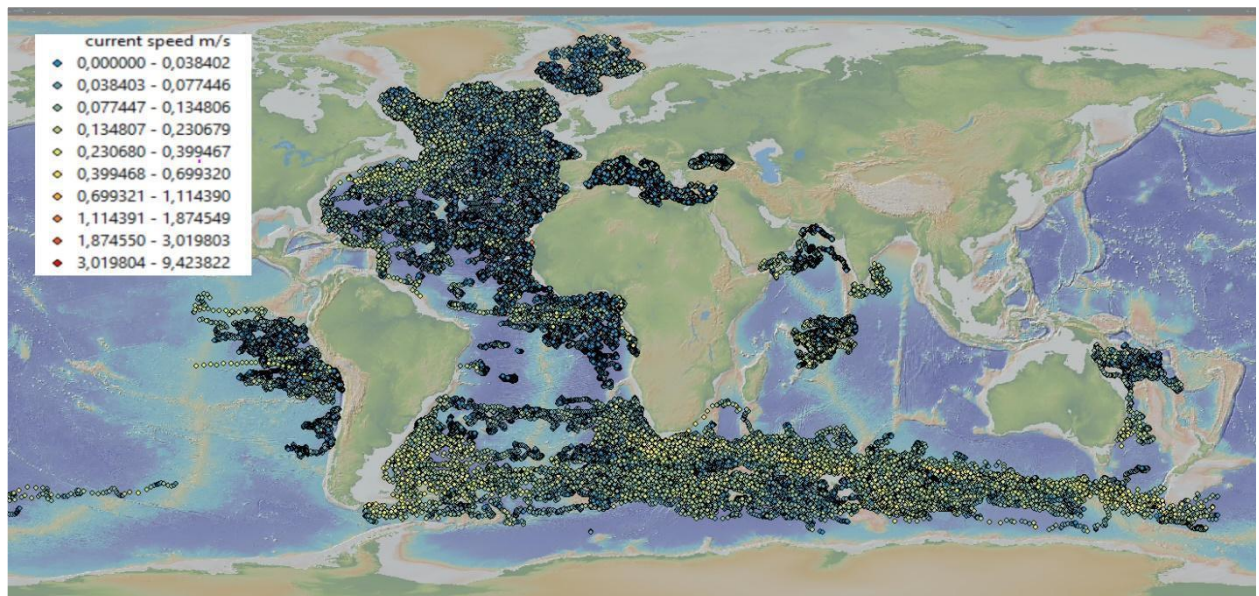

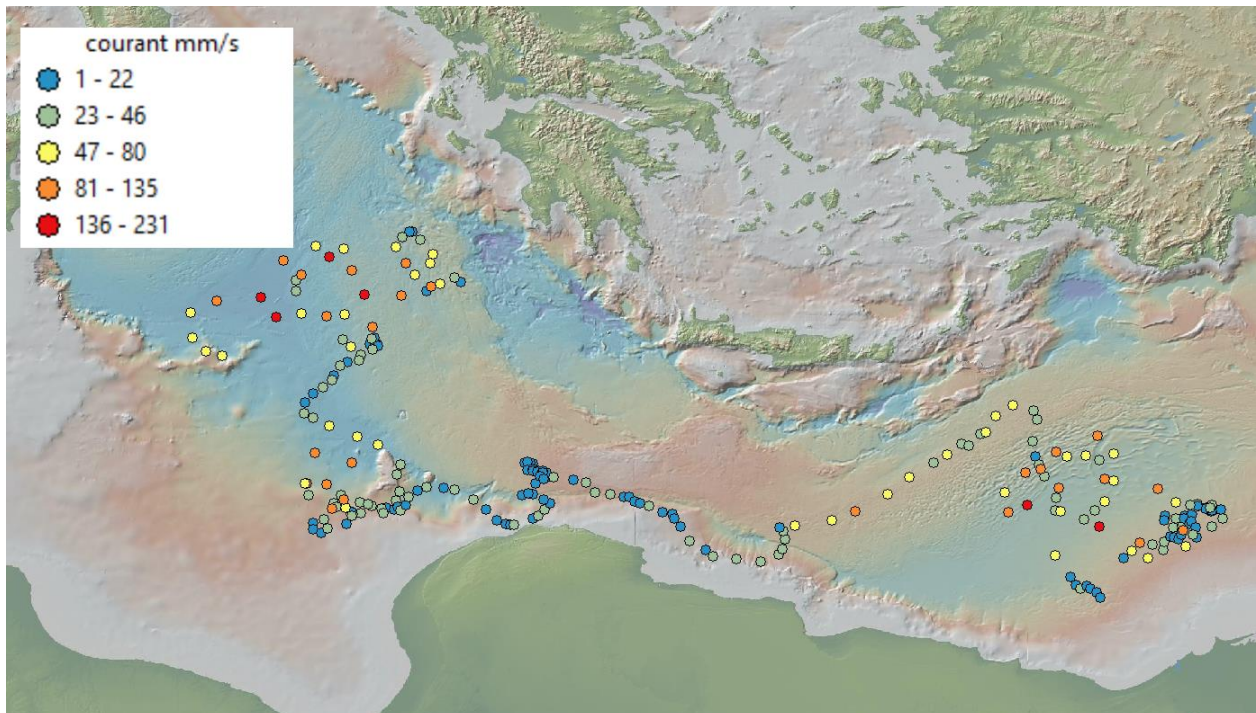*Figure 10:* ***Argo currents from 577 Coriolis DAC trajectory files***

*Figure 11: **Argo current from float 6900967: 250 values from 1 millimeter/second to 231 millimeter/second.***
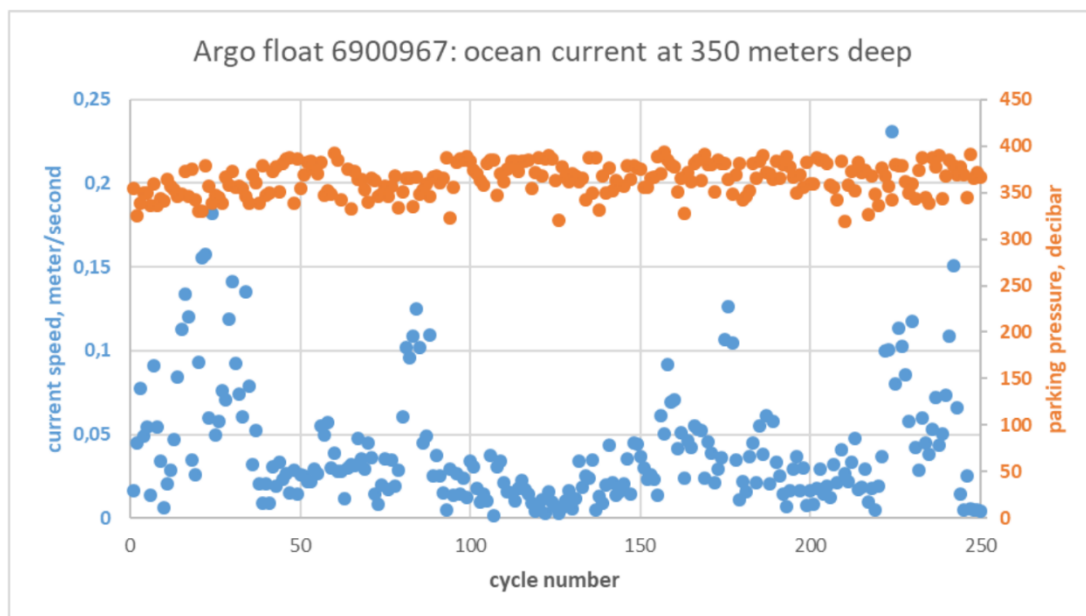

*Figure 12: **Argo current from float 6900967 around 350 meter deep.***

3. Web services for Argo operators

3.1. Argo floats recovery web service

A web service for the recovery of Argo floats in the ocean has been developed. It is intended for float recovery cruises.

A float to be recovered drifts on the ocean surface while continuously transmitting its position. The vessel that comes to collect it must be informed in real time of the position of the float.

The float recovery service is activated on request. A high frequency decoding of the float data is then activated (one decoding per minute). A web page displays the positions of the float and the last position of the vessel. It is available from a PC or mobile phone on:

- https://floatrecovery.euro-argo.eu

This service, available since summer 2021, has been used successfully for float recovery in the Atlantic, Mediterranean and Baltic sea.
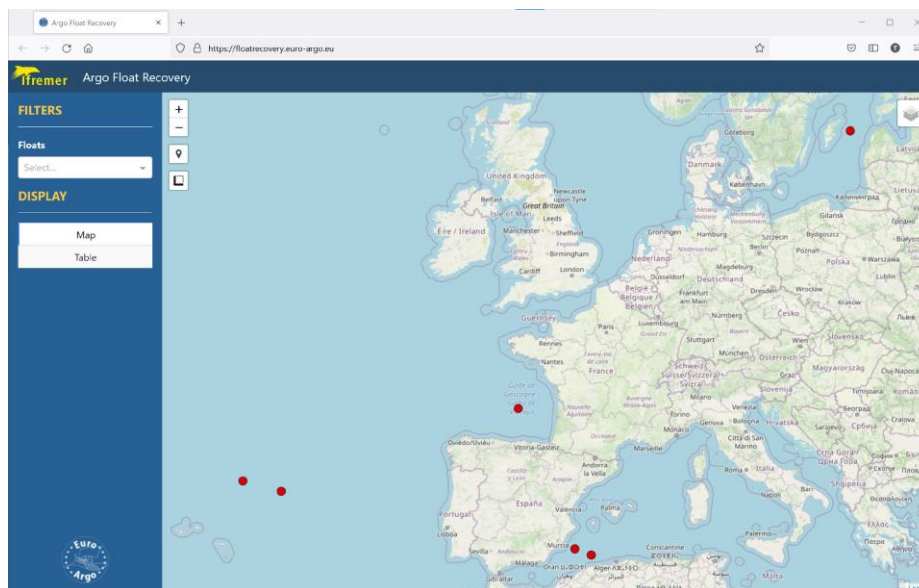

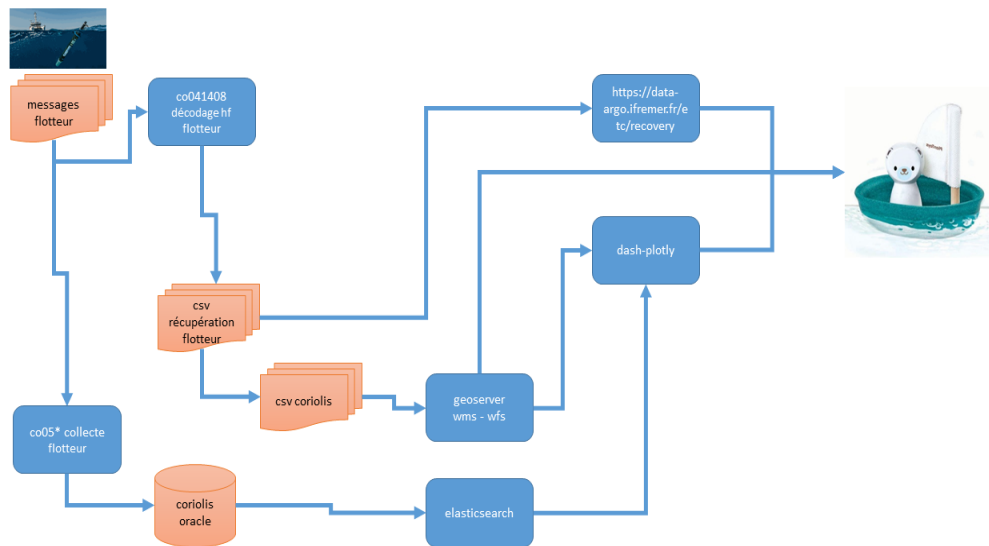*Figure 13: the graphic user interface of the float recovery web service*

*Figure 14: **the technical architecture of the float recovery service***

3.2. WMOP currents

The Western Mediterranean OPerational forecasting system (WMOP) is a high-resolution ocean forecasting system implemented over the Western Mediterranean Sea. It is run operationally on a daily basis, producing 72-hour forecasts of ocean temperature, salinity, sea level and currents (Juza et al., 2016 [6], Mourre et al., 2018 [7]).

Systematic validation procedures based on the inter-comparison of model outputs and satellite and in-situ observations are implemented to continuously assess the accuracy of the model. Model indicators (volume transports, average temperature, salinity, kinetic energy and heat content, maximum mixed layer depth) are also computed every day to monitor the system.

SOCIB developed a tool called Euro-Argo RISE experiment, which shows the WMOP currents forecasting at different depths in the study area. This tool was developed within WP6, to improve decision-making on parameter changes needed to maintain Argo profilers in shallow water.
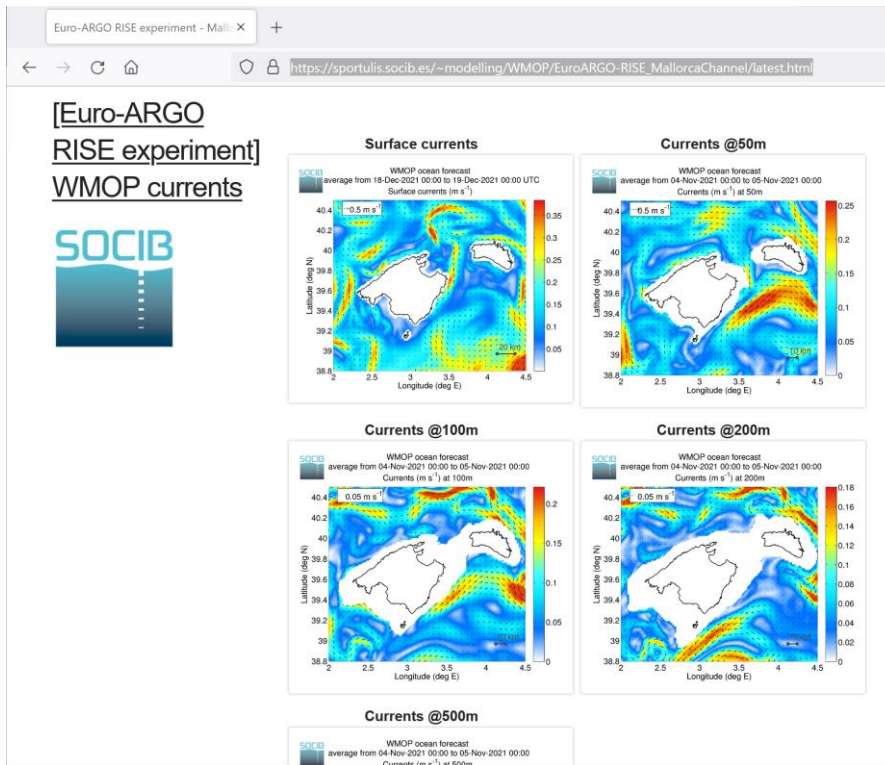
Figure 17 : **WMOP currents available on a new web interface**

https://sportulis.socib.es/~modelling/WMOP/EuroARGO-RISE_MallorcaChannel/latest.html

4. Tools to enhance Euro-Argo visibility

4.1. Wesstiti, a serious game for college Argo apprentice oceanographers

Wesstiti is a serious game intended for schools and colleges. It presents a float (randomly or adopted float), shows its trajectory in the ocean and ocean circulation models.

The player should guess the future trajectory (float surfacing) and compare his score with his previous choices or other players' choices.

Wesstiti queries data from Argo GDAC. It is a docker application, written in Java, on an Apache Tomcat, PostgreSQL and Angular architecture. The frontend is a web responsive Graphic User Interface. The backoffice is a regular Java scientific data application.

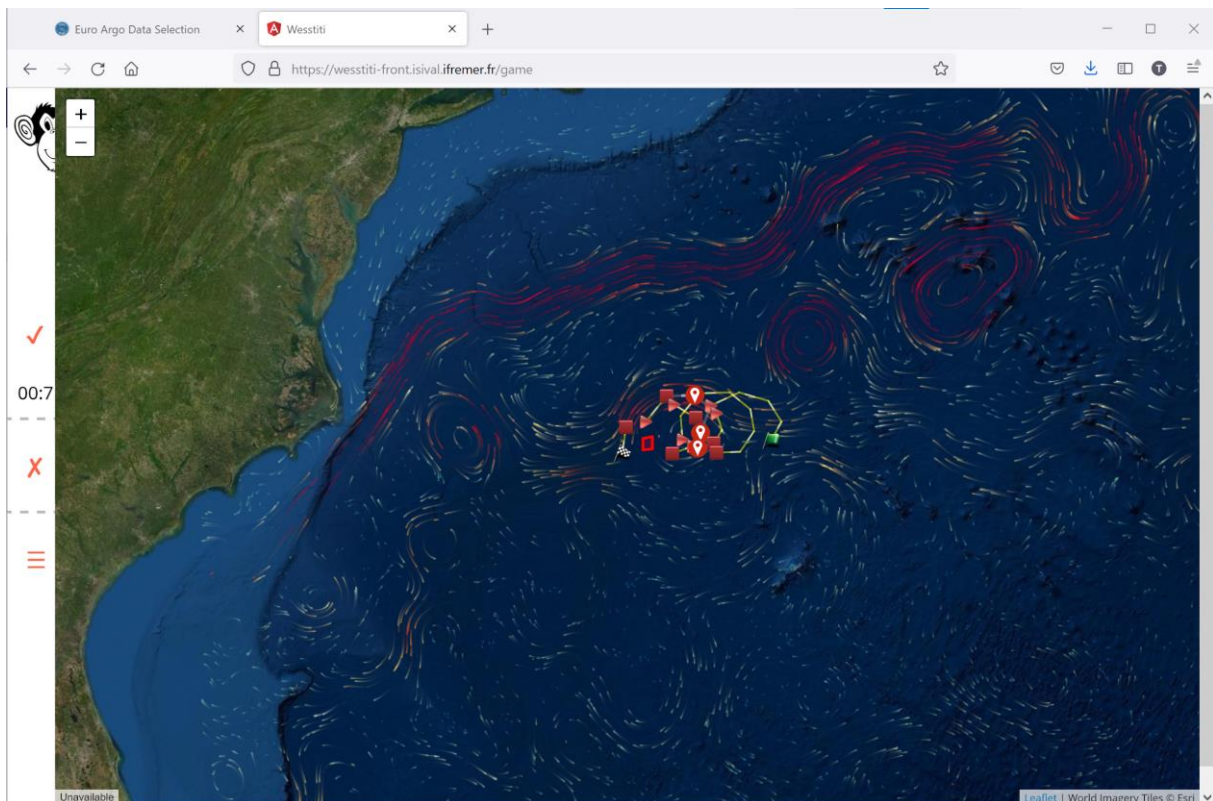Front-end and back office are developed in a DevOps infrastructure.

*Figure 15: **Wesstiti serious game for college students, select a float and predict its trajectory** https://wesstiti.ifremer.fr (will be available soon).*

4.2. Argo smartphone app

Communicating about the Argo initiative to the general public is more and more present in the projects and having the right tools and support to do so is important. With that in mind, Ifremer developed an **android smartphone application** that presents the Argo project and allows users to explore the data from the global Argo network (Data access powered by Ifremer & Euro-Argo).

This app is a simple but efficient outreach tool that will facilitate the discussion, especially with a young audience. It's available in the google play store.

It was promoted during CommOcean 2020.

The available languages are English, French and Spanish.

- Play with Argo app from: https://play.google.com/store/apps/details?id=com.kb.android.argo
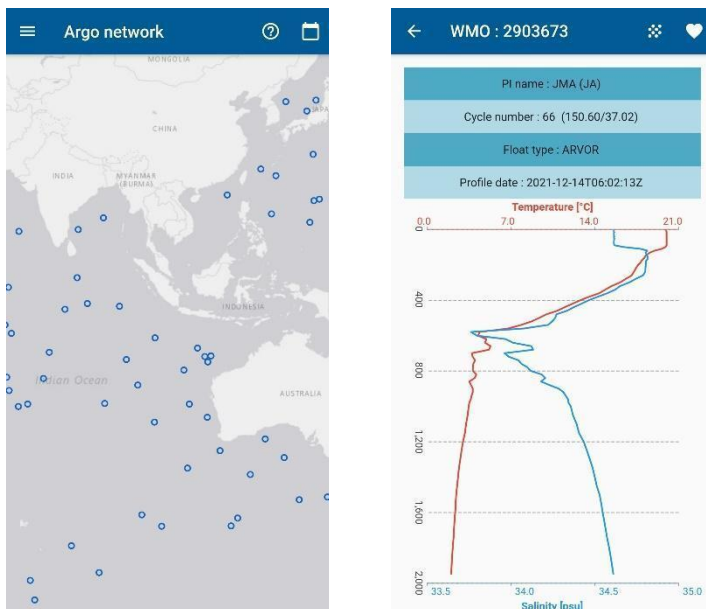- On Play Store : Argo floats

Figure 16: on your phone, the interactive floats map, a temperature and salinity profile

5. Conclusion

This Deliverable describes several tools and products that were developed within the Euro-Argo RISE project in order to fulfil WP7 objectives to enhance Euro-Argo visibility, promote data access to attract new users and improve services to existing users. The tools have been advertised or will be advertised widely using Euro-Argo communication channels.