Argo "use cases" records

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Description	**Argo "use cases" records: Use cases presented in a format understandable by the general public, and featured on the Euro-Argo website**
Work Package number	**WP7**
Work Package title	**Euro-Argo RISE visibility: communication and dissemination towards user's community**
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V1.0	30/06/2021	E. Evrard & M. Bollard	First draft
V1.1	16/07/2021	E. Evrard	Integration of WP7 partners' comments

EXECUTIVE SUMMARY

Argo use cases aim at highlighting the different applications of Argo data use to promote the importance of Argo data for research and societal benefits.

These use cases, covering different categories of Euro-Argo users, are targeted to the general public but also to policy-makers and funders and are presented in a format easily understandable.
This deliverable explains the methodology and steps followed to construct Argo use cases and present an example as a concrete output.

TABLE OF CONTENT

1 Context and rationales

Argo data are used by various kinds of users from operational centers like Copernicus (CMEMS, C3S, national centers), weather forecasting centers (ECMWF and national centers) and hydrographic centers to European data aggregators (EMODnet) and scientific community (Figure 1).

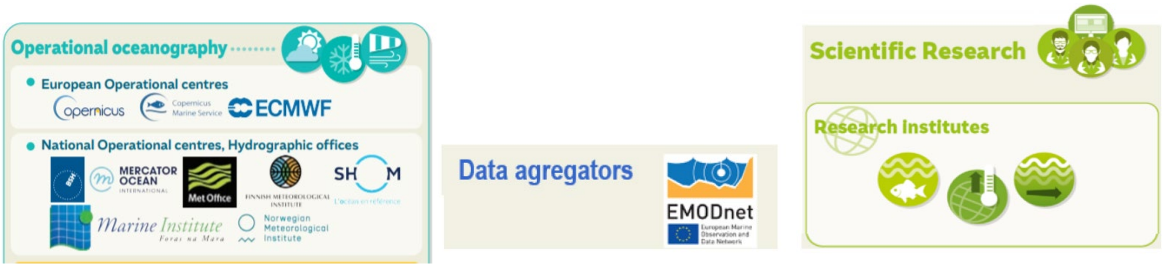


Figure 1: Users of Argo data

Argo has demonstrated during the past two decades a game changer role in observing and understanding the ocean. For science, Argo provides an unprecedented dataset for research, improving our understanding of ocean physics and biogeochemistry in all oceans, including marginal seas, all year round. On the other hand, Argo is a unique source of data in support of operational oceanography, providing in situ real-time data in support of more reliable ocean forecasts and climate predictions and a more accurate monitoring of ecosystem's health.

Indeed, Argo data supports a variety of applications. To showcase this wide range of use, a dedicated activity within WP7 aims at producing "use cases". By highlighting the different applications of Argo data use and covering different categories of Euro-Argo users, these "use cases" will promote the importance of Argo data for research and societal benefits. These use cases are targeted to the general public but also to policy-makers and funders and are presented in a format easily understandable.

The report presents the methodology and steps followed to construct the use cases, with an example presented as a concrete output.

2 Methodology

2.1. Existing use cases: some examples

2.1.1 CMEMS Use cases

CMEMS proposes more than 200 use cases on its website, promoting the Copernicus products through a wide range of applications: http://marine.copernicus.eu/markets/use-cases/

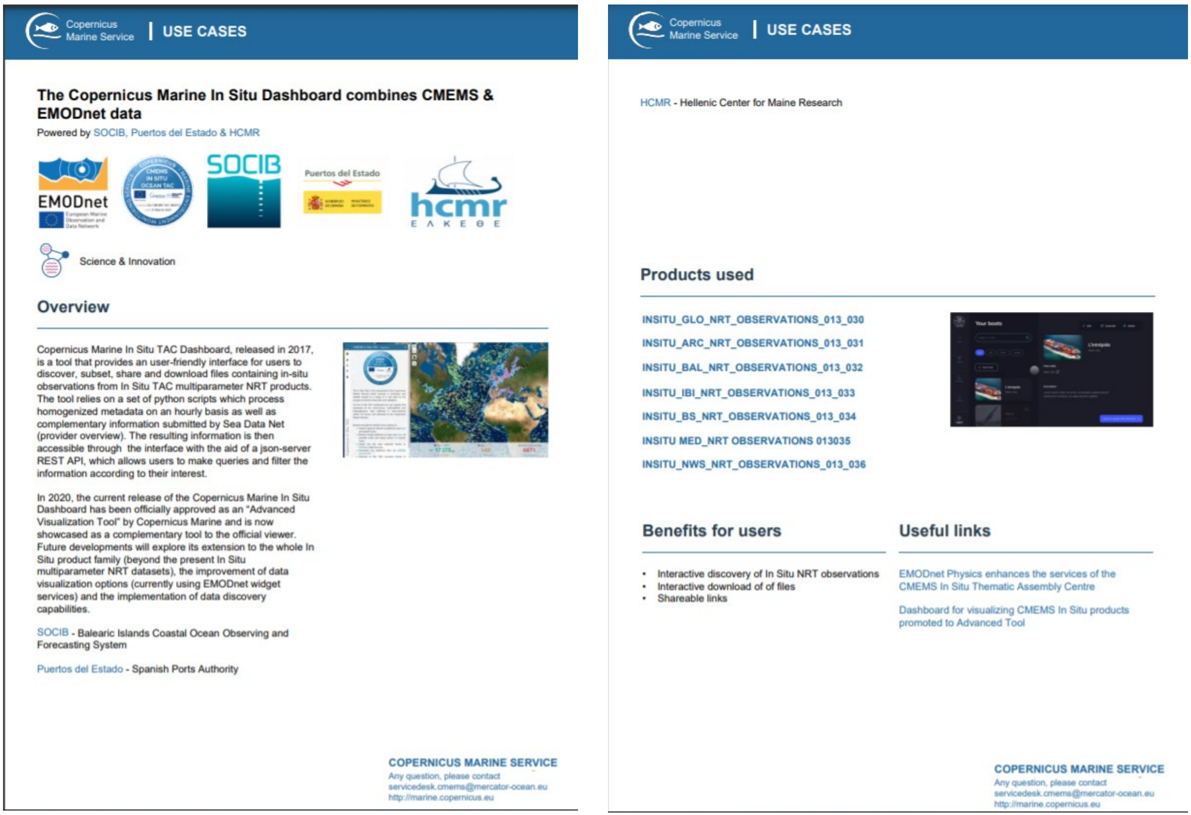
They are untitled by "user", i.e. the company or institute who develop it, and classified by:

- Region
- Markets (Coastal services, Marine food, Science & innovation, Climate & Adaptation, etc. – 13 in total)
- Country

Each use case follows the same template:

- Use Case Overview
- Products used
- Benefits for user
- Useful links

These use cases are in a 2-page format (A4) and are accessible through the website and could be downloaded as a pdf (Figure 2).



Copernicus Marine Service | USE CASES

The Copernicus Marine In Situ Dashboard combines CMEMS & EMODnet data

Powered by SOCIB, Puertos del Estado & HCMR

Science & Innovation

Overview

Copernicus Marine In Situ TAC Dashboard, released in 2017, is a tool that provides an user-friendly interface for users to discover, subset, share and download files containing in-situ observations from In Situ TAC multiparameter NRT products. The tool relies on a set of python scripts which process homogenized metadata on an hourly basis as well as complementary information submitted by Sea Data Net (provider overview). The resulting information is then accessible through the interface with the aid of a json-server REST API, which allows users to make queries and filter the information according to their interest.

In 2020, the current release of the Copernicus Marine In Situ Dashboard has been officially approved as an "Advanced Visualization Tool" by Copernicus Marine and is now showcased as a complementary tool to the official viewer. Future developments will explore its extension to the whole In Situ product family (beyond the present In Situ multiparameter NRT datasets), the improvement of data visualization options (currently using EMODnet widget services) and the implementation of data discovery capabilities.

SOCIB - Balearic Islands Coastal Ocean Observing and Forecasting System

Puertos del Estado - Spanish Ports Authority

COPERNICUS MARINE SERVICE
Any question, please contact
servicedesk.cmems@mercator-ocean.eu
http://marine.copernicus.eu

Copernicus Marine Service | USE CASES

HCMR - Hellenic Center for Maine Research

Products used

INSITU_GLO_NRT_OBSERVATIONS_013_030
INSITU_ARC_NRT_OBSERVATIONS_013_031
INSITU_BAL_NRT_OBSERVATIONS_013_032
INSITU_IBI_NRT_OBSERVATIONS_013_033
INSITU_BS_NRT_OBSERVATIONS_013_034
INSITU MED_NRT OBSERVATIONS 013035
INSITU_NWS_NRT_OBSERVATIONS_013_036

Benefits for users

- Interactive discovery of In Situ NRT observations
- Interactive download of of files
- Shareable links

Useful links

EMODnet Physics enhances the services of the CMEMS In Situ Thematic Assembly Centre

Dashboard for visualizing CMEMS In Situ products promoted to Advanced Tool

COPERNICUS MARINE SERVICE
Any question, please contact
servicedesk.cmems@mercator-ocean.eu
http://marine.copernicus.eu

Figure 2: Example of a CMEMS use case

2.1.2 HELCOM Fact Sheets

[HELCOM Baltic Sea Environment Fact Sheets](#) (BSEFS) provide information on the recent state of and trends in the Baltic marine environment. These fact sheets are written by scientists from various research institutes around the Baltic Sea and present information using data obtained by HELCOM monitoring programme. They cover 5 main categories: biodiversity, eutrophication, hazardous substances, hydrography and maritime activities.

These Fact Sheets have a specific outline that must be followed, to be clear and reader-friendly. Generally, they are no longer than 5 pages, to keep key messages short and comprehensive (Figure 3).

Page 1

Hydrography and oxygen in the deep basins

Author: Lena Viktorsson, Swedish Meteorological and Hydrological Institute

Key Message

The Baltic Sea is a sensitive sea area. The region is characterised by its natural formation as an enclosed estuary with high freshwater input and restricted access to oceanic high saline water. The stratification and fjord-like conditions, in combination with eutrophication and other factors, form the basis for a problematic oxygen situation in the deep water.

Anoxic conditions are characterised by the total absence of oxygen. When all oxygen is consumed by microbial processes hydrogen sulphide (H_2S) is formed, which is toxic for all higher marine life. Anoxic conditions lead to release of phosphate and silicate from the sediments to the water column, which, through vertical mixing, can reach the surface layer and the photic zone. A surplus of phosphate in relation to nitrate favour cyanobacteria growth in the Baltic Sea during summer.

This fact sheet gives an overview of the development of salinity since 1990 to 2017 and oxygen from 1960 to 2017 and describes recent changes in these variables. The most notable changes since the major Baltic inflow in 2014 are:

- Deep water salinity has increased in the Baltic Proper, which hampers vertical mixing.
- The area of the central Baltic affected by oxygen deficiency (hypoxia, $O_2 < 2$ ml/l) and absence of oxygen (anoxic or sulphidic conditions) remains high.
- The hydrogen sulphide concentrations are lower than before the inflow 2014.

Results and Assessment

Relevance of the BSEFS for describing developments in the environment

Salinity, temperature and oxygen are physical background parameters, constraining biodiversity, fish recruitment and water quality in a semi-enclosed water body as the Baltic Sea.

Surface waters in the Baltic are strongly influenced by land run-off of freshwater. Changes in run-off alter the surface salinity while inflows through the Sound and the Belt Sea control the salinity of the deeper waters. Stratification between the upper and lower layers inhibits surface and deep waters mixing together, and thus preventing the oxygenated surface water penetrating to deep water. The strength of the stratification is indicated by the salinity difference between the surface and deep water.

Oxygen depletion is widely used as an indicator of the indirect effects of nutrient enrichment due to increased oxygen consumption. Lowest oxygen levels are experienced at the end of summer, between August and October, when detritus from biological activity in the surface waters has sank, and is decomposed by bacteria. This process consumes the oxygen. When oxygen is depleted bacteria start to use anaerobic processes for degradation of organic matter, producing toxic hydrogen sulphide. Oxygen levels above 4.6 mg/l (3.2 ml/l) are considered to cause no problems for most macroscopic animals and this limit could be considered as a precautionary limit to avoid catastrophic mortality events (Vaquer-Sunyer and Duarte (2008)).

Policy relevance and policy references

Oxygen levels are used as an indicator of eutrophication by both HELCOM and OSPAR. It is listed as a core variable of the HELCOM COMBINE programme. Oxygen is delivered to the deep waters of the Baltic in the saline inflows that come through the Sound and Belt Sea. Hydrographic measurements (temperature and salinity) allow us to trace these inflows, and other water movements within the Baltic.

Assessment

Changes in salinity

[...] Page 3

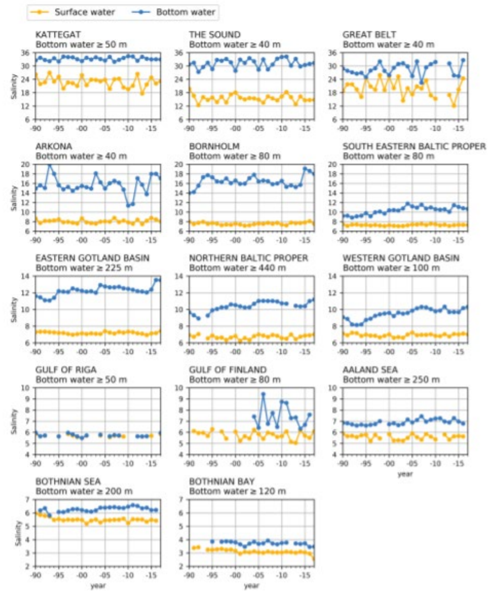


Figure 1. Surface (orange) and deep water (blue) salinity from 1990 to 2017 at selected monitoring stations in the HELCOM marine area. Depth for surface water is 0-10 m at all stations, deep water values are calculated from a mean of all values at and below the depths specified in the title of each plot.

Figure 3: Example of a HELCOM Fact Sheet on Hydrography and oxygen in the deep basins.

2.1.3. EUDAT

The EUDAT Collaborative Data Infrastructure (or EUDAT CDI) has a dedicated section on its website highlighting use cases: https://eudat.eu/use-cases

These use cases were built to show how different communities are benefitting from EUDAT infrastructure. They are classified in 11 topics and include the following sections: overview, the scientific challenge, who benefits and how, the technical implementation, contacts and further information.

In addition to the pre-cited use cases/fact sheets, other examples (EMODNET, MARCO project) were consulted to have a better view of different ways of developing use cases highlights.

2.2 Selection of use cases topics

Based on our 5-year plan and the review described in paragraph 2.1 of existing use cases, a reasonable number of use cases that illustrated the variety of use of Argo data were selected. The topics of interest were discussed with the Euro-Argo ERIC Management Board, to get feedback from the Members and see if some topics should be added or deleted.

The list of proposed use cases is:

1. Contribution to Ocean Heat Content estimates

2. Improvement of physical ocean forecasting systems

2bis. Improvement of biogeochemical ocean forecasting systems

3. Monitoring Ocean acidification with Argo

4. Support to Ocean Colour satellite validation

5. Moose observatory (Argo part of an integrated multiplatform ocean observing system)

6. Argo contribution to MSFD implementation

7. Ocean currents atlas (ANDRO) computed from Argo

8. Atmospheric models improvement

8bis. Climate models improvement Argo in the Baltic Sea

9. Argo in support of HELCOM monitoring in the Baltic Sea (Argo in the Baltic Sea: a breakthrough in monitoring)

10. Argo measurements under-ice

11. Argo measurements in shallow coastal areas

This list is non-exhaustive and will evolve in the coming years. An additional use case will be in relation with education, to highlight how Argo can be used for educational purposes.

2.3 General Template

To have an homogeneity in the variety of use cases, a general template for the writing was defined. It is composed of 8 sections that are:

- The title with a specific angle
- Overview/Introduction
- Specificity of the use-case
- Argo Data used (parameters & timescale)
- Argo data user
- Reference(s) & links
- What are the main results/conclusions of this use case? + a box with “Benefits for end-users”
- Glossary

Technical specifications were written by the Euro-Argo ERIC office to guide in the writing and help to select the most important information within a limited format (2 pages maximum). The document was kept short to keep the messages focused to the point.
An online template was proposed, explaining the main concepts of the use cases and tackling both the content and the general organisation (see below and Figure 4).

Specifications and organisation for each sub-section of the template

- Short title with a specific angle + 2 pictures
- Use Case Overview / Introduction – 800 characters (spaces included)

This is the pitch answering 4 of the 5 questions (where, when, who, why).

- Specificity of the use case – 1200 characters (spaces included)

Answer why Argo data are required and crucial in this region, or what is the main technical challenge there etc.

- Argo Data used (parameters & timescale) – 500 characters (spaces included) + 1 table with the measured parameters + 1 map

Answer where and when Argo floats collected data in this use case. This is a short summary of the various parameters studied in the use case. Be careful not to expose some scientific result here, only methodology or data period. You can rely on **various definition boxes** to be clearer and only use easy vocabulary in the main text.

- Argo data user – 250 characters (spaces included) + 1 or 2 logos

Answer who operated the use case.

- References and links – 2 or 3 references

Scientific publications or public at large outreach documents.

- What are the main results/conclusions of this use case? – 2000 characters (spaces included) + 1 graph + 1 box with "Benefits for end-users" (3-4 bullets points)

This is the paragraph where we really stick to the use case angle.

This part highlights the results and answers the 5th question (**what**).
When you are writing this section, you can imagine that you are talking to someone of your family who doesn't have any scientific background and that you only have two minutes to synthetize the main results. You should then **extract the 1 or 2 most appealing/important information** of the use case.
You can rely on **various definitions** to be clearer and only use easy vocabulary in the main text.
Here is a list of questions you can rely on to write the text:

- What is the main result of this publication?
- We can present only one figure, which one would you pick and why? Would you please explain it in the legend?
- What would be the bigger or most surprising impacts?
- What is new or never done before in this way?
- What was the main technical challenge to face?

- Glossary

This box allows you to define up to 4 vocabulary words.

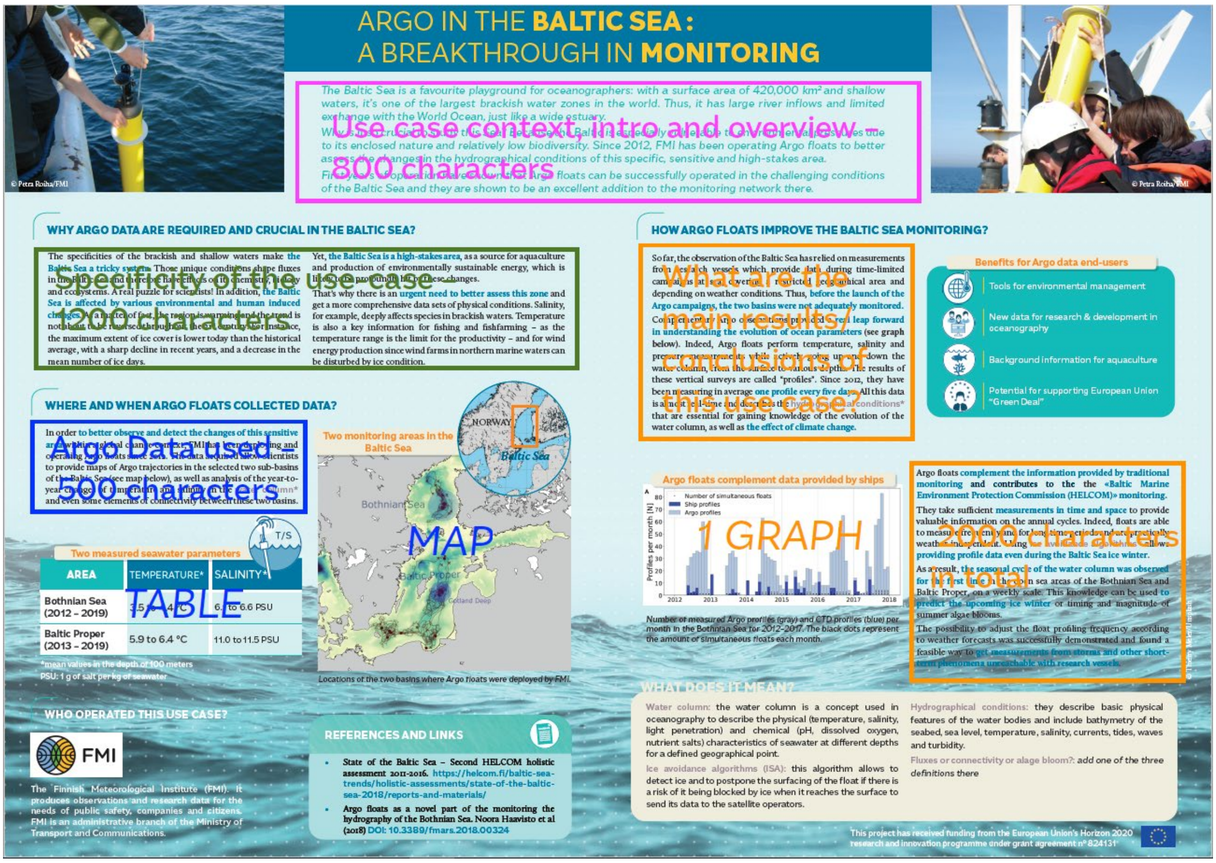


Figure 4: Reminder of the general organisation, relying on the first example.

3 Steps for use case writing

As a first step, the scientific content was constructed with the help of scientists, experts in the topic of the use case. Content was discussed and the template shared, so the different sections could be filled in according to the 5 main questions to be answered (when, where, who, why, what).

Then, the outreach content was built by the Euro-Argo ERIC office through an interview/series of interviews to select one key message and popularise the speech. As the use cases were targeted to non-specialists, particular efforts were made to avoid scientific jargon to make the use cases understandable to a large audience. Scientific terms were defined through a glossary and included in a specific box, providing a simplified key to reading. This work was done in parallel with the layout, by selecting the best infographics to help in the comprehension of the text.

This work resulted in a 2-page use case (A3 format), easily understandable by all, highlighting the usefulness of Argo data for a topic (one use case = one application of Argo data).

Each use case was/will be presented and discussed with the Euro-Argo ERIC Management Board, to get an endorsement by the Euro-Argo community and fully include this project activity in the outreach approach of the research infrastructure. Indeed, this activity on use cases will continue after the end of the Euro-Argo RISE project.

4 Conclusions and future steps

These use cases will be featured on the Euro-Argo website, to be showcased to a wide audience.

An update of the outreach section is planned to include this work. A future possibility for the audience will be to sort the use cases by categories, to be able to select and consult only those of interest.

The following categories have been proposed:

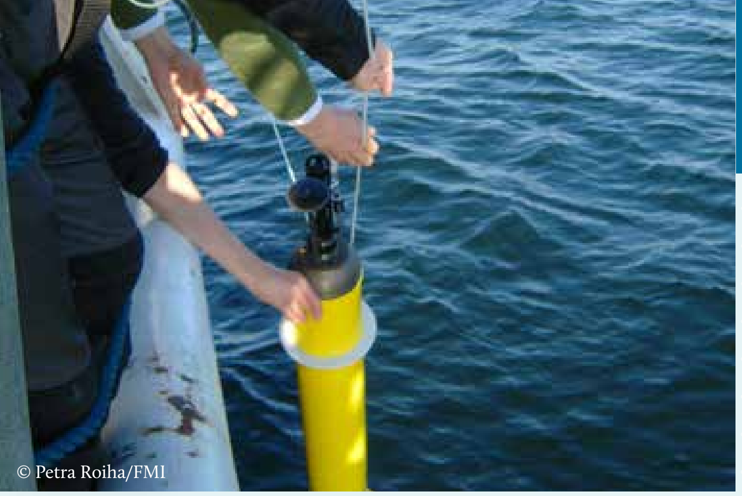
- **Use type**: Ocean Science, Operational Services, calibration/validation, environment monitoring
- **Geographical Area**: global, European marginal seas, Nordic seas, southern ocean, Arctic ocean...
- **Type of data**: core, BGC, Deep
- **End user**: Scientific Community, Users of Copernicus Services, satellites community, environmental agencies, local authorities.

These categories, still under definition, will evolve as the list of use cases will increase in the future.

5 Annex: Argo use case in the Baltic Sea

This section presents the first use case constructed, that corresponds to the topic 9. Argo in Support of HELCOM monitoring in the Baltic Sea. It is entitled “Argo in the Baltic Sea: a breakthrough in monitoring”.

This first use case for the Baltic was based on a HELCOM Fact Sheet and was made in collaboration with FMI. The output is presented below (figures might evolve in the coming months to include latest details).



ARGO IN THE **BALTIC SEA:** A BREAKTHROUGH IN **MONITORING**

The Baltic Sea is a favourite playground for oceanographers: with a surface area of 420,000 km^2 and shallow waters, it is one of the largest brackish water zones in the world. Thus, it has large river inflows and limited exchange with the World Ocean, just like a wide estuary.*

Why is it so crucial to study this Sea? Because the Baltic is especially vulnerable to environmental pressures due to its enclosed nature and relatively low biodiversity. Since 2012, FMI has been operating Argo floats to better assess the changes in the hydrographical conditions of this specific, sensitive and high-stakes area.

First years of operation have shown that Argo floats can be successfully operated in the challenging conditions of the Baltic Sea and they are shown to be an excellent addition to the monitoring network in place.

WHY ARGO DATA ARE REQUIRED AND CRUCIAL IN THE BALTIC SEA?

The specificities of the brackish and shallow waters make **the Baltic Sea a tricky system**. Those unique conditions shape fluxes in the Baltic Sea and therefore have effects on its chemistry, biology and ecosystems. A real puzzle for scientists! In addition, **the Baltic Sea is affected by various environmental and human induced changes**. As a matter of fact, the region is warming and the trend is not about to be reversed throughout the 21st century. For instance, the maximum extent of ice cover is lower today than the historical average, with a sharp decline in recent years, and a decrease in the mean number of ice days.

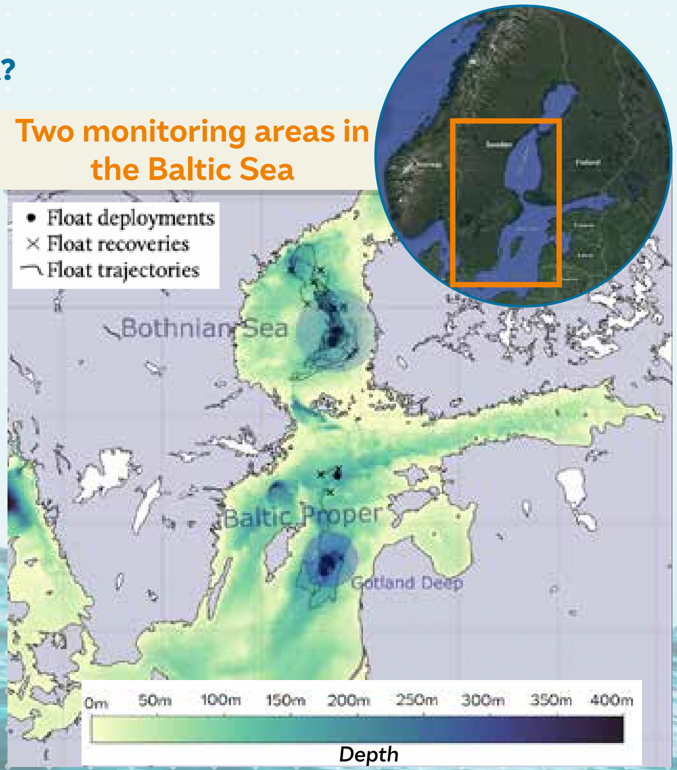
Yet, **the Baltic Sea is a high-stakes area**, as a source for aquaculture and production of environmentally sustainable energy, which is likely to be profoundly hit by these changes.

That's why there is an **urgent need to better assess this zone** and get a more comprehensive data sets of physical conditions. Salinity, for example, deeply affects species in brackish waters. Temperature is also a key information for fishing and fishfarming – as the temperature range is the limit for the productivity – and for wind energy production since wind farms in northern marine waters can be disturbed by ice conditions.

WHERE AND WHEN ARGO FLOATS COLLECT DATA?

In order **to better observe and detect the changes of this sensitive area** within a global change context, FMI has been deploying and operating X Argo floats since 2012. The data acquired (**see table below**) allow scientists to provide maps of Argo trajectories in the selected two sub-basins of the Baltic Sea (**see map below**), as well as analysis of the year-to-year changes of temperature and salinity in the water column*.

Two monitoring areas in the Baltic Sea



Locations of the two basins where Argo floats were deployed by FMI.

Two measured seawater parameters

T/S

AREA	TEMPERATURE*	SALINITY*
Bothnian Sea (2012 – 2019)	3.5 to 4.4 °C	6.1 to 6.6 PSU
Baltic Proper (2013 – 2019)	5.9 to 6.4 °C	11.0 to 11.5 PSU

*mean values in the depth of 100 meters

PSU: 1 g of salt per kg of seawater

WHO OPERATED THIS USE CASE?

FMI

The Finnish Meteorological Institute (FMI). It produces observations and research data for the needs of public safety, companies and citizens. FMI is an administrative branch of the Finnish Ministry of Transport and Communications.

REFERENCES AND LINKS

- State of the Baltic Sea – Second HELCOM holistic assessment 2011-2016. https://helcom.fi/baltic-sea-trends/holistic-assessments/state-of-the-baltic-sea-2018/reports-and-materials/
- Argo floats as a novel part of the monitoring the hydrography of the Bothnian Sea. Noora Haavisto et al (2018). DOI: 10.3389/fmars.2018.00324

HOW ARGO FLOATS IMPROVE THE BALTIC SEA MONITORING?

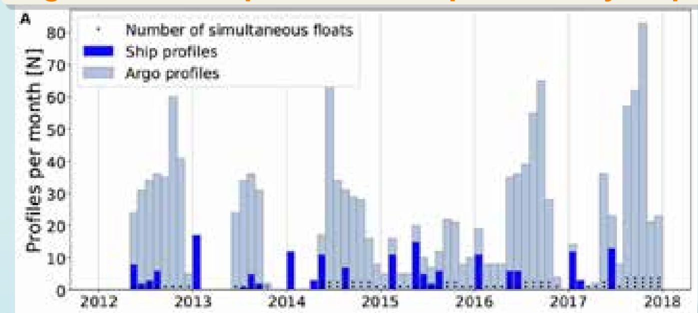
So far, the observation of the Baltic Sea has relied on measurements from research vessels which provide data during time-limited campaigns at sea, covering a restricted geographical area and depending on weather conditions. Thus, **before the launch of the Argo campaigns, the Baltic Sea was not adequately monitored.**

Complementary Argo observations provided a **real leap forward in understanding the evolution of ocean parameters** (**see graph below**). Indeed, Argo floats perform temperature, salinity and pressure measurements while actively going up and down the water column, from the surface to various depths. The results of these vertical surveys are called "profiles". Since 2012, they have been measuring in average **one profile every five days**. All this data is almost real-time and describes the hydrographical conditions* that are essential for gaining knowledge of the evolution of the water column, as well as **the effect of climate change**.

Benefits for Argo data end-users

- Tools for environmental management
- New data for research & development in oceanography
- Background information for aquaculture
- Potential for supporting European Union "Green Deal"

Argo floats complement data provided by ships



Number of measured Argo profiles (gray) and CTD profiles (blue) per month in the Bothnian Sea for 2012–2017. The black dots represent the amount of simultaneous floats each month.

Argo floats **complement the information provided by traditional monitoring** and contributes to the **«Baltic Marine Environment Protection Commission (HELCOM)» monitoring**.

They take sufficient **measurements in time and space** to provide valuable information on the annual cycles. Indeed, floats are able to measure frequently and for long time periods and are practically weather-independent. Using ice sensing algorithms* allows **providing profile data even during the Baltic Sea ice winter.**

As a result, **the seasonal cycle of the water column was observed for the first time** in the open sea areas of the Bothnian Sea and Baltic Proper, on a weekly scale. This knowledge can be used **to predict the upcoming ice winter** or timing and magnitude of summer algae blooms.

The possibility to adjust the float profiling frequency according to weather forecasts was successfully demonstrated and found a feasible way to **get measurements from storms and other short-term phenomena unreachable with research vessels.**

GLOSSARY

Water column: the water column is a concept used in oceanography to describe the physical (temperature, salinity, light penetration) and chemical (pH, dissolved oxygen, nutrient salts) characteristics of seawater at different depths for a defined geographical point.

Ice sensing algorithms (ISA): this algorithm allows to detect ice and to postpone the surfacing of the float if there is a risk of it being blocked by ice when it reaches the surface to send its data to the satellite operators.

Hydrographical conditions: they describe basic physical features of the water bodies and include bathymetry of the seabed, sea level, temperature, salinity, currents, tides, waves and turbidity.

Brackish waters: waters occurring in a natural environment having more salinity than freshwater, but not as much as seawater. It may result from mixing seawater (salt water) with fresh water together, as in estuaries.

The work was carried out during the Euro-Argo RISE project that has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement n° 824131