ACTIVITY REPORT 2021

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EUROARGO

EUROPEAN RESEARCH INFRASTRUCTURE CONSORTIUM FOR OBSERVING THE OCEAN

Foreword

Almost 15 years ago, back in 2008, in the mind of a group of European scientists, the idea was born that it would be possible to strengthen the European contribution to the Argo international programme, by creating a sustained Research Infrastructure. This unique European Research Infrastructure dedicated to *in situ* ocean observation would allow Member States to join forces with a clear end goal: to support 25% of the Argo network. At that time, I was leading the Argo Data Management workpackage in the preparatory phase of the Euro-Argo ERIC project. I never imagined that six years later I would become the director of the Euro-Argo ERIC at its launch.

Since then, building the Euro-Argo ERIC has been a fantastic professional, but also personal, experience in many domains. One of the main challenges was to administrate the ERIC as a company and to build, year after year, a team capable of handling the entire Argo value chain, from technology to deployment, data processing, services to users, outreach and training. In addition to their skills, I can confidently say that the Euro-Argo Office team in Brest has been able to build relationships over the years and is now able to respond to the different needs of the 12 European Members in a united, responsive and organised way. This cohesion and team spirit is also the key to success which has enabled us to develop a common workplan with our 12 European Members.

Our commitment at European level has enabled us to develop new funding opportunities and to propose or contribute to a variety of ambitious European projects. All these efforts were highlighted through the development of a multi-media communication strategy addressing various targets, ranging from the Argo community to the European Commission. As a result, eight years after its creation, Euro-Argo ERIC is recognised as a successful Research Infrastructure, both at international level – within Argo and GOOS – but also at European level, with the Environmental Research Infrastructures Cluster. One of ERIC's common threads, which we have always tried to emphasise, whether in technical operations or in our promotional activities, is that working together makes us stronger and is the key of our success.

This summer, it is with great emotion that I am retiring and embarking on a new chapter in my life. But I leave with peace of mind, proud to have contributed to the Euro-Argo development with all the Euro-Argo partners and the ERIC Office team. The Euro-Argo book that I opened eight years ago has been one of my greatest adventures and I will never close it completely as I will miss you all.

Sylvie Pouliquen
Euro-Argo ERIC Director

Table of contents

Euro-Argo Office team loading the European floats on board the Atlantic charter.

Executive summary

In 2021, the Euro-Argo ERIC intensified its efforts to compensate for the lower number of deployments in 2020 due to COVID 19 and vessels stuck at port during lockdown. The Euro-Argo Office and the 12 national Members managed to fulfil all the commitments both in projects and services, in line with the five objectives of the five-year plan, with particularly significant contribution for the BGC and Deep missions. At the end of the year, the Danish Institute AQUA-DTU sent its application as a candidate Member of Euro-Argo ERIC, the first step towards a Membership of Denmark to the ERIC. In the frame of the Euro-Argo RISE project, the first Euro-Argo Regional workshops and an unprecedented political event were organised, gathering more than a hundred people each.

In 2021, implementation of the five-year plan continued through European and national projects. In particular, the Euro-Argo ERIC was involved in key European projects (ENVRI-FAIR, EuroSea, ERIC-Forum and the new DOORS project, launched in 2021) and the Euro-Argo Office coordinated the Euro-Argo RISE project. This year the ERIC Office team welcomed Luc van Dyck, as an advisor for policy and partnership relations.

The European contribution represented 32% of the global effort in 2021 in float deployments, one of the highest percentages since 2008.

As a contribution to the Argo network, the total number of floats deployed by the Members and the ERIC in 2021 reached 257, representing 32% of the global effort, one of the highest percentages since 2008. The year 2021 remained marked by the COVID pandemic but Euro-Argo ERIC managed to catch up with most of the deployment backlog, due to research vessels cruises postponed or cancelled in 2020. The European contribution is progressing towards the implementation of the Deep (33 floats deployed) and BGC missions (68 floats carrying at least one BGC sensor deployed). Efforts made to develop these two extensions resulted in a European contribution to the global effort of 63% for the Core with O_2 sensor, 51% for the Deep and 50% for the BGC. An Atlantic charter – the "Blue Observer" sailing expedition – allowed deployement of 17 European floats. This first ambitious mission was the result of an international collaboration and will be closely analysed to identify advantages and limitations of using a charter vessel to complement research vessels.

In 2021, most of the data were processed in less that 12 hours from acquisition and the GDAC presented a high level of reliability, close to 99,54%. 72413 Argo data profiles were processed by the two European DACs. Nearly 80% of the European floats were scientifically assessed to reach the accuracy needed for climate applications.

In addition to the data processing itself, both Coriolis/Ifremer and BODC were able to make progress in different aspects of Argo data management, in the framework of the Euro-Argo RISE and ENVRI-FAIR EU projects.

The Euro-Argo ERIC Office team at Ifremer facility, Brest, France.

© Noé Poffa/Ifremer

These latest improvements include, for instance, the development of new tools for data Quality Control, the use of the NERC controlled vocabulary or enrichments of the Argo Reference Data Base used for data Quality Control and corrections.

In 2021, Euro-Argo RISE project progressed in all the different aspects of the project. The beginning of the year was rich in events, with three workshops organised and held by the European partners, to consolidate the network of scientists engaged in climate and ocean research using Argo data and to demonstrate the importance of Argo for environment and society to politicians, decision-makers and high-level stakeholders. The 2nd Euro-Argo RISE General Assembly was held and introduced Euro-Argo ERIC's vision "beyond the project", with the willingness to implement all the results at the infrastructure level. This step will shape the ERIC for the next 10 years through a revised strategy, implementation and long-term sustainability plans. In 2021, 21 deliverables were released (out of 63 deliverables in total) and three milestones were achieved. The Ocean Observers workshop was successfully held at the end of the year, to discuss educational activities around *in situ* ocean observations at an international level. Significant developments were achieved regarding: technology, data management, networking, outreach, training and engagement with stakeholders.

Activities aimed at increasing Euro-Argo visibility were pursued in 2021, through 27 news items published throughout the year on the Euro-Argo website. A poster about the environmental impacts of Argo floats was also published and presented during the AST meeting. The outreach section of Euro-Argo website was updated with new information, such as the first "Use Case", published in the frame of Euro-Argo RISE project. The Blue Observer sailing mission was a good opportunity for a wide press coverage at local and regional scale, with more than 30 press articles and some diffusion on TV and radio, but also at GOOS level (WMO, UNESCO).

The 2nd Euro-Argo RISE General Assembly was held and introduced Euro-Argo ERIC's vision "beyond the project".

This year's report highlights two scientific papers published in 2021 in which Argo data play a critical role: the study of Jean-Baptiste Sallée et al. on the "Summertime increases in upper-ocean stratification and mixed-layer depth" and the publication about Argo floats in the southern Baltic Sea by Waldemar Walczowski et al. (2021).

A positive balance in Euro-Argo ERIC 2021 budget execution was reached at the end of the year and Euro-Argo ERIC's core income is expected to increase in 2022 following the accession of Denmark. Concerning the four projects that started in 2019, the budget execution is as planned. For the AtlantOS and MOCCA projects that ended last year, the overheads collected during the projects are presently used to pay the satellite communication for the active floats. Finally, an investment subvention was received from Orange Marine to buy three floats that will be deployed on Orange Marine vessels within the partnership that was signed.

1 FIVE-YEAR PLAN OBJECTIVES

Over the past seven years, the Euro-Argo ERIC has demonstrated its ability to develop and manage the European contribution to the international Argo programme. Many activities and services have been implemented and need to be continued through the next phase of Argo. Committing to the Euro-Argo ERIC five-year plan (2019-2023) will ensure programme sustainability.

▸ See the full five-year plan on https://doi.org/10.13155/71936

The five-year plan articulated five objectives against which its achievements will be measured in the coming years. The challenges of this next phase are multiple:

- Core Argo activities need to be maintained.
- Extensions towards the "Global, full-depth and multidisciplinary" OneArgo mission ("On the Future of Argo: A Global, Full-Depth, Multi-Disciplinary Array", Roemich et al., 2019) need to be further developed in a sustainable way.
- Engagement with existing and new end-users is necessary to meet societal needs.

Euro-Argo is not alone and must evolve within a landscape of complementary Research Infrastructures (RIs). The development of an integrated ocean observing system is being pursued by various observation coordination bodies (GOOS at global level, AtlantOS and SOOS at basin levels, EOOS at European scale) in their respective strategies as a contribution to the UN Decade of Ocean Science for Sustainable Development. Euro-Argo must contribute to this landscape to complement the other observation networks as efficiently as possible.

To face these challenges, the five Euro-Argo objectives are interconnected and many partners are involved → **Figure 1**. This report describes the activities carried out by the Euro-Argo ERIC with respect to the five objectives.

THE FIVE OBJECTIVES OF THE 2019-2023 FIVE-YEAR PLAN

Objective 1	Objective 2	Objective 3	Objective 4	Objective 5
Sustain the existing Core Argo mission.	**Develop the extension of Euro-Argo contribution to Argo according to the Euro-Argo** strategy as a contribution to the "Global, full-depth and multidisciplinary Argo" design.	**Develop scientific and technological coordination** with other ocean observing networks and contribute to a Global Ocean Observing System (GOOS) design and its European contribution through European Ocean Observing System (EOOS) initiative.	**Develop the engagement with European Argo user communities and stakeholders and reinforce Euro-Argo visibility.**	**Operate the Euro-Argo ERIC Office** under good governance.

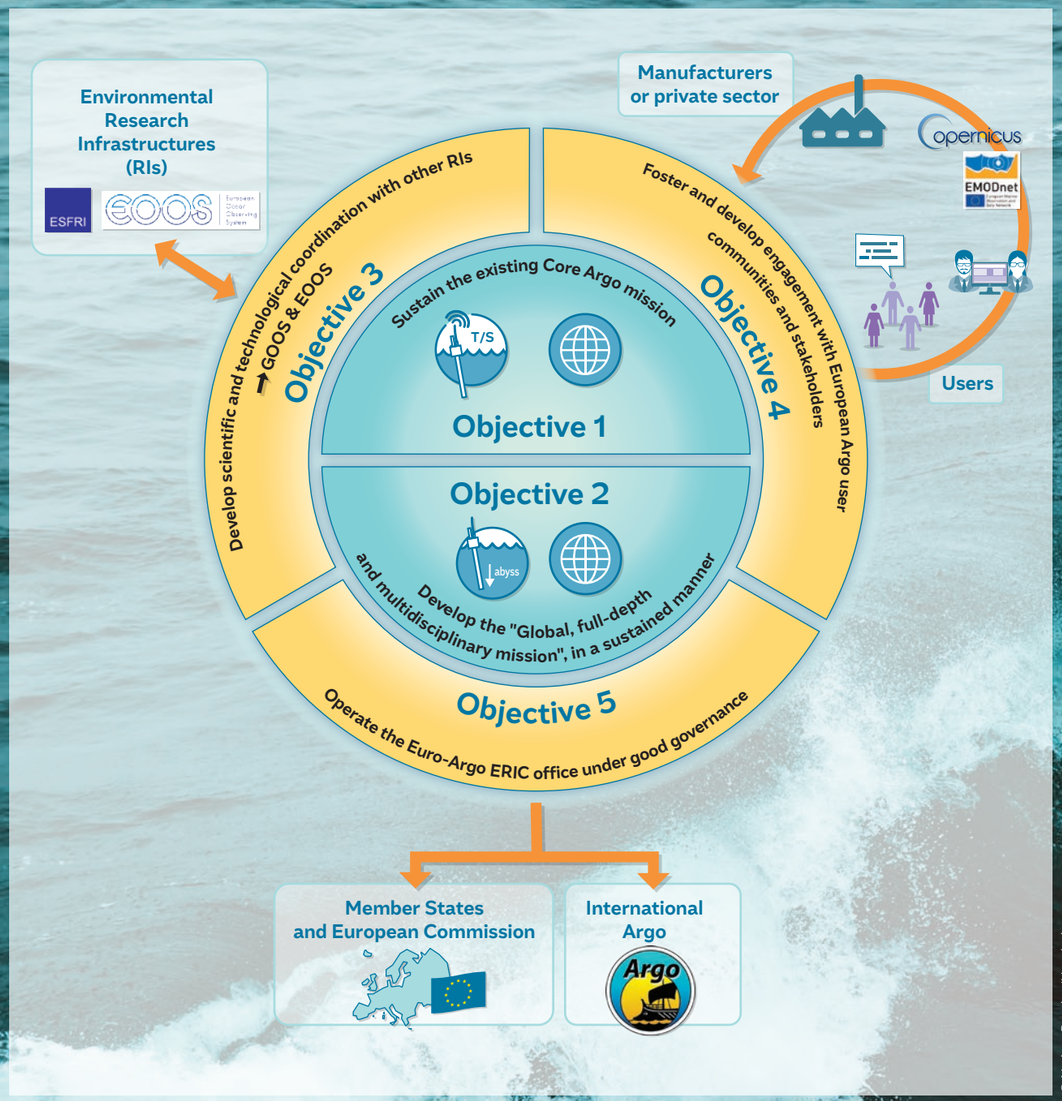

Figure 1: The five objectives of the five-year plan and the involved partners.

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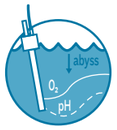
2 REVIEW OF 2021 ACTIVITIES

In 2021, the Euro-Argo ERIC intensified its efforts to compensate for the lower number of deployments in 2020 due to COVID 19 and vessels stuck at port during lockdown. The Euro-Argo Office and the 12 national Members managed to fulfil all the commitments both in projects and services, in line with the five objectives of the five-year plan, with particularly significant results for the BGC and Deep missions.

Objective 1

Objective 2



SUSTAIN THE EXISTING CORE ARGO MISSION AND EXTEND THE EURO-ARGO CONTRIBUTION TO THE "GLOBAL, FULL-DEPTH AND MULTIDISCIPLINARY ARGO" DESIGN

Network implementation

→ 2021 float deployments

In 2021 Euro-Argo deployed 257 floats, representing 32% of the global effort → **Figure 2**, one of the highest percentages since 2008. The year 2021 remained marked by the COVID pandemic but Euro-Argo ERIC Members managed to catch up with most of the deployment backlog (due to research vessels cruises postponed or cancelled in 2020). Those efforts resulted in the deployment of ~100 more floats than in 2020, with particularly significant contribution for the BGC and Deep missions **(see p. 12)**. The launch location of all Argo floats deployed in 2021 are shown, → **Figure 3 p. 10**.

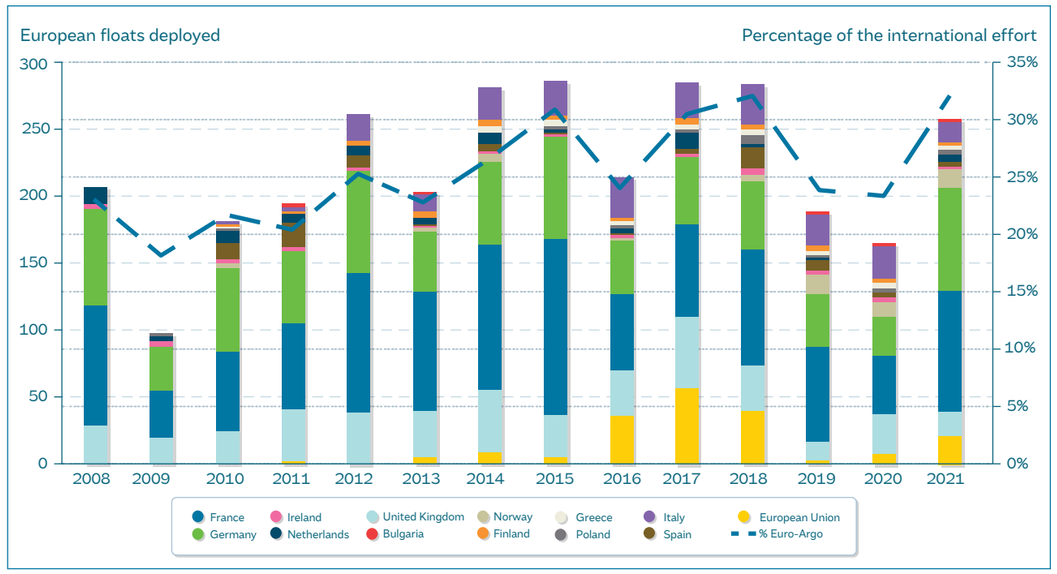
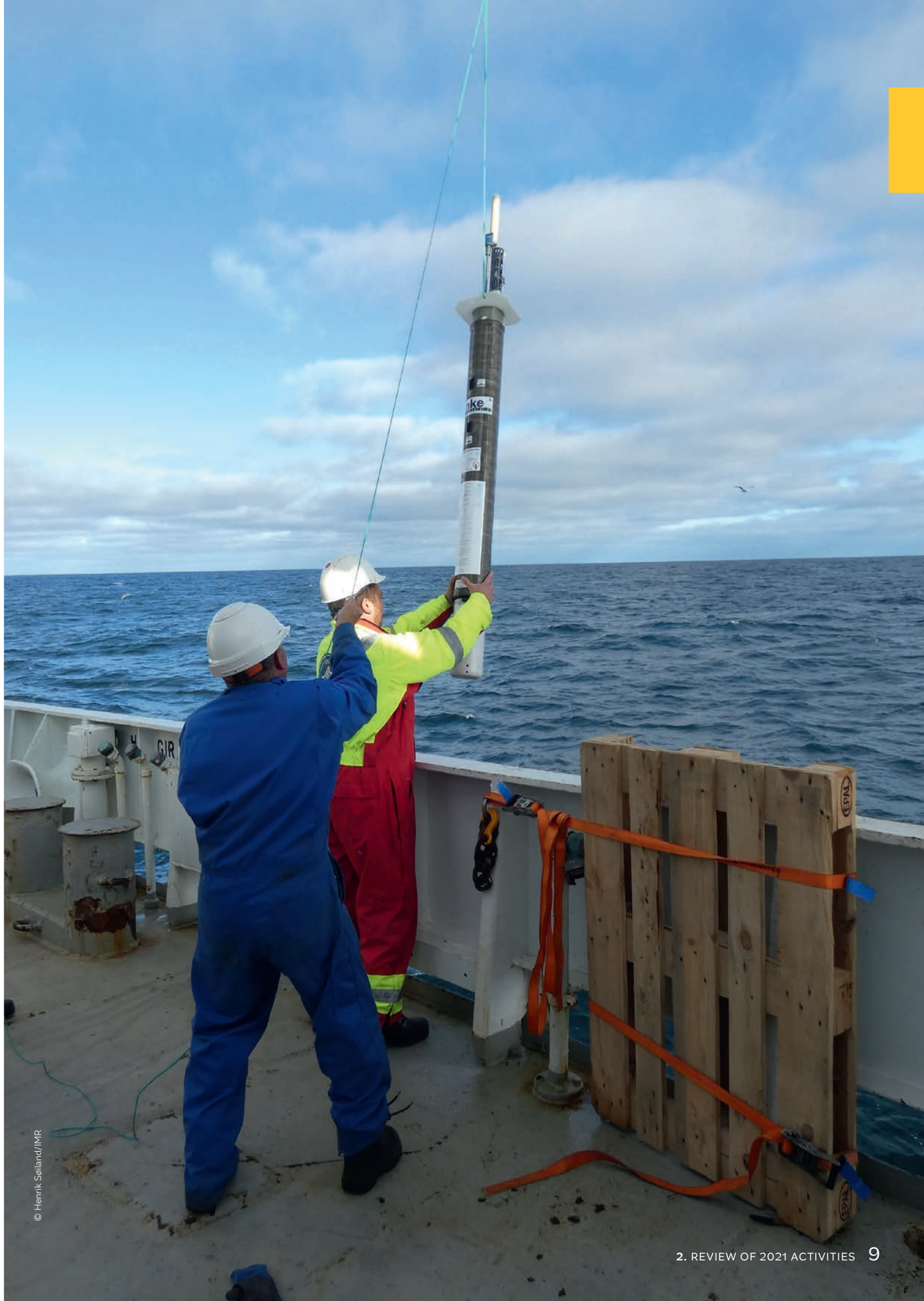


Figure 2: Timeline of European Argo float deployments showing the evolution of European float deployments in float number (colors, left axis) and as a percentage of the international effort (blue dashed line, right axis). © OceanOPS/AIC



Deployment of a Deep BIO float in the Nordic Seas.

© Blue Observer

The Blue Observer team on board the Iris with an European float ready to be deployed.

An Atlantic charter – the "Blue Observer" sailing expedition – deployed 17 European floats (French, Dutch, German and from the ERIC). This first ambitious mission was funded by the National Oceanic and Atmospheric Administration (NOAA) and its partner Woods Hole Oceanographic Institution (WHOI), Argo Canada and Euro-Argo. It was the result of an international collaboration coordinated by OceanOPS. This first ambitous mission will be closely analysed to identify advantages and limitations of using a charter vessel for the deployment of European floats to complement research vessels.

To remedy the COVID pandemic situation, other innovative solutions were adopted, such as taking advantage of the cruise ships that bring tourists to remote areas. This was the option chosen by KNMI: during the summer 2021, the institute deployed one float thanks to the Bark Europa sailing ship. Ten more will be deployed in 2022 in the Southern Ocean.

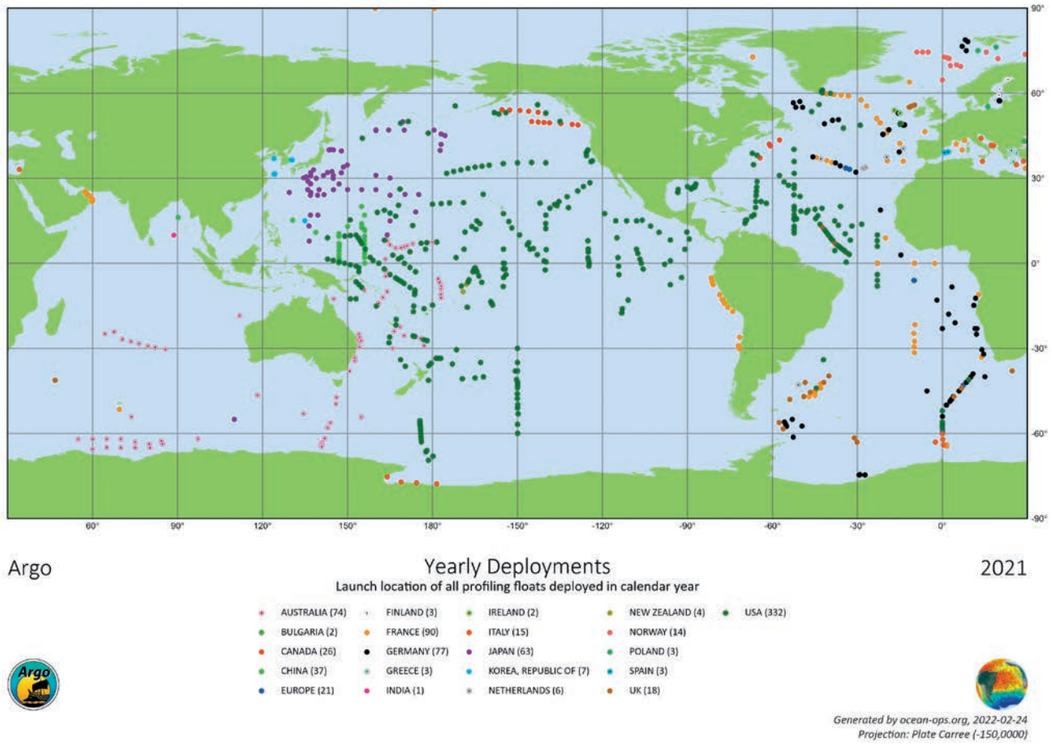


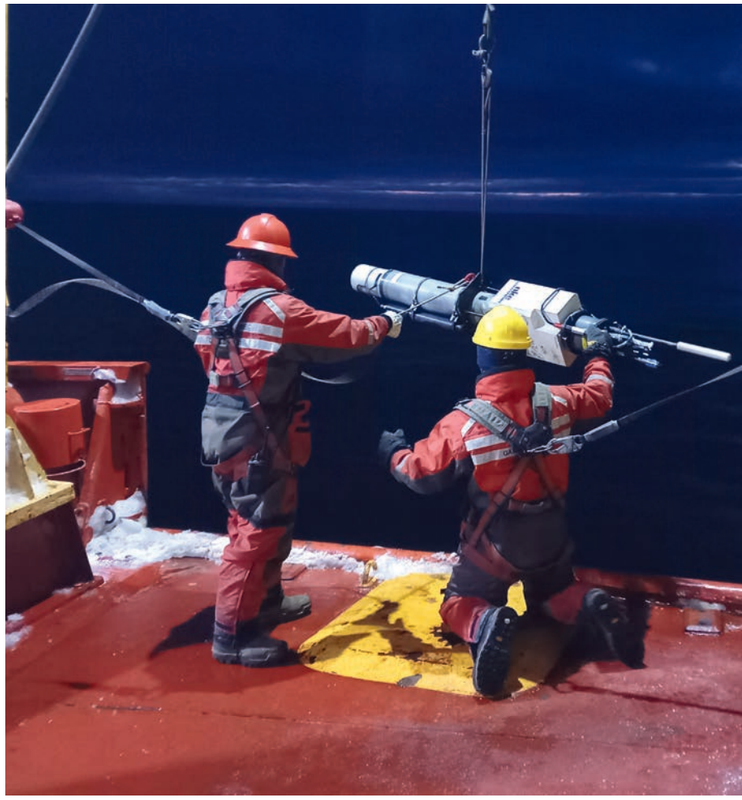
Figure 3: The launch locations of all Argo floats deployed in 2021: 257 Euro-Argo floats among the 801 deployed in 2021, representing 32% of the deployments of the global effort. © OceanOPS/AIC

Number of floats	Variables							Float types				
	T/S	O_2	Chl-a	Suspended particles	Nitrate	Downwelling irradiance	pH	Core	BGC	Bio	Deep	Total
Nordic Seas	18	8	4	4	1	4	1	10	1	6	1	**18**
Mediterranean Sea	22	9	3	3	1	3	2	13	1	7	1	**22**
Black Sea	2	2								2		**2**
Baltic Sea	13	11	9	9	2	5	2	2		11		**13**
Southern Ocean	23	2	1	1		1		20		3		**23**
Arctic Ocean	7	7	4	4	4	4				7		**7**
Global Ocean without the specific regions above	172	58	17	17	_	10	12	111		30	31	**172**
Total	**257**	97	38	38	8	27	17	156	2	66	33	**257**

Table 1: Euro-Argo float deployments in 2021, by variables measured (orange) and float types (blue). BGC stands for BioGeoChemical floats (6 variables) & Bio stands for BioGeoChemical floats with only 1 to 5 of the variables.

→ **Table 1** shows the distribution of 2021 floats deployments by basins, by parameters measured (in orange) and types of floats (in blue). The objective is to annually increase the number of floats deployed from 250 to 350 floats deployed per year by 2030, integrating the new OneArgo design (50 BGC and 50 Deep floats per year for Europe, see Euro-Argo strategy https://doi.org/10.13155/48526).

A BGC float deployed in the Baffin Bay in October.



© Édouard Leymarie/LOV

The European contribution is progressing towards the implementation of the Deep (33 floats deployed) and BGC missions (68 floats carrying at least one BGC sensor deployed) → **Figure 4 & Table 2**, even if the implementation of 6-variables floats remains expensive and is limited at larger scale for the moment (only 2 full BGC 6-variables). The oxygen network is progressing with more than 1/3 of Euro-Argo floats deployed in 2021 carrying an oxygen sensor. 15% of the deployed floats are equipped with a chlorophyll and suspended particle sensor, a few with pH sensor and even less with nitrate sensor (the most expensive sensor of the BGC suite).

	Euro-Argo deployments	International deployments	Euro-Argo deployments in % of the global effort
Core	156	546	28%
Core with O2 sensor	56	88	63%
Deep	33	64	51%
BGC	97	194	50%
Full BGC	2	9	22%
At least O2 sensor	97	191	50%

Table 2: Key numbers about 2021 deployments. In 2021 Euro-Argo deployed 50% of the BGC and Deep floats deployed in total (all countries) at international level. © OceanOPS/AIC

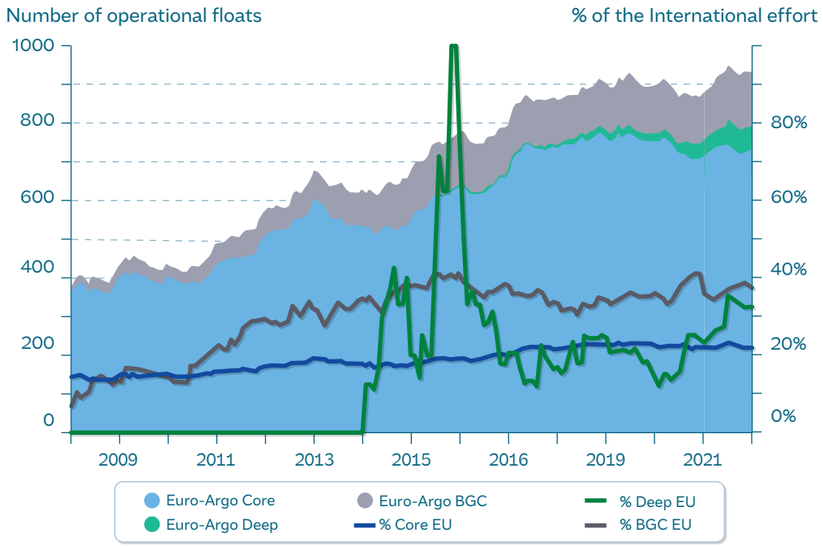


Figure 4: Evolution of Core (T&S), BGC and Deep missions, in number of operational floats (colour, left axis) and in percentage of the international effort (blue, grey and green lines, right axis). © OceanOPS/AIC

© Bernard Bourles/IRD

Deployment of a BGC float in March in the frame of the EuroSea project during the PIRATA FR 31 cuise.

These deployments relied on national programs complemented by two European projects (EuroSea and Euro-Argo RISE) and by national projects such as DArgo25. This highlights the need for new funding, through both national partners' contribution and direct European Union funding, to implement the new OneArgo mission. Thus, this new phase of Argo includes the BGC and Deep floats, which are more expensive than the Core floats and are forecast to triple the total cost for the same number of floats. Core mission is still well implemented but will also require sustained funding while the Deep and BGC missions are developing.

→ 2021 ERIC float procurements

Since 2017 a service for float procurement is available for Euro-Argo partners. Framework contract agreements ended in 2021 and new calls for tenders were issued. Technical specifications and evaluation criteria have been prepared by the ERIC Office with the help of an evaluation committee. Contracts have been awarded to nke Instrumentation for float procurement for the three Argo missions. In 2020, a multi-annual contract was awarded to SeaBird Scientific Inc., for the supply of BGC sensors. This made possible the purchase of sensors to measure nitrate, chlorophyll-a concentration, backscattering coefficient, radiometry and coloured dissolved organic matter (CDOM) concentration.

Euro-Argo ERIC Office technical team deals with the inbound logistics (follow-up of the manufacturing process, delivery dates, coordination of the telecommunication, contracts opening etc.), to carry out acceptance tests in the Ifremer testing facilities (seawater basin for real profiling down to 20 meters, hyperbaric chamber for the Deep floats) and finally to ship the equipment either to the purchasing institutes, or directly to the deployment vessels. Assistance with the handling of float metadata for the data centres, as well as "at-sea monitoring" was also offered.

© Euro-Argo ERIC

Preparation of the European floats for the Blue Observer mission at ERIC facility.

2021 was marked by a significant workload for the Euro-Argo ERIC Office to sustain this service for its Members, due to some increasing manufacturers lead times and delays, the Ifremer pool tank for acceptance tests out of service most of the year, and changing deadlines for deployments with the return of research cruises and backlog from 2020.

Additionally, the orders became increasingly complex with the development of the BGC mission and the diversity of sensor suites. Acceptance tests and metadata preparation for BGC floats required also significant additional efforts, as the procedures had to be revised to deal with difficulties with importation (VAT, customs) procedures for BGC sensors purchased in USA.

The details of the 83 floats purchased in 2021, for 8 countries and a total of about 2.15 M€ and 0.72 M$ are provided below in → **Table 3**.

COUNTRY/INSTITUTE	Number of floats					
	Total	Core	Core + DO	DEEP + DO	BGC 6 variables	BGC (< 6 variables)
BULGARIA/IO-BAS	4	1	2			1
FRANCE/IFREMER	9		2		3	4
ITALY/OGS	19	12	4			3
NETHERLANDS/KNMI	19	19				
NORWAY/IMR	18	3	4	2	5	4
POLAND/IOPAN	3		3			
SPAIN/SOCIB	3	3				
UK/METOFFICE	2				2	
ERIC (EU projects + ERIC)	6		5			1
Total	83 (~2.15 M€ and 0.72 M$)	38	20	2	10	13

Table 3: ERIC float procurement in 2021 (by country and float types), on behalf of Euro-Argo Members.

Technical developments

→ Towards One Argo strategy

Europe keeps on testing technological developments in line with the "OneArgo strategy" (https://www.frontiersin.org/articles/10.3389/fmars.2019.00439/full). One of the main goals of the Euro-Argo RISE project is to diversify sensors in order to sustain and expand the network at a competitive cost. To that end, various sensors of the three types of Argo mission were tested in 2021:

RBR sensors were tested for the Core mission. Two RBR floats were deployed during the Blue Observer mission, from the Iris sailing boat. Two more Arvor-I-RBR floats were deployed by FMI in the Baltic Sea in May and a CTD calibration cruise is scheduled, to get more detailed comparison with ship CTD. Ifremer also started evaluating the RBR-CTD pilots accuracy and stability of data acquired during 2020. Common diagnostics were shared through EuroArgoDev GitHub. In addition, data were pooled with the international pilot project task team on Argo RBR, (see p. 18). In January BSH deployed ten floats for a swarm experiment in the frame of the DArgo2025 project, one of whose aims is to diversify the Argo network with alternative CTD sensors. Thus, five sensors from Seabird and five others from RBR were mounted on floats and these were launched in pairs to compare their accuracy and stability. All pairs were released within minutes in a strong cyclonic eddy in the Northeast Atlantic to ensure the swarm would stay together as long as possible. This experiment was a success, with initial float profiles in agreement with CTD casts performed during deployment. The comparison to climatological reference data showed the expected fresh bias of the eddy but also the good agreement in the magnitude of the bias between all floats during the first 30 cycles. Some necessary adjustments for the pressure dependency of the RBR sensor had to be performed for these five floats, but will in future be taken care of by the lab calibrations. So far, no drift in time of the salinity sensor of the floats has been detected. In conclusion, it appeared that RBR CTDs were a viable option for Argo sensor diversification.

RBR and SBE sensors accuracy were also tested for the Deep mission. For instance, the RAPROCAN2012 cruise allowed for further testing of the three-headed floats. In March, another three-head float was recovered in the frame of Euro-Argo RISE project, as a problem with the transmission of hydrographic data was detected. The float has been repaired, the SBE sensors (SBE61 and SBE41) were re-calibrated and a new RBR sensor was incorporated. In parallel, design, qualification and last tests of the two two-headed Deep floats (with RBR sensor on top and a SBE61 on the side) progressed. These three prototypes are planned to be deployed during the next Raprocan cruise in Spring 2022.

BGC sensors were tested. The first profiles of hyperspectral irradiance were collected in the global ocean! A Ramses float was deployed in May in the Baltic Sea (WMO 6903706), after a first deployment in the Mediterranean Sea. It was equipped with an OCR sensor from SeaBird, a Ramses sensor from TriOS Gmbh, an EcoPuck fluorometer from SeaBird and an oxygen optode from Aanderaa. This prototype is complementary to those in the DArgo2025 German project and should help Europe to develop the extension towards BGC.

© Patrick Rousseau/Ifremer

Argo France and Euro-Argo ERIC joint effort during the tests of one three-headed and two two-headed floats qualification at the Ifremer pool in the frame of the Euro-Argo RISE project.

→ Test Argo into shallow coastal waters

In the frame of Euro-Argo RISE Project, Argo floats were tested closer to the shallow coastal waters, showing the potential but also the complexity of operating floats in these areas. The preliminary results from targeted Argo missions in Mediterranean, Baltic and Black Sea were analysed. European partners (OGS, HCMR, SU, SOCIB, IO-BAS, FMI, IO PAN) are now working on additional monitoring tools and on optimising the configuration of their national floats to keep them in the target area and avoid stranding events, getting stuck at the sea bottom, or risky areas (coastline, islands, or high-maritime traffic). For instance, HCMR modified the configuration settings in order the float to sample in high frequency (2 – 4 days), and to drift close to the seabed (at 500 or 800 metres depth). Argo Italy deployed one float to replace the Euro-Argo RISE float off the North Adriatic coast the 4th of May. It has been configured like the Euro-Argo RISE platform, with a cycle length of five days and a parking depth at the sea bottom, to be used as a virtual mooring. SOCIB also deployed one float in the Balearic Archipelago in March 2020 and used the Western Mediterranean OPerational forecasting system (WMOP) as well as the Argo fleet monitoring tool superimposing the sea currents provided by the latest AVISO satellite derived data to better understand if the float was going to move away from coastal water. Some floats were recovered in the Marginal Seas (Mediterranean, Baltic etc.), highlighting the potential of recovery in these key areas (see p. 19).

→ Test Argo in high latitudes areas

In the frame of Euro-Argo RISE Project, Argo floats were also deployed in high latitude areas. BSH, FMI, IMR, IO PAN and SU have been particularly active in deploying national floats. For instance, BSH compiled a database with temperature profiles classified according to the profile locations relative to the ice edge, to determine the ISA settings in various regions. Thanks to this first step, tools to estimate the location of the Argo float and of the under-ice profiles, as well as a sophisticated method for bathymetry following interpolation, were tested and made available in EuroArgoDev Github for data users. A best practices document is under preparation and will be released in 2022.

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Luca Arduini Plaisant at Ifremer facility.

→ Luca Arduini Plaisant's work

Hired in mid-2020 at the ERIC Office, Luca continued to work in 2021 in technical and logistic activities (acceptance tests, shipments, monitoring, etc.) and for the Euro-Argo RISE and EuroSea projects. Luca especially managed the BGC floats and handled settings and configurations, metadata preparation for real-time decoding and analyses of the sensors data from acceptance tests, and monitored the floats after their deployments. This notably led to the successful launch of Norwegian floats and BGC floats for the H2020 EuroSea project.

Luca spent most of his year working on the deliverable D2.6 "Recommendations to increase the overall life expectancy of Argo floats" of the Euro-Argo RISE project and related activities. Submitted in December, this report analysed the performances of Argo floats, comparing models across the three Argo missions (Core, Deep, BGC), areas of deployment and types of configurations and technical behaviours. This report also highlighted the less reliable ones presenting an important early failure rate or accomplishing less cycles than the theoretical estimated lifetime. These analyses are mainly derived from survival rates computations with three complementary metrics: the number of cycles achieved, the age reached and the vertical kilometres travelled by the floats → **Figure 5**.

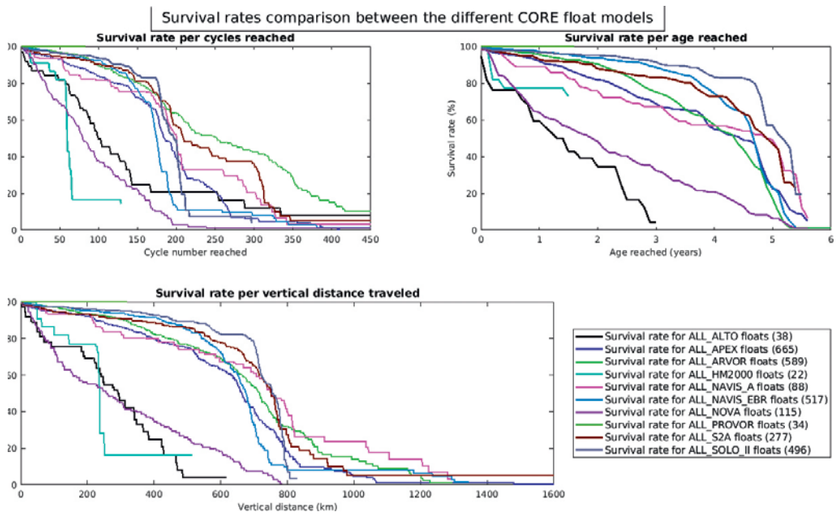


Figure 5 : CORE float models survival rates comparison

© Euro-Argo ERIC

Luca Arduini Plaisant at Ifremer facility.

To perform comparisons between at-sea survival rates and their theoretical lifetimes, a list of floats with depleted batteries was created. This list was also used to try to analyse the impact of specific configuration parameters and technical behaviour on floats lifetime.

Eventually, a summary table of float model performances across Argo missions was provided with information about theoretical lifetimes, average number of cycles achieved, averaged lifetime for floats until battery depletion, etc.

A condensed version of the deliverable D2.6 was created in order to gather and share all the main observations of this work. All the scripts developed and used to perform these analyses are on the Euro-Argo GitHub server, ready to be reused in a couple of years' time when more floats will have depleted their batteries, increasing the dataset or verifying trends already observed.

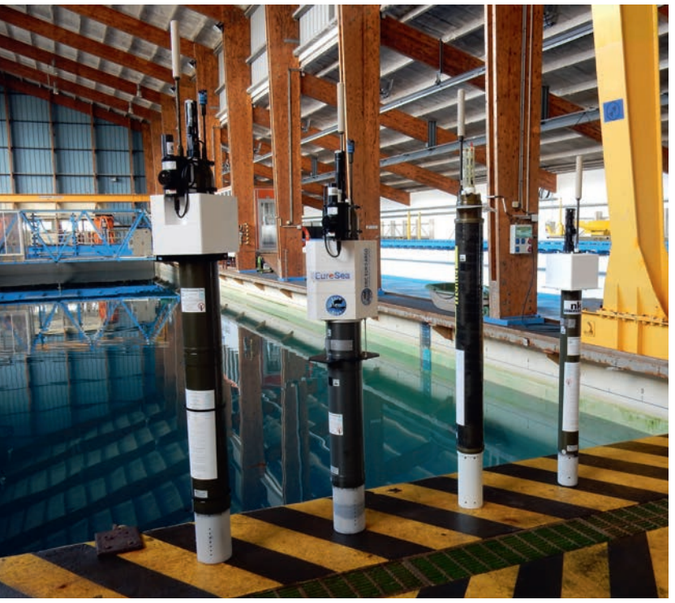
One important recommendation that came out of the work carried within task 2.1 of Euro-Argo RISE is the need to strengthen Argo metadata filling and consistency.

Additional activities were required and performed in order to improve Argo metadata, such as the audit of all the European recovered floats **(see p. 19)**. This audit identified an issue – which is now resolved – in the metadata managed by OceanOps, and to update all this information for Euro-Argo floats.

Luca has also been highly involved within the Fast Salinity Drift (FSD) now Abrupt Salinity Drift (ASD) international Task Team and especially contributed to the implementation of a collaborative spreadsheet for fast salinity drift assessment, gathering key findings from the Delayed-Mode operators regarding the data quality of the floats. This work has been valuable to monitor the ASD in floats since 2018 and assess independently of Seabird if the issue is solved or still remains in recent serial numbers.

For the EuroSea project, Luca coordinated with the SailDrone (autonomous vessel streered from shore) mission in the Tropical Atlantic to organise an inter-platform appointment between the Saildrone and two of the BGC floats deployed. These data will be analysed later on within the project.

Finally, Luca performed on a regular basis the at-sea monitoring of the Argo floats purchased by the ERIC on behalf of Members. He interacted with deployment teams when alerts were raised on the technical behaviour of the floats.



© Stéphane Lesbats/Ifremer

Floats tested at Ifremer facility in February.

Data management

Europe hosts one of the two Argo Global Data Assembly Centres (GDAC): Coriolis/Ifremer, in France, and two of the eleven Argo Data Assembly Centres (DAC): Coriolis/Ifremer, and BODC in the UK. In 2021, 72413 Argo data profiles were processed by these two centres → see Figure 8 p. 20. Delayed Mode Quality Control (DMQC) of the European floats are performed by four institutes (BSH, OGS, Coriolis/Ifremer and BODC) and almost 80% of the European floats were scientifically assessed to reach the accuracy needed for climate applications.

In addition to the data processing itself, European partners made progress in different aspects of Argo data management, in the framework of the Euro-Argo RISE and ENVRI-FAIR EU projects. These efforts were presented to the international community at the 22nd Argo Data Management Team meeting in December:

– the OWC tool used for Delayed Mode QC of the Argo float data is now available in python on EuroArgoDev GitHub (BODC Euro-Argo RISE project);

– continuation of the work started in 2019 within ENVRI-FAIR project at BODC to use the NERC Vocabulary Server to provide Machine readable access to all the Argo reference tables described in the Argo User's Manual;

– release in summer 2021 of the French GDAC new data access service: the Euro-Argo data selection tool, developed by Ifremer and Euro-Argo ERIC within Euro-Argo RISE and ENVRI-FAIR projects. This tool allows selecting, visualising and downloading Argo profile data, through a user-friendly web interface → see Figure 6 p. 19;

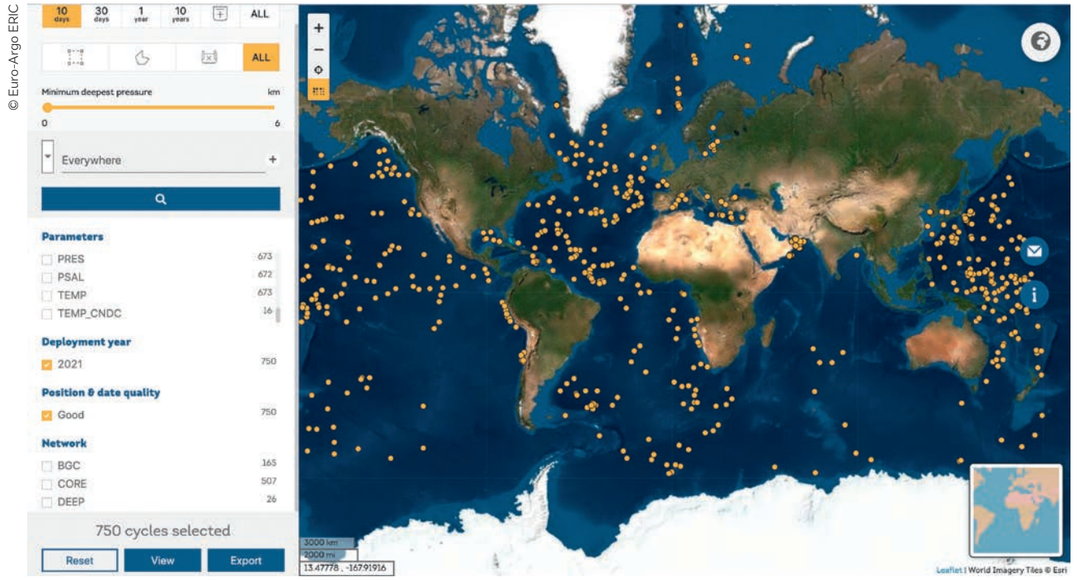
– release of the DMQC cookbook for Core parameters in March (V1.0);

– in the frame of Euro-Argo RISE project, the Argo Reference Data Base relying on high-quality ship-based CTD reference data and used for Delayed Mode QC has been enriched in poorly covered areas such as the Arctic Ocean by BSH and in the Mediterranean and the Black Sea by OGS (MedArgo Program). Moreover, a classification method using machine learning techniques has been developed to select the most relevant one;

– enhancement of Deep Argo data flags and correction of the pressure effect on salinity computation, in real time and delayed mode, by Ifremer and BODC;

– monitoring of Abrupt Salinity Drifts observed by DMQC operators continued thanks to the collaboration of the Euro-Argo ERIC Office and European partners (BSH/Ifremer/OGS/BODC), still involved in the international working group on this subject;

– the Europeans participated in the Argo RBR data task team, enabling the RBR data to be considered as good data for operational and research studies.

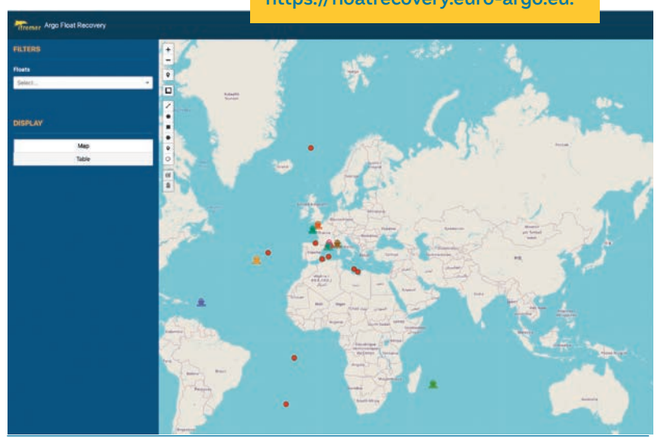


© Euro-Argo ERIC

Figure 6: The Argo data selection tool.

Most of the above tools have been developed and are available on the EuroArgoDev Github initiated in 2019 by Ifremer and all European partners involved in Euro-Argo RISE WP2.

European partners have also made important progress regarding the management of BGC Argo data processing workflow. Several options proposed within Euro-Argo RISE WP4 for the future organisation of BGC Argo data management at European level were discussed by Euro-Argo Management Board during its 21st meeting. In addition, procedures for quality control of several BGC parameters proposed by European teams (LOV, PML, Geomar) were agreed during the 10th international BGC Argo Data Management Team meeting in December 2021. In the framework of the Euro-Argo RISE project, significant work was done in analysing the data of recovered Deep floats, in close interaction with the manufacturers (Seabird and RBR) (see pp. 36-37).



© Ifremer

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

Figure 7: The Argo float recovery web service.

New web service for Argo float recovery

Finally, an Argo float recovery web service was developed by Ifremer and Euro-Argo Office, dedicated to float operators. This tool, developed in the frame of Euro-Argo RISE WP7 and available since summer 2021, was used successfully for float recovery in the Atlantic, Mediterranean and Baltic Sea. The float recovery service is activated on request and 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.

KPIs regarding floats and data processing

→ Number of available profiles collected by Euro-Argo floats

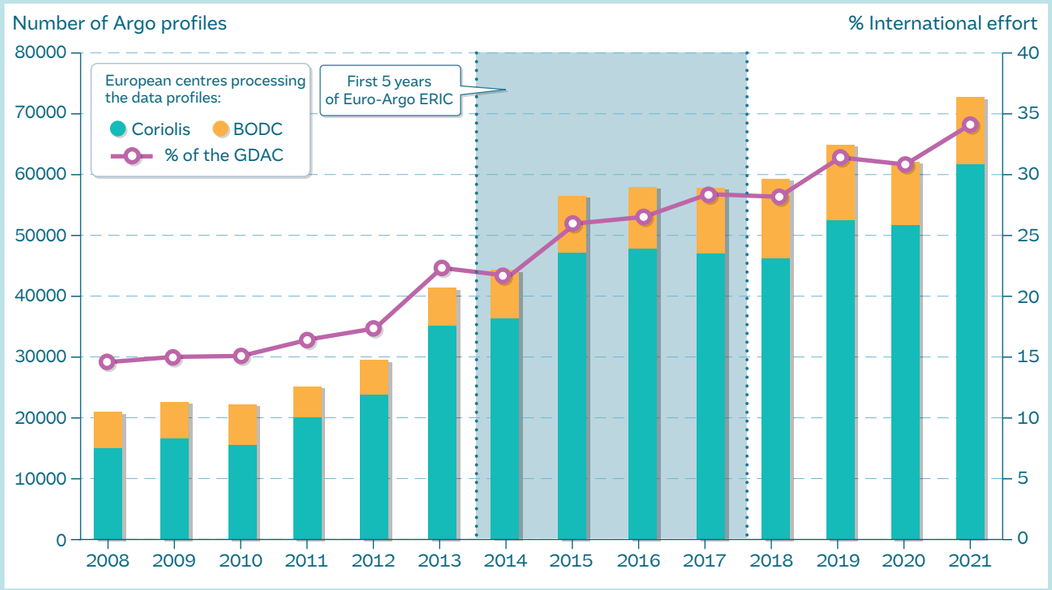


Figure 8: Argo data profiles available on Coriolis and BODC DACs: in number of profiles (left axis, blue: Coriolis and orange: BODC) and in percentage of the total number of profiles available on the GDAC (right axis). © Ifremer/GDAC

→ Number of Euro-Argo operational floats

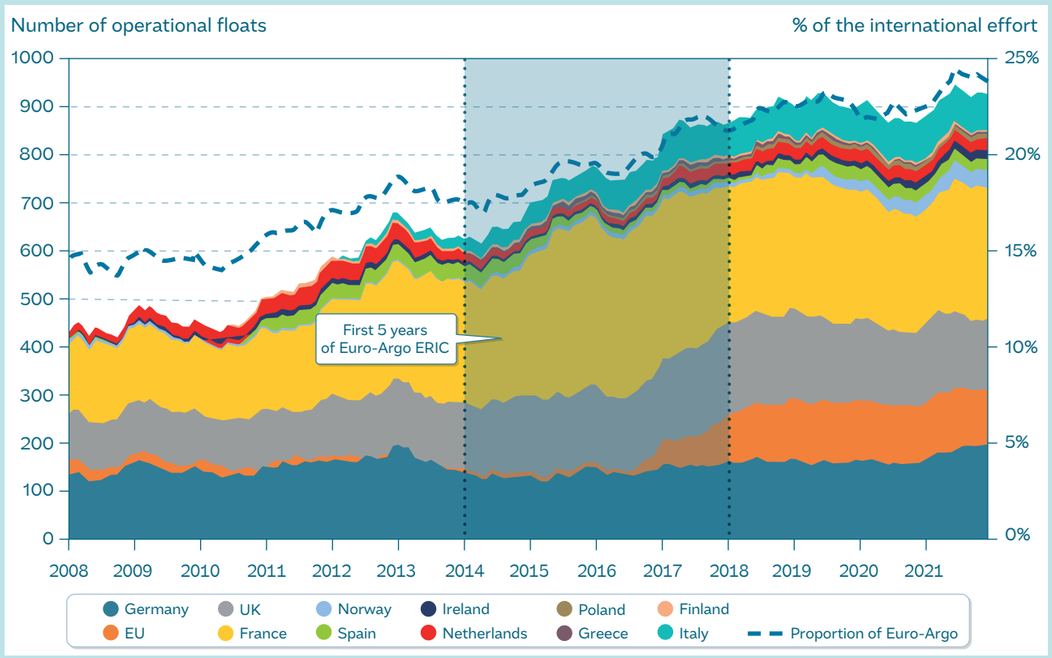


Figure 9: Evolution of the European contribution to the Argo network in number of operational floats (colour, left axis) and in percentage of the international effort (blue dashed line, right axis). © OceanOPS/AIC

→ Number of operational Euro-Argo floats measuring BGC variables

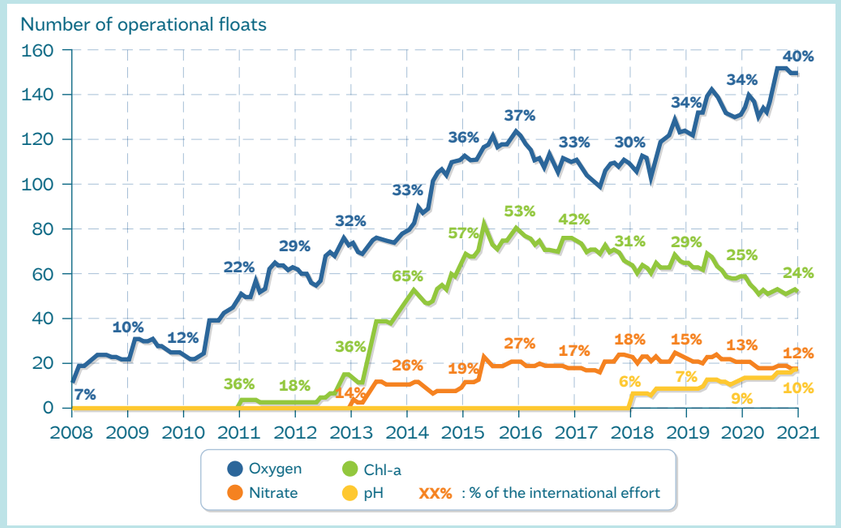


Figure 10: Evolution of the European contribution to four of the six biogeochemical parameters, in number of active Euro-Argo floats measuring that variable (left axis, solid curve), and percentage of active Euro-Argo floats measuring that variable in the global array (percentage of each year on the curves). © OceanOPS/AIC

→ Number of floats reaching the 50 or 100 cycles target

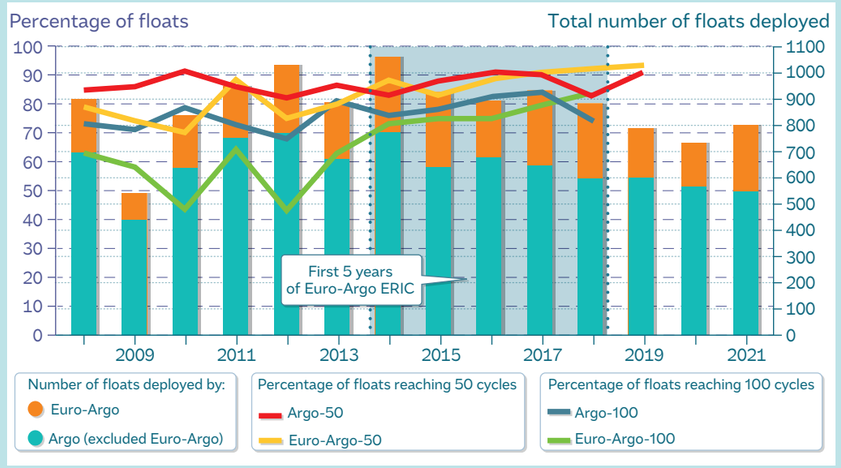


Figure 11: Percentage of floats reaching the 50 or 100 cycles target compared to the Argo fleet (coloured lines, left axis) and total number of floats deployed (right axis). Since 2015, the performance of the Euro-Argo fleet has steadily improved both in reliability (50 cycles) and longevity (150 cycles target). © OceanOPS/AIC

→ Number of floats per manufacturer

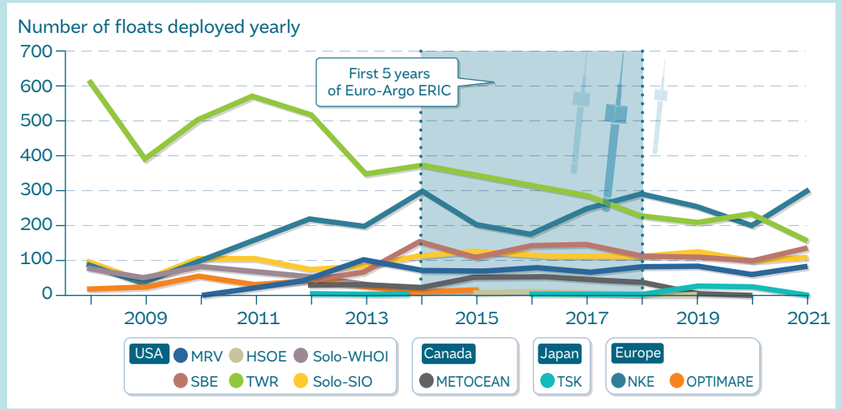


Figure 12: Evolution of number of floats deployed per year, grouped by float manufacturer. © OceanOPS/AIC

Objective 3

CONTRIBUTE TO A GLOBAL OCEAN OBSERVING SYSTEM

Develop stronger partnership with other Marine Research Infrastructures

In 2021, the Euro-Argo ERIC strengthened its partnerships with environmental and other RIs through its participation in various EU-funded projects (Euro-Argo RISE, EuroSea, ENVRI-FAIR, ERIC-Forum, DOORS). To improve the coordination with other RIs to evolve towards an integrated observing system, the ERIC became a member of the EU project GROOMII advisory board and participated in a workshop on Marine RIs landscape during the kick off meeting in February. Finally, the ERIC organised with ten other Marine RIs a side event at the 9th EuroGOOS Conference (in May) aiming to foster joint activities and future strategic collaborations.

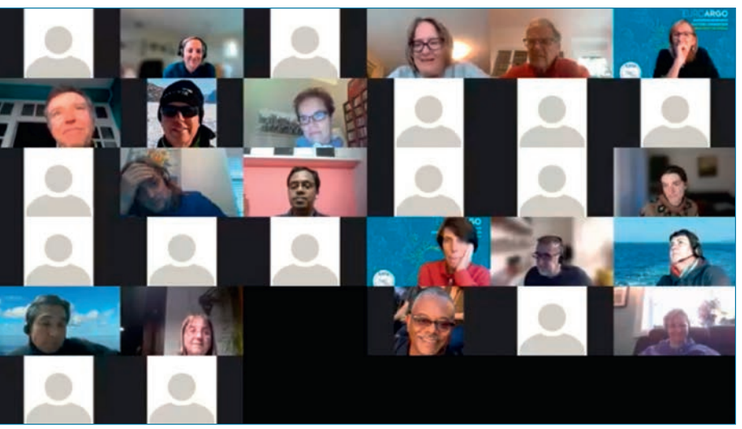
Anchor Euro-Argo development within the international context

In 2021, various data and technical developments (see p. 14 and p. 18), such as new quality control methods or tests of BGC sensors, were endorsed by the Argo community at the 22nd Argo Steering Team Meeting (AST) in March and the 22nd Argo and 10th BGC Data Management Team Meetings (ADMT) in December. During the AST, the growing European contribution to the Argo programme was highlighted and special attention was paid to the development of BGC Argo in Europe. One of the main goals of the ADMT was to review the progress on the OneArgo data management system (see pp. 18-19) on the basis of the preparatory work carried out by dedicated working groups. The significant role played by the European partners in this collaborative effort was duly acknowledged.

As a contribution to the UN Ocean Decade, the role and importance of ocean observations was promoted through a series of events. In May, European partners were strongly involved in the "Global Biogeochemical-Argo Fleet: Knowledge to Action Workshop". The workshop was directed towards potential funders of BGC Argo from the G7 countries. It highlighted the latest scientific advances and showcase dthe range of applications possible from a global data-stream of the BGC Argo array in fisheries, carbon budget verification, and environmental forecasting.

At the European Commision meeting "Ocean observing technology: optimising European capability & ocean observing gaps and requirements" (in June), Euro-Argo ERIC advocated for sustained funding for ocean observations and highlighted how the MOCCA project contributed to strengthening European manufacturers' position in the Argo programme. The importance of R&D projects to support floats and sensors innovation and testing in Europe, as well as the crucial need to set up implementation projects – or sustained funding mechanisms – to turn these R&D innovations into significant European market capabilities were emphasized.

EC Ocean Observation event.



© Euro-Argo ERIC

Figure 13: Ocean Observers initiative three main goals.

The month of June was also notable for an unprecedented event: the first Euro-Argo political event organised in the framework of the Euro-Argo RISE project targeting high level stakeholders and decision makers. Keynote speakers from the Euro-Argo community shed light on the importance of Argo for environment and society, with a focus on the European Marginal Seas. During the panel discussion, the crucial role BGC floats can play to meet the needs of the Marine Strategy Directive (MSFD) and the importance of Argo data for the quality of the services provided by Copernicus Marine Service for operational oceanography were highlighted. The IOC-UNESCO provided a clear support to the development of the Argo Programme while the European Commission listed the objective of developing a sustained ocean observing system as a high priority.

The Euro-Argo ERIC reinforced its contribution to the ocean Literacy programme by participating in the EuroGOOS Ocean Literacy Working Group meeting in October and co-organising with OceanOPS the 2nd Ocean Observers Workshop at the end of November → **Figure 13**. This workshop, which was held online with simultaneous translation in English, Spanish and French, gathered 70 participants from 22 countries. It identified many educational resources (from primary school to graduate school) and created various connections between different science mediation programmes from international partners and scientific institutes.

Support to national and European initiatives to expand the European Argo community

Euro-Argo strongly encouraged the consolidation of the Euro-Argo community either as Member of the Euro-Argo ERIC or as Contributor, helping for instance with float deployment and recovery, or facilitating float drift in EEZ to allow full coverage of the Marginal Seas. All those efforts led to the creation of the EuroGOOS Euro-Argo TaskTeam, which aims at strengthening the Euro-Argo community.

As part of the EOOS operational committee, Euro-Argo also worked towards the integration and better coordination of the European ocean observing system. In that framework, the idea of extending OceanOPS services and tools to European observation data was raised.

On October 26-28th, OGS attended the MonGOOS Workshop & General Assembly. Several topics were discussed, such as the extension of Argo towards shallow coastal areas, the collaboration with regional partners, the BGC and Deep extensions, and the delayed-mode quality control of Argo data in the Mediterranean Sea.

Objective 4

DEVELOP ENGAGEMENT WITH THE EUROPEAN ARGO USER COMMUNITIES & STAKEHOLDERS AND REINFORCE EURO-ARGO VISIBILITY

Major events

The 2nd General Assembly of the EuroSea project was held in January, with the aim of developing a multi-network strategy and sharing some Standard Operating Procedures (SOP) between the various networks. The EuroSea BGC Argo and Deep Argo workshops held in September aimed at strengthening the European ocean observing system, disseminating good practices and fostering interactions with other components of the ocean observing system such as Deep Ocean Observing Strategy (DOOS), GO-SHIP, OceanSITES, and OceanGliders. More specifically, the BGC Argo workshop allowed to review progress done in implementing best practices in the area of floats preparation, float deployment and data management, and to exchange with user communities (e.g. biogeochemical modelers, ocean colour specialists). The objectives of the Deep Argo workshop were to assess progress of the Deep Argo mission (from scientific use of Deep Argo data to technological ability of floats and sensors), to review end-users' needs, and to finalize the implementation plan of the global Deep Argo array of 1250 floats. These two workshops were a success, with 140 to 180 participants for each session.

In the framework of the Euro-Argo RISE project, the first Euro-Argo Regional workshop (Mediterranean and Black Seas & Arctic and Baltic Seas) was organised by IO PAN, HCMR and Euro-Argo in April. It gathered more than a hundred people coming from 23 different countries. For the first time, this event connected the communities sharing an interest in these very specific regions such as scientists, but also operators and stakeholders. The main objectives of the workshop were, first, to present the technical aspects of Argo and the scientific usage of Argo data in these areas and, second, to develop new regional collaborations and engage with new teams from various countries. This event was a success since it set up the basis for new collaborations to extend Argo interest into regional spheres and to consolidate a network of scientists engaged in climate and ocean research using Argo data.

Finally, after three years of work, the 2nd Euro-Argo RISE General Assembly held in November was a key meeting for the consortium to gather and discuss results obtained so far in a very concrete manner. This event revealed that the Euro-Argo RISE project is a real booster towards sustained operational implementation.

Above all, it was an opportunity for the ERIC to introduce its vision "beyond the project", with the willingness to implement all the results of the project at the infrastructure level. This step will shape the ERIC for the next 10 years through a revised strategy, and new implementation and long-term sustainability plans.

To facilitate interactions with float manufacturers, a series of workshops were organised at the end of the year. To strengthen the link and support to operational users, a Memorandum of Understanding (MoU) was signed with Copernicus Marine in July where Euro-Argo ERIC and Copernicus Marine committed themselves to promote the need for a sustained and consolidated European contribution to the OneArgo mission and to coordinate their activities to maximize and ease the use of Argo data by the Copernicus Marine Service.

© Euro-Argo ERIC

22nd Argo and 10th BGC Data Management Team Meetings.

EVENTS WHERE EURO-ARGO WAS PRESENT IN 2021	DATES
ADMT 22	6 – 10 December
ENVRI FAIR week	November
2nd Ocean Observers Workshop	29 November – 30 December
2nd Euro-Argo RISE General Assembly	18 – 19 November
EuroGOOS Ocean Literacy	20 – 21 October
Deep and BGC workshop	27 September – 1 October
European Commission Ocean Observation event	18 June
Euro-Argo Political event	8 June
Global Biogeochemical-Argo Fleet: Knowledge to Action Workshop	May – 4 weeks
Marine RIs Side Event - 9th EuroGOOS Conference	5 May
Euro-Argo Regional workshops (Mediterranean and Black Sea & Arctic and Baltic)	8 – 9 April
AST 22	22 – 26 May
EuroSea General Assembly	18 – 22 January

Table 3: Events where Euro-Argo was present in 2021.

At the end of the year, a support letter with Copernicus Climate Change Service (C3S) was started in the same spirit. Discussions were also held between Euro-Argo and representatives of the Copernicus Marine Service Data Assimilation Working Group both during the EuroSea BGC Argo workshop in September and in a dedicated meeting organised by Copernicus in October, to identify ways to progress on the use of BGC Argo data by the modeling community.

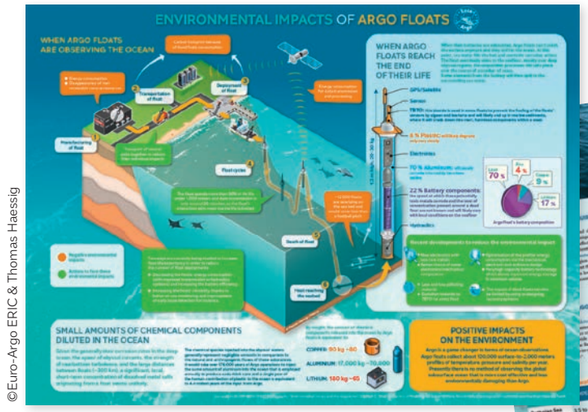


Figure 14: Leaflet Environmental Impacts of Argo Floats, based on the Argo international community statement "Environmental Issues and the Argo Array", S. C. Riser; S. Wijffels and the Argo Steering Team".

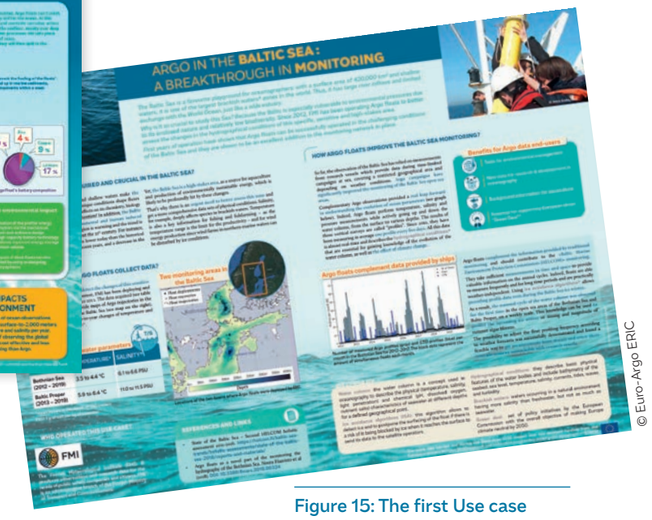


Figure 15: The first Use case published online in collaboration with FMI: "Argo in the Baltic Sea : a breakthrough in monitoring"

Communication activities and tools

Activities aiming at increasing Euro-Argo visibility were pursued in 2021, through 27 news items published throughout the year on the Euro-Argo website, and sent to a large audience in two News Briefs campaigns (in July and January).

→ Two printed documents published

The 2020 Euro-Argo Activity Report was released with a new double-page dedicated to the socio-economic impacts of Argo. A leaflet including a poster about the environmental impacts of Argo floats was also published and presented during the AST meeting. It shows that, for the time being, there is no method of observing the subsurface global ocean that is less environmentally damaging and more cost effective than Argo.

→ Social media in constant progress

The Twitter account continued to attract new followers → **Figure 18**. Since 2021, Twitter has been used to highlight a scientific publication every month, called "Read of the Month", also recorded on the website.

→ Website updates

The outreach section of Euro-Argo website was updated with new information, such as the first "Use case", published in the framework of the Euro-Argo RISE project. These "Use cases" allow for popularisation of scientific concepts related to the observation of the ocean, as well as concrete applications of Argo data. A new section was created to explain the mission of Argo floats to children aged 9 to 12 in a simple way. The bibliography section was improved with a new searchable table. Finally, the Argo Online School, an open and freely-available online educational tool elaborated by IEO to popularise the Argo data among high school or graduate students, was released.

→ Ocean Observers community reinforced

Euro-Argo continued its activities with the Ocean Observers educational community, initiated in collaboration with OceanOPS in 2017. The 2nd Ocean Observers Workshop was held online at the end of November **(see p. 22)**. The Ocean Observers website was also enriched with some first pedagogical resources and will be further completed in 2022.

→ Press coverage thanks to Blue Observer

The Blue Observer mission **(see p. 10)** represented a great opportunity to get a wide press coverage at local and regional scale, with more than 30 press articles and some diffusion on TV and radio, but also at GOOS level (WMO, UNESCO).

KPIs regarding users, data access and publications

→ Data access in average

633 VISITORS PER MONTH (AVERAGE)

5218 SESSIONS

4,53 TERABYTES OF DATA FILES DOWNLOADED

→ Number of publications

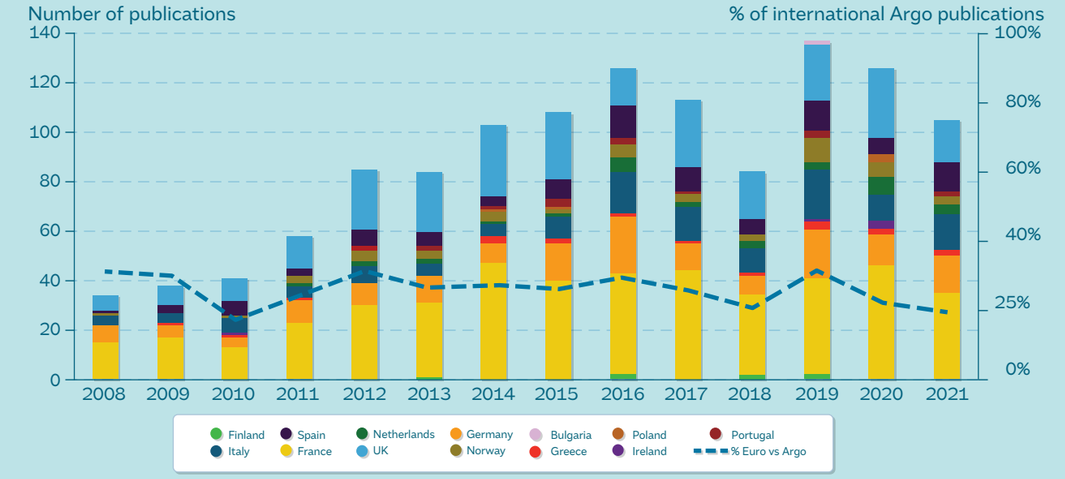


Figure 16: Euro-Argo publications per year (defined as publications using Argo data with first author's affiliation in a European country) in number of publications (left axis) and in percentage of the international Argo publications (right axis).

→ Number of Twitter followers

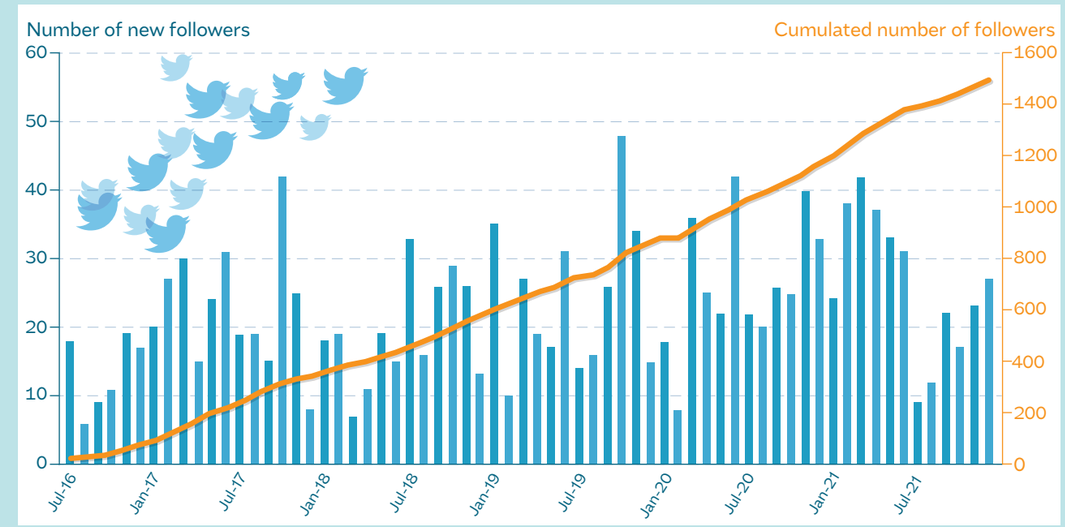


Figure 17: Evolution of the number of new (left axis, in blue) and cumulated (right axis, in orange) followers of the Euro-Argo Twitter account.

Objective 5

OPERATE THE EURO-ARGO ERIC OFFICE UNDER GOOD GOVERNANCE

Main operational outcomes in 2021

In 2021 two Management Board meetings and two Council meetings were held remotely → Table 4, thereby contributing to an effective management of the ERIC despite the pandemic situation.

In 2021, the Euro-Argo ERIC Office and the Management Board started working on three documents which will be crucial for the mid- to long-term development of Euro-Argo ERIC, namely, the 2024-2033 Euro Argo Strategic Plan and the associated Implementation Plan and Sustainability Plan, which will both cover the period 2024-2028. These documents are deliverables of the Euro-Argo RISE project to be delivered by the end of 2022.

The Management Board continued to act as an advisory board for the Euro-Argo RISE project, focusing more specifically on the work packages developing recommendations on the development of the Euro-Argo ERIC after the completion of the project. The Management Board was also involved in the Political Event and the Regional Workshops of Euro-Argo RISE to better link with stakeholders, and in the BGC and Deep Workshop to discuss the main areas of collaboration to address the issues that were identified (see p. 22).

After the presentation of the 2022 Euro-Argo work plan at the Council in December, the STAG provided a set of recommendations regarding the OneArgo developments in Europe. These recommendations included, for instance, the need to keep diversifying the manufacturers' landscape and to extend the services (procurement, support for implementation, data management etc.) to the BGC Argo mission. The STAG stressed the complexity of this mission, which will require a strengthening of the central team to support the ERIC participating entities. The STAG was also supportive of the strong commitment of Euro-Argo ERIC to OneArgo missions, highlighting the specific needs of the BGC mission (complex ordering and data processing) and of the long-term strategy for recoveries of floats.

At the end of the year, following the regional workshop organised in the framework of the Euro-Argo RISE project, the Danish Institute AQUA-DTU sent its application as a candidate Member of Euro-Argo ERIC, the first step towards a Membership of Denmark to the ERIC. This application was accepted at the 16th Council Meeting in December.

Event	Date
20th Management Board	March, online
15th Council	June, online
21st Management Board	October, online
16th Council	December, online

Table 4: Euro-Argo Management Board and Council meetings in 2021.

© Euro-Argo ERIC

Euro-Argo ERIC 20th Management Board.

© Euro-Argo ERIC

Luc van Dyck, consultant advisor for policy and partnership relations.

Euro-Argo ERIC Office team

2021 was marked by the arrival of Luc van Dyck in the Euro-Argo ERIC Office. Luc holds a degree in chemical engineering for bio-industries and a PhD in the life sciences and has an extensive experience in research, European affairs and science policy. He notably worked during ten years at the European Molecular Biology Laboratory (EMBL), where he served as executive coordinator of a platform of scientific organisations and learned societies involved in policy and advocacy at the European level. At Euro-Argo ERIC, Luc will serve as Senior Advisor for Policy and Partnership Relations, and will participate in various Euro-Argo ERIC EU-funded projects. He is based in Munich, Germany, but will spend at least a week per month in the ERIC Office in Brest.

3 EURO-ARGO MEMBERS MAIN ACHIEVEMENTS IN 2021

ARGO BULGARIA

© IO-BAS

- Deployed **2 ARVOR floats** with **oxygen sensor** during the research vessel Akademik cruise in the western Black Sea.
- Was deeply involved in **the "Developing Optimal and Open Research Support" for the Black Sea (DOORS) project** and its multi-sensor strategy.

ARGO GERMANY

© Dimitris Kassis/HCMR

- Acquired 93 floats and deployed 75 floats, the remaining 18 are onboard of ships and will be deployed early 2022.
- Deployed floats **in the Baltic Sea for the 1st time**.
- Held **1 kick-off meeting in January for the C-Scope project.** The project aims at a sustainable CO_2 observation system, integrating ICOS and Argo activities.
- Conducted a successful **swarm experiment** in the frame of DArgo2025.
- Finished DArgo2025 project which allowed to deploy **15 BGC floats** and to test new sensors for nitrate and hyperspectral light.

© Michael Naumann/IOW

ARGO FINLAND

© Simo Siiriä/FMI

- Deployed **2 national and 4 Euro-Argo RISE floats** during the Aranda cruise.
- Enhanced the **development of DMQC in the Baltic** thanks to a dedicated cruise that collected 105 profiles to calibrate the data.
- Successfully tested the Arvor C as a **virtual mooring** in the Bothnian Sea.
- FMI and IO PAN initiated the establishment **of Argo & Glider cooperation working group**, under the Baltic Operational Oceanographic System (BOOS), to share information between Baltic Sea operators.

ARGO GREECE

© Dimitris Kassis/HCMR

- **Recovered a float with a scuba diving** in north-western Crete in June.
- Organised a **general public event**, in November, in the framework of the Euro-Argo RISE educational and outreach activities.
- Deployed 5 floats in September and November.

ARGO FRANCE

© Lisa Matthes/Takuvik

- Held **1 kick-off meeting early 2022 of 3 crucial projects** in January: 21M€ invested until 2029 to consolidate the French contribution to OneArgo and to develop and test a "Deep-6000 float" and a "BGC-ECO float".
- Acquired 82 floats and deployed 90 floats, including 7 floats equipped with oxygen sensor, 10 BGC and 22 Deep.
- Produced the new **ISAS release**, providing gridded fields of temperature and salinity and now also O_2.

ARGO IRELAND

© C. O'Malley, A. Berry, K. Reilly/Marine Institute

- Deployed 2 floats in March during the Annual Ocean Climate Cruise and 2 others in **collaboration with Argo Germany** during the AIMSIR cruise in June.
- Reached its **highest number of 18 operational floats**.
- Was deeply involved in the drafting of the **Sustainability Plan for Euro-Argo RISE project**.
- Developed its promotional activities through its **updated webpage and social media**.
- Won the Euro-Argo Rise General Assembly 2021 **photo contest**.

ARGO ITALY

- Deployed its **1st BGC** float in the Southern Adriatic in November.
- Deployed 1 Deep float in the Levantine with the help of Argo Greece. **This is the 1st time an Argo float acquires deep profiles in the Rhodes Gyre**.
- Achieved its **2nd campaign in the Ross Sea** where floats operated under **ice sea conditions** and transmitted their data after 9-10 months.
- Deployed 1 national Argo float i**n the shallow/ coastal area** of the Northern Adriatic Sea, in the frame of the Euro-Argo RISE project.
- **Collaborated with Greece, Malta and Israel** for deployments.
- Enhanced the Mediterranean community attending the **MonGOOS Workshop & General Assembly**.
- Reviewed and improved the **high-quality ship-based CTD reference data** for QC of core variables, in collaboration with Greece and Spain.

© Pierpaolo Falco - Università Parthenope

ARGO POLAND

- Deployed **6 floats** in the Arctic – 4 German and 2 Polish – during the AREX 2021 summer cruise.
- One of them was **experimentally launched in a shallow region south of Svalbard (Storfjordrenna)**.
- Deployed 1 float in the Baltic Sea in June, with the aim to keep it on the shelf to use it **as a virtual mooring**.
- At the end of 2021, the IO PAN together with the Institute of Geophysics and Maritime Academy established the Consortium Argo-Poland and applied to the **Polish ministry for funding the consortium**.

© Przemyslaw Makuch

ARGO NETHERLANDS

- Deployed 5 floats through the **Blue Observer mission**.
- Enhanced **citizen science** sending 7 floats to Southern Ocean thanks to **Bark Europa tourist ship**.
- Secured funding for 7 floats, earmarked for the Caribbean Sea.

© Jordi Plana Morales

ARGO SPAIN

- Deployed 3 ARVOR-I in the Western Mediterranean.
- Reached a number of **24 operational floats.**
- Finalized **90% of the remaining DMQC**.
- Secured funding for 10 floats/year in the Atlantic, including 1 Deep float and 1 BGC float for 2022 – 2024, and 12 Core floats for 2021 – 2024 in the Western Mediterranean Sea.

© SOCIB

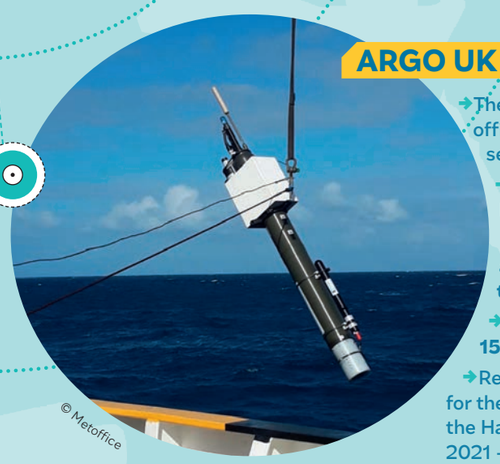
ARGO NORWAY

- Deployed 14 floats (8 BGC, 1 Deep and 5 Core floats) **through NorArgo2 project**.
- Reached its **highest number of 38 operational floats** (14 BGC and 7 Deep).
- NorArgo2 project helped to strengthen the links with the Norwegian components of **EMSO, ICOS and Monitoring Forecast Centres in Norway**.
- NorArgo2 project also allowed to launch a **new NorArgo website** (https://norargo-map.hi.no).

© NorArgo

ARGO UK

- The **NERC Vocabulary Server (NVS)** was officially endorsed as the Argo vocabulary service.
- Deployed 16 core Apex floats and 1 Navis BGCi float (that failed).
- Secured funding for 66 core Apex floats and an order for **2 Prov-Bio floats was placed through the Euro-Argo ERIC**.
- Funded and procured through NOC **15 six-parameter Prov-Bio floats**.
- Regular UK Argo funding through the Met Office for the next 2 years was included within the Hadley Centre Climate Programme plan for 2021 – 2024.



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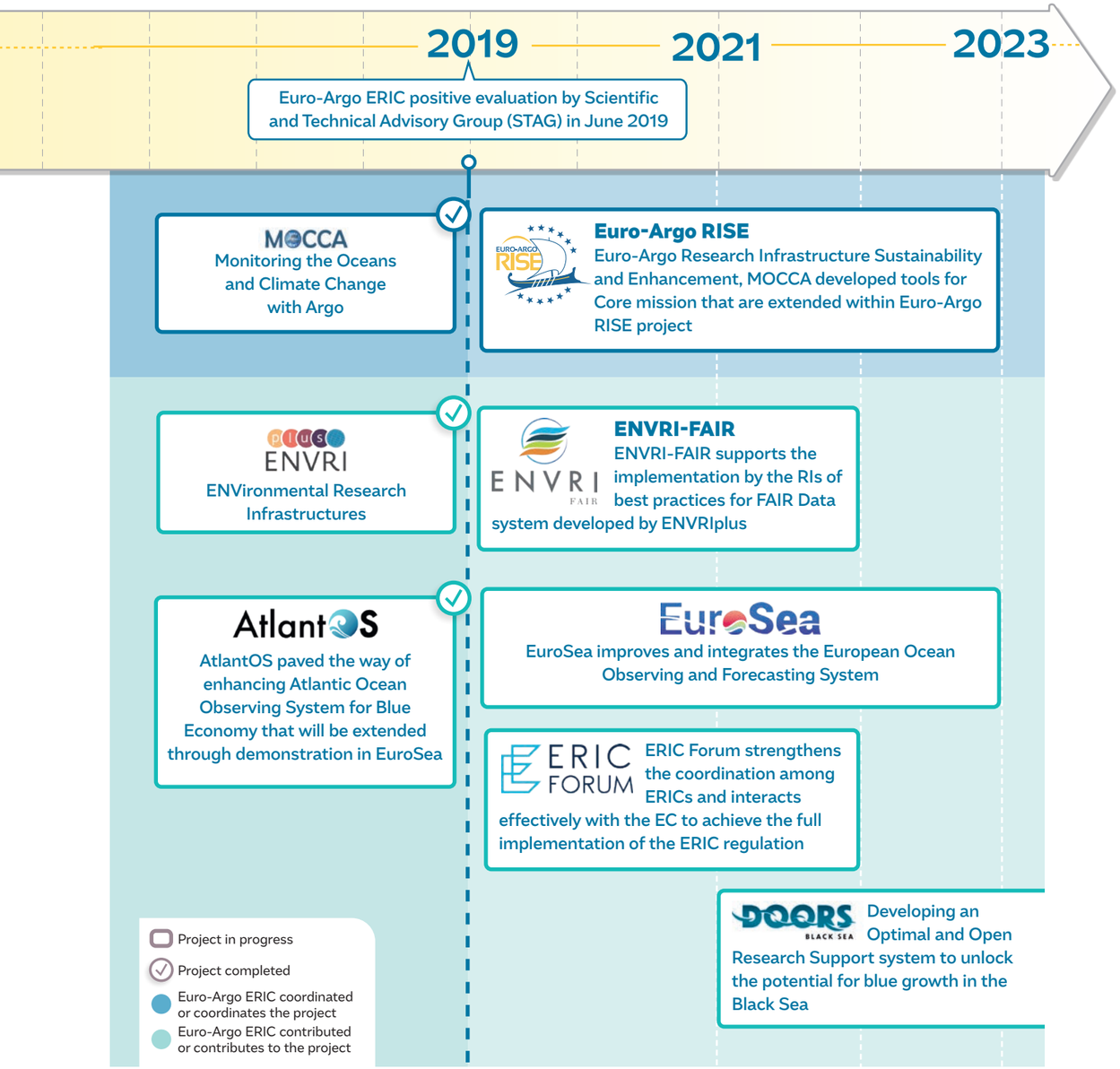
4 PROJECTS INVOLVING EURO-ARGO IN 2021

In 2021, the Euro-Argo ERIC continued its involvement in the four Horizon 2020 projects launched in 2019: ENVRI-FAIR, EuroSea, ERIC-Forum and Euro-Argo RISE and joined a new project "Developing an Optimal and Open Research Support system to unlock the potential for blue growth in the Black Sea" (DOORS), which was launched in June.



A PROVOR BGC float recovered during the MOOSE campaign

© Laurent Coppola/LOV

EURO-ARGO RISE

EURO-ARGO RESEARCH INFRASTRUCTURE SUSTAINABILITY AND ENHANCEMENT

The Euro-Argo RISE project will enhance and extend the European capacity of the Argo network to provide essential ocean observations to better answer societal and scientific challenges. To reach this goal, it enhances and organises the new EU Argo observations towards biogeochemistry, greater depth, ice-covered and shallower water regions. Euro-Argo RISE will enable Europe to fulfil its international commitments to the revamped Argo programme and preserve its key international position.

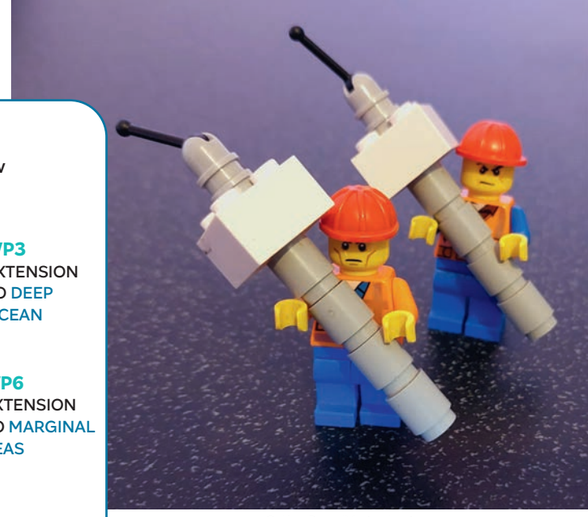
2019-2022
Coordination by Euro-Argo ERIC

- **Funding:** 3.95M€, 536K€ for Euro-Argo European Union's Horizon 2020 research and innovation programme
- **Grant agreement ID:** 824131
- **Call for proposal:** H2020-INFRADEV-2018-1

WORK PACKAGES

The Euro-Argo RISE project is organised in eight work packages that allow the project to progress along Euro-Argo five-year plan objectives.

- **WP1** PROJECT MANAGEMENT
- **WP2** IMPROVEMENT OF THE CORE ARGO MISSION
- **WP3** EXTENSION TO DEEP OCEAN
- **WP4** EXTENSION TO BIOGEOCHEMICAL PARAMETERS
- **WP5** EXTENSION TO HIGH LATITUDES REGIONS
- **WP6** EXTENSION TO MARGINAL SEAS
- **WP7** EURO-ARGO RISE VISIBILITY: COMMUNICATION AND DISSEMINATION TOWARDS USER'S COMMUNITY
- **WP8** INTEGRATION OF EURO-ARGO ACTIVITIES IN THE GENERAL CONTEXT OF GLOBAL OCEAN OBSERVATIONS



© Alan Berry/Marine Institute

https://www.euro-argo.eu/EU-Projects/Euro-Argo-RISE-2019-2022
Read the two news about the progress of the project

MAIN ACHIEVEMENTS IN 2021

In 2021, work progressed in all the different aspects of the project. The beginning of the year was rich in events for European partners and December was especially intense, with the submission of 13 Deliverables to the European Commission, of the 21 that were submitted this year. In November, the 2nd Euro-Argo RISE General Assembly was held and introduced Euro-Argo ERIC's vision "beyond the project", with the willingness to implement all the results at the infrastructure level. This step will shape the ERIC for the next 10 years through a revised strategy, implementation and long-term sustainability plans.

© Tuomas Kärnä

Deployment of a Core float in May 2021 in the Baltic Sea.

TECHNOLOGICAL PROGRESS

About deployments

The tests carried out by different partners in various coastal and high latitude regions were pursued at the national level, with new deployments and new tools to progress in evaluating the potential of Argo in European marginal Seas (see pp. 14-15). In addition, the analysis of float survival rates across different perspectives, finalised in December (see p. 17), led to recommendations. They were shared with Argo deployment groups in order to maximise their floats lifetime and pay attention to certain critical parameters.

About prototypes

To diversify providers and to secure sensor provision at a competitive cost in order to sustain and expand the network, work continued on various sensors in 2021.

→ RBR sensors for Core floats
Two Arvor-I floats equipped with RBR CTDs were deployed in the Baltic Sea by FMI in May and their data are now distributed to users with a QC flag of "good data".

→ Sensors accuracy for Deep floats
The first results of the 3-headed floats were presented by Ifremer to the AST. Two 2-headed Deep-Arvor and one 3-headed Deep-Arvor profiling floats were tested in the Ifremer pool in December (see pp. 14-15).

→ New sensors for BGC floats.
One BGC float equipped with a RAMSES sensor was deployed in the Baltic Sea in May. The RAMSES data were among the first profiles of hyperspectral irradiance collected in the global ocean.

COMMUNITY ENHANCEMENT

The network of scientists engaged in climate and ocean research using Argo data was first consolidated via two workshops held online on 8-9th April, gathering for the first time Argo Mediterranean and Black Seas communities, as well as Arctic and Baltic Sea communities (see p. 24). The importance of Argo for environment and society, as well as Argo contribution to the UN Decade, was then demonstrated to politicians, decision-makers and high-level stakeholders, during a Political Event held online on 8th June. Eventually, the Ocean Observers workshop was successfully held on 9th November & 1st-2nd December to discuss educational activities around *in situ* ocean observations at an international level (see p. 24).

SERVICES TO USERS

To ease access to Argo data, the new Argo data selection tool developed by Ifremer (Euro-Argo RISE / ENVRIFair project synergies) was officially released: there are now three possibilities to export data with the tool. One step forward was made for the Argo Online School to teach the basic foundations to use and understand the Argo data: the school, created by IEO, is now almost finalised.
To increase awareness about the services/products provided by Euro-Argo, a first Argo Use Case was published online to promote Argo data in the Baltic Sea. In addition, Argo user communities' specific requirements were analysed by MI and gathered in a report: a set of eight main recommendations for Euro-Argo ERIC were discussed and validated at the European level. To enhance the services for existing users, a Memorandum of Understanding was signed in July between Euro-Argo and Copernicus Marine Service and a letter of support from Copernicus Climate Service / ECMWF to Euro-Argo is in preparation (see p. 24). Finally, the increased potential of Argo to provide additional valuable information for the Good Environmental Status of MSFD was also underlined, highlighting the particularly important role of Argo for the MSFD implementation in the near future.

DATA MANAGEMENT

Euroargodev collaborative framework was continuously enriched with materials and the improvement of the Global Argo reference database used for DMQC was pursued. A new quality control method based on machine learning was assessed by Ifremer and an implementation plan was proposed.
Following the new procedures and guidelines of the DMQC analysis of Deep Argo floats, partners submitted to the GDAC Argo data in D-mode, adjusted by CpCor corrections.
The work performed by Euro-Argo RISE partners in 2021 for the enhancement of BGC quality control procedures for various parameters was presented and agreed at international level during the last ADMT22 meeting.
Finally, to improve the BGC data processing workflow at the European level, several options were defined within the WP4 workpackage for the organisation of BGC Argo data management. They were presented to the Euro-Argo Management Board during its 21th meeting and the discussion will continue in 2022.

PARTNERS

ENVRI-FAIR

FINDABLE, ACCESSIBLE, INTEROPERABLE AND REUSABLE SERVICES

ENVRI-FAIR aims at enhancing the connection of the Cluster of ENVRI to the European Open Science Cloud (EOSC). It supports all participating Research Infrastructures to build a set of FAIR data services to increase efficiency and productivity of researchers and enable data and knowledge-based decisions.

2019-2022

Coordination by FZJ

- **Funding:** 18.99M€, 105,5K€ for Euro-Argo
  European Union's Horizon 2020 research and innovation programme
- **Grant agreement ID:** 824068
- **Call for proposal:** H2020-INFRAEOSC-2018-2

EURO-ARGO CONTRIBUTION

Built on ENVRIplus achievements, ENVRI-FAIR enhances access to environmental Research Infrastructure data and products. It is first driven by individual RI user needs, then by marine domain user needs for integrated services, services that will be in the future available through the European Open Science Cloud (EOSC). These two themes allow the project to progress along the Euro-Argo Five-Year plan objective n°3 (see p. 18). Euro-Argo and EMSO Research Infrastructures coordinate the WP9 about the improvement of the FAIRness of the Marine Research Infrastructures.

EURO-ARGO MAIN ACHIEVEMENTS IN 2021

Based on the FAIRness assessment elaborated by the five marine RIs (Euro-Argo, EMSO, SeaDataNet, ICOS and Lifewatch) in 2020 and relying on joint ENVRI-FAIR cross cutting developments organised through multi-RI Task forces, the 2021 year allowed progress on metadata and data services at many levels.

At the RI level, harmonised vocabularies were published on a common vocabulary server (NVS managed by NOC-BODC/UK) facilitating interoperability between all these RIs vocabularies.

Each RI provided a DCAT standardised catalogue description of its data services using the DCAT protocol, set up and improved its data and metadata application programming interfaces (APIs).

A broker layer was developed at the marine subdomain level that allows a user to query the five Research Infrastructure through a unique request using smart mappings performing translation from one RI naming convention to another one, and using the metadata and data APIs set up by the five RIs → Figure 18.

Such service will benefit European *in situ* data integrators such as Copernicus Marine Service or EMODnet as it will facilitate integrated products updates with new data managed by the five RIs. It will also allow the development of Virtual Research Environments (VRE), such as JupyterHub for scientists or connection to existing cloud based systems (SeaDataCloud, BlueCloud or Copernicus WEKEO).

Finally all these services are available through the ENVRI-HUB, a central gateway to environmental data and services offered by the European environmental RIs. It will broaden the visibility of the existing Euro-Argo services and the marine broker, and also facilitate visibility on the European Open Science Cloud (EOSC).

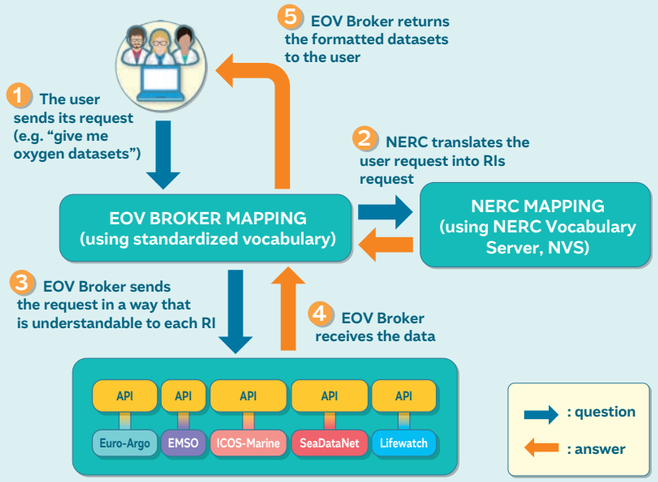


Figure 18: The Marine Use case full steps achieved in 2021 for a FAIR data management system. The API chosen in 2021 was ERDAPP.

PARTNERS

EUROSEA

EUROPEAN OCEAN OBSERVING AND FORECASTING SYSTEMS

In the continuation of the AtlantOS project achievements, the EuroSea international consortium aims at advancing research and innovation towards a user-focused, truly interdisciplinary, and responsive European ocean observing and forecasting system for a sustainable use of the ocean.

2019-2023

Coordination by GEOMAR

- **Funding:** 12.642M€, 796K€ for Euro-Argo
  European Union's Horizon 2020 research and innovation programme
- **Grant agreement ID:** 862626
- **Call for proposal:** H2020-BG-2019-1

EURO-ARGO CONTRIBUTION

The Euro-Argo ERIC is involved in two work packages: WP3 "Network Integration and Improvements" and WP7 "Ocean Climate Indicators Demonstrator", with the following objectives:
– WP3 will improve and strengthen ocean observing networks, foster networks innovations and oversee key aspects of technological integration;
– WP7 will assess the ocean role in climate through new ocean climate indicators with decreased uncertainty and will evaluate the economic value of the ocean carbon sink.

EURO-ARGO MAIN ACHIEVEMENTS IN 2021

The year 2021 was mainly devoted to collect data that will be exploited later. In the frame of the WP7, five BGC floats with pH sensors and five Deep floats with oxygen sensors were deployed in the Atlantic in May and June respectively. All these floats were tested by the Euro-Argo ERIC team to maximise the chances of successful deployments at sea.

The five BGC floats were deployed in the tropical Atlantic during the PIRATA-FR31 cruise. They are framed in the task on "Quality enhancement of tropical carbon fluxes through network optimisation of the Tropical Atlantic Observing System" of the EuroSea Climate Demonstrator. The collected data will help developing indicators for carbon flux at the air-sea interface and for ocean acidification based on an improved Atlantic observing system.

The five Deep floats were deployed together with another 15 Deep Argo floats from Ifremer on the BOCATS-OVIDE cruise starting in June. In addition to the regular acceptance tests, conducted in the Ifremer pool tank, the Euro-Argo ERIC technical team performed intensive tests in the hyperbaric chamber at Ifremer premises to ensure the good functioning of the hydraulic system under high pressure. The floats are framed in the task "Carbon audit of the European relevant deep convection regions" of the EuroSea Climate Demonstrator. The collected data will be used to improve methods to monitor the uptake and storage of carbon in the Irminger Sea and to investigate mechanisms, such as deep convection, involved in the storage and propagation of the carbon signal.

In the frame of the WP3, the BGC and Deep workshops were held to strengthen the European component, disseminating good practices and to reinforce links with other networks and observing programs (see p. 22).

Finally, ten innovative EU projects joined forces in the cluster "Nourishing Blue Economy and Sharing Ocean Knowledge" and published in October a joint policy brief, under the lead of EuroSea and listing recommendations for sustainable ocean observation and management.

Stéphane Lesbats/Ifremer

Romain Cancouët/Euro-Argo ERIC

Acceptance tests of the BGC floats in February. Left: Water samples collected and further analysed by Ifremer/LOPS. Right: EuroSea NKE PROVOR CTS4 float with its BGC sensors.

PARTNERS

ERIC-FORUM

2019-2022

Coordination by BBMRI ERIC

- **Funding:** 1.5M€
  44K€ for Euro-Argo
  European Union's Horizon 2020 research and innovation
- **Grant agreement ID:** 823798
- **Call for proposal:**
  H2020-INFRASUPP-2018-1

EUROPEAN RESEARCH INFRASTRUCTURES CONSORTIUM

The ERIC Forum was established in 2017 in order to strengthen the coordination among ERICs and interact effectively with the EC to achieve the full implementation of the ERIC regulation. The forum speaks with one voice on issues of common interest for the ERICs and interacts with all stakeholders much more efficiently than individual ERICs.

PROJECTS OBJECTIVES AND EURO-ARGO CONTRIBUTION

The ERIC Forum Implementation Project brings together the ERIC community to strengthen its coordination and enhance collaborations between the partners. The major objectives of the project are to: (a) support the organisation of specific meetings, targeted thematic workshops focusing on shared challenges such as the development of internal procurement rules, harmonized reporting, VAT exemption practices, insurances and pensions policies and training of governance bodies representatives; (b) support ERICs in preparation, based on best practices; and (c) support common communication and outreach activities and strengthen external representation of ERICs' as a stakeholder in consultations and other policy actions that could affect them.

MAIN HIGHLIGHTS IN 2021

A series of reports and guidelines were delivered by the ERIC Forum Implementation Project, most of which are highly relevant for Euro Argo ERIC:
– Guidance document on accounting principles for ERICs;
– Report on practices and challenges in recruitment for distributed ERICs;
– Best practices guidelines in employment and secondment for ERICs;
– Report on proposed approach and dashboard for common ERIC KPIs;
– Procurement rules, VAT exemptions practices and economic activities;
– Best practices guidance document on contracting, insurance and intellectual property for ERICs;
– Report on quality management and reproducibility in academic research.

As part of task 4.3 in WP4 of the project, Euro-Argo ERIC contributed to an extensive survey on measuring and defining the socio-economic impact of ERICS, including the related challenges.

Euro-Argo ERIC participated in an event entitled "Planning for Sustainability of Research Infrastructures" jointly organized by the Horizon 2020 projects ACCELERATE and ERIC Forum Implementation aiming to present and discuss instruments to address expectations, requirements and approaches in planning for the medium to long-term sustainability of the RIs. The topics discussed also included the positions of the RIs in the wider European policy framework, the renewed European Research Area (ERA), Horizon Europe and the new Cohesion policy, ERIC instrument and European Open Science Cloud (EOSC).

On September 14th, the ERIC Forum took part in the Science Summit around the 76th United Nations General Assembly (UNGA76) to raise awareness about Research Infrastructures' role and contribution to the attainment of the United Nations Sustainable Development Goals (SDGs). In preparation for this, the forum gathered the contribution of the ERICs. Euro Argo ERIC highlighted and detailed its contribution to SDG 13 "Take urgent action to combat climate change and its impacts" and SDG 14 "Conserve and sustainably use the oceans, seas and marine resources for sustainable development".

ERIC Forum meeting in Oslo.

© ERIC-Forum

PARTNERS

DOORS

2021-2025

Coordination by National Institute of Marine Geology and Geoecology - GeoEcoMar

- **Funding:** 19.25M€,
  180k€ for Euro-Argo ERIC
  European Union's Horizon 2020 research and innovation
- **Grant agreement ID:** 101000518
- **Call for proposal:** H2020-EU.3.2.3.3

DEVELOPING AN OPTIMAL AND OPEN RESEARCH SUPPORT SYSTEM TO UNLOCK THE POTENTIAL FOR BLUE GROWTH IN THE BLACK SEA (DOORS)

The overall objective of DOORS is to work with stakeholders to implement the Strategic Research Innovation Agenda (SRIA) for the Black Sea, to support the successful implementation of Blue Growth and to contribute to a healthy, productive and resilient Black Sea.

PROJECTS OBJECTIVES AND EURO ARGO CONTRIBUTION

Euro-Argo goal is to demonstrate the potential of BGC Argo, as part of the integrated multiplatform observing system for the Black Sea. The Euro-Argo ERIC is involved in two work packages: WP4 "Deep knowledge" and WP8 "Stakeholders engagement".

MAIN ACHIEVEMENTS IN 2021

The DOORS project was officially launched in June. A first WP8 meeting was organised in October. On this occasion, DOORS plan for the youth engagement and ocean literacy (OL) activities and a draft stakeholder engagement strategy were presented. In addition, ways to engage stakeholders strategically and in a consolidated manner were discussed and the progress on the establishment of the DOORS Foresight Committee (FC) and the DOORS stakeholder conference was also highlighted. After this first WP8 meeting, a new web-based mapping tool that illustrates the main marine observing capacities and marine data infrastructures identified in the Black Sea was released → Figure 19 This interactive tool allows users to navigate across the different observing and data initiatives, including Argo, and find links and relevant information for the marine observing community and related stakeholders in the Black Sea.
In the frame of the WP4, two BGC floats measuring Oxygen, Nitrate, Chl-a/CDOM/Backscatterring and Radiometry will be deployed. The sensors are funded by the H2020 project, with one float funded by IO-BAS and the other one by the ERIC itself.

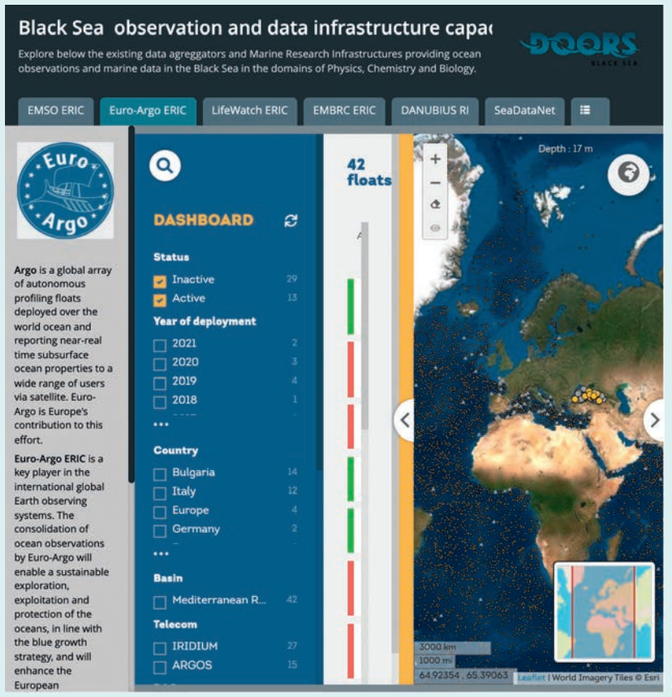


Figure 19: The new interactive tool enhanced by DOORS for the marine observing community in the Black Sea (https://www.doorsblacksea.eu/observationtool).

© DOORS

PARTNERS IO-BAS GeoEcoMar®

5 SCIENTIFIC HIGHLIGHTS

"Summertime increases in upper-ocean stratification and mixed-layer depth"

Authors: Jean-Baptiste Sallée et al.
First published: 24 March 2021
https://doi.org/10.1038/s41586-021-03303-x

Abstract

Sometimes the bad news is worse than expected. Over the past fifty years and as a result of climate change, the stability of the ocean increased much more than expected. This could affect the ocean's ability to absorb heat from the atmosphere and thus fulfil its crucial role as a global thermostat buffering global warming. To reach this alarming conclusion, researchers from the CNRS, Sorbonne University, and Ifremer relied on oceanographic observations from 1970 to 2018. They focused on the upper layer of the ocean, which continuously exchanges heat, freshwater and carbon with the atmosphere: the surface mixed layer. They showed that the summertime density contrast between the upper and deep ocean was six times greater than previously estimated → **Figure 20**. Indeed, the ocean surface is getting warmer faster than the deep ocean due to the atmosphere temperature rise, which make the upper ocean lighter. In addition, at high latitudes surface waters get less salty due to the combination of polar icecap melt and acceleration of the global hydrological cycle associated with an increase in precipitation at high latitudes. Therefore, this warmer and less salty upper ocean layer becomes more and more lighter, just like a layer of oil on top of water, and harder to mix with the deepest waters. Another consequence of global warming is an intensification of wind strength. According to this study, these stronger winds result in a deepening of the ocean surface layer by 5 to 10 m per decade over the last half century. Thus, in the same way that blowing harder with a straw on the surface of a glass of water causes deeper bubbles, the upper ocean mixing zone becomes thicker.

These two observations seem to conflict with each other: one would think that a lighter mixed layer would cut itself off from the depths and yet this layer seems to penetrate deeper. So, the effect of the stronger winds seems to prevail for the moment. One thing remains certain: what this study shows, above all, is that these two combined effects – a stratification and deepening of the mixed layer – deeply affect the stability of the ocean and may make it harder to mitigate climate change. These phenomena could also affect ocean ecosystems: if marine organisms are dragged deeper into the ocean, this could, for example, hinder their vital access to light. All these complex effects should therefore be quantified more precisely in the future, in the hope of better news.
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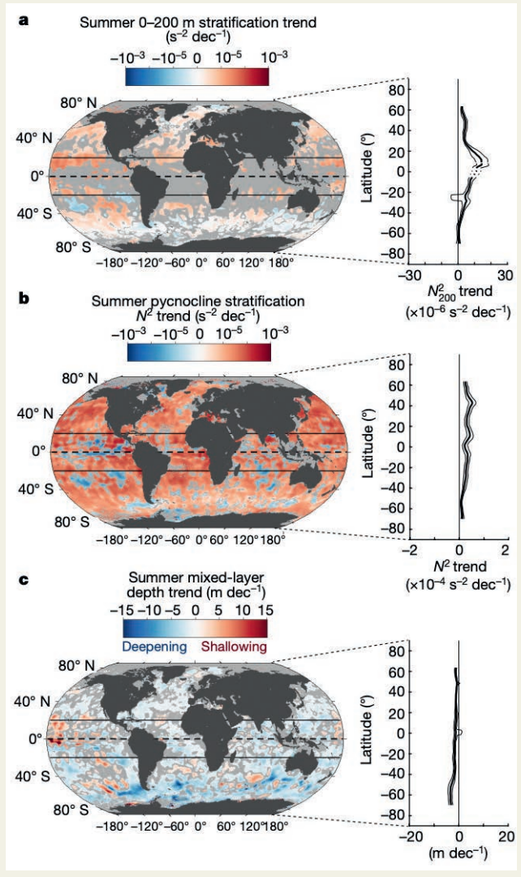


Figure 20: 1970-2018 trends in summer upper-ocean stratification (a. for the first 200 m and b. for the pycocline, the layer below the mixed layer, characterized by a large density difference between surface waters and deep ocean water) and c. mixed-layer depth.

"Argo floats in the southern Baltic Sea"

Authors: WaldemarWalczowski et al.
First published: 7 August 2020
https://doi.org/10.1016/j.oceano.2020.07.001

A revolution in the Baltic Sea monitoring is underway!

In November 2016 Institute Oceanology Polish Academy of Sciences (IO PAN) deployed the first Argo floats in the southern Baltic Sea. This paper describes the experiences gained during the period 2016–2019 from Argo-Poland's operations in the Baltic Sea.

In this complex region, the shallow waters and the large river inflows and limited exchange with the World Ocean make the Baltic Sea one of the largest brackish waters zones in the world and imposes somewhat different requirements on Argo floats than the deep ocean.

Most of the time during this 3-year period, the floats remained in deep regions, only occasionally drifting into shallow water or coming dangerously close to the shore → **Figure 21**.

As the Baltic Sea is very shallow, a profiling period of one or two days was used; See https://www.euro-argo.eu/content/download/155833/file/Baltic_USECASE_septembre.pdf

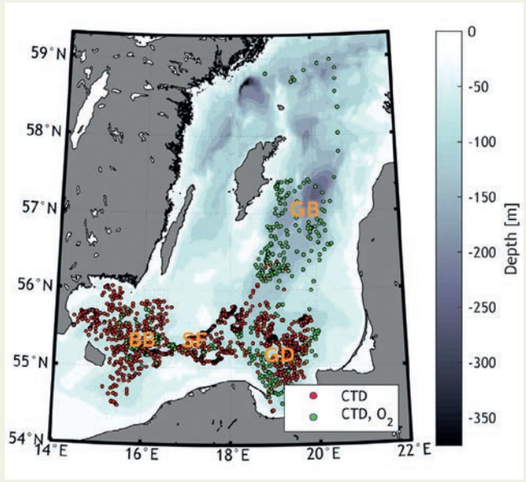


Figure 21: Positions of IO PAN Argo float profiles in the Baltic (Bornholm Basin, BB; Gdansk Deep, GD; Gotland Basin, GB; Slupsk Furrow, SF).

Key results

1000 CTD profiles were collected;
600 CTD/O_2 profiles were collected.
8 cm/s was the mean drift speed in deep basins;
20 cm/s was the mean speed during transitions between deeps;
4km was the smallest radius of the loops the floats moved in.

What did the profiles reveal*?

- Seasonal variability of temperature in the upper layer;
- Spatial variability of salinity in the deeper layers in various regions of the southern Baltic;
- Considerable seasonality of temperature and DO concentration in the upper layer (0—40 m) and the lack of seasonality in the deep layer;
- Well-oxygenated surface waters;
- Strong oxycline and anoxic waters in the Gdansk and Gotland Deeps;
- Temporal increase of DO in August—September 2019 at the 100 m level that indicates a weak baroclinic inflow to the Gdansk and Gotland Deeps.

*Most of these phenomena are known from systematic synoptic measurements, however Argo gives much better spatial and temporal resolution and guarantees continuity of observations.

Conclusions about the monitoring

- The current observations from vessels and surface buoys are sufficient for investigating the seasonal and long-term variability of southern Baltic water masses and for monitoring Major Baltic Inflows (MBIs);
- The complementarity of observations from various networks, such as Argo floats, cruises and moorings, is crucial for the better monitoring of the Baltic Sea, the improvement of numerical models and validation of satellite observations;
- Contact with the sea bed (grounding), proximity to the shore and collisions with ships are not as dangerous for the float as had seemed earlier;
- In small seas like the Baltic, floats – mostly the sophisticated and expensive BGC floats – can be profitably recovered, refurbished and redeployed;
- Seven continuously operating floats should be adequate for the basic monitoring of Baltic deep waters, although their recovery, redeployment and relocation may be necessary.

6 FINANCIAL STATUS

There is a positive balance of about 80k€ in Euro-Argo ERIC 2021 budget execution. This is due, in part, to 158k€ that the ERIC received in 2021 for staff funding from the EU projects . Euro-Argo ERIC's core income in 2021 remained at 340k€ – with 11 Member countries and one Observer – but is expected to increase in 2022 following the accession of Denmark.

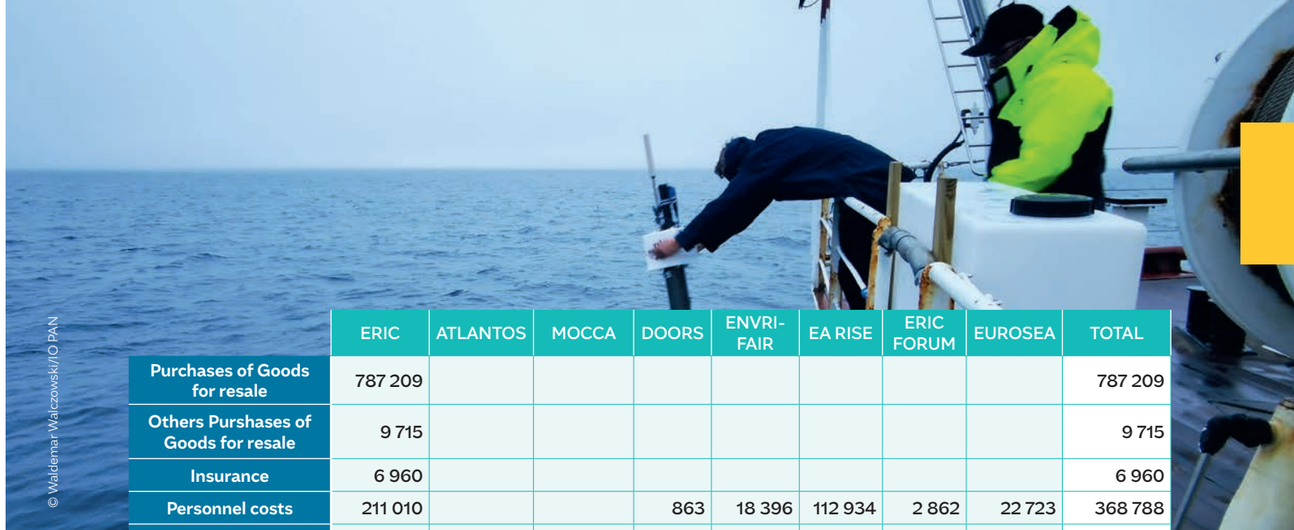
Salary expenses are around 369K€ (211K€ on ERIC and about 158K€ on projects) and other expenditures of 174K€ with business travel costs remaining low due to COVID19 pandemic situation. In 2021, the Euro-Argo ERIC dedicated 43k€ to the charter organised jointly with NOAA/USA and Canada to support float deployment in the Atlantic Ocean. 24K were also dedicated to the organisation of fully virtual meeting for Ocean Observer workshop allowing simultaneous translation in 3 languages. Five floats that were not purchased in 2020 on the ERIC budget were bought in 2021, when research vessels were operating more routinely. Finally, an investment subvention of 44K was received from Orange Marine to buy 3 floats that will be deployed on Orange Marine vessels within the partnership that was signed with industry. The positive balance of 80k€ (42k€ on the ERIC, 38K€ on projects) was reached at the end of the year 2021.

Concerning the four projects that started in 2019, the budget execution was as planned. For the AtlantOS and MOCCA projects that ended last year, the overheads collected during the projects were presently used to pay the satellite communication for the active floats. This corresponded to a cost of 50k€ for 2021 and this cost will decrease in 2022 as these floats are approaching their end-of-life time.

EURO-ARGO 2021 FINANCIAL STATUS

TYPE	DEBIT	CREDIT	TOTAL
INITIAL BALANCE			**1 204 278**
SG: Sales of goods		802 081	802 081
GC: Grants & Contracts		425 061	425 061
MF: Membership fees		340 000	340 000
II: Interest income		0	0
IG: Investments grants		44 082	44 082
PG: Purchases of Goods	796 924		-796 924
PE: Personnel costs	368 788		-368 788
TV: Travel costs	24 196		-24 196
MA: Material costs	2 712		-2 712
AC: Accounting fees	7 238		-7 238
BS: Bank services	3 291		-3 291
SC: Other subcontracts	136 870		-136 870
DP: Depreciation	191 325		-191 325
TOTAL FLOWS	**1 531 344**	**1 924 535**	
END BALANCE			**1 284 158**

Table 5: Financial status – Summary 2021 – Grand Total.


© Waldemar Walczowski/IO PAN

	ERIC	ATLANTOS	MOCCA	DOORS	ENVRI-FAIR	EA RISE	ERIC FORUM	EUROSEA	TOTAL
Purchases of Goods for resale	787 209								787 209
Others Purshases of Goods for resale	9 715								9 715
Insurance	6 960								6 960
Personnel costs	211 010			863	18 396	112 934	2 862	22 723	368 788
Studies	43 855								43 855
Business travel	7 576					16 620			24 196
Telecommunication cost	4 263	4 613	45 045					5 813	59 734
Commnication	8 585					1 319			9 904
Subcontract									
Other cost	4704					24 768		186	29 659
Depreciation	34 069							157 256	191 325
Subtotal	1 117 946	4 613	45 045	863	18396	155 641	2 862	185 978	1 531 344
Sales of goods for resale	802 081								802 081
Operating Grants				1 079	22 995	164 938	3 577	232 472	425 061
Subscription members et observers	340 000								340 000
Others income	6 836								6 836
Accounting result	30 299	- 4 613	- 45 045	216	4 599	9 297	715	46 494	41 961

Table 6: Financial analysis for each project Euro-Argo is involved in.

EURO-ARGO MEMBERS AND OBSERVER 2021 BUDGET

COUNTRY	FLOATS PURCHASED	FLOATS DEPLOYED FROM AIC	FULL TIME EMPLOYEE
Bulgaria	3	2	0,1
Finland	2	3	0,21
France	82	90	10,2
Germany	93	75	2,5
Greece	6	3	0,3
Ireland	0	2	0,1
Italy	19	16	2
Netherlands	7	6	0,08
Norway	17	14	2,9
Poland	3	3	0,3
Spain	3	3	2,25
UK	64	18	391
Total	299	235	24,85

Table 7: Euro-Argo Members and Observer 2021 budget.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ANNEX 2 - GLOSSARY

ADMT
Argo Data Management Team

AIC
Argo Information Centre

API
Application Programming Interfaces

AQUA-DTU
National Institute of Aquatic Resources

ARC
Argo Regional Centre

ASD/FSD
Abrupt/Fast Salinity Drift

AST
Argo Steering Team

AtlantOS
All-Atlantic Ocean Observing System

BGC
Biogeochemical

Bio
Biogeochemical floats with only 1 to 5 variables

BODC, NOC
British Oceanographic Data Centre, National Oceanography Centre

BOOS
Baltic Operational Oceanographic System

BSH
Bundesamt für Seeschifffahrt und Hydrographie

CDOM
Colored dissolved organic matter

Chl-a
Chlorophyll a

CMEMS
Copernicus Marine Environment Monitoring System

CNRS
Centre national de la recherche scientifique

Core
Standard Argo float measuring temperature and salinity (T/S)

CTD
Conductivity, Temperature, Depth

DAC / GDAC
Data Assembly Centre / Global Data Assembly Centre

DCAT
Data Catalog Vocabulary

Deep
Argo floats diving to greater depths than 2000 meters

DO
Dissolved Oxygen

DOORS
Developing an Optimal and Open Research Support

DOOS
Deep Ocean Observing Strategy

DMQC
Delayed Mode Quality Control

ECMWF
European Centre for Medium-Range Weather Forecasts

EMODnet
European Marine Observation and Data Network

EMSO
European Multidisciplinary Seafloor and water column Observatory

ENVRI
Environmental and Earth System Research Infrastructures

ENVRI-FAIR
ENVRI- Findable, Accessible, Interoperable and Reusable services

ENVRIplus
ENVRI- Providing Shared Solutions for Science and Society

EOOS
European Ocean Observing System

EOSC
European Open Science Cloud

EOV
Essential Ocean Variables

ERA
European Research Area

ERIC
European Research Infrastructure Consortium

ERIC Forum
Network of ERICs to strengthen their coordination and interact effectively with the EC

EU
European Union

Euro-Argo RISE
Euro-Argo Research Infrastructure Sustainability and Enhancement

EuroGOOS
European Global Ocean Observing System

EuroSea
European Ocean Observing and forecasting systems

FMI
Finnish Meteorological Institute

FZJ
Forschungszentrum Jülich

GDAC
Global Data Assembly Centre

GeoEcoMar
The national Institute for Research and Development of Marine Geology and Geoecology of Romania

Geomar
Helmholtz-Zentrum für Ozeanforschung Kiel

GOOS
Global Ocean Observing System

GO-SHIP
Global Ocean Ship based

HCMR
Hellenic Centre for Marine Research

ICOS
Integrated Carbon Observation System

IEO
Instituto Español de Oceanografía

Ifremer
Institut Français de Recherche pour l'Exploitation de la Mer

IMR
Institute of Marine Research

IO PAN
Institute of Oceanology of the Polish Academy of Sciences

IO-BAS
Institute of Oceanology – Bulgarian Academy of Sciences

IOC
Intergovernmental Oceanographic Commission

ISA
Ice Sensing Algorithm

KNMI
Koninklijk Nederlands Meteorologisch Instituut

LOV
Laboratoire d'Océanographie de Villefranche

MB
Management Board

MBI
Major Baltic Inflows

MI
Marine Institute

MOCCA
Monitoring the Oceans and Climate Change with Argo

MONGOOS
Mediterranean Operational Network for the Global Ocean Observing System

MSFD
Marine Strategy Directive

NERSC
Nansen Environmental and Remote Sensing Center

NOAA
National Oceanic and Atmospheric Administration

NVS
NERC Vocabulary Server

OceanOPS
The WMO-IOC Joint Technical Commission for Oceanography and Marine

OGS
Istituto Nazionale di Oceanografia e di Geofisica Sperimentale (National Institute of Oceanography and Applied Geophysics)

OneArgo
Global, full-depth and multidisciplinary mission

OWC
OWC method (Owens and Weng, 2009; Cabanes et al, 2016)

PML
Plymouth Marine Laboratory

R/V
Research vessel

SDG
Sustainable Development Goals

SOCIB
Sistema d'observació i predicció costaner de les Illes Balears (Balearic Islands Coastal Observing and Forecasting System)

SOOS
Southern Ocean Observing System

SOP
Standard Operating Procedures

SRIA
Strategic Research Innovation Agenda

STAG
Scientific and Technical Advisory GroupT/S Temperature/Salinity

SU
Sorbonne Université

VRE
Virtual Research Environments

WHOI
Woods Hole Oceanographic Institution

WMO
World Meteorological Organisation

WMPO
Western Mediterranean Operational forecasting system

ANNEX 3 - PARTNERS OF EURO-ARGO ERIC

Country	Statute	Representing Organisation
Bulgaria	Member	IO-BAS
Danemark	Candidate	DTU aqua
Finland	Member	FMI
France	Member	Ifremer
Germany	Member	BSH
Greece	Member	HCMR
Ireland	Member	MI
Italy	Member	OGS
Netherlands	Member	KNMI
Norway	Member	IMR
Spain	Member	SOCIB, IEO
United Kingdom	Member	Met Office
Poland	Observer	IO PAN

*** The listed institutes represent the Member States, but other institutes in the country can also participate to the Euro-Argo activities.**

ANNEX 4 - EURO-ARGO ERIC GOVERNANCE BODIES

	Profession / Position
Council Members	
Jean-Marie Flaud	*Chair* - MESR France
Pierre-Marie Poulain	OGS – Italy
Jon Turton	Met Office – UK
Aristomenis Karageorgis	HCMR – Greece
Sybren Drijfhout	KNMI – Netherlands
Mikko Strahlendorff	FMI – Finland
Kerstin Jochumsen	BSH – Germany
Marta Tarnogrodzka	Ministry of Science and Higher Education – Poland
Christine Daae Olseng	Research Council of Norway - Norway
Joaquin Tintoré	SOCIB – Spain
Michael Gillooly	Marine Institute - Ireland
Atanas Palazov	Institute of Oceanology - Bulgarian Academy of Sciences - Bulgaria
Pierre-Yves Le Traon	Special Advisor to the French representative - France
Management Board Members	
Birgit Klein	*Chair* – BSH – Germany
Laura Tuomi	*Vice-Chair* – FMI – Finland
Alan Berry	Marine Institute – Ireland
Gerasimos Korres	HCMR – Greece
Pedro Vélez-Belchi	IEO – Spain
Guillaume Maze	Ifremer – France
Kjell Arne Mork	IMR – Norway
Waldemar Walczowski	IOPAN – Poland
Andreas Sterl	KNMI – Netherlands
Matt Donnelly	BODC-NOC – United Kingdom
Giulio Notarstefano	OGS – Italy

	Profession / Position
Euro-Argo ERIC Central Research Infrastructure	
Sylvie Pouliquen	Programme Manager – Ifremer France
Francine Loubrieu	Administrative Assistant – Ifremer France
Romain Cancouët	Operational Engineer – Euro-Argo ERIC
Claire Gourcuff	Science Officer – Euro-Argo ERIC
Estérine Evrard	Euro-Argo RISE Project Manager – Euro-Argo ERIC
Marine Bollard	Communication Officer
Luca Arduini Plaisant	Research Engineer
Luc van Dyck	Advisor for policy and partnership relations
Scientific & Technological Advisory Group (STAG)	
Arne Körtzinger	*Chair* – GEOMAR Germany – Research
Inga Lips	EuroGOOS Secretary General – EOOS
Susan Wijffels	WHOI USA – Argo International
Johnny Johannessen	NERSC Norway – Copernicus Marine Service
Philip Browne	ECMWF UK – weather forecasting and Coupled Data Assimilation
One Euro-Argo ERIC expert assists the STAG	
Hervé Claustre	LOV France – Bio-Argo

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