PROJECT FINAL REPORT

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4.1 Final publishable summary report

4.1.1 Executive summary

ARGO is an international global ocean observing system based on an array of some 3.000 autonomous floats drifting freely in the world's oceans. Those floats, which probe the water to a depth of 2.000 m and report temperature and salinity data to land stations, constitute one of the essential components of the Global Climate Observing System. They also provide invaluable data in support of ocean and climate research, operational oceanography and ocean monitoring. The system is implemented by a large number of agencies and scientists in over 40 countries. A high level of coordination is necessary to organize efficiently the operations at sea, maintain the array, and to perform the required tasks of data management (e.g. collection, validation and quality control, distribution and availability, and safe keeping).

The main objective of the EURO-ARGO consortium is to organize and consolidate the European contribution and to set up a research infrastructure in support of the global ARGO programme. Euro-ARGO having been endorsed by the ESFRI (European Strategic Forum on Research Infrastructures), the Preparatory Phase Project had several objectives to progress towards defining the appropriate legal framework, and to address several critical technical points related to instrumentation and sensors, data management, and array design. Capacity building and outreach have also been given due consideration. The most important results of the project can be summarized as follows:

After extensive review of possible legal frameworks for the EURO-ARGO RI, it has been decided to adopt the ERIC status. Since this is a new concept (which was elaborated by the Commission during the course of the project) it has taken some time to obtain agreement by the project participants to join in the Consortium. The EURO- ARGO ERIC statutes have been drafted, including the governance structure, which consists of a Council, a Management Board, a Programme Office and a Scientific and Technical Advisory Group. The EURO- ARGO ERIC will include members and observers. Budgets have been proposed for the first five years, with an examination of the anticipated expenses and possible sources of national and international funding.

It has been agreed that the research infrastructure will be distributed, with national activity centres and the Central research infrastructure (the ERIC) to be established in France at Ifremer. As of the end of the project, France, Germany, United Kingdom, Italy, Spain, Netherlands, Bulgaria and Greece will be members, and Ireland, Poland, Portugal will be observers. The draft statutes have been endorsed by the French ministries and forwarded to the Commission for review.

The technical activities of the project considered the status of float technology and its likely evolution over the coming years (design, lifetime, cost, new sensors, improved telecommunications, etc...). A comparative evaluation has been made of new sensors like O_2 and bio-geochemical sensors, ice sensing algorithms, vertical sampling strategy, transmission systems (Argos and Iridium), batteries etc. A comparison of the performances of different types of floats (Provor, Nemo and Apex) has also been made. Sampling strategies for the Nordic, Mediterranean, and Black seas have been examined. Four aspects of data processing and distribution system have been considered: enhancement of the mandatory functions related to ARGO Regional centres both in Nordic seas and in Mediterranean and Black seas; the development of new tools to help float deployment plans and monitor the behaviour at sea; definition of real-time quality control procedures for biochemical data; and improvements of the consistency of the ARGO dataset.

Finally, a European ARGO user group has been set-up, outreach activities have been carried out in the Black sea; an educational web-site has been posted with pedagogical and illustrative material on ocean dynamics, observations, and the ARGO system.

4.1.2 Summary description of project context and objectives.

The context

Global change is one of the most pressing issue and concern that mankind is facing in this century. Burning fossil fuels releases huge amounts of green house gases into the atmosphere, which affect the radiative balance and lead to global warming. The impact on society is potentially highly damaging and irreversible; this poses a formidable challenge to the policy makers and citizens of the world. Decisions and actions to alter the present course taken by humanity should be taken on the basis of sound scientific knowledge, not only in the fields of Earth sciences (hydrology, climatology, oceanography, glaciology, meteorology, soil, ecosystems,...), but also in the humanities (political and social sciences, economics, demographics,...).

In this very complex system, the ocean plays a key role by its ability to absorb, transport and/or release green house gases, heat, and water, and redistribute them on the Earth surface. The ocean also reveals the impact of climate change. There is increasing evidence that sea level is rising at an accelerating rate of 3 mm/year, the Arctic sea ice cover is shrinking and high latitude areas are warming rapidly. These effects are caused by a combination of long-term climate change and natural variability.

Lack of sustained observations of the atmosphere, oceans and land has hindered the development and validation of climate models. For instance, there is an ongoing controversy on the transport of heat northwards in the Atlantic and its influence on western European climate: has it weakened by 30% in the past decade, as some scientists claim (a result based on just five research cruises spread over 40 years), or was this change part of a trend that might lead to a major change in the Atlantic circulation, or due to natural variability that will reverse in the future, or is it an artefact of the limited observations?

Collecting the observations necessary to understand the ocean role in the climate system, and in climate change, is a task accessible only to those few research groups having access to research vessels. There is a need for systematic global ocean observations, providing high quality data and information products to research groups in Europe and elsewhere.

An infrastructure for global in situ ocean observations

The Euro-Argo infrastructure (http://www.euro-argo.eu) will be a major component of the Argo global in situ ocean observatory. The Argo network is a global array of autonomous instruments, deployed over the world ocean, reporting subsurface ocean properties to a wide range of users via satellite transmission links to data centres. It is now the major, and only systematic, source of information and data over the ocean's interior. The international Argo programme was initiated in 1999 as a pilot project endorsed by the Climate Research Programme of the World Meteorological Organisation, the Global Ocean Observing System (GOOS), and the Inter-governmental Oceanographic Commission. The Argo ocean observatory must be considered in its ensemble: not only the instruments, but also the logistics necessary for their preparation and deployments, field operations, the associated data streams and data centres and the interfaces with research and operational user communities. The objective of Euro-Argo is to develop and progressively consolidate the European component of the global network. The European contribution should be of the order of a quarter of the global array. Specific European interest also requires a somewhat increased sampling in regional seas (Nordic, Mediterranean and Black seas). Overall, the Euro-Argo infrastructure will comprise 800 floats in operation at any given time. Given the average float life time (presently below 4 years), the maintenance of such an array requires Europe to deploy about 250 floats per year.

A unique contribution to global ocean and climate research and environmental monitoring

Argo measures temperature and salinity over the upper 2000 m of the ocean. These two essential climate variables describe the oceans' physical and thermodynamic state. The Argo array is thus an indispensable component of the Global Ocean Observing System required to understand and monitor the role of the ocean in the Earth's climate system, in particular the heat and water balance. The sampling characteristics allow for the first time the resolution of seasonal and inter-annual variability of the global ocean circulation. Through Argo the systematic estimation of the heat and fresh water budgets (storage, transport, and atmospheric fluxes) is now possible. Argo is strongly complementary to satellite observations; to use a meteorological analogy, satellite altimetry provides the equivalent of the atmospheric pressure field and Argo profiles are the equivalent of the radio-sounding network. Argo data are readily assimilated with those from satellites into ocean circulation and climate models, in support of research and operational applications. The proposed contribution to the Argo array is integrated into the GMES[2] and the Global Earth Observing System of Systems (GEOSS).

Advanced instrumentation for world wide coverage

The instruments are autonomous floats, battery powered, with a design life of between 4 and 5 years. The sensors provide high accuracy, high resolution measurements, which are transmitted in real time. One of the key objectives is to provide truly global coverage, in particular in the southern hemisphere which, prior to Argo, was direly under-sampled. It was estimated that some 3000 floats in operation would be required to reach that objective. Argo's goal is to build and maintain the 3000 float array. Success in such a major undertaking can be achieved only through a very high degree of international cooperation and integration. That is why Euro-Argo proposes to build up and maintain a major node in the global network, with a European contribution of 800 floats.

Support to the users

Two broad classes of users of Euro-Argo are identified: the scientific community and the operational services for ocean monitoring (e.g. ocean and climate forecasting centres). While the former require uniform validated data sets of the highest quality, the latter place the emphasis on the real time efficient delivery of quality controlled data. Euro-Argo responds to those requirements by adopting the open data policy of Argo, free for all users, with user-friendly data formats and delivery. An integrated data management system is developed, which includes 1) one of the two Argo Global Data Assembly Centres, in charge of data collection, validation, distribution and archiving; 2) specialized Atlantic and Southern ocean Regional Data Centres, providing integrated data sets, delayed mode quality control; 3) a full range of services including elaboration of value added data syntheses (climatology, ocean indicators), array monitoring, expertise on instruments and sensors, coordination of field operations, resources on complementary data sets, integration into the international network and Argo management (Project Office, Argo Steering Team, Argo Information Centre).

[2] *Global Monitoring for Environment and Security*

Project objectives

The main objective of the Euro-Argo preparatory phase project was to undertake the work needed to ensure that by 2012 Europe will be able to deploy, maintain and operate an array of 800 floats. This requires Europe to deploy some 250 floats per annum worldwide. Moreover, Euro-Argo will provide a world-class service to the research (climate) and environment monitoring (e.g. GMES) communities.

The main expected outcome of the preparatory phase proposal was to reach an agreement between member states and other funding agencies for long term (> 10 years) operation of Euro-Argo (financial, governance, organisation, technical). To reach such an agreement, it has been necessary to work on several key technical (float technology, data management and delivery system) and organizational (logistics for deployment, coordination of national contributions) issues; to consolidate and broaden the user community; and to demonstrate further the impact and utility of the infrastructure for Europe.

The preparatory phase was structured along several work-packages focusing on:

- Consolidation and strengthening of existing national contributions to the infrastructure.
- Development of a direct EC-wide contribution through GMES.
- Development of legal and governance arrangements for the Euro-Argo infrastructure.
- Evaluation and improvement of the European contribution to the Argo data management and delivery system.
- Enhancement of European float technological capabilities (performances, sensors, communication systems) and working towards using Argo to study aspects of ocean biogeochemistry.
- Development of a vigorous European Argo user community.
- Using open access to Argo data as an educational “window” on the oceans and their role in climate.
- Development new partnerships between European Argo nations, new European countries and nations outside Europe.
- Integration of the European observing array into the international system.

4.1.3 Description of the main results

The main results are best described in the context of the work-packages wherein they were achieved, under the leadership of the WP leaders.

WP1: Project management and communication

The structured adopted for the project management, with its project office and the Steering Committee, has proven quite effective in monitoring the project planning and progress, thus ensuring that deadlines were met, and that all project reports were submitted timely.

Several project meetings were organized, and all documentation has been made available on the project web site.

Ifremer participated to European Commission meeting and workshops on ESFRI research infrastructures and has provided regular inputs on progress and issues to the European Commission.

Ifremer, as project Coordinator has managed the budget, prepared the financial and administrative reports for the Commission, and transferred to the partners their share of the Commission grant.

Different communication activities have been carried out (see also section 4.1.4) of this report. Brochures, posters and a Euro-Argo movie (DVD) were prepared. The Euro-Argo movie is a 10 minutes movie that provides a comprehensive description of Euro-Argo and its application. It features interviews of the contributors and stakeholders (GMES, DG research).

A consortium agreement (CA) has been prepared, and endorsed by the Contractors. It has served as the basis of the CA signed by the Consortium to carry on the Euro-Argo activities in the interim period from the end of the project (June 2011) to the establishment of the ERIC.

WP2: Legal and governance work

The two aspects of the legal framework under which the research infrastructure will be established and operated, and its governance structure are closely related.

<u>Legal work:</u>

Various options for the legal framework of the Euro–Argo research infrastructure have been considered, including international treaties, European legal structures and national legal structures. A set of objective criteria and a scoring system were agreed upon in order to assess the relative advantages or drawbacks of each option.

The objective criteria have been selected to meet the research and operational requirements of the Euro–Argo programme. This evaluation was then used to select the most appropriate legal structure for Euro–Argo.

The Memorandum of Understanding / Consortium approach was deemed not appropriate because this arrangement is based purely on a contract between the member organisations. Euro-Argo needs to establish a separate legal entity with independent legal personality to hold funds and enter into legal arrangements on behalf of the Euro-Argo members.

It was extremely unlikely that it would be possible to establish Euro–Argo as an international body under international treaty before the Euro-Argo project deadline (end June 2011) because of the lengthy and complicated international negotiation process required to establish international governmental organisations. An international governmental organisation is also more appropriate for organisations which are larger and more heavily structured than Euro-Argo with wider reach activities and responsibilities. The funding proposed for Euro-Argo is also small by comparison with other international governmental organisations.

Due to the distributed pan-European character of the Euro–Argo programme, the need to avoid specific national laws and political differences, and for European visibility, a national form is unlikely to be appropriate. Most importantly, it was intended to keep open the option that the operational centre of Euro-Argo may move between host nations, if appropriate. This means that an organisation under national law should not be chosen. It would not be practical or sensible to set up Euro-Argo under one national law and for its operations to be run in a different Member State. Setting up an organisation subject to European law provides a neutral solution to this problem.

The European Economic Interest Group (EEIG) is unlikely to be appropriate because it cannot offer limited liability to the member organisations and is also subject to VAT.

The European Research Infrastructure Consortium (ERIC) appears to be more appropriate for Euro–Argo. However the Euro-Argo cannot simply choose to proceed with the ERIC, instead Euro-Argo will have to apply to the Commission to establish whether Euro-Argo is sufficiently of a research nature to warrant being set up as an ERIC. It should be noted that Euro-Argo has been identified as a key research infrastructure of pan-European interest by the European Strategy Forum on Research Infrastructures (ESFRI) through its inclusion in the ESFRI 'Roadmap'. However, there was concern that if the Commission believed that Euro-Argo were primarily an operational programme to assist the maintenance of the global array and the delivery of marine products and services, then it might refuse Euro-Argo to establish an ERIC. It has, however, been confirmed that a Euro-Argo ERIC would be eligible for operational funding from the EC (e.g. through GMES).

Another concern was that, although the ERIC structure was approved by the European Council in June 2009, the European Commission would be responsible for approving the establishment of ERICs. Dealing with the Commission in relation to this untried and untested legal structure may be time consuming, the Commission may find difficult to perform functions quickly and efficiently.

Under the scoring system that was devised, the ERIC scored highest, so that it is this option that is recommended as an outcome of this analysis. Some of arguments are summarised here:

- Tax Exemptions (in particular VAT): The ERIC structure is exempt from VAT and should be treated like as an international organisation for the purposes of VAT; it is also exempt from excise duties and public procurement regulations. This is a major benefit of the ERIC and the international governmental body over all other legal frameworks which are not VAT exempt.
- European Character: The aim of Euro–Argo is to create a truly European endeavour. The ERIC was specifically established to assist co-operation and collaboration between Member States and Member State organisations. This is the fundamental reason why national forms are not appropriate. Moreover, the ERIC will allow third countries (countries that are Non-EU Member States) and intergovernmental organisations to become members of an ERIC. Since organisations within Member States do not become members of an ERIC themselves but will become members on behalf of their respective Member State, each organisation involved with Euro-Argo will need to make appropriate internal arrangements with its respective Member State government.
- Flexible structure: The legal structure should not be overly cumbersome or restrictive and should be able to adapt to the changing operational needs of the Euro–Argo programme. The ERIC provides a flexible legal structure from which the member organisations can specify governance provisions as they so wish.

Governance

The broad roles of the Governance structure have been identified to include the following:

- To supervise operation of the infrastructure and ensure that it evolves in accordance with the requirements set forth by the research and operational communities.
- To coordinate and supervise float deployment to ensure that Argo objectives are fulfilled (e.g. global array, filling gaps, open data access).
- To decide on the evolution of the Euro-Argo infrastructure (e.g. data system, products, technology and new sensors, number or floats deployed per year).
- To monitor the operation of the infrastructure and to maintain the links with research and operational (GMES) user communities.
- To organize float procurement at European level (e.g. in case of direct EC funding for small participating countries).
- To link with the international Argo structure (Argo Project Office, international Argo Steering Team, Argo Information Centre).

Accordingly, the following bodies have been recommended and have been set-up at the end of the project. This governing structure is part of the Statutes of the ERIC, which spell out the rules for designation of the members of those bodies, the powers, voting procedures, organization of meetings, etc... Additional rules have been agreed upon, and explained in a document entitled “Internal Working Procedures”.

The Council

The Council is the only body of the E-A ERIC that has the power to establish, or to discontinue the E-A ERIC. The Council defines the broad strategic direction for the E-A ERIC, and its evolution. It allocates funds received from the EC and any funds/subscriptions received from partners. It takes all decisions concerning major investments (e.g. buildings, large equipments) at the European-level. It decides on the opening of staff positions, or on the designation of seconded personnel, for the Programme Office.

The Council decides membership in the E-A ERIC including the addition of new Members and the withdrawal or exclusion of Members. The Council designates the members of the Management Board and the Programme Manager.

The Management Board

The Management Board shall supervise the operation of the E-A ERIC and ensure that it operates and evolves in accordance with the strategic direction set by the Council, and the requirements set forth by the research and operational communities.

The Management Board designates the members of the Scientific and Technical Advisory Group (STAG), and establishes the terms of reference for their work.

The Management Board shall take all necessary decisions relating to the implementation of the annual work plan, to the operation of the E-A ERIC (in particular float procurement and deployment strategy), its relations with the International Argo programme and relevant European institutions.

The Management Board validates the annual work plan prepared by the Programme Manager and submits it to the Council for formal approval. Likewise, it submits to the Council proposals for the annual budget and on the allocation of funds received from the EC and any funds/subscriptions received from Members and Observers.

The Programme Manager

The Programme Manager is responsible for the proper preparation and implementation of the decisions and programmes adopted by the Management Board. The Programme Manager shall take all necessary decisions for the execution of the annual work plan and the day-to-day administration and management of the E-A ERIC.

The Programme Manager represents the E-A ERIC in the International Argo governance structure (International Argo Steering Team). This does not preclude national representation from Members.

The Programme Manager shall be entitled, subject to prior to approval by the Council, to sign legally binding contracts and agreements on behalf of the E-A ERIC with third parties.

The Programme Manager is accountable to the Management Board. She/he assists the Chair of the Management Board in preparation of the meetings of the Management Board.

A Programme Office shall be set-up to assist the Programme Manager and support the day to day management of the E-A ERIC (including without limitation filing of mail and correspondence, archiving of documents, travel arrangements, organizing meetings, preparing reports and financial documents).

The Scientific and Technical Advisory Group

The STAG, consisting of independent experts, is established to advise the Programme Manager and the Management Board on any scientific or technical matters (including data management and instrumentation) relevant to the operation, development, and evolution of the E-A ERIC, and access to its data by research and operational users. The Management Board may request the STAG to consider, and make recommendations on, issues that it needs to resolve. The STAG formulates recommendations on scientific and technical aspects and direction of the E-A ERIC.

WP3: Financial work

The objective of this work-package was to define and consolidate the national financial commitments to the Argo infrastructure (seeking long-term commitments) and in parallel to define and set up other funding sources (in particular through GMES) to meet the overall objective of Europe to operate an array of 800 floats with a deployment of about 250 floats per annum.

It included an analysis of the expected Euro-Argo infrastructure costs, together with a breakdown of how these might be shared between national and European (e.g. through GMES) funding. The present estimation of Euro-Argo costs is about 8.14 M€ per year. This includes an expected level of direct EC funding through GMES of about 2 to 3 M€ per year, with the majority of the cost being met through member state (partners) funding.

To achieve the goals of Euro-Argo and to sustain the operation of the ERIC, it will be necessary to secure long-term national commitments, while at the same time establishing a long-term EC contribution through GMES. All partners have worked with their national funding agencies (government ministries or departments) to try and secure long term national commitments to Argo (and Euro-Argo).

To assist partners in their negotiations with their funding agencies an initial template was devised to capture and summarize the member state contributions to Argo. This enables each partner to see at a glance the level of all previous contributions to the Argo array, the status of other partner's efforts to secure national funding, and an overall 'traffic-light' display showing they are collectively progressing towards securing funding for the Euro-Argo infrastructure. Also to assist partners in making the case for Euro-Argo a detailed report outlining the costs, impact and financial benefits from Euro-Argo was prepared.

During the course of the project, Euro-Argo has seen a number of new countries, i.e. those who have not previously been involved with Argo, initiate national Argo programmes. These include: Poland, Greece, Bulgaria and Italy.

At the time of writing (July 2011) the various national Argo/Euro-Argo funding commitments are:

France: 70 to 80 floats per year with 60 to 65 funded by Ifremer (10 to 15 coming from

NAOS/Equipex proposal from 2011 for 10 years) and 10 to 15 by SHOM (annual budget but stable). Additional floats funded through research activities will complement the above activities.

Greece: Contribution of 3 floats/year approved from the Greek Secretary General for R&D. Additionally, HCMR is considering the possibility of developing a DMQC facility for Argo profiles collected within the Eastern Mediterranean region.

Ireland: 3 floats per year is the target funded by the MI (although long term funding is not assured). Contributions to the ERIC office as an observer member will be made from MI annual operational budgets.

Norway: Have submitted a proposal to the Norwegian Research Council (Ministry of Research) for 8 floats/year for the next five years and to be full member. The review and answer from the Research Council was positive, but they need to submit a modified proposal with a revised (reduced) budget within 19th August. Final answer from the Research Council is 21st October. The most likely outcome is that Norway will be a full member, and deployment of 6-8 floats per year.

Netherlands: have a regular budget through KNMI and plan to sustain a level of 8 floats/year.

UK: Have around 100 floats already available for the coming years. NERC funding for Argo (science, data management and floats) has been given high priority for the period 2011-2015. Longer term Met Office funding for Argo (management and coordination, float procurement and deployment) from DECC (and/or other departments) is not yet assured. Future funding may continue to be variable from year-to-year.

Italy: The Italian Ministry of Research has allocated an extra 1ME for Euro-Argo within the 2011 OGS budget. It is hoped that this amount will be allocated every year but at this point there is no firm commitment to do so. Plan is for 30 floats/year to be deployed subject to funding.

Germany: long-term funding through BSH agreed to purchase 45-50 floats per year, with additional floats funded through KDM.

Bulgaria: BulArgo project initiated with an ongoing contribution of 2 floats/year.

Spain: Funding agency is planning to fund the IEO so Spain will become a full member of Euro-Argo with an annual deployment of 5-10 floats per year. In 2011 will deploy around 30 floats with funds for 8 in 2012. However for 2013 and later, do not yet have budget approved or allocated.

Poland: Expect to contribute 2 floats per year and vessel to deploy floats at the Nordic Seas.

Portugal: Portugal keeps its commitment to this joint activity, even if some changes on national representatives may have to be considered in the future, since the Portuguese Government was recently elected and hasn't yet started the full course of its activities. FFCUL are currently contacting several other institutes in the field who had shown a strong interest in the infrastructure, in order to consolidate a national consortium to clearly demonstrate to our funding agency the importance of this ERIC to fulfill our scientific and operational national goals.

Concurrently, several meetings have been held with the GMES bureau, DG Research, the EEA[3] and EuroGOOS to discuss funding issue, since Argo is the single most important in-situ observing system for the GMES Marine Core Service (MCS). It is thus essential for GMES (as it is for satellite data) to ensure that over the next 10 to 20 years, Argo will continue to provide the required global temperature and salinity observations.

Analyses carried out as part of the Euro-Argo preparatory phase show that a direct EC contribution is needed to complement the Member States contributions. GMES has clearly recognized the need to support in-situ infrastructure.

By setting up and securing a funding line of 3.3 Meuros/year from 2010/2011, GMES will secure a critical data set for the Marine Core Service and its climate applications; facilitate the setting up of European governance for in-situ data linked to the MCS, and contribute to a truly global and international array and give a strong signal to the international community (e.g. GEO, GCOS/GOOS, JCOMM) about the leading role of GMES for sustaining global earth observations. In the 2014-2020 perspective: Euro-Argo should be included in a proposed “operational” GMES funding line.

The tables below summarize the budgets anticipated for Euro-Argo and the ERIC.

An estimation of the requested funding (from 2010 to 2020) for Euro Argo is given in table 1 including float procurement, operations, data management, Euro-Argo central infrastructure and International infrastructure support.

Category	Unit cost	Number	Cost (Keuros)
Float procurement			
Global (assumes standard Argo float)	14	200	2800
Regional (assumes enhanced float)	17	50	850
Operations			
Telecommunications	0.4	800	320
Personnel for management/coordination	100	5	500
Personnel for technical/logistic support	100	6	600
Misc. (e.g. freighting)	0.2	250	50
Equipment and consumables			50
Dedicated ship time			300
Data management			
Personnel	100	19	1900
Equipment, other			100
Euro-Argo central infrastructure (C-RI)			
Personnel for management/coordination	100	2	200
Personnel for technical/logistic support	100	3	300
Missions (users workshop, board, council) equipment…			100
International Infrastructure support			
Support to Argo Information Center			40
Support to Argo Project Office/Director			30
Total			8140

Table 1: Estimated consolidated costs, on a yearly basis, in thousands of Euros (k€)

[3] *European Environment Agency*

A proposal for the sharing of costs between Member States and EU GMES is given in the table 2 below. Priority for GMES funding should be for contribution to the global array. It is thus suggested that GMES should co-fund (50%) the float procurement for the global array and the specific ship time that is likely needed to maintain the global array. Float procurement at regional level should be funded by member states as well as the overall operation costs. The European Commission (GMES, DG Research) should also fund the European management and coordination costs and the contribution to the international structure (Argo international information center and Argo international project office). Argo data processing and service is partly planned in the Marine Core Service and started with the MyOcean project (MyOcean funding is not, however, at the required level to cover all Euro-Argo data processing activities).

Category	Member	EC	TOTAL
Float procurement			
Global (assumes standard Argo float)	1400	1400	2800
Regional (assumes enhanced float)	850		850
Operations			
Telecommunications	160	160	320
Personnel for management/coordination	500		500
Personnel for technical/logistic support	600		600
Misc. (e.g. freighting)	50		50
Equipment and consumables	50		50
Dedicated ship time		300	300
Data management (Part of GMES MCS)			
Personnel	950	950	1900
Equipment, other	50	50	100
Euro-Argo central infrastructure (C-RI)			
Personnel for management/coordination	200		200
Personnel for technical/logistic support		300	300
Missions (users workshop, board, council) equipment, etc	50	50	100
International Infrastructure support			
Support to Argo Information Center		40	40
Support to Argo Project Office/Director		30	30
Total without MCS	3850	2280	6140
Total with MCS	4860	3280	8140

Table 2: Proposed sharing of infrastructure costs (Keuros) between Member States and European Commission (GMES, DG Research).

WP4: Strategic and logistic work

The objective of this work-package was to analyse several key aspects of the infrastructure : the overall infrastructure and the role of partners, technological issues (float technology and evolution), logistical issues (organization of float deployment) and strategic issues (sampling of marginal and Nordic seas).

The Euro-Argo research infrastructure: a very complete description of the research infrastructure has been made from the points of view of the functions to be fulfilled by its different components, the technical options, the integration in the international context, the contributions from the different partners, and the necessary evolution from the present situation to the anticipated European Infrastructure to be set-up.

The analysis has covered the governance structure of the international Argo programme and the role that the ERIC intends to play therein, particularly in the coordination of the deployments; the float technology, with the different manufacturers (essentially NKE in France, Optimare in Germany, and Webb Research Company and Scripps Institute of Ocanography in the USA) and the characteristics and performance of their instruments A review of the sensors available has been included.

The tasks necessary for the reception and testing of the instruments, their preparation for shipment and deployment at sea were listed in detail, along with the associated logistics. Continuous array monitoring is required to assess performance of the instruments and to detect early on any dysfunction. One must consider the sensors accuracy and stability, as well as all other performance indicators: mission parameters, energy budgets, transmit power, rate and causes of failure, etc. This is done now by several groups but will be harmonized at European level.

Data management is of paramount importance to facilitate access by the research community and the operational centres to quality-control data of the highest standards. The data management and processing is performed in a distributed network of Centres, several of which are operated by European Centres associated to the ERIC : the Coriolis Global Data Centre, real-time Data Assembly Centres and Regional Data centres in France and the UK. Each provide services in data validation, data assembly, elaboration of data products (maps, statistics, derived quantities), and user access adapted to different mode of use (e.g. ftp, web access, or Google ™ visualisation).

The role of each partner (past, present and future) in this complex distributed organisation has been analysed, serving as the basis for budget estimates for the whole operation of the Infrastructure.

Float technology analysis

The status of float technology and its likely evolution over the coming years (design, lifetime, cost, new sensors, improved telecommunications, etc...) has been investigated. A comparative evaluation has been made of possible improvements of CTD[*] measurements, new sensors like O_2 and bio-geochemical sensors, ice sensing algorithms, vertical sampling strategy, transmission systems (Argos and Iridium), batteries etc. A comparison of the performances of different types of floats (Provor, Nemo and Apex) has also been made.

The CTD: the most promising developments concern the possibility to reach greater depths, reduce energy consumption, and various algorithmic upgrades for data compression, and choices of mission parameters prior to deployment.

Dissolved-oxygen: there is growing interest in the scientific community for oxygen measurements, which can be directly related to the carbon cycle and ocean biology. Some 120 floats in operation world-wide are presently so equipped. Two different sensor types are used today on Argo floats, Seabird electrochemical sensor and Aanderaa Optode 3830. Each of these has pros and cons; while for response times and initial accuracy the Seabird sensors are thought to be superior, it is the long term stability, the ability to measure in low O2 concentrations, and the robustness against biofouling that speaks for the Optode. Several generic issues (e.g. accuracy, calibration, measurement stability, quality control, life-time, optimum position of the sensor on the float, data transmission) have been reviewed for the two types of sensors.

This is an area of active ongoing research and development, and sea trials, where no single solution is generally agreed upon, nor adopted in an international context.

[*] *CTD : Conductivity, Temperature, Depth : the sensors that give salinity and temperature data*

Ice sensing: Initially Argo was intended to observe the deep ice-free ocean in real time. However, during recent years, the ice-resilience of Argo floats has been increased. Today four different types of ice compatible floats are in use, two commercial, and two research types. Different solutions must be sought according to the type of ice likely to be encountered (Southern ocean, Arctic, marginal ice zones, or ice floes), with corresponding solutions in hardware and software (e.g. sensor protection, ice sensing algorithm, data storage and positioning while under ice).

Biogeochemical: traditionally, measurements of biogeochemical parameters are made from oceanographic vessels, where the highest data quality can be obtained, and multi-parameters collected. With the coming of new sensors with relatively low power requirements, measurement of some key bio-related variables is possible on floats (e.g. transmitometers, radiometers, fluorescence, backscattering). Observation of zooplankton by acoustics can also be made. Here again the implications on float lifetime, data transmission, sensor stability are numerous, and no universal international agreement is yet reached.

Satellite communication: continuous improvement on the data transmission systems (Argos-3, Iridium) allows new opportunity for the transmission of larger data sets (improved resolution of the measurements), better positioning at the surface, more efficient energy budget, and reduced surface time (hence reduced vulnerability).

Further considerations addressed in the report concern the mission control, different types of batteries, performance and lifetime, operations in marginal seas (in particular avoidance of grounding on the sea-floor), transmission of technical parameters for monitoring of the instruments and detection of possible dysfunctions, user interfaces, and field operations (shipping, logistics, handling, etc...).

Deployment issues

It is anticipated that the Euro-Argo infrastructure will comprise 800 floats in operation at any given time. Successfully managing such a complex array will require a high level of co-operation between European partners and of efficiency in all implementation aspects (co-ordination of deployments, operations at sea, array monitoring and evolution, technological and scientific advancement and data management). Specific European interests will also require increased sampling in some regional seas and the adaptation of the float technology and mission parameters to these particular environments. A review was made of the required networking and information access to facilitate deployment and of the necessary links with international structures and partners.

Co-operation and appropriate decision tools are needed to optimise the array density and select future deployment locations, as well as to co-ordinate procedures between the regional centres. A discussion of the requirements to obtain deployment capacity for areas not visited by research vessels is included. A sustainable network requires continuous quality management and monitoring of the performance of newly deployed floats at sea in order to react quickly to potential problems.

Useful tools for array monitoring and deployment planning are available at the Argo Information Center. Some data information systems on research vessels have been developed but they are unfortunately not kept up-to-date with the necessary forward looking planning (at least some 6 months ahead would be necessary to the logistical arrangements to be made). Recourse to dedicated vessels is an option that allows full flexibility, but it is often prohibitively costly.

Other issues relevant to deployment and field operations have extensively reviewed, including the preparation of the floats, testing and programming prior to deployment, notification the Argo Information Centre, providing instruction manuals for the crews at sea, monitoring of the floats at sea (data return and quality, transmission to the data centres, conformity with mission parameters.

Strategy for float deployment in marginal and in the Nordic Seas

While the Argo strategy for the open ocean has been defined and agreed at international level, the sampling strategy in areas of European interest (Nordic Seas, Mediterranean and Black Seas) have been defined and validated.

- Nordic Seas pose specific challenges due to the complex topography, and the weak mean stratification. An analysis of Argo floats deployed since 2001, providing more than 4300 vertical profiles of temperature and salinity, have been conducted. The results from the analyses of the float data can be summarized as follows: meso-and sub-mesoscale variability cannot be resolved by any financially and logistically reasonable float programme. This variability has to be treated as noise. The mean seasonal variability of both the circulation and the stratification is resolved by the present float data set. The data set also indicates inter-annual changes of the seasonal cycle of the hydrographic parameters. Analysis of ship-borne hydrographic surveys indicate that at least six floats have to be present in each basin in order to reduce the uncertainties below the signal level. Long-term (over a decade) changes of heat- and freshwater contents are also detected in the float time series.

In conclusion it is advised to operate at least 3-4 floats in each of the Nordic Seas basins at any time. The inherent danger of loss of floats, due to encounters with sea ice in particular during winter and spring, would make a population of 4-5 floats per basin desirable.

Mediterranean and Black Seas : a strategy has been proposed, based on a study of historical Argo data in the Mediterranean , and of simulated Argo float trajectories in a circulation model of the Mediterranean for years 2004 to 2007.

Robust statistics of temperature and salinity can only be obtained with a large number of float dispersed quasi-uniformly in all the areas, but monitoring the Mediterranean and Black Seas with hundreds of floats is not practically possible due to logistical and economical reasons. In contrast, the observed trends in the deep layers of the Mediterranean characterized by less spatial variability, suggest the opportunity to increase the observations at great depths with the Argo network.

Despite the problem of under-sampling, the following recommendations for the continuation of the Argo program in the Mediterranean Sea can be advised:

(1) Maximum profiling depth of 2000 m at every cycle or every two cycles, with a short 700 m profiles in between;

(2) Deployment in deep waters (depth > 2000 m);

(3) Cycles of 5 days is a good compromise to capture more variability of the sub-surface velocity field and to obtain a robust estimate of the mean velocity at parking depth.

(4) Parking depth between 300 and 400 m to track the Levantine Intermediate Water throughout the Mediterranean;

(5) Use Argos-3 or Iridium telemetry to reduce surfacing time (from about 6 h to less than one hour) and probability of hazards (stranding, theft by seafarers, etc.);

(6) Maintain a minimum population of 30/50 floats in the Mediterranean. If Argos-3 or Iridium telemetry is used, the “mortality” of the floats should be reduced and reseeding of 5/10 floats per year might be sufficient.

(7) Deploy the floats inside and outside the significant circulation structures (with sub-basin scale of about 100 km) such as the instability eddies of the Algerian and Lybio-Egyptian Currents, in order to obtain unbiased statistics.

The analyses of the sparse historical Argo float data in the Black Sea can be summarized as follows:

A minimum population of 5 floats is required; an array of 5 operating floats requires deployment of one or two floats per year, since floats operated in the Black Sea indicate a longer operating life with respect to the Mediterranean (with a half mean file near 1000 days).

WP5: Technical Work

This technical work was motivated by the need to facilitate access to data as soon as possible at the start of operation of the infrastructure, to improve the float technology and to demonstrate the impact of Argo data on applications. Although significant developments had already taken place in setting up the data streams, further improvements were needed on the automation of the processes needed to provide validated data of the highest quality (up to the exacting climate requirements) with the shortest delays.

I. Improve the data processing and delivery system:

Significant improvements have been made on both the data management of Argo data and on the float technology. Four aspects of data processing and distribution system have been considered: enhancement of the mandatory functions related to Argo Regional centres both in Nordic seas and in Mediterranean and Black seas; the development of new tools to help float deployment plans and monitor the behaviour at sea; definition of real-time quality control procedures for biochemical data; and improvements of the consistency of the Argo dataset.

a) Argo Regional Centres improvement

Within Argo, Regional data centres, also called ARC, have been set up to enhance the quality of the Argo data for research activities. European partners coordinate the North Atlantic and the Southern Ocean ARCs. Within EuroArgo, activities have been conducted in two regional seas: the Mediterranean and the Black Seas and the Nordic seas. The delayed mode procedures have been tested in these regions and were considered as suitable for these regional seas. Data have been processed in delayed mode and the reference CTD database has been enhanced with recent data.

Nordic Seas

Delayed mode quality control of floats deployed in the Nordic Seas and in the Atlantic Ocean has been achieved, and the results were submitted to the Coriolis Data Centre. A specific pressure adjustment procedure for APEX floats has been adapted to the delayed-mode quality control, because those floats may transmit erroneous surface values (which are used to reset the pressure reference (figure1)).

Further work is planned to modify the pressure corrections for time series with many missing values due to truncation problems, in order to rescue otherwise valuable data.

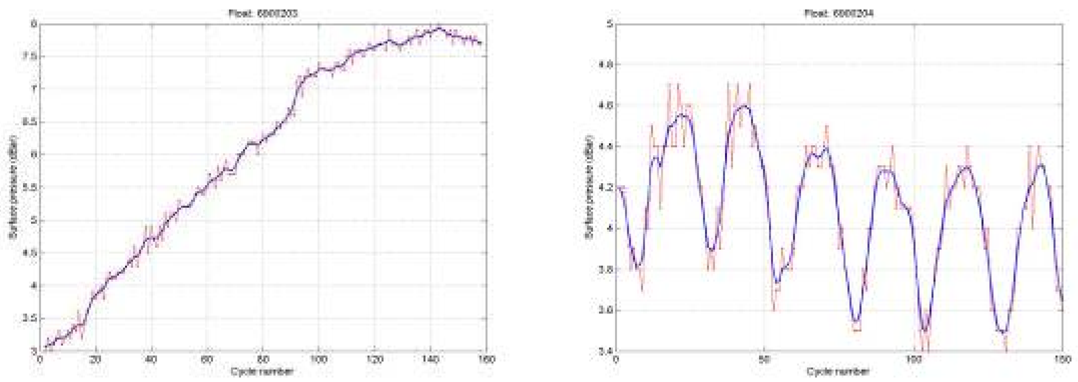


Figure 1: Surface pressure time series, left: float 6900203, right: float 6900204 ; red: raw SP time series, blue: filtered SPs used for pressure adjustment in DM.

<u>Mediterranean and Black seas</u>

Delayed Mode Quality Control for the Mediterranean has been further carried out, on the basis of historical reference data for the Mediterranean which have been uploaded and transformed in the correct format needed for the procedure. Even though the standard method is not quite efficient in this context –due to the large number of shallow profiles, the substantial natural variability of the thermo-haline properties, and the scarcity of reference data– it has been implemented to calibrate the salinity data of the long-lived floats that stopped working in 2009 and before. So far, all the floats considered can be considered as well calibrated. It is planned to integrate (in an incremental way) the validated/calibrated Argo data in the reference dataset.

<u>b) New tool for Deployment planning</u>

Presently the deployment planning is performed using data coverage maps provided by the Argo Information Centre (AIC) that show the number of floats per latitude-longitude square, derived from the network picture at T0 ; however, there is no way to take into account the ocean circulation and the float failures until the float are deployed to T0+n. A mapping tool for addressing the float density (i.e. the health of the network) in different parts of the global ocean has been developed and tested. It will help the user community to identify areas in which float density might or might not be adequate to resolve scientific objectives, and it will help float providers as a guide for future deployment strategies. A large data base has been obtained for this purpose.

The new tool accepts as input float positions and their age. The tool provides maps that show, based on the input, the representative sampling of anomalies in the oceans and the corresponding age of the floats. Mapping of number of floats and float ages takes changes in the ocean into account. Extensions to take into account the topography or current field would be possible.

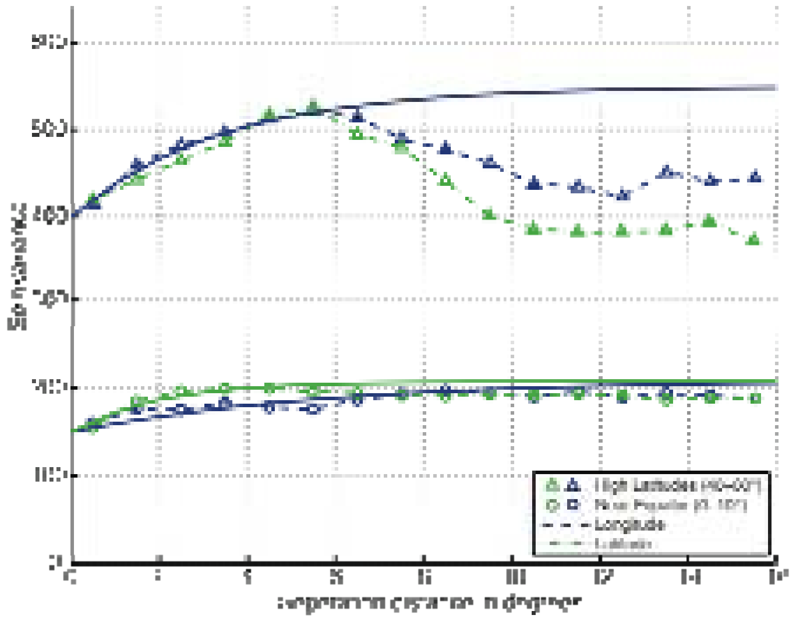


Figure 2: Semi-variogram for high latitudes and near the equator from a data subset. These allow to determine for each grid point a statistically analysis based determination of actual float density.

Using this approach in future deployments, over sampling of homogeneous (interior) regions might be reduced and might lead to a better float distribution in the future, independent of topography, boundary currents and fronts.

<u>New tools for at sea monitoring of Euro-Argo Fleet</u>

A new tool to monitor float behavior at sea has been developed to monitor the French Provor fleet. The purpose of the tool serves three kind of users : a) project managers or scientific leaders; b) float developers or the floats deployment team; c) the manufacturers. Exhaustive statistics allows to identify major anomalies, to relate them to specific versions or configuration of floats, and to determine whether it is a single failure or a real anomaly needing correction. An automatic alarm system has been set-up to alert when a failure rate goes beyond and accepted threshold.

<u>c) Define real-time quality control procedure for biochemical data</u>

Biogeochemical Profiling Floats have an enormous potential and will likely become key components of an integrated system devoted to evaluating, characterising and predicting the state of the oceanic ecosystems. In this context, they will represent a milestone for the future oceanographic studies and for derived applications.

Argo floats, originally designed to measure pressure, temperature and salinity, are presently carrying additional sensors to perform biogeochemical measurements. A real-time quality control (QC) procedure for chlorophyll measurement has been developed. He has adapted the real time quality control tests for temperature and salinity measurement to Chlorophyll specificity. This procedure was turned into operation at the Coriolis data center in 2011 (figure 3).

The definition of the protocols for autonomously measuring two key oceanic ecosystem parameters, the effort to harmonise and produce a unique set of data, indifferent to the platform source, and the proposition of a first, tentative, QC protocol are the three main results obtained in this task.

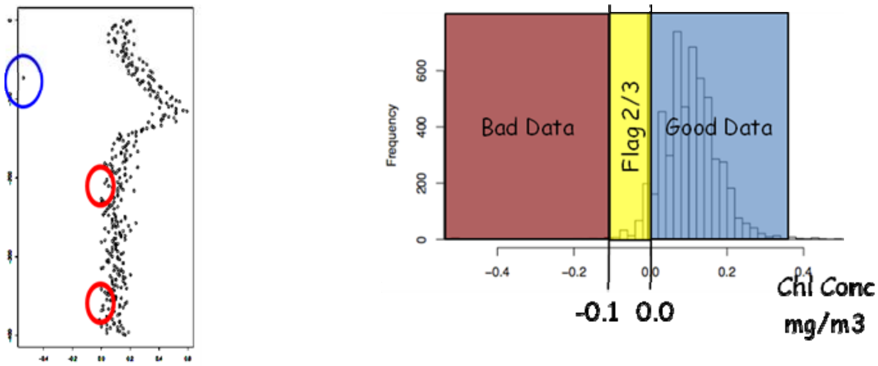


Figure 3 The Global range test for Chl profile. As Chl data can be slightly negative automatic test should only flag as bad the point circle in blue in left figure and not the red ones. The proposed test considers that measurement less than 0.1mg/m3 are bad, and data between 0.1 and 0 should be handled with caution.

d) Improve the consistency of Argo dataset

At Argo Data Center, float data are processed profile by profile in real-time , float by float in delayed mode without checking the consistency with the other data available in the area for the same period. Within EuroArgo, several methods have been proposed to improve the Argo profile data real time and delayed mode quality control at Global Data Center level. These methods complement those already implemented at international level.

(1) Comparison with recent climatology. The comparison of Argo data with recent climatological means and variability allow us to better detect anomalous floats. A new seasonal temperature and salinity climatology derived from Argo data over the time period 2003-2008 has been prepared by Von Schuckmann et al. (2009). Several tests were then performed as part of Euro-Argo to compare individual profiles and/or their average in space and time with this new climatology. This shows that a better detection of anomalous profiles can be achieved.

(2) Using Altimetry to detect potential suspicious profiles. The comparison of Argo dynamic heights and altimeter sea level observations should complement the previous method. This was fully tested and demonstrated by Guinehut et al. (2008) as part of a Coriolis and Euro-Argo study and is now endorsed by the Argo program as one main element of Near Real Time Quality control of the Argo dataset

(3) Using neighbor to detect potential suspicious profiles. We also propose to test a method to systematically compare floats with their neighbors in space and time. This method is implemented at the Coriolis data centre and the anomalies detected are sent to the DAC to correct if necessary the Argo data (figure 4).

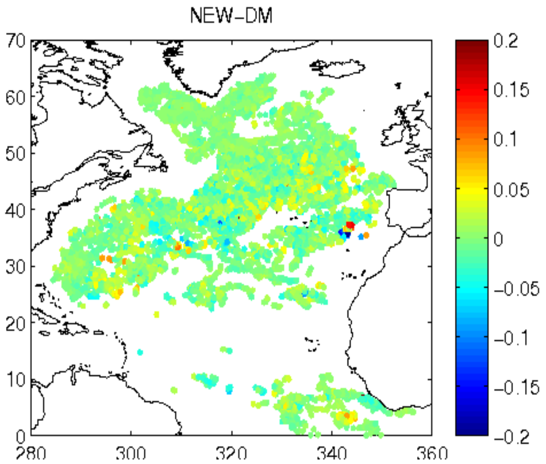


Figure 4: The method allows detection of some suspicious DM profiles, to be analysed more in details

Using feedback from forecasting models : In perfect world, some profiles declared as good by Argo Data Centers (or the other way round) could be declared as bad (or good) by models as their QC are targeted to prevent bad data to pollute forecasting. But this should only happen for a small percentage of the profiles and if the number is important feedback to Argo Data System has to be done (figure 5).

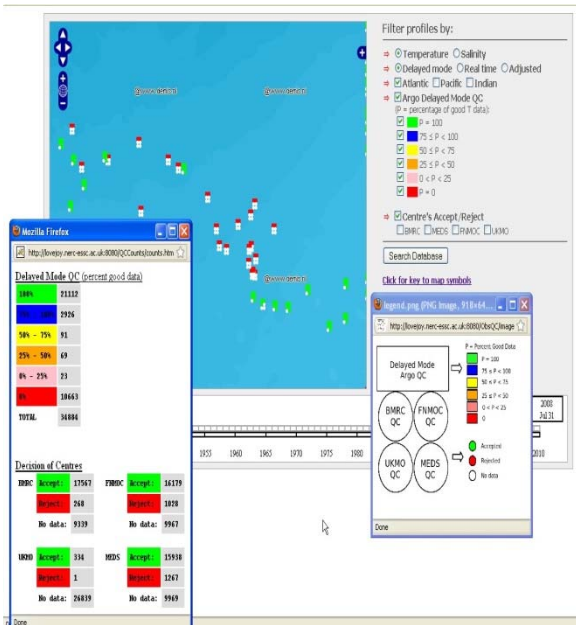


Figure 5: Difference between flags provided by Argo Data Centres and QC performed by forecasting centres

The first three tools will continue to be used within Argo to detect earlier anomalies in the Argo data. The development of the latest one will be pursued within MyOcean and MyOceanII projects.

II. Improve and test float technology

The improvements that have been carried out within Euro-Argo are related to the test of new satellite communications for use in marginal seas, the adaptation of float technology to survive in partially ice covered areas such as Arctic/Subarctic regions and the evaluation of oxygen sensor for Argo application.

a) Two way data transmission

The first development has dealt with the new satellite communication possibilities, and their use in marginal seas, where it is critical to reduce the transmission time at the surface, to reduce the risk of grounding and thus to augment the lifetime float, to reduce the risk of thefts in these highly trafficked seas, and to have better estimates of subsurface currents. The performances of the new bi-directional Argos3 transmission have been analyzed and implemented on profiling floats. Test of new floats with both Iridium and Argos3 technology (2 of each type) were carried out in the Mediterranean sea.

The standard Arvor float uses Argos2 transmission. For marginal seas, an Iridium model has been developed.

The first Arvor-I was deployed in the south of Cyprus in early December 2009. The float was programmed to cycle every day from 700 m depth and to go at 2000m every 10 cycles for validation purposes (figure 6).

Only 3 minutes are needed to transmit the data when the float is at surface. The total time at surface is around 30 minutes, including the time needed to increase the buoyancy for good satellite transmission, and then to reduce buoyancy to start a new cycle (to be compared to more than 8 hours presently with Argos2). The objective to reduce the time at surface has been reached.

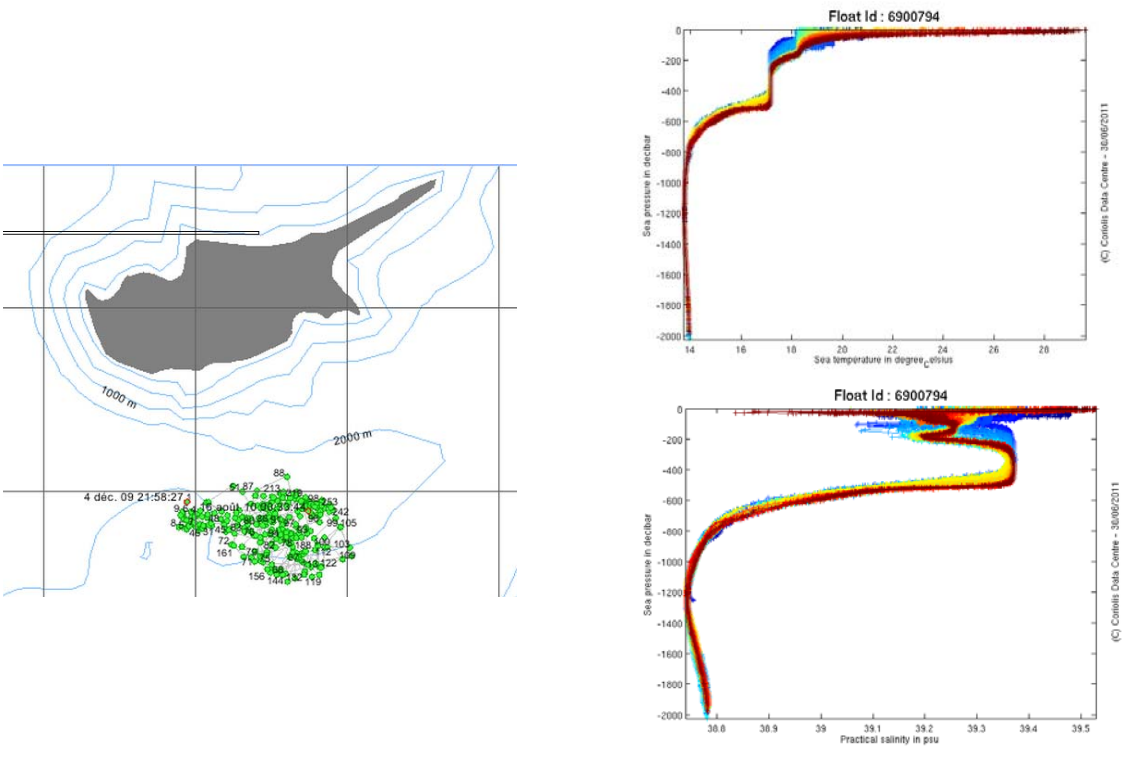


Figure 6: Arvor-I deployed south of Cyprus from TARA vessel

Argos satellite communication system represents today six non-stationary polar-orbit satellites, with one active Argos3-mode (MetopA) available with 2 ways communication. In order to have an alternative way to improve communication performances on floats, an Argos-3 PMT developed by CLS was fitted on Arvor float. The software was specified to be able to communicate both in Argos2 and Argos3 protocols. To fully benefit from Argos3, the float uses an ephemeride of the pass prediction to adjust the RDV with the satellite. The capability of transmitting one profile during one satellite pass has been assessed (less than 15mn) as well as transmission performance (error rates, influence of satellite elevation and orientation, power balance, scheduling strategy for the float to surface (using pass prediction tables), and downlink communication. From the first trial at sea it appears that there are still some adjustments to perform as the at sea results are not as good as what achieved on land. Recent results are, however, promising.

b) Ice-sensing algorithm for arctic/subarctic region

During recent years, the ice-resilience of Argo floats for the Southern Ocean has been considerably increased by the development of an ice-sensing algorithm (ISA). This algorithm is based on a relation between the subsurface-temperature and the probability of sea ice at the surface. Within the Euro-Argo project the Antarctic ISA was adjusted for Arctic/Subarctic regions. For this purpose, temperature profiles have been analyzed in conjunction with the corresponding sea ice situation as obtained from satellite observations. The near surface temperatures show correlation between temperature and ice, albeit less pronounced compared to that of the Weddell Sea. Unlike the Southern Ocean, large areas of the Arctic Ocean remain ice covered even in summer, which might result in Arctic floats being trapped under the sea-ice for several years.

Thus, a major development objective was to try ascending to the surface to submit data even in small ice-free areas. For this reason, previously used safety margins were abandoned in this first version of Arctic-ISA, which was defined as to abort ascent, if the median of the temperature measurements between 10 and 20db is less than -1.3°C. Both, the averaging interval and the temperature are adjustable and can be easily optimized and adapted to different areas.

Arctic floats will have physical contact with sea-ice more frequently than Antarctic floats. To provide additional protection against harsh contacts, a synthetic cage is added to protect the sensors and the lower part of the antenna.

Simultaneously, the NEMO-floats have been fitted with an Iridium transmission module, which has drastically reduced the surface time.

The new Arctic ISA was implemented on two NEMO floats which were deployed into the Sub-Arctic Ocean in July 2010 in close collaboration with the Euro-Argo partner "Institute of Oceanology Polish Academy of Science", with satisfactory results.

c) Evaluation of Oxygen sensors for Argo application

Oxygen is another important parameter that can be observed using Argo floats. Evaluation of oxygen sensor accuracy has been carried out. Optodes have been prepared and deployed (funded by other resources). Three of these (2 APEX and 1 PROVOR) were deployed in the oxygen Minimum Zone off West-Africa.

- **Sensor type issues:** two different sensor types are used today on Argo floats, Seabird electrochemical sensor and Aanderaa Optode 3830. Each of these has pros and cons; while for response time and initial accuracy the Seabird sensors are thought to be superior, it is the long term stability, the ability to measure in low O2 concentrations, and the robustness against biofouling that speaks in favour of the Optode.

- **Accuracy considerations:** O2-sensors have to be improved for long term stability, time constant, calibration etc., and some efforts were devoted to this
- **Calibration issues:** The Aanderaa Optode 3830 is used on various platforms, including moored fixed level instruments, moored profilers, autonomous gliders, and profiling floats. The instrument specifications claim long-term stability of measurements (more than one year) without recalibration. However, our comparisons with CTD measurements show that the factory settings require an instrument-specific calibration to satisfy the accuracy requirements. A careful pre-deployment calibration is therefore of great importance.
- **O2 Float lifetime:** Generally the lifetime of a profiling float is reduced significantly when O2 sensors are implemented. It is too early to judge whether O2 sensors are reliable for durations extending beyond the approximately 3-year float-lifetime of any of the O2 sensor model; however temperature and salinity sensors can be used beyond that duration. Therefore, it must be investigated whether total float life time should be extended by the use of Lithium batteries to assure that the Argo requirements could be fulfilled.
- **Long Term stability and Quality Control (delayed mode):** Compared to the effort with the salinity quality control (delayed mode QC) the O2-QC is in its infancy; one of the problems is the availability of reliable historical oxygen data. Here, Euro-Argo should encourage the research community to timely make their measurements available

d) Implications for the Argo Array

Several float types (WEBB, NEMO, AND ARVOR) have been prepared with alternative communication routes (different from classical Argos 2). Surface times can be drastically reduced to just a few minutes which is be of great importance for regions with heavy traffic (Med Sea) or in partly ice covered regions. Bi-directionality would also offer the opportunity to alter the schedule of the floats, e.g. from high frequency profiling to normal schedules. Second, bidirectional communication offers the opportunity of altering the Floats schedule on demand – profiling depths and profiling frequency both are issues.

This work is ongoing and requires time beyond the Euro Argo preparatory phase for final evaluation. Work regarding the use of oxygen sensors will continue within science driven programs and (slow) evolution should be expected.

Task 5.3 – Impact studies and demonstration cases

Argo-data provide a step change in our ability to observe the sub-surface ocean. This is very likely to lead to substantial improvements in monitoring, understanding, and predicting ocean variability and change, and associated impacts. Argo is therefore likely to be a key dataset, delivering important societal benefits.

As with all new datasets it will take time to develop the best ways in which to exploit the data to maximum benefit. Within EuroArgo we have demonstrated the use of Argo in a variety of applications, and – where possible – assessed its impact. The key results obtained in the frame of this project are summarised below:

Work at the UK Met Office: observing system experiments using a ¼ degree ocean model, show a substantial reduction of errors when Argo data are assimilated.

A large ensemble of idealised decadal climate prediction experiments has been made, demonstrating significantly improved skill when sub-surface temperature and salinity are assimilated compared with using sea surface temperature alone. Temperature and salinity in the upper 2000m, as potentially provided by Argo, are sufficient to enable skilful predictions of the Atlantic Meridional Ocean circulation on decadal timescales in idealised experiments. Furthermore, additional observations below 2000m increase the overall skill, especially in the Southern Ocean.

It has been demonstrated that forecasts of upper ocean temperatures from March 2007 to August 2008 are more accurate when the model is initialised with the full Argo array than when it is initialised with sub-sampled observations typical of historical periods.

Work at IFREMER: the impact of Argo data on Mercator ocean analyses and forecasts at 1/3 and 1/4 degree resolution has been analysed. Argo data enable the model to simulate the correct properties of Mediterranean water. Furthermore, cold sub-surface anomalies in the tropical Pacific, which are an important precursor of La Niña, are successfully captured only when Argo data are assimilated. This would be expected to lead to improved ENSO predictions.

Time series of heat content and sea level have been analysed. In the north Atlantic the earlier CTD-based results are consistent with the Argo data, giving increased confidence in the historical estimates. Furthermore, the Labrador Sea and Mediterranean outflow waters have been monitored, with a substantial reduction in errors since the availability of Argo data. This analysis shows decadal changes in the potential vorticity of these two water masses. Whilst the Atlantic shows the largest heat content trend in the upper 2000m between 2003 and 2007, amounting to 2.0±0.4 Wm^{-2}, the Indian ocean also has a significant positive trend of 0.87±0.4 Wm^{-2}, but the Pacific has no significant trend over this period. The trend in global 2000m heat content of 0.84±0.2 Wm^{-2} is also reflected in a trend of 1.2±0.2 mm/year in steric sea level. New estimations over 2005-2010 have been recently derived (Von Schuckmann et al., 2009, Von Schuckmann and Le Traon, 2011). They suggest smaller steric sea level (~0.7 mm/year) and heat content trends (~0.6 Wm^{-2}).

A reconstruction of ocean circulation with the baroclinic component deduced from Argo floats data, combined, and a barotropic component deduced from Argo float horizontal displacement and satellite altimetry shows that both the mean and inter-annual variations of the baroclinic meridional circulation are in very good agreement with model simulations.

The new PROVBIO floats and concurrent SeaWifs Ocean color surface chlorophyll observations highlight important differences in physical biological interactions between the east and west Mediterranean.

The sea level budget using Grace, altimeter and Argo data suggests that land ice loss is the dominant factor in recent sea level rise. However, signal to noise ratios are low, and continued monitoring is required.

Work at the University of Lisbon have analysed Argo and altimeter data to provide the first observational evidence of a cyclonic circulation driven by the Mediterranean outflow, in agreement with model simulations. A comparison of Argo and World Ocean Atlas (WOA) observations in the north-east Atlantic, show an increase in both temperature and salinity in Argo relative to WOA.

Work at the KDM: Argo data show the relationship between temperature and salinity in the Nino 3 and 4 regions, demonstrating that observations are consistent with the expected influence of El Nino on the Walker circulation.

Work at IEO: Argo data shows significant inter-annual temperature and salinity variability at 24.5ºN in the north Atlantic. Investigation of the Meridional Overturning Circulation at 24 and 36N in the North Atlantic, shows that 1) time-averaged transport estimates derived from Argo have significant less eddy noise than individual hydrographic sections, 2) Argo drift velocities provide significant information to the inverse solution for the ocean interior, and 3) comparison of the total integrated interior mass transports in the thermocline waters for the period 2003-2007 with the previous estimates based on trans-ocean hydrographic sections shows that the Meridional Overturning Circulation has not significantly changed since 1957.

Work at IMR: has investigated the inter-annual variability of the spring bloom and mixed layer depth in the Nordic Seas from Argo data. Such information is likely to be important for the fisheries industry. Large-scale deep cyclonic circulation is observed in the Lofoten Basin, thereby demonstrating the use of Argo for improved monitoring and understanding of ocean circulation.

Work at MI: has demonstrated the use of Argo data for monitoring the skill of operational forecasts of the north-east Atlantic ocean on daily timescales.

Work at OGS has demonstrated that assimilation of Argo float data into the Mediterranean Forecasting System significantly improves the forecast skill.

WP6: Strengthening the user community

Task 6.1 – Set up and run a European Argo User Group

Three Euro-Argo user group scientific meetings have been held with the aims of improving information flow among the group and thus assisting in problem solving (technical, scientific or data). A further objective is to enable the European Argo community to play a stronger role in international Argo programme.

The first Euro Argo User Group meeting took place at Southampton in June 2008, with invited talks, posters, submitted talks and round-table discussions. It was attended by 63 scientists from 9 countries. The second took place in June 2009 in Trieste, Italy and attended by 49 scientists from 10 countries. The Trieste workshop was supplemented by a training day for new Argo data users. The third workshop was held over 2 days in June 2010 at the Institute Océanographique in Paris. It was attended by 63 scientists from 15 countries.

A Euro-Argo Users mailing list has been established.

Euro Argo member countries have been encouraged to discover Argo data users previously unknown to the main partners. In the UK this has revealed a total of 50 individuals and/or projects. France has also been running workshop for its users to inform them on Argo data processing and QC issues.

Capacity building, training-new EC and non-EC countries

A priority target has been to contribute to implement Argo in the Black Sea. A EuroArgo Black Sea meeting was organized in Varna (Bulgaria) in December 2009, including a full day of talks and discussions, and one day onboard R/V Akademik to deploy the first EuroArgo float (a Provor kindly donated by France) in the south-western Black Sea. Representatives from Turkey, Bulgaria, Romania, Ukraine, Russia, the Black Sea Commission, took part in these activities.

In addition, OGS has been continuously promoting Euro-Argo and encouraging participation in several Eastern Mediterranean countries, such as Cyprus and Israel. Two Argo floats were deployed in the Eastern Mediterranean in December 2009 with the help of oceanographers from Cyprus.

OGS organized and hosted a Euro-Argo information and training day on 18 June 2009 in Trieste, just after the 2nd Euro-Argo Users Workshop, attended by more than 20 people from Italy, Slovenia, Spain, UK, Germany and France.

Education and outreach

An educational website has been designed and published, with the aim to make Argo and its data accessible to a non-specialist audience. The site is centred on a selection of floats, which have been chosen because of the insight they provide into key oceanographic processes, the physical characteristics of different regions around the world, and the role of the ocean in the global climate system.

The link: http://www.euro-argo.eu/Outreach/Educational-Web-Site

The eight sections of the site cover the main aspects of the Argo programme, its history and applications, provide basic technical information and data access, and give brief overview of the national Argo programmes run by the Euro-Argo partners. Lower level pages provide more detailed technical information and background information on physical oceanography and the role of the ocean in the climate system.

In addition, a Euro-Argo brochure has been printed, which is used to inform on the infrastructure, and to communicate its objectives to different audiences. It has been distributed during several events (scientific conferences and other meetings).

A DVD presenting Euro-Argo has also been realised.

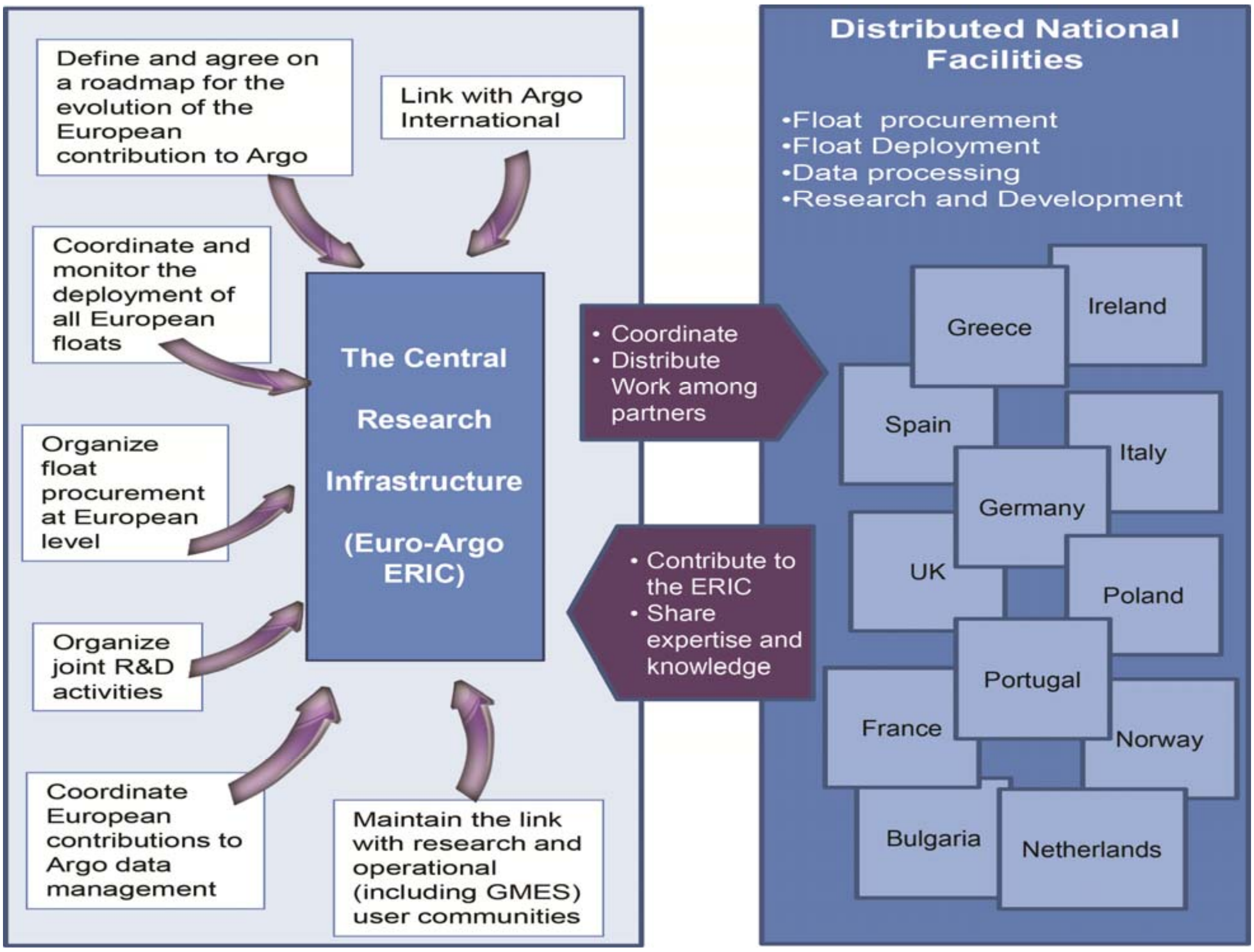
See page § 4.1.5 - page 34.

WP7: Final recommendation for the implementation of Euro-Argo

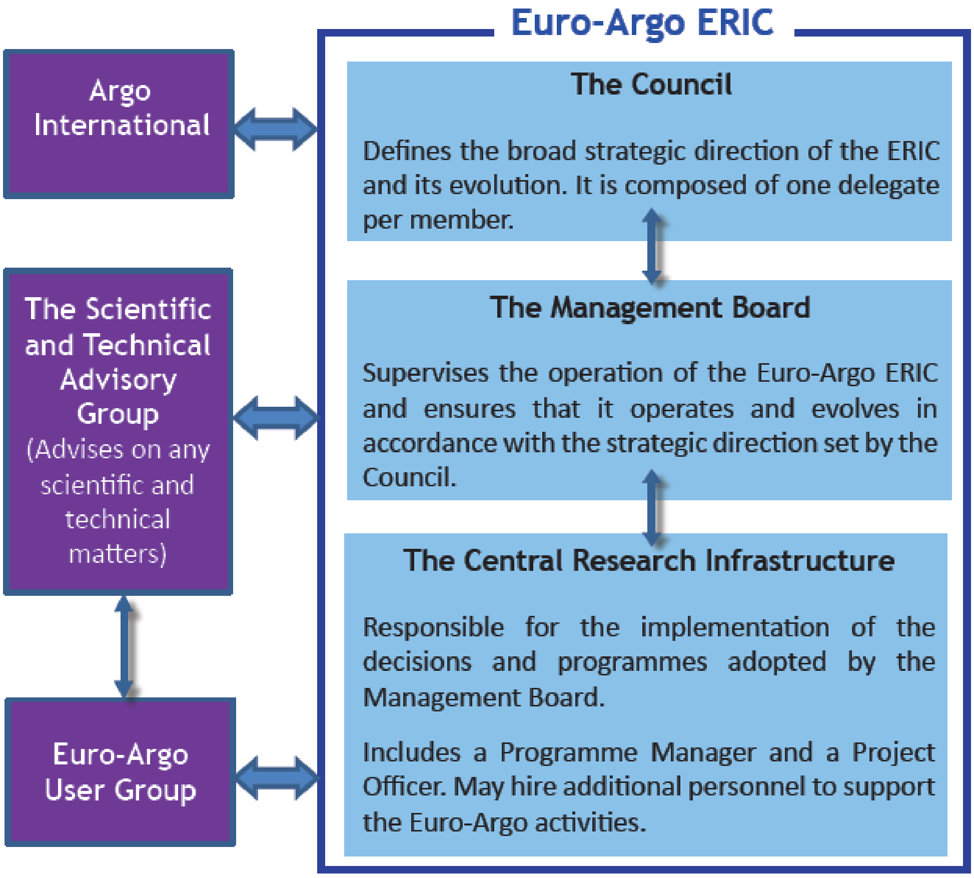
This work package follows up on WP2 activities, which have concluded on the appropriate legal structure and on the governance for Euro Argo. The legal framework of an ERIC, whose definition was being finalized by the EC during the time frame of the project, has been adopted by all Euro Argo partners.

Accordingly, several key documents have been drafted and circulated to the member states for approval. They include the proposed ERIC Statutes, the Technical and Scientific Description of the Euro Argo infrastructure, the Internal Working Procedures and the Ifremer proposal to host the Euro-Argo ERIC.

The Euro-Argo Research Infrastructure (RI) will include a central facility (Central RI) and distributed national facilities (with coordination via the central RI). The Central RI will be a European legal entity (i.e. the Euro-Argo ERIC). The floats will be procured through the C-RI and through national facilities. The central RI will provide the overall coordination for the programme and will organize and distribute the work in the national facilities (see figure below). It will host the Programme Manager and the Project Office.



The ERIC governance structure (Council, Management Board, Scientific and Technical Advisory Group, Programme Manager and Project Officer) is as described in WP2 (see figure below).



The planned members of the ERIC are Germany, United Kingdom, France, Italy, Netherlands, Bulgaria, Spain, Greece and Norway (to be confirmed). The observers are Ireland, Poland, and Portugal. The hosting institution for the Euro-Argo ERIC is France (Ifremer, Brest) for the first 5 years.

Since the very concept of an ERIC is a new one, it will undoubtedly take some time to reach the full capacity and organization. We anticipate three stages from the end of the Preparatory Phase: a short transition of a few months during 2011, pending formal signature and approval from all the Members; a ramping up period of consolidation during 2012 and 2013 with funding mostly from the Members (Euro-Argo ERIC Phase 1), and a full operation from 2014 (Euro-Argo Phase 2) when funding from the EU (GMES) will bring operations to the expected level of some 250 floats deployed every year:

- <u>Euro-Argo ERIC –Phase 1 (January 2012-January 2014) (ramping up period).</u> This period will start after the signature of the ERIC agreement by all parties, expected to take place during 2011. Initially, the number of floats to be handled, deployed and processed will not be much greater than what is handled by the national facilities. The need for specific logistical support at the ERIC is therefore not significant. The main activity is that of a Programme Office and coordination, including continuing efforts to develop and secure funding from the EU. The total budget is estimated to 270 Keuros/an. This will come from the agreed contributions from Euro-Argo ERIC members (30 keuros/year) and observers (10 keuros/year).

- Euro-Argo ERIC Phase 2 (2014 and beyond) (full operation). It is expected that during that period, the funding from the EU (GMES or other sources) will increase very significantly the number of floats to be deployed, and, correspondingly, so will the requirements for support personnel and technical facilities in the central RI. This additional funding from the EU (either FP7/FP8 or direct GMES funding) will contribute significantly to the EA ERIC, allowing it to reach its full objectives of deploying 200 floats per year in support of the global Argo array plus an additional 50 floats per year for enhanced coverage in the seas in and around Europe. This operation would include the procurement, testing, and deployment of some 50 - 100 floats per year, with associated data management and quality control, and other scientific activities. At that point, the ERIC will reach its full capacity with up to 4 to 5 full time positions (funded by the Members and by the EU). Part of the EU funding would also be devoted to ship time, support to International Argo, funding for the data system to be redistributed to those members engaged in data management activities.

The ERIC being a new concept for all concerned, many discussions have been held in each partner country with the appropriate authorities (Ministries and Agencies), and between the Coordinator and the Commission to ascertain that all agree on the plans developed in the course of the project. As the coordinator, Ifremer has submitted the application to the relevant government services (*Ministère de l'Enseignement et de la Recherche, Ministère du Budget, Secrétariat aux Affaires Européennes*), for whom the ERIC was also a novel concept. Several meetings have been held to clear all hurdles, and prepare the file for submission to the Commission.

The French government recently agreed to recognize the ERIC framework and validated the Euro-Argo ERIC application. The French ministry of research will officially send the Euro-Argo ERIC application to the European Commission on behalf of all future members. Unfortunately, it has not been possible to obtain formal ministerial agreement for a few countries. Every effort will be made to reach overall agreement before the end of 2011, so that the ERIC can be formally established with its full list of members in the beginning of 2012.

In order to pursue the activities of the Euro-Argo consortium, as described in the Technical and Scientific Description and to coordinate and follow up on the process leading to the formal creation of the E-A ERIC a transition phase is necessary. The partners will make this link between the end of the preparatory phase of the Euro-Argo project and the creation of the Euro-Argo ERIC through the implementation of a Transition Phase. For that issue, partners have signed a consortium agreement maintaining the Euro-Argo coordination for the next 6 months, from 1st July to December 2011, until the implementation of the ERIC in early 2012.

4.1.4 Potential impact (including the socio-economic impact and the wider societal implications of the project so far) and the main dissemination activities and exploitation of results (not exceeding 10 pages).

Toward a sustained contribution of Europe to Argo

The international Argo project is a presently at a critical juncture where strategic decisions have to be taken. The observatory has been developed progressively over the years on a best effort basis, in a very mixed context of mostly research funds, with rather limited sustained operational funding. Now that the array has reached its nominal size of 3000 floats in operation, that data centres are effectively collecting and distributing high quality data, and that the project has demonstrated its ability to detect critical ocean processes, the main challenge is to transition to a permanent infrastructure for ocean and climate research and monitoring.

Monitoring of the global climate system requires long term, high quality time observations. The critical question is to transition from a research project to a sustained, long term, observing system. Research projects have a relatively short time span, and are strongly dependent on the individual scientists who conduct them. A permanent observatory must have the proper organizational back-up, funding basis, and institutional framework to operate independently of the individuals involved.

In order to optimise the investment and to operate the infrastructure most efficiently, a high degree of integration is necessary. The project has succeeded in establishing a Research infrastructure in which agencies from twelve countries will coordinate their efforts and resources to contribute effectively to the Argo programme. They share a vision for the strategic and tactical choices that must be made. Finally, a continuous feedback with the scientific community has been initiated with the creation of the User Group, so that science users can express their requirements with respect to the observing array design.

Argo is an ambitious project that is breaking new ground in the widespread deployment of low cost autonomous instruments in hostile environments. Technology development in a European context will be a specific beneficiary of the results of the project.

Specifically, the emphasis on building and sustaining the array in a cost-effective manner places particular emphasis on monitoring the performance of all European deployed instruments and hence learning how to diagnose incipient float failure and using this to improve float design. The effort to increase the effectiveness and throughput of delayed mode data quality control will have significant benefit in learning how sensors perform and degrade following long exposure to bio-fouling and pressure/temperature cycling.

The formation of a Euro-Argo users group provides an effective forum for the discussion of these issues between users and between users and float and sensor manufacturers. Since one of the commercial float manufacturers is European, this information could provide a competitive advantage.

Finally, Euro-Argo provides encouragement for the participation of new and small European nations in the use of the float technology and in the use of Argo data.

Specific benefits from building a long-term European infrastructure for Argo

The specific benefits from building a European infrastructure for Argo are expected to include:

- Greater efficiency in float procurement as the smaller countries will be able to rely on Euro-Argo for specifying their floats, procuring their floats and potentially benefit from price reductions associated with larger orders.
- Euro-Argo will provide a central capability for float testing and preparation and storage which will mean that new participants do not have to invest in technical staff or storage facilities.
- Stronger European coordination of float deployments will ensure that certain areas are not overpopulated at the expense of others or the global array.
- Strengthening the European Argo data processing centres.
- Providing a mechanism for developing consistent inputs and a more concerted European voice into the international Argo programme, hence giving a stronger European influence on how Argo develops in the future.
- Euro-Argo will deliver a stronger and more coherent European contribution to float technology development, with particular emphasis on European needs leading to improved capability, performance and lifetime.
- Through Euro-Argo it will be possible to sustain and build upon the European Argo Users' Group established during the Preparatory Phase in order to ensure that users' needs are articulated and that the best scientific and technical advice continues to feed into Euro-Argo.
- It will also provide the means to sustain important outreach activities needed to explain to schoolchildren and the general public the importance of observations from the oceans towards dealing with climate change and other environmental issues.
- Euro-Argo will play a leading role in extending float coverage into the Nordic Seas and Arctic Ocean, regions which are presently outside of the 'core' Argo design but which have a significant impact on the Atlantic circulation and climate change impacting western Europe.
- A stronger European contribution to Argo will also be a major contribution towards sustaining the global float array, which has been shown to be an essential core element of our ability to run predictive climate models (e.g. on seasonal to decadal timescales) and to run operational models (e.g. for the GMES Marine Service) for ocean analysis and prediction.

The collection of ocean observation from research vessels is accessible only to a few major Marine Institutes which have the ability to organise and conduct research cruises. Systematic in-situ global ocean observations are presently available only through the Argo array. There is no doubt that the Euro-Argo research infrastructure will greatly contribute to foster active research programmes in Europe in the fields it aims to serve : ocean science in general, and more particularly the role of the ocean in the global climate system. By providing adequate networking and cooperation between member states, it will contribute to the development of Europe excellence in ocean and climate research. The open policy on data access, which is easily and freely available, is aimed to facilitate the development of vigorous and successful research by a wide ocean scientific community in Europe.

GMES and the Marine Service

Argo is the single most important in-situ observing system for the GMES Marine Service and its MyOcean project. Based on the combination of space and in situ observations and on data assimilation, MyOcean provides information on the ocean for the large scale (worldwide coverage) and regional scales (main European basins and seas): temperature, salinity, currents, ice extent, sea level, primary ecosystems.

The targeted applications belong to four main areas:

- Marine safety (e.g. marine operations, oil spill combat, ship routing, search & rescue);
- Marine resources management (e.g. fish stock management);
- Climate and seasonal forecasting (e.g. climate change monitoring, ice seasonal forecasting);
- Marine and coastal environment (e.g. water quality, coastal activities).

Argo delivers critical data (especially over the vertical dimension of the oceans) for assimilation in MyOcean ocean models. Without Argo and a strong European contribution to Argo, MyOcean modelling and assimilation systems will thus not be sufficiently constrained and will not be able to serve several key applications.

The UNFCCC and the Global Earth Observation System of Systems

The Euro-Argo project can be seen as one of the actions that the European Union and participating Member States are taking to fulfil their obligations under several Conventions and international treaties.

The European Union is a signatory to the United Nations Framework Convention on Climate Change (UNFCCC), which includes (Article 4) a Commitment to:

- “Promote and cooperate in scientific, technological, technical, socio-economic and other research, systematic observation and development of data archives related to the climate
- system and intended to further the understanding and to reduce or eliminate the remaining
- uncertainties regarding the causes, effects, magnitude and timing of climate change and the
- economic and social consequences of various response strategies;
- Promote and cooperate in the full, open and prompt exchange of relevant
- scientific, technological, technical, socio-economic and legal information related to the climate
- system and climate change, and to the economic and social consequences of various response
- strategies;
- Promote and cooperate in education, training and public awareness related to
- climate change and encourage the widest participation in this process, including that of
- non-governmental organizations;

Its Article 5 is fully devoted to **Research and Systematic Observation**.

All of those commitments underpin the Euro-Argo terms of reference and have been included ab initio in its design, data policy and data system architecture, as well as in several actions initiated under the Euro-Argo Preparatory Phase Project.

Similarly, the Group on Earth Observations (GEO) was launched in response to calls for action by the 2002 World Summit on Sustainable Development and by the G8 (Group of Eight), and in the spirit of the UNFCCC. These high-level meetings recognized that international collaboration is essential for exploiting the growing potential of Earth observations to support decision making in an increasingly complex and environmentally stressed world.

GEO is a voluntary partnership of governments and international organizations. It provides a framework within which these partners can develop new projects and coordinate their strategies and investments. As of March 2011, GEO's Members include 86 Governments and the European Commission. GEO is constructing GEOSS on the basis of a 10-Year Implementation Plan for the period 2005 to 2015. The Plan defines a vision statement for GEOSS, its purpose and scope, expected benefits, and the nine "Societal Benefit Areas" of disasters, health, energy, climate, water, weather, ecosystems, agriculture and biodiversity.

In this somewhat complex architecture of System of Systems is the Global Climate Observing System and its ocean component, the Global Ocean Observing System (GOOS), all of which have strongly endorsed Argo as a high priority programme. Indeed, one can readily see how Argo fits into a vision that will go towards meeting several of the societal benefit areas :

- Reducing loss of life and property from natural and human-induced disasters, through applications of the GMES Marine Core Services (e.g. ocean surface conditions for hurricane prediction);
- Improving the management of energy resources, ocean knowledge necessary for off-shore operations such as deep sea oil, or wind turbines;
- Understanding, assessing, predicting, mitigating, and adapting to climate variability and change, where ocean observations are indispensable;
- Improving water resource management through better understanding of the water cycle, upper ocean knowledge for understanding air sea interaction and the evaporation / precipitation balance (e.g. monsoons)
- Improving weather information, forecasting and warning, obvious need for ocean data;
- Improving the management and protection of terrestrial, coastal and marine ecosystems,
- Understanding, monitoring and conserving biodiversity, including ocean biodiversity (e.g. impact of ocean acidification).

<u>Other international conventions or directives, the European Marine Strategy</u>

There are numerous international conventions covering the marine environment, all of which call for the implementation of ocean monitoring systems and strong research programmes. For instance, the OSPAR Convention is the current legal instrument guiding international cooperation on the protection of the marine environment of the North-East Atlantic (the European Commission, representing the European Union, is among the participants). The Convention includes a strategy for the Joint Assessment and Monitoring Programme, which assesses the status of the marine environment and follows up implementation of the strategies and the resulting benefits to the marine environment. Although this is not a separate Strategy, the OSPAR Commission has also considered the relevance of climate change issues in a wider context.

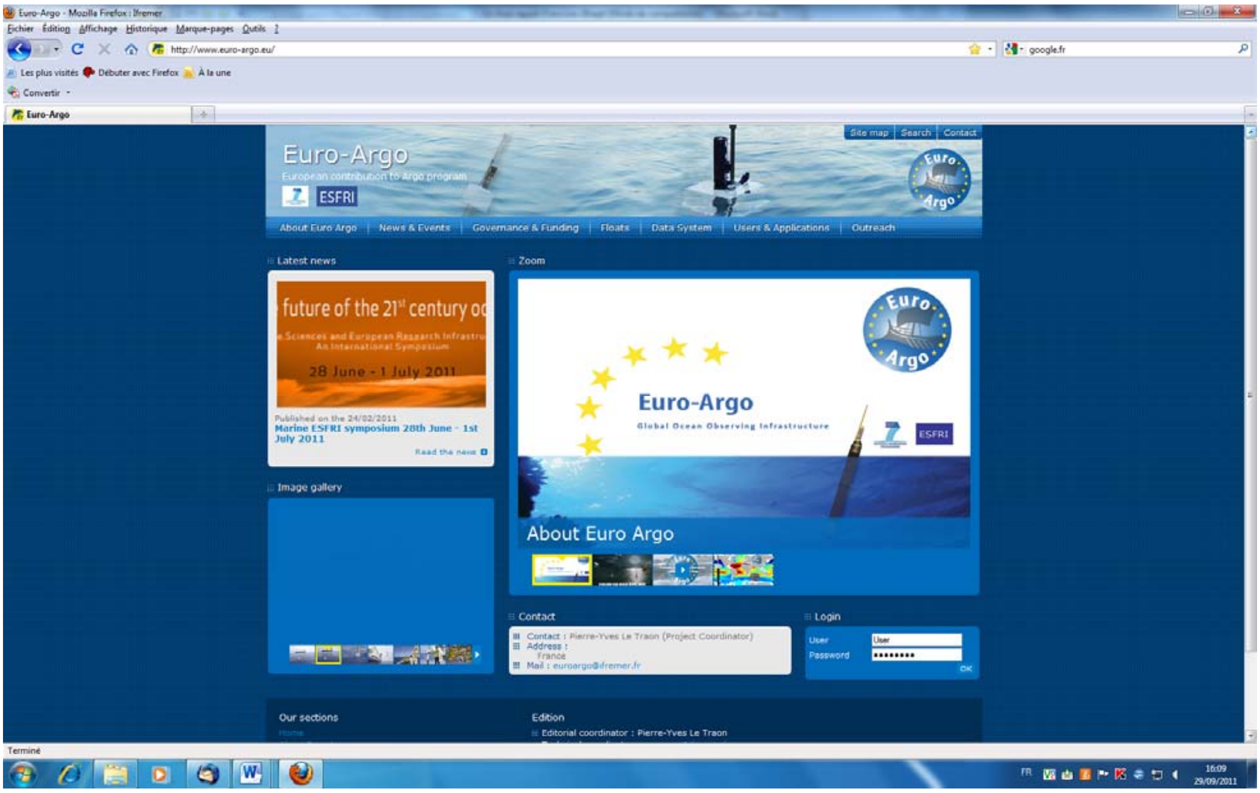
Another example is the European Union's ambitious Marine Strategy Framework Directive (adopted in June 2008) to protect more effectively the marine environment across Europe. It aims “to achieve good environmental status of the EU's marine waters by 2020 and to protect the resource base upon which marine-related economic and social activities depend. The Marine Strategy Framework Directive constitutes the vital environmental component of the Union's future maritime policy, designed to achieve the full economic potential of oceans and seas in harmony with the marine environment.”

The main dissemination activities

The main tool for the dissemination and exchange of information among project partners and other interested parts is the Euro-Argo website: **www.euro-argo.eu**.

The other dissemination activities are described above in the task 6.3 (poster, brochure and movie).

4.1.5 The address of the project public website, if applicable as well as relevant contact details. Furthermore, project logo, diagrams or photographs illustrating and promoting the work of the project (including videos, etc…), as well as the list of all beneficiaries with the corresponding contact names can be submitted without any restriction.



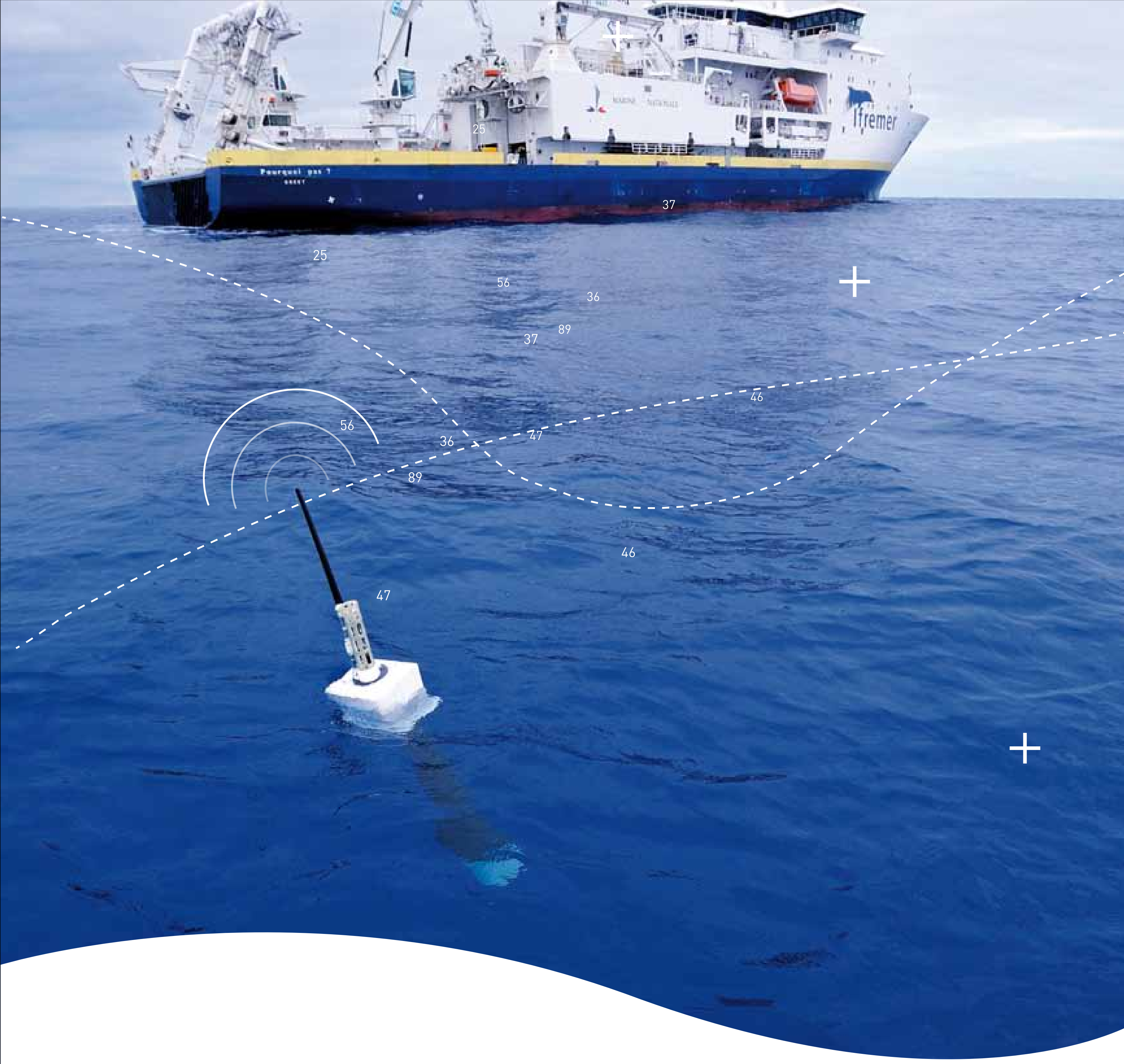
The Euro-Argo public website has been designed and published with the aim to make the Euro-Argo preparatory phase project information available to all interested people.

The link: http://www.euro-argo.eu/.

Relevant contact: euroargo@ifremer.fr

Project logo:

See the Brochure and the Poster here after

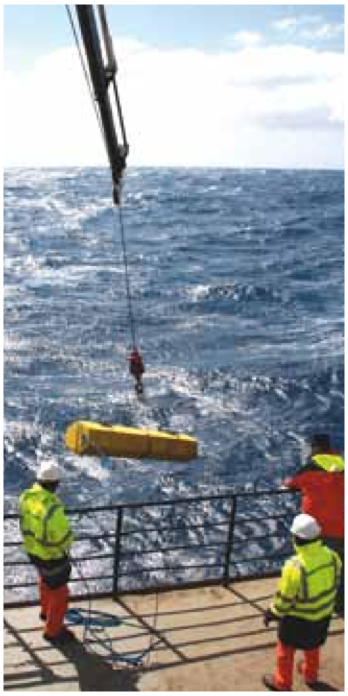


EURO-ARGO
Research Infrastructure

THE EUROPEAN CONTRIBUTION TO THE INTERNATIONAL ARGO PROGRAM

A new Research Infrastructure for Observing the Oceans

ESFRI



Acting to face up to climate change

Climate change is one of the most pressing issues of our century. The oceans have a fundamental influence on our climate and weather. They store, transport and exchange with the atmosphere large amounts of heat, water and gases. These exchanges affect dramatically global and regional climates on time scales ranging from days to centuries.

Long term high quality global ocean observations are needed to understand the role of the ocean on the earth's climate and to predict the evolution of our weather and climate.

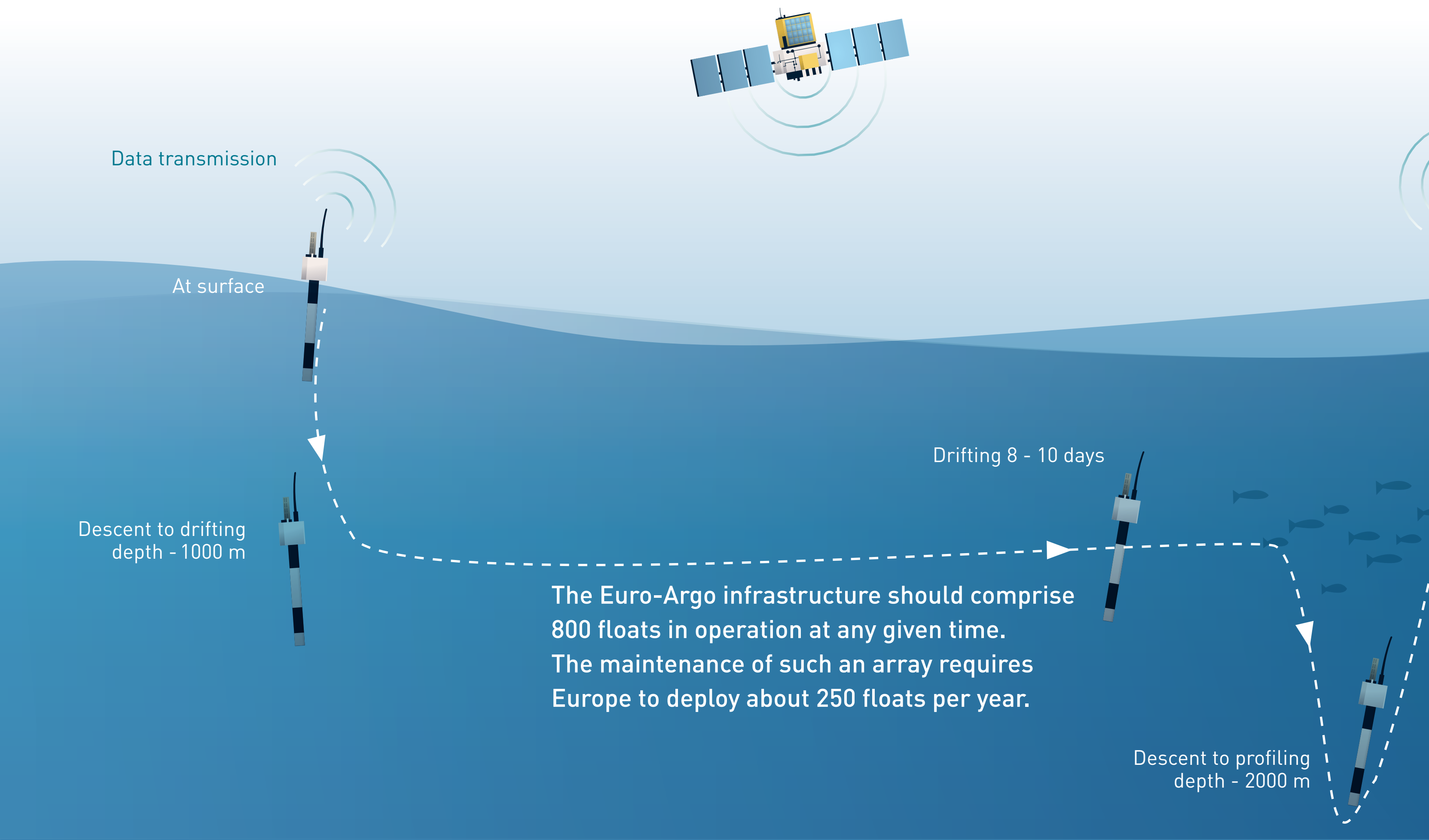
Deploy floats to observe the global ocean

In November 2007, the international Argo programme reached its initial target of 3,000 profiling floats. These floats measure every 10 days temperature and salinity throughout the deep global oceans, down to 2,000 metres and deliver data both in real time for operational users and after careful scientific quality control for climate change research and monitoring. Argo is widely recognized as a revolutionary achievement in ocean observation.

The main challenges for Argo

The international Argo programme has defined as a first priority the maintenance of the global array of 3000 floats over the next 20 years. The enormous scientific potential of Argo is directly related to this long term global coverage. This is extremely challenging. Profiling floats have potential for additional measurements (e.g. under ice, biochemical observations). European researchers have been at the forefront of some of these developments and the work is still on going to adapt new sensor packages.

Technical evolutions for constantly improving reliability, lifetime, energy savings, costs and easy deployment are also necessary to maintain the Argo array on the long term.



The Euro-Argo Research Infrastructure

Role

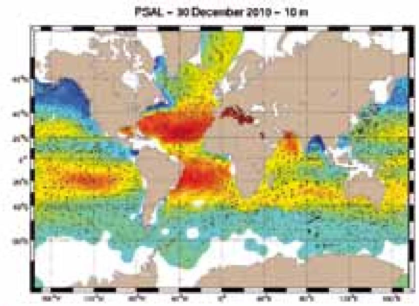
The Euro-Argo research infrastructure (RI) federates and optimizes European contributions to Argo. This leads to improved efficiency in all implementation aspects: float procurement, operation at sea, array monitoring and evolution, technological and scientific developments, improving data access for research and operational oceanography users, coordination of the European contribution to the international management of the Argo programme.

Organisation

The Euro-Argo RI includes a central facility (Central RI) and distributed national facilities. The floats are procured through the Central-RI and through national facilities. The central RI provides the overall coordination for the programme and organises and distributes the work in the national facilities.
The Central RI will be a European legal entity: Euro-Argo ERIC (European Research Infrastructure Consortium).

Link with the GMES Marine Core Service

Euro-Argo is the single most important in-situ observing infrastructure for the GMES (Global Monitoring for Environment and Security) Marine Core Service. It delivers critical data (especially over the vertical dimension of the oceans) that are strongly complementary to satellite observations for assimilation in ocean analysis and forecasting models.

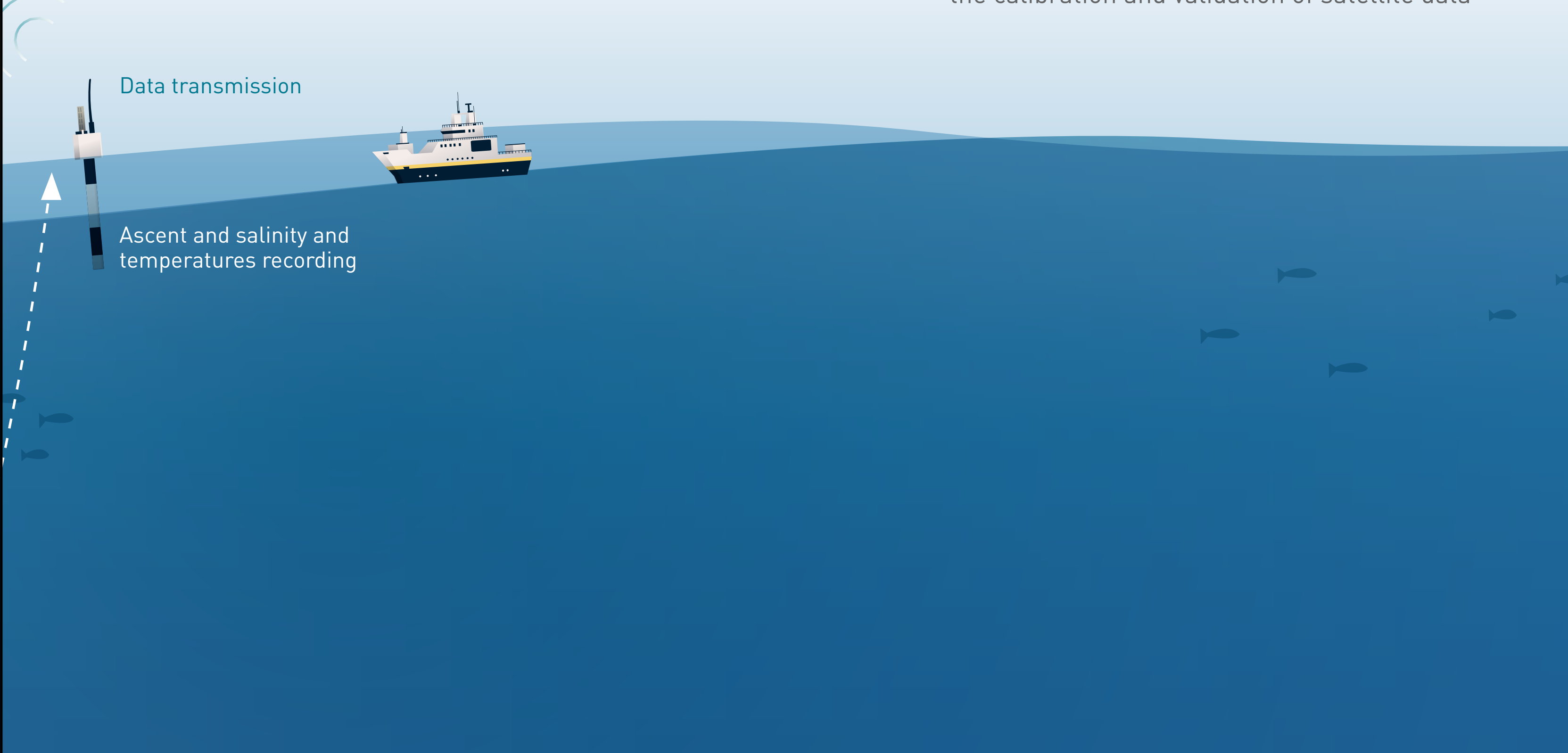


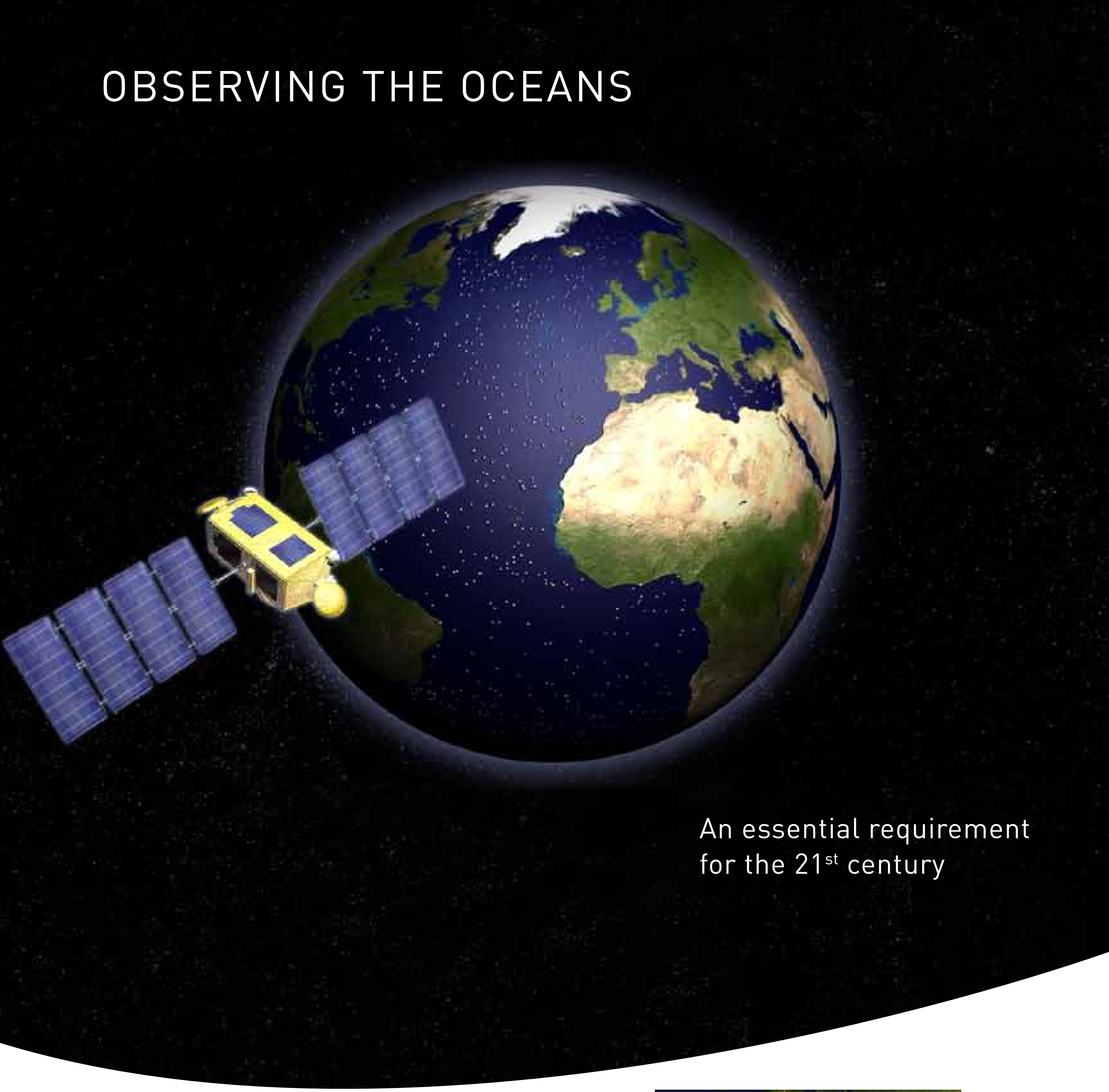
Salinity gridded map from one month of Corolis data

Why do we need Argo and Euro-Argo?

Argo aims to establish a long-term global array of in situ measurements integrated with other elements of the climate observing system (in particular satellite observations) to:

- Detect climate variability from seasonal to decadal scales and provide long-term observations of climate change in the oceans. This includes regional and global changes in temperature and ocean heat content, salinity and freshwater content, sea level and large scale ocean circulation.
- Provide data to constrain global and regional ocean analysis and forecasting models, to initialize seasonal and decadal forecasting coupled ocean-atmosphere models and to validate climate models.
- Provide information necessary for the calibration and validation of satellite data




OBSERVING THE OCEANS
An essential requirement
for the 21st century

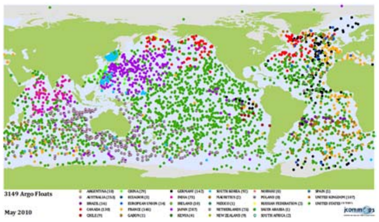
Euro-Argo: A new European Research Infrastructure

European contribution to a global ocean observatory

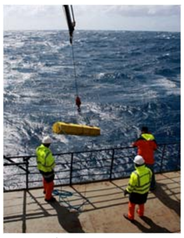
E. Mamaca, P.Y. Le Traon, Ifremer, Brest, France

Argo, a global ocean observing system for the 21st century

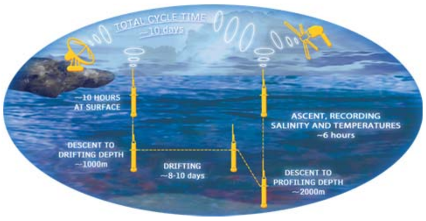
The science of climate change is one of the most pressing issues of our century. Understanding and prediction of changes in the atmosphere and ocean are needed to guide international actions and government's policies. This requires global data sets of the highest quality.



Active Argo floats by country



Argo float deployment



An Argo float mission cycle

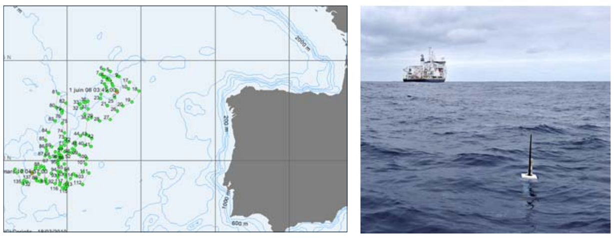
In 2007, the international Argo programme reached its initial target of 3,000 profiling floats. These floats measure temperature and salinity down to 2,000 metres and deliver data in real time. This is the first-ever global, in-situ ocean observing network in the history of oceanography, providing an essential complement to satellite systems.

The Euro-Argo research infrastructure

Maintaining the array's size and global coverage in the coming decades is the next challenge for Argo. Euro-Argo will consolidate the European component of the global network. Specific European interests also require increased sampling in regional seas. Overall, the Euro-Argo infrastructure should comprise 800 floats in operation at any given time. The maintenance of such an array would require Europe to deploy about 250 floats per year.

The Euro-Argo research infrastructure will strengthen European excellence and expertise in climate research and will establish a high level of cooperation between partners in all implementation aspects:

- operation at sea,
- array monitoring and evolution,
- technological and scientific developments,
- improving data access for research and operational oceanography (GMES),
- link to the international management of the Argo programme.



A European Argo float still active after 4 years of operation

The Euro-Argo Preparatory Phase (Jan. 2008 – June 2011)

As a new European research infrastructure, Euro-Argo started a preparatory phase funded through the EU 7th Framework Research Programme.

Its objective is to undertake the work needed to ensure that Europe will be able to deploy and operate an array of 800 floats on the long term and to provide a world classe service to the research and operational oceanography communities.

Its expected outcome is an agreement for long term (10-20 years) operation of Euro-Argo.

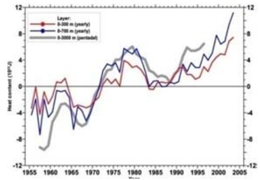
The Euro-Argo preparatory phase is coordinated by Ifremer, France.

The consortium comprises 15 organisations from 12 European countries (France, Germany, United Kingdom, Netherlands, Spain, Italy, Ireland, Norway, Portugal, Greece, Poland, Bulgaria).

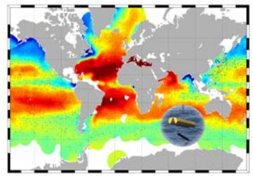
Dual use: Research and Operational Oceanography

The science case: Climate change and global warming

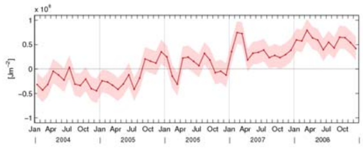
The oceans have a fundamental influence on our climate and weather, both of which are affected by changes in the currents and heat content of the ocean. Argo is a unique system to monitor heat and salt transport and storage, ocean circulation and global overturning changes and to understand the ability of the ocean to absorb excess CO_2 from the atmosphere.



Over the past 50 years, the oceans have absorbed more than 80% of the Earth warming due to the anthropogenic increase of greenhouse gas concentration.

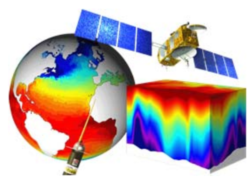


Argo observations allow us to monitor the large scale temperature and salinity variations (here the salinity at 10 m).



Global ocean heat content changes derived from Argo data during 2004-2008.

Operational Oceanography and the GMES Marine Core Service



Argo is the single most important in-situ observing system required for the GMES Marine Core Service (MCS). Argo and satellite data are assimilated into MCS models used to deliver regular and systematic reference information on the state of the ocean for the global ocean and the main European seas.

The Euro-Argo Long Term Research Infrastructure

As part of the Euro-Argo Preparatory Phase, the future long-term structure for Euro-Argo has been agreed by all partners. It will allow us :

- To supervise operation of the infrastructure and ensure that it evolves in accordance with the requirements set forth by the research and operational communities.
- To coordinate and supervise float deployment to ensure that Argo and Euro-Argo objectives are fulfilled.
- To organize float procurement at European level.
- To monitor the operation of the infrastructure and to maintain the links with research and GMES user communities.
- To decide on the evolution of the Euro-Argo infrastructure.
- To share expertise on all scientific/technological developments and use of Argo.
- To conduct R&D activities at European level.
- To fund and link with the international Argo structure.

The Euro-Argo Research Infrastructure (RI) will include a central facility (Central RI) and distributed national facilities. The floats will be procured through the C-RI and through national facilities. The central RI will provide the overall coordination for the programme and will organize and distribute the work in the national facilities. The Central RI will be a European legal entity: Euro-Argo ERIC (European Research Infrastructure Consortium).

The statutes of the Euro-Argo ERIC and its technical & scientific description have been validated at institute level. The members are Germany, UK, France, Italy, Netherlands, Bulgaria, Spain and Greece. The observers are Ireland, Poland, and Portugal. The hosting institution for the Euro-Argo ERIC is Ifremer (France) for the first 5 years.

The Euro-Argo ERIC application is expected to be validated at ministerial and European Commission levels by the end of 2011.

http://www.euro-argo.eu/

Contact : euroargo@ifremer.fr

Ifremer
INSTITUTE OF MARINE RESEARCH
HAVFORSKNINGSINSTITUTTET
Met Office
NATURAL ENVIRONMENT RESEARCH COUNCIL
KNMI
OGS
INSTITUTO ESPAÑOL DE OCEANOGRAFÍA
Marine Institute
FACULDADE DE CIÊNCIAS UNIVERSIDADE DE LISBOA
H.C.M.R.

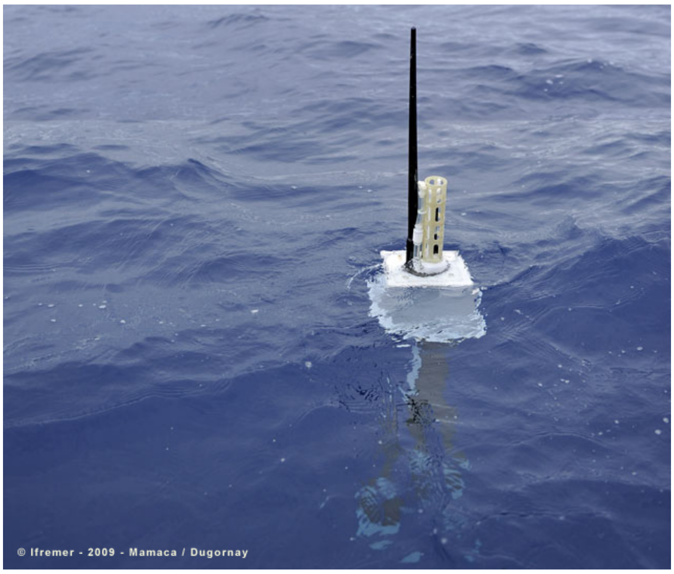
Video link: http://www.euro-argo.eu/

Euro-Argo movie in English. A DVD presenting Euro-Argo has also been realised and distributed.

Photos:

Arvor deployment

Arvor deployed



Arvor at sea

Arvor technology

Arvor with Irridium antenna

List of all beneficiaries:

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4.2 Use and dissemination of foreground

Section A (public) - *This section describes the dissemination measures, including any scientific publications relating to foreground.* ***Its content will be made available in the public domain*** *thus demonstrating the added-value and positive impact of the project on the European Union.*

TEMPLATE A1: LIST OF SCIENTIFIC (PEER REVIEWED) PUBLICATIONS, STARTING WITH THE MOST IMPORTANT ONES										
N°	*Title*	*Main author*	*Title of the periodical or the series*	*Number, date or frequency*	*Publisher*	*Place of publication*	*Year of publi cation*	*Relevant pages*	*Permanent identifiers[4] (if available)*	*Is/Will open access[5] provided to this publicat°?*
1	Mid-depth circulation of the eastern tropical South Pacific and its link to the oxygen minimum zone	Czeschel R., KDM	Journal of Geophysical Research				2010	116, C01015		no
2	Seasonal to inter-annual variability of temperature and salinity in the Greenland Seas Gyre: heat and freshwater budgets	Latarius K,. KDM	Tellus 62A				2010		DOI: 10.1111/j.1600-0870.2010.00444.x	no
3	The middepthcirculation of the Nordic Seas derived from profiling float observations	Voet G., KDM	Tellus 62A				2010		DOI: 10.1111/j.1600-0870.2010.00444.x	No
4	Monitoring der Grönlandsee-Hydrographie mit Hilfe autonomer prolierender Floats.	Manuela Köllner., KDM	Bachelor-Arbeit		Universität Hamburg,	Institut für Meereskunde	2010			no

[4] *A permanent identifier should be a persistent link to the published version full text if open access or abstract if article is pay per view) or to the final manuscript accepted for publication (link to article in repository).*

[5] *Open Access is defined as free of charge access for anyone via Internet. Please answer "yes" if the open access to the publication is already established and also if the embargo period for open access is not yet over but you intend to establish open access afterwards.*

5	Regional Heat and Freshwater Balances of the Oceanic Surface Mixed Layer derived from Argo Float and Air-Sea Flux Data	Antje Müller-Michaelis., KDM	Diploma thesis,		Universität Hamburg,	Institut für Meereskunde				no
6	South Equatorial Undercurrent in the western to central tropical Atlantic	Jürgen Fischer., KDM	Geophys. Res. Lett., 35, L21601				2008		doi: 101029/2008GL035753	no
7	Warming of deep and abyssal water masses along the Greenwich meridian on decadal time scales: The Weddell gyre as a heat buffer	Fahrbach E., KDM	Deep-Sea Research II		Elsevier		2011 (in press)			no
8	Variations of Winter Water properties and sea ice along the Greenwich meridian on decadal time scales	Fahrbach E., KDM	Deep-Sea Research II		Elsevier		2011 (sub mitted)			no
9	The mid-depth circulation of the Nordic Seas derived from profiling float observations	Voet, G., KNMI	Tellus - A	Vol. 62	The Internationa l Meteorolo-gical inst.	Stockholm	2010	pp. 516-529	http://onlinelibrary.wiley.com/doi/10.1111/j.1600-0870.2010.00444.x/abstract	yes
10	Climatic importance of large scale and mesoscale circulation in the Lofoten Basin deduced from lagrangian observations during ASOF	Gascard, J.C., KNMI	Arctic–Subarctic Ocean Fluxes	March 03, 2008	Springer Verlag	Netherland	2008	pp. 131-143	http://www.springerlink.com/content/w700682x338l6whp/	no
11	Changes in Temperature and Salinity Tendencies of the Upper Subtropical North Atlantic Ocean at 24.5°N	Vélez-Belchí P. & al. , I.E.O	J. Phys. Oceanogry	40, 2546–255			2010		doi: 10.1175/2010JPO4410.1	no
12	Using Argo data to investigate the Meridional Overturning Circulation in the North Atlantic	Hernández-Guerra & al. A., I.E.O	Deep Sea Research	57			2010	29–36		no

13	On the assessment of Argo float trajectory assimilation in the Mediterranean Forecasting System	P-M. Poulain & al., O.G.S	Ocean Dynamics DOI				*2011*	10.1007/s10 236-011-0437-0		no
14	Mediterranean intermediate circulation estimated from Argo data	M. Menna and P. M. Poulain., O.G.S	Ocean Sciences				2010	6, 331–343		no
15	Preliminary deployment of Grid-assisted oceanographic applications	M. Poulain, & al., O.G.S	Adv. Geosci.,				2010	28, 39–45		no
16	Remote oceanographic instrumentation integrated in a GRID environment. Computational Methods in Science and Technology	M. Poulain, & al., O.G.S	Computational Methods in Science and Technology				2009	15(1), 49-55		no
17	'Interannual variability in Sub-Arctic Intermediate Water of the Northeastern Atlantic'	I.M.R	*Not published yet*				*2011*			no
18	The mid-depth circulation of the Nordic Seas derived from profiling float observations	Voet G., & al., I.M.R	Tellus - A	Vol. 62	The Internationa l Meteorolo-gical inst.	Stockholm	2010	pp. 516-529	http://onlinelibrary.wiley.com/doi/10.1111/j.1600-0870.2010.00444.x/abstract	yes
19	Climatic importance of large scale and mesoscale circulation in the Lofoten Basin deduced from lagrangian observations during ASOF	Gascard, J.C., & al., I.M.R	Arctic–Subarctic Ocean Fluxes	March 03, 2008	Springer Verlag	Netherland	2008	pp. 131-143	http://www.springerlink.com/content/w700682x338l6whp/	no
20	Evidence of time-mean cyclonic cell southwest of Iberian Peninsula: The Mediterranean Outflow-driven b-plume	Luisa Lamas, FFCUL	Geophysical Research Letters	No 39, June 2010	American Geophysica l Union	United States	2010	2010L12606	*http://europa.agu.org/?view=article&uri=/journals/gl/gl1012/2010GL043339/2010GL043339.xml&t=Lamas*	no

21	Forecasting the Aegean Sea hydrodynamics within the POSEIDON-II operational system	Gerasimos K. K. HCMR	Journal of Operational Oceanography	Bi-annual		Vol. 3	2010	pp 37-49		no
22	Influence of the West Spitsbergen Current on the local climate	Waldemar Walczowski, IOPAS	International Journal of Climatology	No 31, 2011	Wiley-Blackewel	USA	2011			no
23	Warming of the West Spitsbergen Current and sea ice north of Svalbard	Jan Piechura, IOPAS	Oceanology	No 51(2)	Institute of Oceanology	Poland	2009	149-164		no

TEMPLATE A2: LIST OF DISSEMINATION ACTIVITIES

N°	*Type of activities*[6]	*Main leader*	*Title*	*Date*	*Place*	*Type of audience*[7]	*Size of audience*	*Countries addressed*
1	Popular press	Ifremer	Les espions des mers	Feb 2008	Sciences et découvertes Magazine, p75	Medias		France
2	Journal	Ifremer	Vers une contribution pérenne de l'Europe au réseau global Argo	Avril 2008	Journal du CNES, n° 37	all		France
3	Journal	Ifremer	Argo: a global ocean observing system for climate research and operational oceanography	Dec 2008	Argos Forum # 67, CLS Toulouse,	all		International
4	Workshop	Ifremer	Legal Framework for the Construction and Operation of new pan-European Research infrastructures	March 2008	Brussels, Belgium	Policy makers	25	European Countries

[6] A drop down list allows choosing the dissemination activity: publications, conferences, workshops, web, press releases, flyers, articles published in the popular press, videos, media bri14efings, presentations, exhibitions, thesis, interviews, films, TV clips, posters, Other.
[7] A drop down list allows choosing the type of public: Scientific Community (higher education, Research), Industry, Civil Society, Policy makers, Medias ('multiple choices' is possible

5	Workshop	Ifremer	Argo Science Team Meeting	17- 21 March 2008	Exeter, UK	Scientific community	40	International
6	Conference	Ifremer	EuroGOOS Conference	20-22 May 2008	Exeter, UK	Operational oceanography	500	European Countries
7	Workshop	Ifremer	1st Euro-Argo Users Meeting	24-25 June 2008	Southampton, UK	Scientific community	40	European Countries
8	Conference	Ifremer	GMES Forum	16-17 Sept 2008	GMES Forum, Lille, France	all	500	International
9	Conference	Ifremer	GODAE: 10 years of achievement - The revolution in global ocean forecasting	12-15 Nov 2008	Nice, France	Scientific community	500	International
10	Conference	Ifremer	European Conference on Research infrastructure (ECRI 5th)	Dec 9-10	Versailles, France	all	500	European Countries
11	Workshop	Ifremer	Legal Workshop - Exchange of Experience between Preparatory Phase Projects	6 Feb 2009	Brussels, Belgium	Policy makers	20	European Countries
12	Workshop	Ifremer	3rd Argo Science Workshop & Argo Science Team Meeting	25 March 2009	Hangzou, China	Scientific community	40	European Countries
16	Proceedings	Ifremer	Euro-Argo: towards a sustained European contribution to Argo	2009	OceanObs 2009	Scientific community		International
17	Article	Ifremer	The Euro-Argo research infrastructure: towards a sustained European contribution to a global ocean observing system	Nov 2009	Parliament Magazine's, Research Review, Brussels	Policy makers		European Countries
18	Article	Ifremer	Euro-Argo News	Oct 2009	Mercator Ocean Quarterly Newsletter, p3, #35	Scientific community		European Countries
19	Workshop	Ifremer	2nd Euro-Argo Users Meeting	17-19 June 2009	Trieste, Italy	Scientific community	40	European Countries
20	Conference	Ifremer	Oceanobs09	21-25 Sept 2009	Venice, Italy	all	500	International
21	Workshop	Ifremer	European RI workshop: Exchange of experience between Preparatory Phase Projects	30 Oct 2009	Brussels, Belgium	Policy makers	20	European Countries
22	Workshop	Ifremer	Euro Argo Black Sea Meeting	7-8 Dec 2009	Varna, Bulgaria	Scientific community	20	Black Sea Countries
23	Workshop	Ifremer	ESFRI WG meeting	15 Dec 2009	Helsinki, Finland	Scientific community		European Countries
24	Workshop	Ifremer	Euro-Argo Annual Meeting	29 Jan 2010	Brussels, Belgium	Scientific community	30	Partners

25	Workshop	Ifremer	Euro-Argo Steering Committee meeting	29 Jan 2010	Brussels, Belgium	Scientific community	10	European Countries
26	Conference	Ifremer	ECRI 2010	23-24 March 2010	Barcelona, Spain	all	500	European Countries
27	Workshop	Ifremer	3rd ePPCC workshop - Financial Issues of Distributed RIs	22 March 2010	Barcelona, Spain	Scientific community	20	European Countries
28	Workshop	Ifremer	Argo Science Team 11 meeting	22-25 March 2010	San Diego, California, USA	Scientific community	40	International
29	Article	Ifremer	Euro-Argo: towards a sustained European contribution to Argo, p8-10	Oct 2010	Mercator Ocean – Coriolis, Quarterly Newsletter, #37,	Scientific community		European Countries
30	Workshop	Ifremer	3rd Euro-Argo Users Meeting	17-18 June 2010	Paris, France	Scientific community	50	European Countries
31	Conference	Ifremer	EGU 2010	2-7 May 2010	Vienna, Austria	Scientific community	500	International
32	Meeting	Ifremer	Maritime Day	19 May 2010	Gijon, Spain	all	500	European Countries
33	Workshop	Ifremer	4th ePPCC Workshop, Distributed RIs on the way towards an ERIC	16-17 Sept 16-17	Amsterdam, Netherlands	Scientific community	20	European Countries
34	Workshop	Ifremer	ERIC members meeting	8 Oct 2010	Paris, France	Scientific community	15	European Countries
35	Workshop	Ifremer	Argo Data Management Team meeting	20-22 October 2010	Paris, France	Scientific community	30	International
36	Workshop	Ifremer	Argo Science Team 12 meeting	14-17 March 2011	Buenos Aires, Argentina	Scientific community	40	International
37	Conference	Ifremer	GMES and Climat Change	16-17 June 2011	Helsinki, Finland	Policy makers Scientific community	200	International
38	Conference	Ifremer	Marine ESFRI symposium and Euro-Argo workshop	28 June - 1 July 2011	Brest, France	Policy makers Scientific community	200	International
39	Press Radio	Ifremer	Several interviews in French Radios (France Inter, RFI, Europe 1)	2009-2010	France	Public	Medias	France
40	Euro-Argo DVD	Ifremer	Euro-Argo : Towards a sustained European contribution to Argo	2010	Brest, France	Public	Medias	International
41	Euro-Argo Flyer	Ifremer	Euro-Argo Reseach Infrastructure	2010	Brest, France	Public	Flyer	International

42	Euro-Argo Web Site	Ifremer	http://www.euro-argo.eu/	2009	Brest, France	Public	Internet	International
43	Meeting	KDM	Measuring oxygen from Argo floats	25 June 2008	User Workshop, Southampton, UK	Scientific community	40	European Countries
44	Meeting	KDM	Using Argo under the ice	25 June 2008	User Workshop, Southampton, UK	Scientific community	40	European Countries
45	Meeting	KDM	Middepth circulation in the South-Pacific and its link to OMZ	25-27 May 2011	Argo-oxygen meeting, Brest, France	Scientific community	40	European Countries
46	Meeting	KDM	Laboratory calibration setup based on an electrochemical O2	25-27 May 2011	Argo-oxygen meeting, Brest, France	Scientific community	40	European Countries
47	Meeting	KDM	Temperature-dependent step response characteristics of Aanderaa oxygen	25-27 May 2011	Argo-oxygen meeting, Brest, France	Scientific community	40	European Countries
48	Meeting	KDM	In-situ calibration of oxygen optodes on gliders and floats	25-27 May 2011	Argo-oxygen meeting, Brest, France	Scientific community	40	European Countries
49	Web Site	NERC	Explore the Ocean with Argo http://www.noc.soton.ac.uk/o4s/euroargo/index.php	2010	UK	Public		International
50	Workshop	Met Office	EN3: quality controlled sub surface ocean temperatures and salinities	24-25 June 2008	1st Euro-Argo User Meeting, Southampton, UK	Scientific community	50	European countries
51	Workshop	Met Office	Ocean data assimilation of profile data on density levels in FOAM	24-25 June 2008	1st Euro-Argo User Meeting, Southampton, UK	Scientific community	50	European countries
52	Workshop	Met Office	The use of Argo data in the FOAM operational ocean forecasting system	24-25 June 2008	1st Euro-Argo User Meeting, Southampton, UK	Scientific community	50	European countries
53	Workshop	Met Office	Ocean warming in an isothermal framework and estimates of sampling uncertainty	24-25 June 2008	1st Euro-Argo User Meeting, Southampton, UK	Scientific community	50	European countries
54	Workshop	Met Office	Using Argo data to initialise decadal climate prediction models	20-22 Jan 2009	1st Euro-Argo annual Meeting, Hamburg, Germany	Scientific community	50	European countries
55	Workshop	Met Office	Use of Argo observations in Met Office forecast systems and climate	15-17 June 2009	2nd Euro-Argo User Meeting, Trieste, Italy	Scientific community	50	European countries
56	Workshop	Met Office	Summary of work performed	27-29 Jan 10	2nd Euro-Argo Annual Meeting, Trieste, Italy	Scientific community	50	European countries
57	Workshop	Met Office	The use of Argo data in the FOAM operational ocean forecasting system	27-29 Jan 10	2nd Euro-Argo Annual Meeting, Trieste, Italy	Scientific community	50	European countries

58	Workshop	Met Office	Decadal prediction with Argo	17-18 June 2007	3rd Euro-Argo User Meeting, Paris, France	Scientific community	50	European countries
59	Workshop	Met Office	An initial evaluation of un-pumped near-surface temperature measurements from Apex floats	17-18 June 2007	3rd Euro-Argo User Meeting, Paris, France	Scientific community	50	European countries
60	Publications	KNMI	A Lagrangian study of pathways from surface and subsurface drifters in the northern North Atlantic	Jan 2007	CLIVAR Newsletter Exchanges, Vol., 12, No.1, January 2007.	Scientific community		European countries
61	Conference	KNMI	Use of Argo data in monitoring and study of the ecosystem in the Norwegian Sea	June 2009	Euro Argo User Group meeting, Trieste, Italia	Scientific community	40	European countries
62	Conference	KNMI	Argo in the Norwegian Sea	June 18, 2010	Euro Argo User Group meeting, Paris, France	Scientific community	50	European countries
63	Euro-Argo annual meeting	KNMI	Argo Norway	8-9 Feb, 2011	Euro-Argo annual meeting, Brest, France	Scientific community	10	European countries
64	Press releases	I.E.O		26 May 2010		Medias		Spain
65	Web argo.oceanografia.es	I.E.O	Argo España	01 Jan 2008		General		Spain
66	Conference	I.E.O	Indian ocean cross equatorial flow	October 2010	I Encuentro de Oceanografía Física Española (EOF). Barcelona (Spain).	Scientific community		Spain
67	Conference	I.E.O	Cambios en las tendencias de temperatura y salinidad en el Atlántico subtropical	December 2009	Taller y tertulia de oceanografía física, Las Palmas de Gran Canaria, 11	Scientific community		Spain
68	Conference	I.E.O	Changes in the temperature tendencies in the upper levels of the subtropical North Atlantic ocean.	March 2009	3rd International Argo Science Workshop, Hangzhou, China	Scientific community		International
69	Conference	I.E.O	Using Argo data to investigate the Meridional Overturning Circulation in the North Atlantic	March 2009	3rd International Argo Science Workshop, Hangzhou, China	Scientific community		International
70	Conference	I.E.O	Changes in the temperature tendencies in the upper levels of the subtropical North Atlantic ocean.	November 2008	American Geophysical Union, San Francisco, EEUU	Scientific community		International

71	Conference	I.E.O	Using Argo data to investigate the Meridional Overturning Circulation in the North Atlantic	April 2008	General Assembly European Geophysical union, Viena	Scientific community		International
72	Conference	I.E.O	CHANGES IN THE TEMPERATURE TENDENCIES IN THE UPPER LEVELS OF THE SUBTROPICAL NORTH ATLANTIC OCEAN	April 2008	General Assembly European Geophysical union, Viena	Scientific community		International
73	Technical report	O.G.S	Valutazione delle correnti sub-superficiali nel Mediterraneo da float Argo	2009	Rel.2009/95 OGA 15 SIRE Trieste, Italy. 63pp.	Scientific community		Italy
74	Technical report	O.G.S	Thermohaline variability in the Mediterranean and Black Seas as observed by Argo floats in 2000-2009.	2009	Rel. OGS 2009/121 OGA 26 SIRE Trieste, Italy. 72pp	Scientific community		Italy
75	Technical report	O.G.S	Assessment of the Argo sampling in the Mediterranean and Black Seas (part I)	2009	OGS 2009/117 OGA 23 SIRE Trieste, Italy. 19pp	Scientific community		Italy
76	Technical report	O.G.S	Assessment of the Argo sampling in the Mediterranean and Black Seas (part II)	2009	OGS 2009/139 OGA 32 SIRE Trieste, Italy. 23pp	Scientific community		Italy
77	Technical report	O.G.S	Delayed mode quality control of Argo floats salinity data in the Tyrrhenian Sea	2008	Rel 2008/125 OGA 43 SIRE Trieste, Italy, 33 pp	Scientific community		Italy
78	Technical report	O.G.S	Sintesi del progetto Argo nel Mediterraneo	2008	Rel.19/2008/OGA/10/SIRE Trieste, Italy. 23pp	Scientific community		Italy
79	Technical report	O.G.S	Trattamento dei dati Argo del Mediterraneo	2008	Trieste, Italy. 14pp	Scientific community		Italy
80	Technical report	O.G.S	Trattamento dei dati di posizione dei profilatori Argo nel Mar Mediterraneo per il periodo marzo 2000 - maggio 2008 (Parte I).	2008	Rel.OGS 85/2008/OGA/30/SIRE Trieste, Italy. 19pp	Scientific community		Italy
81	Technical report	O.G.S	Trattamento dei dati di posizione dei profilatori Argo nel Mar Mediterraneo per il periodo marzo 2000 - maggio 2008 (Parte II).	2008	Rel.OGS 86/2008/OGA/31/SIRE Trieste, Italy. 46pp	Scientific community		Italy
82	Meeting	O.G.S	European contribution to worldwide ocean monitoring	22-24 March 2011	EuroSites, Heraklion, Greece	Scientific community		European countries
83	Meeting	O.G.S	Euro-Argo: going from the Preparatory Phase to the European Research Infrastructure Consortium	22-24 March 2011	EuroSites, Heraklion, Greece	Scientific community		European countries
84	Workshop	O.G.S	Lagrangian monitoring of the Mediterranean thermohaline properties and currents: Past results and future plans	8-10 June 2010	4th HyMeX Workshop, Bologna Italy	Scientific community		European countries

85	Workshop	O.G.S	Argo in the Mediterranean and Black seas	17-18 June 2010	3rd EuroArgo User Workshop, Paris	Scientific community		European countries
86	Conference	O.G.S	Subsurface (350m) circulation in the Mediterranean Sea based on Argo data	10-14 May 2010	39th CIESM Congress,Venice, Italy	Scientific community		European countries
87	Conference	O.G.S	Euro-Argo: A Global Observing Infrastructure	26-30 April 2010	42nd International Liege Colloquium on Ocean Dynamics, Liege, Belgium	Scientific community		European countries
88	Meeting	O.G.S	The Argo program in the Mediterranean and Black seas	7-8 Dec 2009	EuroArgo Black Sea Meeting, Varna, Bulgaria	Scientific community		European countries
89	Meeting	O.G.S	The MedArgo or Argo Program in the Mediterranean Sea	15-17 June 2009	2nd EuroArgo User's Meeting, Trieste, Italy	Scientific community		European countries
90	Conference	O.G.S	MedArgo, il programma Argo nel mare Mediterraneo	8-10 June 2009	1° Convegno del GNOO, Genoa, Italy	Scientific community		European countries
91	Conference	O.G.S	The Argo program in the Mediterranean and Black seas	6-9 October 2008	BS - HOT 2008 Conference, Sofia Bulgaria	Scientific community		European countries
92	Workshop	O.G.S	MedArgo or Argo Program in the Mediterranean Sea	24-25 June 2008	1st Euro-Argo Users Workshop Southampton, UK	Scientific community		European countries
93	Conference	O.G.S	MedArgo or Argo Activities in the Mediterranean Sea	18-20 March 2008	AST-9, Exeter, UK	Scientific community		European countries
94	Seminar	O.G.S	MedArgo or Argo Activities in the Mediterranean and Black Seas	19-20 February 2008	CoNISMa-MERSEA Seminars on Operational Oceanography, Naples, Italy	Scientific community		European countries
95	Meeting	O.G.S	MedArgo or Argo Activities in the Mediterranean and Black Seas	7-8 February 2008	IOCCG BIOARGO Meeting, Villefranche-sur-mer, France	Scientific community		European countries
96	Meeting	M.I.	Higher Education Authority /Forfas ESFRI Meeting	15 July 2008	HEA Offices in Dublin	Scientific community	13	Ireland
97	Poster	M.I.	Operational Applications of Euro Argo Data – Ireland (First Euro Argo User's Workshop)	24-25 June 2008	NOC Southampton, UK	Scientific community	63	European countries
98	Meeting	M.I.	Higher Education Authority /Forfas ESFRI Meeting	07 April 2009	Forfas Offices in Dublin	Scientific community	15	Ireland

99	Meeting	M.I.	Higher Education Authority /Forfas ESFRI Meeting	02 June 2010	HEA Offices in Dublin	Scientific community	10-15	Ireland
100	Meeting	M.I.	Higher Education Authority /Forfas ESFRI Meeting	26 Nov 2010	HEA Offices in Dublin	Scientific community	12	Ireland
101	Meeting	M.I.	Higher Education Authority /Forfas ESFRI Meeting	10 March 2011	Forfas Offices in Dublin	Scientific community	10-15	Ireland
102	Poster	M.I.	Assessing Mixed Layer Depth Variability And Sub-Polar Frontal Dynamics In The Northeastern Atlantic	June 18, 2010	Euro Argo User Group meeting, Paris	Scientific community	50	European
103	Publications	I.M.R	A Lagrangian study of pathways from surface and subsurface drifters in the northern North Atlantic	January 2007	CLIVAR Newsletter Exchanges, Vol., 12, No.1, Jan 2007.	Scientific community		European
104	Conference	I.M.R	Use of Argo data in monitoring and study of the ecosystem in the Norwegian Sea	June 2009	Euro Argo User Group meeting, Trieste, Italia	Scientific community	40	European
105	Conference	I.M.R	Argo in the Norwegian Sea	June 18, 2010	Euro Argo User Group meeting, Paris	Scientific community	50	European
106	Workshop	I.M.R	Argo Norway	8-9 Feb 2011	Euro-Argo annual meeting, Brest	Scientific community	15	European
107	Workshop / poster	FFCUL	2nd Euro-Argo Users' Workshop & Euro-Argo Information and Training Day	15-18 June 2009	Trieste, Italy	Scientific community	50	European
108	Workshop / communication & poster	FFCUL	2nd Euro-Argo Users' Workshop & Euro-Argo Information and Training Day	15-18 June 2009	Trieste, Italy	Scientific community	50	European
109	Workshop / poster	FFCUL	4th ESF MedCLIVAR Workshop "Feedbacks of the Mediterranean Dynamics in the Global Climate System"	28-30 Sept 2009	Sesimbra, Portugal	Scientific community	80	International
110	Workshop / poster	FFCUL	4th ESF MedCLIVAR Workshop "Feedbacks of the Mediterranean Dynamics in the Global Climate System"	28-30 Sept 2009	Sesimbra, Portugal	Scientific community	80	International
111	Workshop / poster	FFCUL	3rd Euro-Argo Users' Workshop	17 – 18 June 2010	Paris, France	Scientific community	50	European
112	Workshop / poster	FFCUL	3rd Euro-Argo Users' Workshop	17 – 18 June 2010	Paris, France	Scientific community	50	European
113	Conference	HCMR	10th International Conference on Meteorology, Climatology and Atmospheric Physics	25-27 May 2010	Patras, Greece	Scientific community	100	Greece - International
114	Workshop	HCMR	2nd Euro-Argo User Meeting	15-17 June 9	Trieste, Italy	User Workshop	50	European countries

115	Conference	IOPAS	Variability of Atlantic Water properties, influence to the climate	Feb 2009	Sopot	Scientific community	200	Poland
116	Conference	IOPAS	IOPAS investigations in the Nordic Seas and Arctic Ocean	Nov 2009	Bremen	Scientific community	200	Germany
117	Scientific meeting	IOPAS	Nordic Seas – deep sea circulation	March 2010	Sopot	Scientific community	100	Poland
118	Science Days poster	IOPAS	EuroArgo- nowa europejska ingrastruktura	Mai 2010	Sopot	Civil Society	2000	Poland
119	Scientific conference	IOPAS	Arctic ROOS IOPAS report	Nov 2010	Sopot	Scientific community	200	Poland
120	Scientific conference	IOPAS	Atlantic Water in the West Spitsbergen Current - interannual variability, transformation and importance	Oct 2010	Woods Hole	Scientific community	300	USA
121	Popular lecture	IOPAS	The West Spitsbergen Current - important factor of the global climate	April 2011	Gdansk	Civil Property	400	Poland
122	Scientific conference	IOPAS	Arctic Climate and Environment of the Nordic Seas and the Svalbard - Greenlad Area	April 2011	Seoul	Scientific community	300	South Korea
123	Concourse	USOF	"Famelab", the new face of science	2008	Bulgaria	Students, young scientists	100	Bulgaria
124	Conference	USOF	International conference on "Global Environmental change : challenges to science and society in southeastern Europe"	19-21 May 2008	Sofia, Bulgaria	Scientific community	100	Southeastern Europe
125	Meeting	USOF	The need of Argo data in the Black Sea	24-25 June 2008	1st Euro Argo Data User Meeting, Southampton, UK	Scientific community	60	European Partners
126	Workshop	USOF	“The perspectives of Euro-Argo in the Black Sea”, 2nd bi-annual and Black Sea Scene EC project joint conference	6-9 October 2008	Sofia, Bulgaria	Scientific community	20	Black Sea countries
127	Workshop and deployment expedition	USOF	“Euro-Argo in the Black Sea”	8-9 Dec 2009	Varna, Bulgaria	Scientific community	10	Black Sea countries
128	Workshop	USOF	1st GMES Operational Capacity Workshop	25-26 March 2010	Sofia, Bulgaria	Scientists, policy makers	50	Bulgaria, EU15
129	Workshop	USOF	Development of the national research infrastructure BulArgo as a bulgarian component of the ERIC Euro-Argo: present state and perspectives	17-18 June 2010	3rd Euro-Argo data users workshop Paris, France	Scientists	60	European Partners

130	Workshop	USOF	Inventory of the Argo data in the Black Sea: usability and quality control	17-18 June 2010	3rd Euro-Argo data users workshop Paris, France	Scientists	60	European Partners
131	Conference	USOF	BulArgo national infrastructure: the present state and perspectives for the Argo data in the Black Sea	7-9 October 2010	10th international conference on marine sciences and technologies, Varna, Bulgaria	Scientists, Engineers	50	Black Sea countries
132	Training-workshop	USOF	"Euro-Argo in the Black Sea: the use of Argo data in the Black Sea"	25-26 October 2010	Sofia, Bulgaria	Scientists	20	Black Sea countries
133	Workshop	USOF	"Euro-Argo-Black Sea: Assessment of the Socio-Economic Impact of Euro Argo to the hosting region"	26-27 October 2010	Sofia, Bulgaria	Scientist, policy makers, end users	20	Bulgaria
134	Workshop	USOF	The new Argo monitoring of the Black sea. The perspectives of the BulArgo national research infrastructure	17-18 March 2011	2nd GMES Operational Capacity, Sofia, Bulgaria	Scientists, policy makers	50	EU15
134	Conference	USOF	BulAGRO the Bulgarian component of the Euro ARGO network	21 – 22 March 2011	IODE 50 Anniv., Inter. Conference Liège, Belgium	Scientists	100	EU
135	Conference	USOF	Development of National research infrastructure as a Bulgarian component of the Euro ARGO network	3-8 April 2011	EGU General Assembly 2011, Vienna, Austria	Scientists	100	International
136	Thesis	USOF	"Euro-Argo activity in the Black Sea", BSc. thesis for obtaining a B.Sc. Degree in "Astronomy, Meteorology and Geophysics	June 2011	Sofia, Bulgaria	Scientists	10	Bulgaria

Section B (Confidential or public: confidential information to be marked clearly)

Part B1 *- The applications for patents, trademarks, registered designs, etc. shall be listed according to the template B1 provided hereafter.*
The list should, specify at least one unique identifier e.g. European Patent application reference. For patent applications, only if applicable, contributions to standards should be specified. This table is cumulative, which means that it should always show all applications from the beginning until after the end of the project.

TEMPLATE B1: LIST OF APPLICATIONS FOR PATENTS, TRADEMARKS, REGISTERED DESIGNS, ETC.					
Type of IP Rights[8]	*Confidential* *Click on YES/NO*	*Foreseen embargo date* *dd/mm/yyyy*	*Application reference(s) (e.g. EP123456)*	*Subject or title of application*	*Applicant (s) (as on the application)*

[8] *A drop down list allows choosing the type of IP rights: Patents, Trademarks, Registered designs, Utility models, Others.*

***Part B2** - Please complete the table hereafter:*

Type of Exploitable Foreground[9]	**Description of exploitable foreground**	Confidential Click on YES/NO	Foreseen embargo date dd/mm/yyyy	**Exploitable product(s) or measure(s)**	**Sector(s) of application[10]**	**Timetable, commercial or any other use**	**Patents or other IPR exploitation (licences)**	**Owner & Other Beneficiary(s) involved**
Arvor profiling float with new satellite communication capabilities	See description 1	NO	None	1) Arvor with Iridium satellite communication 2) Arvor with Argos3 satellite communication 3) Iridium high pressure antenna 4) Argos3 high pressure antenna	M72 - Scientific research and development	2010	no	
Arvor standard for Argo program	See description 2	no	none	Arvor profiling float	M72 - Scientific research and development	2010	A licence for manufacturing the Arvor float has been given to the manufacturer NKE	Ifremer NKE
Argo float data base	See description 3	no	none	data base	M72 - Scientific research and development	2011 - continuous	none :	scientific community world - wide

Description1

The aim was to fit an Argo profiling float with new satellite communication systems, in order to reduce the data transmission time when the float reaches the surface. This is particularly critical in marginal seas to lower the risk of thefts, trawling or impacts in highly trafficked seas, to delay the time of beaching on the shores, and to have better estimates of subsurface currents. These instruments can be exploited by scientists for climate research.

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9 A drop down list allows choosing the type of foreground: General advancement of knowledge, Commercial exploitation of R&D results, Exploitation of R&D results via standards, exploitation of results through EU policies, exploitation of results through (social) innovation.

10 A drop down list allows choosing the type sector (NACE nomenclature) : http://ec.europa.eu/competition/mergers/cases/index/nace_all.html

Description2

The Arvor float has been designed to become the standard European designed and manufactured float for the Argo programme. It is derived from previous models (the Provor), but incorporates the newest development in data acquisition, storage, and transmission, as well as on the vehicle design (the pressure case, the pump and its motor), and the internal electronics. This instruments is now easier to handle at sea, and has an extended life-time. Those developments and extensive testing have been made at Ifremer. A license for manufacturing has been granted to the NKE company. This float is now available for purchase world-wide.

Description3

All data from the Argo array –and in particular its Euro Argo component, are freely available to all users for scientific research and operational requirements. Thus all developments and results (e.g. data quality control procedures for regional data sets or for bio-geochemical data) achieved in the course of the project are incorporated at the data centres for the benefit of them. The open data policy ensures the largest possible use of the data for users worldwide.