Project	AtlantOS – 633211
Deliverable number	6.6
Deliverable title	Integrated Atlantic Ocean Observing System Shared Infrastructure Report
Description	Best practice document and review / inventory of current methods for sharing components of the Integrated Atlantic Ocean Observing System, such as ships, fixed and mobile observing systems, calibration facilities and support the use of the infrastructure for innovation testing, validation, or demonstration.
Work Package number	6
Work Package title	Cross-cutting issues and emerging networks
Lead beneficiary	PLOCAN
Lead authors	Eric Delory
Contributors	IEEE, IFREMER
Submission date	
Due date	M45
Comments	Legal consultancy subcontract process implied a two-month delay in the delivery of this deliverable

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Last updated: 19 March 2019

Stakeholder engagement relating to this task*

WHO are your most important stakeholders?	☒ Private company If yes, is it an SME ☐ or a large company ☐? ☒ National governmental body ☐ International organization ☐ NGO ☒ others Please give the name(s) of the stakeholder(s): Research vessel fleet operators, Ocean observatories operators and network managers (JERICO, EMSO, OOI, ONC Canada) Ocean observing platform and sensor development SMEs: examples are NKE, Turner design, RTSYS, ALSEAMAR
WHERE is/are the company(ies) or organization(s) from?	☒Your own country ☒ Another country in the EU ☒ Another country outside the EU Please name the country(ies): USA, Canada, Brazil, Argentine, France, UK, Spain Portugal, South Africa
Is this deliverable a success story? If yes, why? **If not, why?**	☒ Yes. Besides documenting the various opportunities and initiatives for sharing infrastructure, two international workshops were held, in collaboration with WP3, with extensions within and support from the EMSO and JERICO community, and a field demonstration of new open technologies took place as enabler of instrument and real-time data sharing. This despite very limited resources in the task.
Will this deliverable be used? **If yes, who will use it?** **If not, why will it not be used?**	☒ Yes, by observatory and research fleet operators, scientists looking for opportunity to access infrastructure, companies interested in new technologies for instrument and data interoperability concepts. ☐ No, because …..

NOTE: This information is being collected for the following purposes:

1. To make a list of all companies/organizations with which AtlantOS partners have had contact. This is important to demonstrate the extent of industry and public-sector collaboration in the obs community. Please note that we will only publish one aggregated list of companies and not mention specific partnerships.
2. To better report success stories from the AtlantOS community on how observing delivers concrete value to society.

*For ideas about relations with stakeholders you are invited to consult D10.5 Best Practices in Stakeholder Engagement, Data Dissemination and Exploitation.

Introduction

Benefits of sharing ocean observing infrastructure are diverse, from the deployment of multiple observing platforms from research vessels, collecting additional samples, adding sensing devices or services to existing activities, and coordinating multiple platforms for specific science.

In order to best identify priorities and opportunities, we consulted the community. These interactions also allowed autonomous ocean observing system operators to express interest in collaborating and engaging with stakeholders, from academia and industry. Several workshops were organized, with attendees from Europe, North and South America. Interactions took place at technical and operators' level (AtlantOS WP3-WP6 joint organisation of workshop 1), infrastructure network level (EMSO ERIC and AtlantOS co-sponsoring of workshop 2), and strategic level (AtlantOS and AORA-CSA co-sponsoring). While several aspects and components of observing infrastructures may be shared for different purposes (improve cost-efficiency, increase scientific experiments spatial coverage, facilitate technology testing, etc), these interactions showed an increasing interest in the sharing of ship-time and, from a more technical and future vision perspective, the new technological developments to share instrumentation and real-time data in Europe and North America.

The first workshop focused on broader interests in order to gather a large enough community around the topic of infrastructure sharing. The workshop addressed strategies, methods and new technologies for a sustained and integrated autonomous in-situ observing system for the Atlantic Ocean. The workshop was also supported by the coordination of the Atlantic Ocean Research Alliance (AORA) Coordination and Support Action (CSA). This workshop was held at PLOCAN, Gran Canaria (Spain) from the 2nd to the 4th of November 2016. The idea of this 3-day scientific and technical joint event was motivated by an attempt to better integrate activities in AtlantOS across work packages, as well as to better involve international participants in the process. The focus of the workshop aimed at better integrating the project's cross-cutting issues, emerging networks and technological innovation activities through the enhancement of the Atlantic network of autonomous observing systems, fixed and mobile. The event was open to all AtlantOS work-packages and task leaders interested in contributing. The event was also open to international participants who have an interest in joining and contributing to the AtlantOS community and initiative. Besides European attendees, clear interest in better integration was substantiated by the attendance of participants from Brazil, Argentina, Canada and the United States. Contributions of the AORA-CSA provided an overview of the strategy across the Atlantic Ocean, helping existing and planned observing networks to align with the requirements of the Galway statement. AORA-CSA contributions mainly included updating attendees of the AtlantOS community on the AORA-CSA initiative, the project's progress with respect to ocean observation (WP5) and the sharing of infrastructures (WP10) activities, and progress in better integrating international perspectives. Key concepts such as infrastructure sharing, autonomous systems operations, new technologies and maturity and best practices were discussed. Priorities and agreed actions with respect to capacity sharing were:

- Focus on significant assets that are either unique or costly, use unique identifiers and produce documentation (ships, research stations, observing equipment).
- determining the scope necessary to build an Atlantic wide sharing mechanism? Should this be an Ocean Facilities Exchange Group (OFEG)-Atlantic?
- Include data sharing and a foundation of shared best practices/identified standards as part of the sharing mechanisms
- Propose an AORA strategic action to compare sharing methods and recommend more Atlantic-wide solutions.

Ship-time sharing mechanisms and of other capacities do exist and are reported here and interactions with

IRSO (International Research Ship Organisation) and AORA help promote the expansion of trans-basin sharing mechanisms. With respect to the sharing of instrumentation and data, we focused on technological advances and a follow-up workshop was organised to engage with the community to train and further demonstrate, in the field, new interoperability tools that have been developed and field-tested for ocean sensor and real-time data sharing. These software and firmware tools have been implemented on different platforms and sensors. They are available open-source and now require substantially less engineering time than in the past. The training also helped those interested in participating in an interoperability experiment in the field, with the Atlantic Ocean as a region of interest and deployment, in the framework of AtlantOS and EMSO ERIC. The workshop and training took place during the Oceanology International 2018 conference to facilitate industry participation. The workshop was open to ocean scientists, engineers and technicians dealing with in-situ sensor and observing systems, from academia or industry. These participants were offered direct experience with the latest interoperability technologies. We report on an experiment that took place off Gran Canaria with the integration of commercial sensors from one institute on a glider from another institute, demonstrating the virtues of interoperability standards in sharing instruments and real-time data.

Methods for sharing infrastructure

Ocean-going vessels: challenges and opportunities

Besides the obvious interest in sharing infrastructure assets such as observing structures, calibration facilities, a major cost driver in Atlantic Ocean observing led to focus on ship-time. Several methods and instruments were presented at the first workshop, these are presented here and complemented based on interactions that took place at the last AtlantOS General Assembly with the AORA-CSA team with respect to the shared infrastructure opportunities and at the last International Research Ship Operators (IRSO)1 meeting held in Barcelona in October 2018, where the European Marine Board (EMB) working group reported on a survey they launched in May 2018, including sharing of ship time (1). EMB WP6 activities entail the Future Development of Research Vessel Fleet Management and Coordination, including:

- Exploring options for future management of the fleet within Europe, exploring wider-ranging collaborations, co-ownership, chartering, training at sea opportunities, etc.
- Exploring options for enhancing the European Research Fleet capability as a world class infrastructure resource for the international marine research community
- Finding ways to strengthen existing collaboration between projects, networks and nations, in order to enhance access, training and interoperability opportunities, and hence cost-efficient use of these valuable resources

The EMB survey's intention was to report on the progress made on recommendations from Marine Board position paper 10 (2), see also Figure 1. References to programmes through names or acronyms are made in the report, these are further described in Table 1.

Enhance coordination of fleet scheduling
Results are very limited so far, mainly through the networking activities of the Eurofleets projects or member's initiatives such as the Marine Facilities Planning (MFP) programme - Lack of visibility and flexibility in Research Vessels (RV) scheduling
Promote bartering to avoid long passage time between cruises
This is being done via the OFEG scheme (for a limited number of European operators using RVs at global scale), European Research Vessel Operators (ERVO) should/could act as a facilitator of the usage of this scheme for Regional Vessels and all other Vessels outside of OFEG
Encourage chartering processes to use the non-funded time

[1] https://www.irso.info/irso-2018/

There have been no overarching initiatives so far - lack of visibility on RVs scheduling - meetings such as the "Regional focus" set through ERVO annual meetings can help to share information on RV scheduling and available periods

Table 1 summarises the programmes in place for sharing ocean going vessel use, some are further described in this section.

Enhanced means of using the European fleet more efficiently	
Recommendations concerning vessels	– Enhance coordination of fleet scheduling; – Promote bartering to avoid long passage time between cruises; – Encourage chartering process to use the non-funded time; – Create a 'scrap premium' to get rid of old and under-utilised vessels;
Recommendations concerning equipment	– Enhance coordination of equipment scheduling; – Achieve interoperability of equipment; – Transnational deployment teams; – Sharing of spare parts;
Proposals for implementation	– Towards funding agencies and National authorities; – Available ship and equipment time to be published; – Reinforcement of the OFEG organisation; – A European initiative for interoperability; – Creation of new marine facilities bartering groups; – Development of national equipment pools;

Figure 1: Excerpt from Marine Board Position Paper 10 (2)

Table 1 Ship-time sharing opportunities in the Atlantic Ocean

Name	Method	Access
Access to ocean-going research ships		
Ocean Training Partnership	Calls for application	http://www.oceantrainingpartnership.org
Marine Facilities Planning	Needs NIOZ, GEOMAR, NERC user registration	https://nerc.marinefacilitiesplanning.com
OFEG	Bartering	www.ofeg.org
Eurofleets	Competitive calls for application	http://www.eurofleets.eu
POGO	See text (fellowships)	http://www.pogo-oceancruises.org
Programmes collecting oceanographic data		
VOS	Meteorological/Climate related data	http://sot.jcommops.org/vos/
SOOP	Sensor deployments	http://www.jcommops.org/
GO-SHIP	Umbrella global programme	http://www.go-ship.org
Other portals with information on cruises and ships		
JCOMMOPS	Coordination	http://www.jcommops.org/
Eurocean	Infobase	http://www.eurocean.org
European and international coordination		
ERVO	Medium size - Network – Info exchange, Coordination	http://www.ervo-group.eu
IRSO	Network – Info exchange, Best	www.irso.info

	practices	

AORA-CSA

The objective of the **Atlantic Ocean Research Alliance Coordination and Support Action (AORA-CSA)** is to provide scientific, technical and logistical support to the European Commission in developing and implementing trans-Atlantic Marine Research Cooperation between the European Union, the United States of America and Canada.

The AORA-CSA project provides an open and inclusive platform to further implement the Galway Statement:

- Providing the European Commission / Atlantic Ocean Research Alliance / Galway Statement Implementation Stakeholder Group (Figure 1.1) with up-to-date assessments and mapping of European research capacity in the six identified research priority areas, including the identification of industry needs and research gaps;
- Facilitating the organisation of networking activities, expert and consultative workshops to bring together the relevant parties interested in, and capable of, initiating trans-Atlantic Research Cooperation;
- Engaging with the wider marine community including policy makers and funders, research scientists and research institutions, industry and Non-Government Organisations (NGOs).

WP10 of AORA-CSA project (Shared access to marine research infrastructures) produced two deliverables (3, 4) focused on the integrated and shared use of infrastructure in relation to in situ observation of the Atlantic Ocean and the Galway priorities. The following excerpt of a table from these reports, besides highlighting the contribution of ocean observatories, also refers to two programmes, Eurofleets and OFEG, as main instruments identified for vessel support to the Galway priorities.

Table 2: Research vessel and in situ observing systems linkages to the Galway priorities. Note the table should include US/OOI in the international links category. [1] X to XXX: from loose to tight interactions. Source: AORA-CSA Deliverable 10.1

Type of research infrastructure	**Operational European projects & *Initiatives***	**Linkages with Galway research priorities**						**Main International links**
		Ecosystem Approach	*Observing Systems*	*Bio-technology*	*Aquaculture*	*Ocean Literacy*	*Seabed mapping*	
Research Vessels & equipment								
Research Vessels and their underwater vehicles and instrument (ROV, AUV, Corer, ...)	EUROFLEETS *OFEG*	XX[1]	XXX			X	XXX	IRSO UNOLS
In situ observing systems								
Mobile ocean observatories (oceanic profilers, gliders, drifters, ...)	Euro-ARGO E-AIMS GROOM	X	XXX			X	X	ARGO/GOOS International Ocean Glider Community
Fixed point open ocean observatories (Oceanic moorings, Seafloor stations, ...)	EMSO FIXO3	XX	XXX	X		X	X	ARGO/GOOS IOOS Neptune-Canada IMOS
Coastal observatories (Coastal automated stations & buoys, HF Radar, Ferrybox, Gliders, ...)	JERICO GROOM	X	XXX	X	X	X	X	ARGO/GOOS IOOS Venus Canada
Integrated Atlantic Ocean Observing System	ATLANTOS	X	XXX			X	X	ARGO/GOOS IOOS Ocean Network Canada

According to (4), with the first AORA-CSA WP10 workshop held along with the IRSO[2] 2016 Forum in Capri (Italy), Thursday 13th October 2016:
"- Overall, there is a huge willingness from marine and maritime stakeholders to improve and share bathymetric data acquisition;
- Technical skills enabling multi-beam data acquisition on board RVs should be promoted;
- Combination and synergies of scientific tasks and activities while at sea should be promoted;
- Information exchange on ship-time planning should be coordinated and centralized;
- Evaluation of cruise proposals should take into account strategic aspects, both geographically (e.g. areas of scientific importance) and technically (seabed data acquisition, open data policy);
- Optimize recurrent transit voyages by proposing alternative routes and adjusting RV operational capabilities while acquiring new data;
- Communication flow needs to be clearly reinforced in each country, from policy and management (policy objectives and targets) to operational (Research Vessels operators) levels;
- Communication flow needs to be improved and sustained across Atlantic fleets;
- There is a need to identify and secure an adequate and long-lasting web platform for displaying cruise related information (programmes, contacts, data management practices etc.)
- Secure governments' implications in AORA efforts (data sharing) and identify potential new sources of bathymetric datasets (e.g. from ARGO floats);
- a Research Vessel Coordinator (RVC) to structure its interactions with operators, PIs and international organizations and forum."

An indicative list of US, Brazilian, Canadian and European RVs operating in the Atlantic Ocean is also provided in (4). That list can be completed with ocean-going vessels from US ocean-going vessels.

Towards an OFEG Atlantic

OFEG, the Ocean Facilities Exchange Group, is often refered to as a well-functioning and good practice mechanism for ship-time sharing (other resources are often offered, such as equipment). Further, from the report of the first joint AtlantOS WP3-WP6 workshop held in Gran Canaria for an Atlantic Sustained and Integrated Autonomous In-situ Observing System (2-4 November 2016) – see Annex 1, OFEG was identified by the attendees and the AtlantOS coordination as a potentially promising mechanism to facilitate sharing of infrastructure across the Atlantic basin.

Is there « scope for an OFEG-Atlantic » ?

OFEG represents Europe's leading oceanographic research organisations and provides a forum to consider barter exchange and co-operation opportunities for the Global and Ocean Class research fleet.
OFEG has the following objectives:

- To barter ship-time and major marine equipment whenever they are not available on a national basis at a certain period of time or in a geographic region;
- To exchange expertise of technological knowledge by using the equipment and technicians of partners;
- To provide a better overview of 'large' and 'expensive' equipment, their technical specifications, and their availability;
- To promote coordination of large marine investments.

Since the mid-1980s, NERC has had a bi-lateral barter arrangement with the National Science Foundation (NSF), providing access to marine facilities programmed by the University-National Oceanographic Laboratory System (UNOLS), who schedule scientific cruises aboard more than 20 research vessels located at 20 operating institutions in the USA. More information on these facilities can be found on the UNOLS website .

[2] International Research Ships Organisation

Table 3 Barter systems in place (from (2))

Type	Name	Partners	Purpose	Since	Ships/equipment involved	Reference
Barter systems	Ocean Facilities Exchange Group, OFEG	IFREMER/F NERC/UK BMBF/D NIOZ/NL UTM-CSIC/ SP IMR/NO	Barter system for Ocean Research Vessels/large equipment	1996	2 polar ships 8 Global class (G) ships 12 Ocean class (O) ships 4 Regional class (R) ships 4 deep sea ROVs, other large equipment, special containers, technical support	http://ofeg.nerc.ac.uk
		NERC/UK & NSF/US	Barter system for Ocean Research Vessels/large equipment	Ca 1985	3 UK ships 27 UNOLS ships	www.nerc.ac.uk/funding/marineplan/tripartitebarterarr.shtml
		NERC/UK & IMR/N	Barter system for Ocean Research Vessels	2005	3 ships from the UK 4 ships from Norway	http://www.nerc.ac.uk/funding/marineplan/tripartitebarterarr.shtml

In practice, OFEG through NERC should be able to make US vessels accessible within the bartering process of OFEG. This was indeed confirmed by IRSO Chair at their last meeting in Barcelona (October 2018). Thus an OFEG Atlantic technically, yet not formally, exists and should be further promoted to the community and further publicised (as in Figure 2)– formally, in order to make the access more visible and the access process clearer.

Figure 2 AtlatnOS - EMSO proposal to IRSO 2018 for ship-time bartering

OFEG Tripartite agreement to which other NIOZ, CSIC and IMR later joined are available at the following URLs:
http://www.ofeg.org/np4/%7B$clientServletPath%7D/?newsId=13&fileName=Tripartite_Agreement.pdf
http://www.ofeg.org/np4/%7B$clientServletPath%7D/?newsId=13&fileName=OFEG_CSIC_and_IMR.pdf

Eurofleets+ opportunities in ship-time access

Eurofleets activities were reported in the first WP6 workshop (Annexe 1). Building on the Eurofleets 1 and Eurofleets 2 projects, the Eurofleets+ project proposal has received support from AtlantOS. Now funded, Eurofleets+ will cooperate closely with fixed and mobile observatory communities, including EMSO, OceanSITES, EuroGOOS, Euro-Argo, JCOMMOPS, and Go Ship, as well as with the Atlantic Ocean Research Alliance (AORA) and Atlantic Seabed Mapping International Working Group (ASMIWG). It will

align with the objectives and future recommendations of the European Marine Board (EMB) Working Group on Research Vessels (2). The role of Research Vessels as part of the wider European Ocean Observing System (EOOS) will be discussed at EOOS conferences and stakeholder events, and there will be strong alignment with the JPI Oceans Strategic Research and Innovation Agenda. Regarding best practice and long-term programme legacy, Eurofleets+ will work closely with the European and international research vessel operator groups ERVO and IRSO, and with UNOLS, the University-National Oceanographic Laboratory System (USA) which coordinates research vessel use for federally funded ocean research. This will be useful in terms of exchanging best practices and examining approaches to long-term solutions for transnational access and standards beyond the project lifetime. Eurofleets+ will create clustering to other research and innovation activities, through the active involvement of consortium participants in relevant projects, including AtlantOS, ARICE, SeaDataCloud, ODIP and ODIP II, EMODNet, Euro-Argo, JERICO-Next, and R2R.

Eurofleet+ will also :

- propose a business plan for a long-term sustainable Transnational Access (TNA) system of research vessels
- identify pilot groups of a TNA system
- fine-tune an integrated system for the coherent, long-term, sustained maintenance and update of outcomes of Networking Activities (NA), TA and Joint Research Activities (JRA) from the Eurofleets projects
- provide an operational proposal toward a sustainable coordination platform for European research vessel fleets
- provide a strategic roadmap and guidelines for the sustainability of the Eurofleets+ platform beyond project lifetime

Eurofleets+ offers the following vessels:

RV Celtic Explorer
MI – Ireland

RV Magnus Heinason
HAVST - Faroe Islands

RV Magnus Heinason
REPLACEMENT DUE
HAVST - Faroe Islands

RV Aranda
SYKE MRC - Finland

RV Simon Stevin
VLIZ – Belgium

RV Skagerak
UGOT - Sweden

RV Aegeo
HCMR - Greece

RV Belgica
RBINS - Belgium

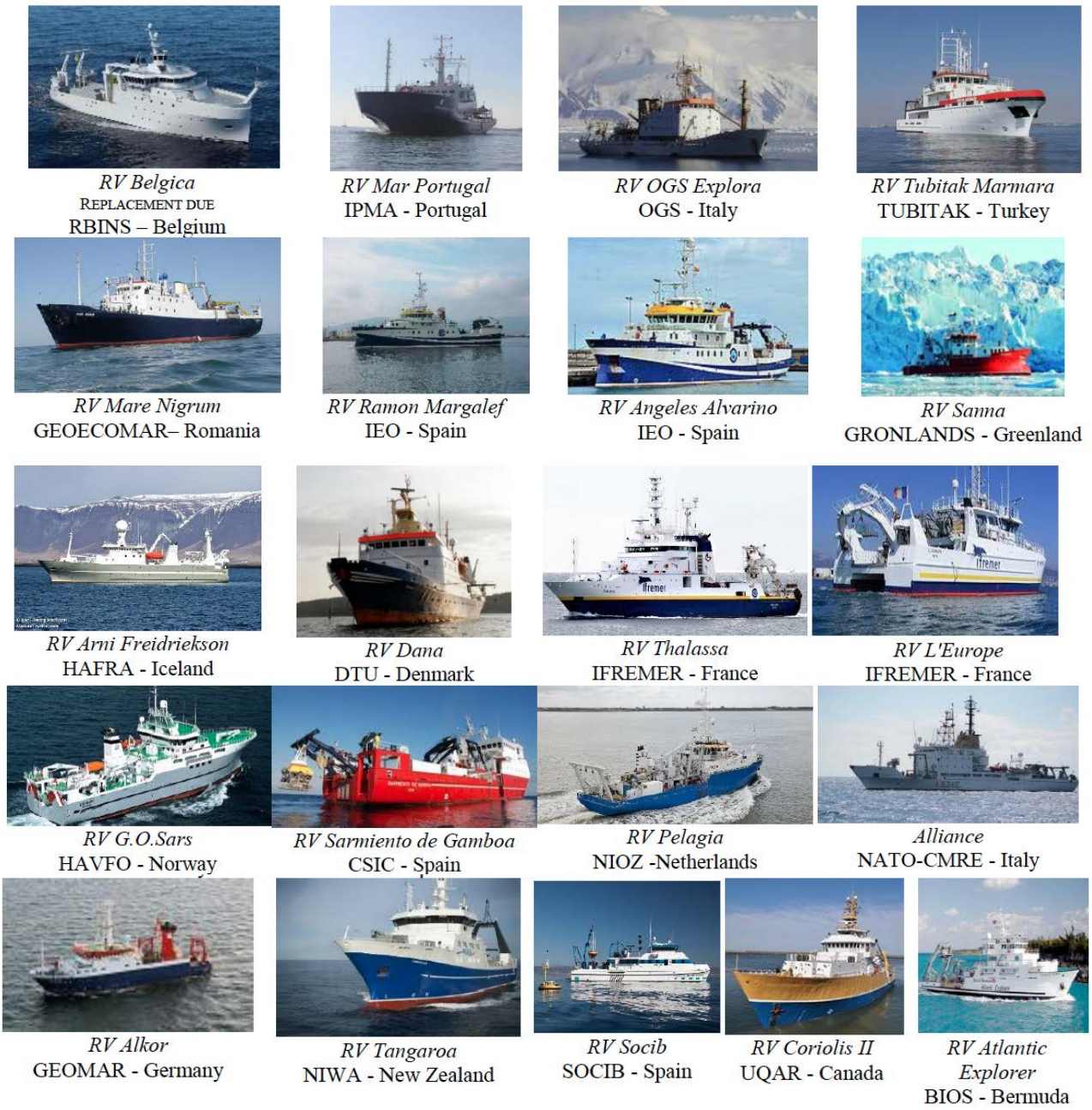

Figure 3 Research vessels accessible through the Eurofleets+ project (Courtesy of Eurofleets consortium)

For more information on the access opportunities: www.eurofleets.eu (upcoming site update soon)

Sharing fixed and mobile observing systems with EU transnational access instruments

Europe has taken a leading role in making open-ocean observing systems available to the international scientific and technical (research and development) community. Here we provide an example of an initiative, funded through the FixO^3 European project, that offers free competitive access with a co-funding approach (partly EU, partly European member states with in-kind). The process allows for the participation of non-European groups. The objective was to support external scientific users by providing coordinated, free-of-charge, transnational access to fixed open-ocean observatories, including:

- Fourteen ocean surface, water column and seafloor observatory installations and systems were considered for transnational access under this initiative
- One shallow water test site (OBSEA) was able to make practical and fast tests of instruments, systems, procedures and new technologies applicable to fixed open-ocean observatories.

Observatory locations ranged from the polar regions of the Antarctic and Arctic, to the Atlantic Ocean and Mediterranean Sea with a choice of seafloor, mid-water and surface infrastructures with varying scientific focus due to each location's characteristics. These observatories were selected as they offer the broadest scientific and technological capabilities for multidisciplinary observations such as atmosphere-ocean interactions at the sea surface and processes in the water column and ocean floor. Gliders are also available for some of the sites. The observatories address a wide range of disciplines such as biology, biogeochemistry, chemistry, physics and geology. Two calls for proposals for TNA have been launched under the FixO^3 project.

Figure 4: Project LOCA^{3}ted addressed a comparison of equipment experimentation at 4 different observatories (Station M, PAP, ESTOC, TENATSO) of the FixO^3 network (blue dots), showing the value of a shared infrastructure (here via EU TNA instrument) in multi-node science. Note FixO^3 observatories are in a process of integration within the EMSO ERIC infrastructure.

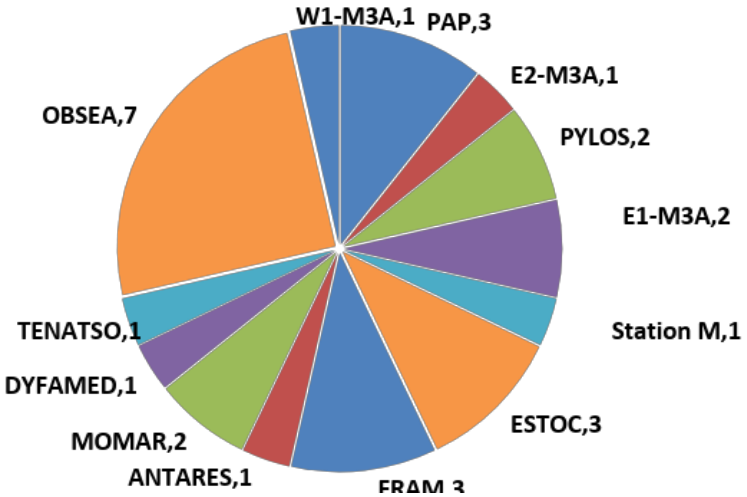

Figure 5: Number of projects completed per observatory, from 1st and 2nd call.

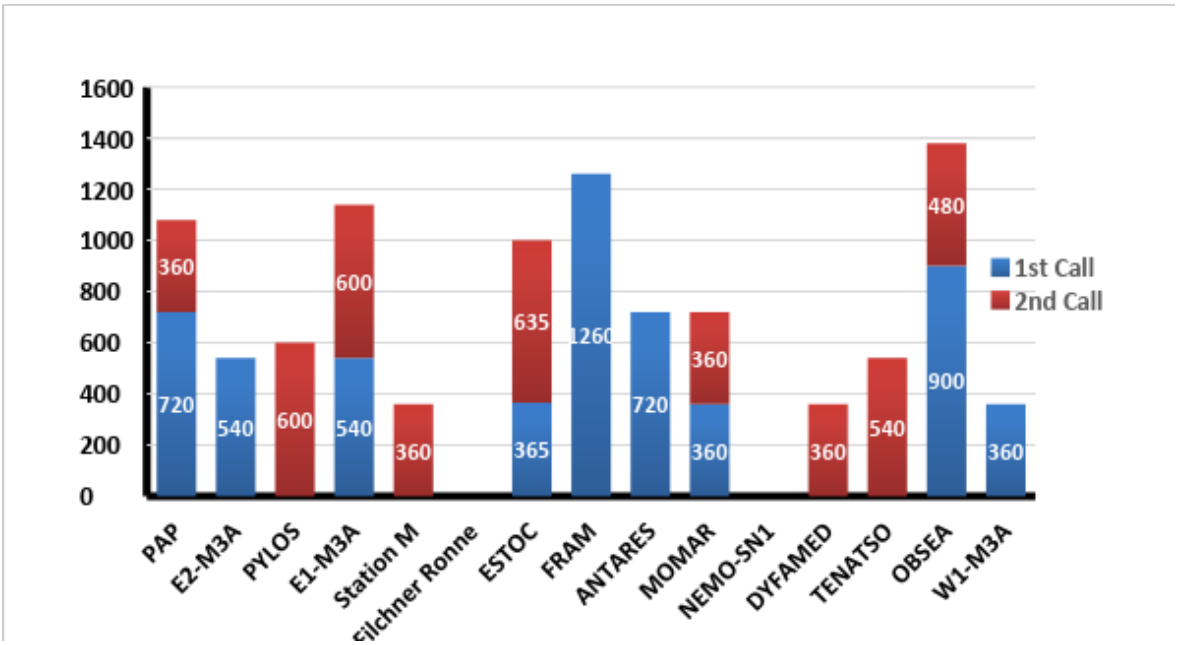

Figure 6: Number of days requested for each observatory to carry out the proposals including both the 1st call proposals (already evaluated) and the 2nd call.

TNA application process: example of the FixO^3 project

The European TNA is a competitive process. The Evaluation Panel assesses all proposals received and recommends a short-list of the user groups that should benefit from access free of charge. In so doing, it applies the principles of transparency, fairness and impartiality. The Evaluation Panel based its selection on scientific merit. The process will also value proposals from user groups composed of users who have not previously used the infrastructure, are working in countries where no such research infrastructures exist or have no prior experience accessing such infrastructures.

The selection process starts as soon as the TNA Office launches a call. The applicant is asked to contact the

Observatory Manager for a pre-feasibility evaluation of his/her project. The application should include a confirmation letter / letter of support from the Observatory Manager as part of the application to the TNA office. The Evaluation Panel, composed of FixO3 Consortium and Advisory board members, will review the applications and establish a ranking based on the evaluation criteria below. Each proposal is then reviewed by three evaluators. The TNA Office invites specialists from the consortium (in this specific project FixO3 partner representatives) if specific expertise is missing in the panel.

A consensus review meeting is held to finalise the individual review reports and the final consensus review report. The criteria shown in Figure 7 are used to evaluate the proposals. The ranking and final evaluation summary reports are sent by the TNA Office to the Observatory Manager, who is responsible for selecting the project(s) requesting the infrastructure, that will be funded. The EC grants the infrastructure up to 20% of the infrastructure operational costs for accepted projects. The final ranking of the submitted proposals is then sorted in descending order. Approval is granted, starting with the proposal that has the highest score. Final decision is communicated to the TNA Office, which communicates the status of their project to the applicant. In some cases, for example, due to unforeseen unavailability or schedule incompatibility, a project may be hosted by an alternate equivalent installation to match scientific requirements, wherever needed and practical, in agreement with the user/user group. The leader of each selected user group is contacted directly by the Observatory Manager chosen for its activities to receive additional information/guidelines and to allow the TNA Office to start drafting the TNA grant agreement.
The agreement delineates the actions to be undertaken, the resources that will need to be allocated, the length of planned user stays if any, and the period of use. It defines the rights and obligations of the parties involved, including provisions for *force majeure* or early termination.

Evaluation Criteria (& maximum number of pages)	Max Score	Threshold
Scientific and technical objectives (Potential interest to the research/service provider community; Originality and innovation, European relevance) – **2 pages**	5	3
Quality of the methodology and implementation: clarity, adequacy in relation to set objectives, work plan, adequacy with the infrastructure (incl. e.g. prior scientific, technical or logistical arrangements, risk table) – **2 pages plus risk table**	5	3
Scientific Excellence of user group – **2 pages**	5	3
Links or potential for seeding links with Industry (e.g., European enterprises interested in the results) – **1 page**	3	-
Applications from Member States where similar infrastructures are not available as well as from user groups with no prior experience accessing an infrastructure	2	-
Total score	20	10

Figure 7: Evaluation criteria for transnational access (TNA) in FixO^3

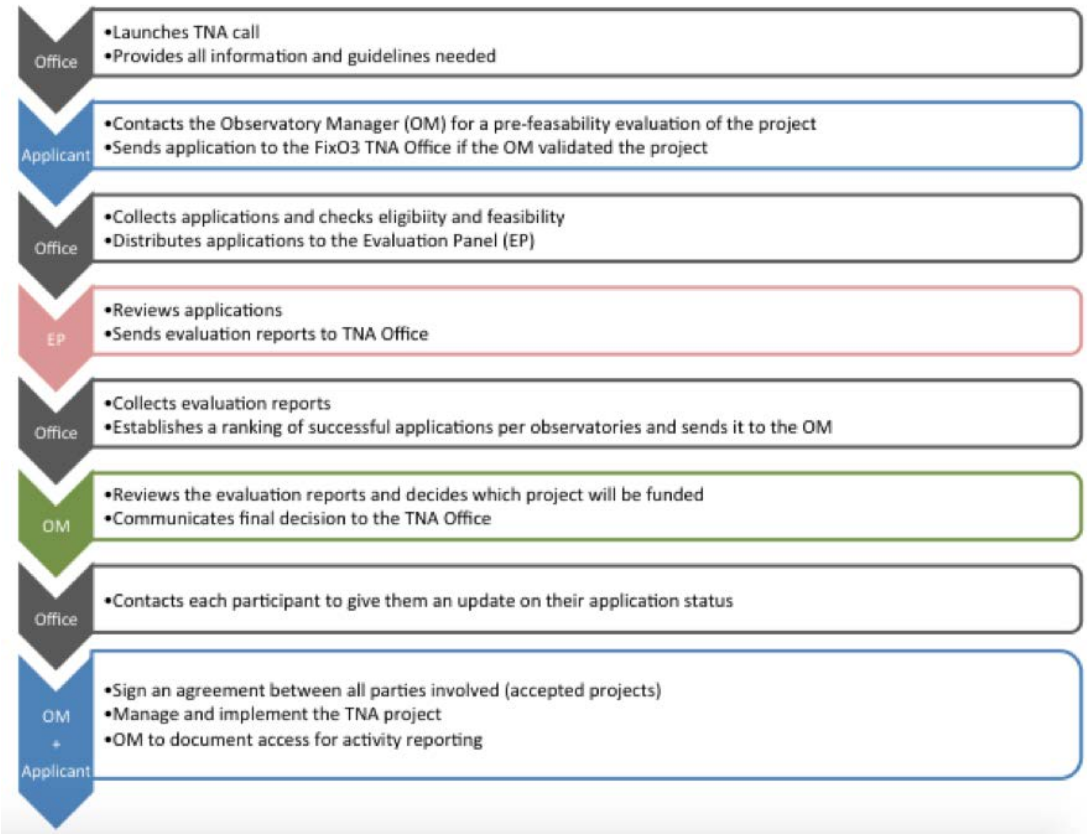

Figure 8: Application and selection process in TNA (FixO^3 project)

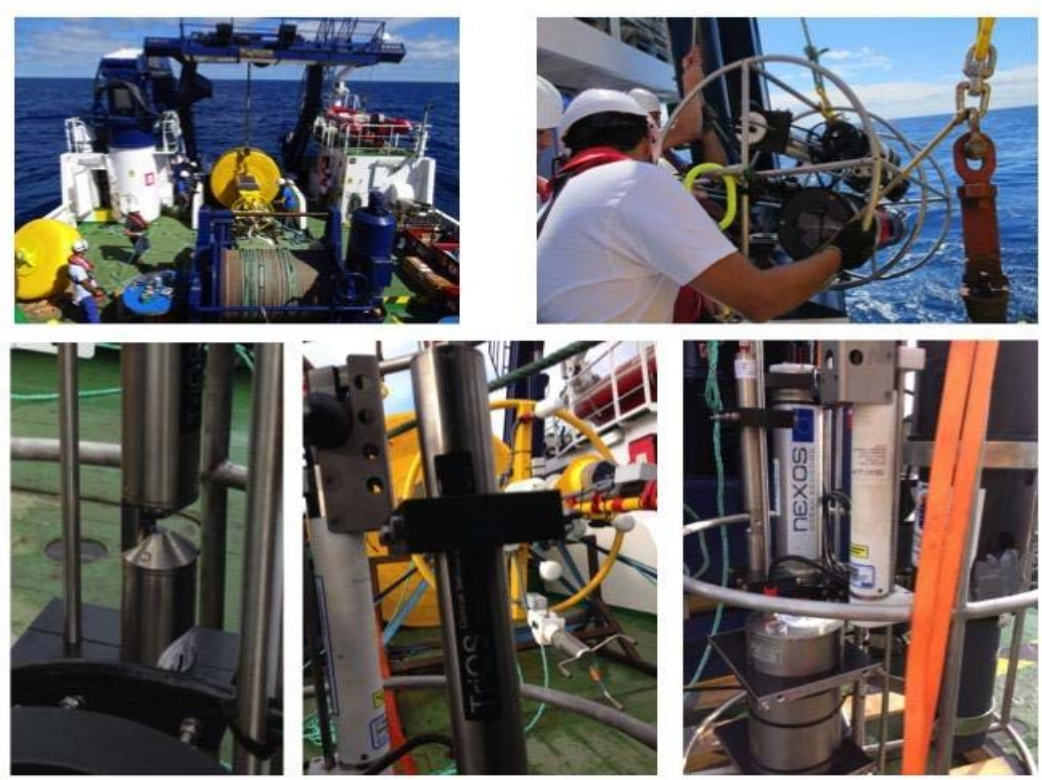

Figure 9: TriOS nutrient sensor installed on the ESTOC frame. Before deployment. FixO^3 TNA Call 2.

Table 4:Atlantic observatories made available for TNA in FixO^3 (2013-2017). Links are provided for each facility for details (sensors available, logistics, conditions of access).

Observatory name (& ID No.)	Location	Short Description
FRAM (ID No. 1)	Fram Strait, Germany	Multidisciplinary, located at Fram Strait, installed to capture the exchange of Atlantic and Arctic waters as well as biogeochemical fluxes and biodiversity patterns, enables long-term, year-round observatories with partial near real-time data access (latitude: 79.07, longitude: 4.13, depth (m): 1000-5500). More...
Station M (ID No, 3)	Norwegian Sea, Norway	Multidisciplinary, located at Norwegian Sea with real-time and delayed mode capabilities, can present the longest existing homogeneous time series from deep ocean (latitude: 66.00, longitude: 2.00, depth (m): 2000). More...
PAP (ID No. 5)	Porcupine Abyssal Plain, UK	Longest running multidisciplinary North Atlantic open ocean sustained observatory delivering atmospheric and physical and biogeochemical ocean datasets in near real-time (latitude: 49.00, longitude: -16.50, depth (m): 4800). More...
MOMAR (ID No.	Azores,	Multidisciplinary (fauna, fluid chemistry, seismicity and ground deformation)

14)	Portugal	situated near the hydrothermal vent Lucky Strike; near real time connection through acoustic link, buoy and satellite communication (latitude: 37.5, longitude: -33.00, depth (m): 1700). More...
ESTOC (ID No. 17)	Off Canary Islands, Spain	Multidisciplinary, located in the Central Eastern Atlantic, open ocean site with over 15 years of continuous surface and mid-water meteorological, physical and biogeochemical monitoring (latitude: 29.04, longitude: -15.15, depth (m): 3670). More...
CVOO (ID No. 19)	Off Cape Verde, Cape Verde	This observatory is composed of a mooring and a small vessel maintaining the time-series continuity at Tropical Eastern North Atlantic (latitude: 17.4, longitude: -24.5, depth (m): 3600). More...
FILCHNER RONNE (ID No. 23)	Antarctic, Norway	Situated at the Filchner sill in the southern Weddell Sea, proved to be the key site for monitoring the Ice Shelf Water overflow produced beneath the huge Filchner Ronne Ice Shelf. It delivers the longest existing marine time series from Antarctica (latitude: -74.65, longitude: -33.55, depth (m): 600). More...

Despite FixO^3 has come to an end as a project, the EMSO infrastructure, which currently includes MOMAR, ESTOC, PAP and may hopefully soon expand to include Norway-operated infrastructures, has the mission to also implement access procedures similar to the TNA mechanism. The AtlantOS community will be informed of the calls. Non-European initiatives similar to TNA have not been identified to date.

EMSO ERIC Transnational Access

While the access opportunity described above (i.e. FixO3 TNA) has now ended, a similar action is in place and planned to continue for the longer term as part of the EMSO ERIC Consortium access to ocean research infrastructures.
Formally, EMSO is a consortium of partners sharing in a common strategic framework scientific facilities (data, instruments, computing and storage capacity). ERIC stands for European Research Infrastructure Consortium (ERIC), the legal framework created for pan-European large-scale research infrastructures.
EMSO consists in a system of European regional facilities placed at key sites, from North East to the Atlantic, through the Mediterranean, to the Black Sea. Observatories are platforms equipped with multiple sensors, placed along the water column and on the seafloor. They constantly measure different biogeochemical and physical parameters, that address natural hazards, climate change and marine ecosystems. EMSO offers data and services to users, from scientists and industries to institutions and policy makers.

Access rules are similar to those described above. They are in fact linked to a structuring project (EMSO-Link) also funded by the European Commission. A first call for proposals was announced in 2018. More information can be found, and for future calls, on www.emso.eu .

Similarly several of the Regional Facilities constituting the EMSO ERIC infrastructure, offer their facilities through open-access. Such infrastructure and access rules are documented below.

Figure 10 EMSO ERIC observatories and test facilities (2018)

Some of the EMSO ERIC regional facilities, like PLOCAN (the Oceanic Platform of the Canary Islands) offer open-access to their installations. The PLOCAN Observatory ESTOC and coastal test site, as the PAP Observatory (operated by NERC/NOCS), EMSO Azores (operated by Ifremer, France) and Smartbay (Ireland) the Marine Institute test site, is part of the Atlantic set of facilities of EMSO ERIC. While EMSO will consolidate as a network of facilities and has the ambition to converge on specific rules of access to the network, and TNA being an example that could be used as reference, each facility may have its own rules for open-access, such as the ones required the Spanish government for their research infrastructure. As such, PLOCAN has its own procedures:

> PLOCAN PERMANENT OPEN ACCESS CALL (2018)
>
> The PLOCAN Access Policy document establishes the guidelines for users to access to our facilities and services. Based on an agile management structure, PLOCAN fosters the use of its facilities and services by public research groups and by the private sector, both national and international communities.
> PLOCAN offers a yearly and permanent Open Access call, based on a simple, flexible and user´s customized access system, always regulated by the principles of transparency, fairness and impartiality.
> Access Committee Regulations
>
> INITIATE ACCESS REQUEST
>
> 1. In order to request access to PLOCAN facilities, please, download and fulfill the Letter of Intent (ALI). This document is necessary to provide your main data contact and express you interest in the use of any particular resource/s, facility/ies and/or service/s offered by PLOCAN.
> 2. Send the document in PDF version to access@plocan.eu using the following identification in the "subject section": "ALI-name of your company-dd/mm/yyyy". For example: ALI-XXXXXXXX-01/05/2017
> 3. PLOCAN will acknowledge receipt and will manage this ALI stating the suitability of the proposal and verifying that the applicant can comply with PLOCAN's access terms and conditions. This stage may require several interactions with the applicant, according to the complexity of the request. PLOCAN will accompany the user throughout the whole process in order to simplify the presentation of the documentation required.

Tropical Atlantic: PIRATA Array

The Prediction and Research Mooring Array in the Tropical Atlantic (PIRATA), initiated in 1997, is now recognized as the reference network of oceanic and atmospheric observations in the Tropical Atlantic, as for climate dedicated research and for operational climate and ocean prediction. The PIRATA network was initiated in the framework of a multinational cooperation and is maintained on the long-term thanks to close

collaborations and a Memorandum of Understanding between US, Brazil and France organizations and now comprises 18 permanent ATLAS buoys along with one ADCP mooring (at 23°W-Equator). As part of AtlantOS, the main objective is to make PIRATA more efficient and relevant in terms of filling bservational gaps- essentially by implementing and operationally maintain additional sensors to existing ATLAS moorings and demonstrating a preview of what could be the "future PIRATA network".

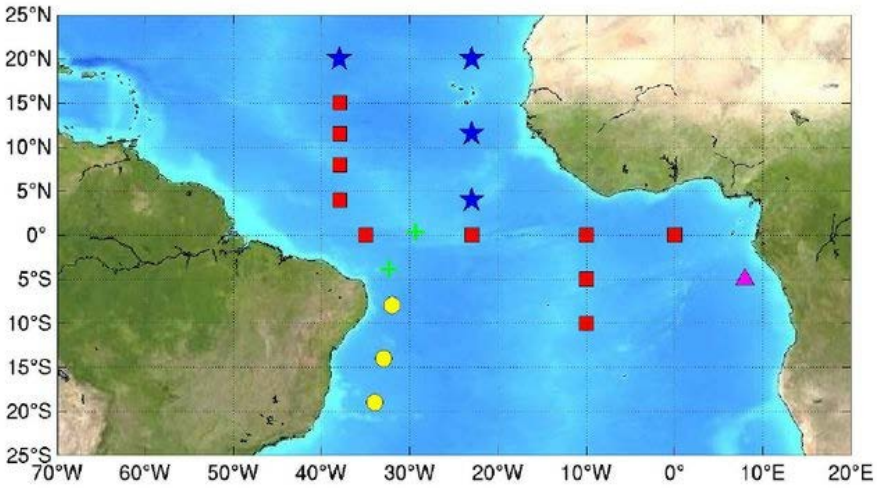

Figure 11: The Tropical Atlantic, showing the PIRATA backbone (red squares), automatic meteorological stations (green +), southwest extension (yellow circles), southeast extension pilot site (magenta triangle), and the proposed northeast extension (blue stars).

This network is maintained thanks to yearly cruises ensured by Brazil (western part), USA (north-eastern part) and France (eastern part). These cruises allow ensuring a large number of measurements (mostly CTD casts along systematically repeated sections at 38°W, 23°W and 10°W) and to contribute to several other programs (e.g., by deploying Argo profilers and SVP drifters).

The first workshop organised by AtlantOS WP6 Task 6.3 identified the following action items (Annexe 1):
Geographic gaps, sustainability and ensuring priorities:

- Propose a meeting jointly with AORA to encourage more multidisciplinary observing in the tropical Atlantic arena, building on PIRATA, RAPID, ESTOC, CVOO, OTN and others. Maybe focus/use of the OSSE work?
- Concerning the sustainability, enhancements create additional costs, efforts, and requirements in terms of power consumption and data transmission. It is therefore necessary to fully justify any additional sensors, e.g., in terms of scientific relevance and impact.
- Seriously consider capacity building (training aspect in particular). This is endangered because of a lack of sponsors. The European Commission should be informed of the training requirement and open topics in this regard.

For more details and developments in AtlantOS WP3:

D3.3 PIRATA network improvement Report: Report on new (physical, meteorological and biogeochemical) sensor implementation and derived time series. PM24.

D3.19 Organization & sustainability of PIRATA network Report: A detailed report on the renewed PIRATA network, and its potential sustainability over long-term. This deliverable will be established with the contribution of the PIRATA International Scientific Steering Group and PIRATA partners. **PM45**). See: https://www.atlantos-h2020.eu/project-information/work-packages/deliverables/

Legal framework in accessing European ocean-going Research Vessels

In this section we focus on the legal considerations to be aware of in accessing European research vessels (RVs) from Norway, France, Spain, Germany, Great Britain, Ireland. This is an excerpt of the full report in Annex 4, where a study of other countries of the Atlantic rim can be found.

"Except for the case of Great Britain in the evolution of the Brexit, and Norway with special agreement with the EEC, all countries are within the range of the European economic community and have very similar legal systems. In all cases, ships with flags in these countries belong directly to public administrations or to agencies that depend on those administrations. The management of these vessels is carried out through the agencies or institutes, in agreement with their own regulations and with a similar management of owned private vessels. There are only exceptions in case the ships belong directly to the navy of different countries. In this cases, vessels do not usually have an IMO number and are exempt from compliance with international treaties, although most of them comply with due diligence in terms of standards of conduct.

MO Regulations and Classification.
For all purposes, except for the ships belonging to the Navy of any of these countries, the rest of the oceanographic ships, even if they are considered public ships, they comply with the international conventions of the IMO, with instruments such as SOLAS, MARPOL, STCW, etc. From the statutory point of view, they are subject to be inspected by the administration of each country, unless they authorize or delegate in a classification society, such is the case of Norway. Likewise, its built has been carried out under the supervision of a classification society, which allows us to know the scope of its certifications and limitations of navigation areas for its use. Having this type of classification, allows to have advantages in everything related to the insurance of the boat and the scope of their terms. In the case of European countries all ships, except the military, are classified in a classification society.

Port State Control and MOU
With the same exception, all European oceanographic vessels will be subject to the regulations of the MOU of Paris, or to the MOU that corresponds in the area or country where the work is carried out. This indicates that all comply with all the guidelines of the agreements that result from the issuance of their statutory certificates, may be inspected and detained if they do not comply with the mentioned regulations, or it may be the circumstance of detention in another country that is not of her flag until the deficiencies observed are amended.

Crews and plan for researchers
All ships have their minimum crew table according to the rules of the flag state administration and the crew will have the qualifications required by the flag according to the position held in that table. Except in the case of military vessels, all these vessels must comply with the SCTW agreement and in case they call to other ports, that are no the port of their flag, they have to comply with the MLC agreement, since crews not need to have a military status, being recruited through Crew Management Companies.
Now, under what rules are included the researchers who use the vessel for their campaigns? In this regard, it should be noted that these are not passenger ships and that there may be circumstances in which the boarding of more than 12 non-crew members could occur, which limit could be considered as a passenger ship. In this regard, it should be noted that the vessel considers these researchers as "non members of the crew". their boarding is made under their own personal responsibility or under the organization for which they provide their services. However, the vessel must provide with sufficient means of rescue according to safety regulations (eg, SOLAS) for the number of researchers that are on board. According to what it has been observed, although each country has its own regulation, the rules is the same as for the crewmembers
We have found certain exceptions for the case of the two vessels assigned to United Kingdom, in which, although complying with the mentioned regulations, it makes exceptions in some of the points mentioned for vessels of the EEC. The training of the personnel of the National Marine Facilities Sea Systems (NMF-SS).

Personal injuries and material damages.
Regarding the regime of responsibilities in the relationship between ship owner or operator and the members of the expedition that embark for a campaign, we can divide them it in two parts for the EU countries.

- Material damages.
- Personal injuries of non-crewmembers

In this regard, except for military vessels, all EU countries, except United Kingdom and Ireland, have Protection and Indemnity Insurance coverage, also known as P&I, under the single premium concept or those with a "mutual" concept through a P&I Club .

In an analysis of the coverages in both modalities, the ship owner face the responsibility of his ship to third parties, personal injuries of his own crew, damages by pollution damages to cargo, possible damages by collision during navigation (most common is ¼ of those from the results responsible) damage to fixed objects, damage to the cargo from which his direct liability refers, wreck removal and other damages to third parties. The limit of liability in the policy is € 500,000. They can limit their liability in case of pollution. According to the rules of the Clubs of P&I companies of the European oceanographic vessels, their coverage does not cover the possible research campaigns carried out in the USA and Canada. This means that, in some exceptional circumstances, these vessels could not operate in these latter two countries except under their own risk.

On the other hand, because the nature of the research campaigns may involve risks that involve the responsibility of the vessel, according to the rules of the Club the members that form part of the campaign of investigation must inform the Club giving details about the nature and risk of the investigation to be carried out. This is what in terms of insurance is called a "warranty", that is, its default implies the nullity of the contract or insurance.

It is evident that the operators of these kind of ships must comply with the due diligence in all their operations and in the care of their vessel. One of the first obligations is to maintain its class condition with the Classification Society, reason why we have tried to identify which ships have it or not. Normally the maintenance of the class is another warranty.

Finally, in this regards other of the most important warranties for the Club is the updated maintenance of the statutory certificates, certificates that can only be issued by the state of the flag or by an entity authorized by the flag. Among the certificates issued by the state is the Blue Card, antipollution certificate and the Wreck Removal certificate, required in foreign ports where the vessels operate.
Being update with the statutory certificates corroborates that the ship complies with all the conventions or instruments of the IMO as those already described.

Considering all the exposed, the liability of the scientific equipment of the campaign, lies on the researchers, who have been declared according to the rules of the Club and they are risks covered according to their rules. From our point of view, the researchers should have their own insurance policy for their equipment for the possible risks at sea or against possible pollution problems that can happen with them, since the Club restrict a lot its coverage to them. In the practice, the best solution is to recover any compensation for damages directly from the insurer of the equipment and if those result to be of owner's responsibility, it is more practical that the insurance of the equipment does the necessary formalities for any recovery action from the P&I Club.

Personal injury of non-crew:
In the case of non-crew members, the P&I Insurance coverage of responsibility for this kind of vessel is extremely. Limited. To avoid surprises in case of illnesses or accidents, it is still advisable to have your own health insurance. In the same way, in regards of the equipment, a declaration must be made to identify the number of people that make up the expedition. It is also usually requested their corresponding medical certificates in order to authorize them to board the vessel.

It is quite recurrent that an evacuation is necessary as a result of illnesses or accidents. For that reason, the insurance of the members of these expeditions must include coverage for this possible evacuation. In this regard it should be noted that the evacuations are usually done with helicopters of public ownership and that due to its cost, the evacuation should be authorized by CIRM (The International Radio Medical Centre), after

making a primary diagnosis with the help of the crew of the vessel. This is very important, since if the relevance of the disease does not justify this kind of evacuation, the vessel should proceed to the nearest port to make the disembarkation of the member of the expedition, with all the inconveniences that may arise from it. In the case of making an evacuation contravening the diagnosis of the CIRM, the full cost of the operation, which would be of a commercial nature, should be paid by the own Insurance of the crew member.

In the cases of the Republic of Ireland and the UK, the particular terms for the researchers or scientists on board, as in the previous cases, involves filling out a certain number of questionnaires similar to those submitted to the P&I Clubs. In the links included in the database, all these particulars can be found.
As we have already explained, all this kind of vessels are public ownership and could be exempt from many IMO agreements and could operate unilaterally. However, most of them have considered more cautious to work as a commercial vessel.

Vessels OFEG (Ocean Facilities Ship Group)
As can be seen in the research vessel information sheet that contains the database, all the European ships registered, except for six of them, are registered in the OFEG (Ship Barter) Ocean Facilities Ship Group. See Webpage http://www.ofeg.org/np4/home.htm. In the case of Irish vessels, they do not belong to this group already set up. The exchange program also covers other types of facilities for oceanographic research. On the web you can verify all the existing programs and availability of equipment and vessels. In the database you can find a large range of links for the exchange process. In the forenamed case of Ireland, although it is not in the OFEG, within the specialized Marine Services of the Government, scientific and logistic operations are offered that are world-leading worldwide, including The Antarctic, Australia, the Pacific, Middle East and the North of Europe. For this purpose, they have two vessels and a wide range of information to request entry into the research programs.

Vessels EUROFLEETS +
Finally, in a European context, from January 2019 the integration within the European fleets of oceanographic or research vessels in the EUROFLEETS agreement has begun. Although this is not the main object of this work about the oceanographic vessels Ocean Going and the Atlantic watershed, they are included as long as they are countries of the EU.

Customs
The installation of equipment on board ships of another nationality on a temporary basis will be subject to temporary imports regimes. All the procedures will be carried out through the local agent of the ship where the installation will take place, so it will be coordinated if it is in transit or with return through the country. All the equipment will be subject to its admission on board the ship depending on their limitations imposed both by the export and import customs of the country of the flag.

In the specific case of countries of the European Community, the transits between countries of the community will have free circulation by road of the equipment to be used in the research programs. However, the difficulties could arise at the time of boarding this equipment or at the moment they have to embark them. and in which country this is carried out. In this regard, apart from the information provided in the forms by the operators of the ship, the visit to the customs office should be asked with a customs agent or freight forwarder, depending on the port where it is intended to embark or return later. All the equipment under temporary import system must be returned to its origin to recover the guarantees that must be deposited. In cases where the demob is carried out through the country of origin of the equipment, the use of the ship's agent, freight forwarder and / or customs agent will always be necessary.

Heavy or dangerous equipment.
We understand that some of the necessary equipment for a research campaign could be heavy, dangerous or oversized. In such cases, they must be shipped and stowed in the same manner as any general cargo that is declared as heavy or dangerous in a commercial vessel. In this respect we must make a synthesis of all the

exposed from the normative point of view and even being a vessel from a public administration, they must keep the duly diligence and the good practices. As explained, the research team must make a detailed statement of all the equipment that will be used, detailing its weight and size.

Usually, vessels have a manual of stowage in which lashing terminal points and lashing equipment are described. The crew of the vessel or its managers should deal with the equipment, if its weight and position on board would affect the stability of the vessel as well as if its installation would require additional benches or structures. All this should be reviewed by a team of naval architects or captains' specialists in stowage on board. The cost of all these calculations should be assumed by the charterer, and it will be under their responsibility and acceptance of the P&I Club.

In the case that the equipment or cargo to be transported is considered as 'dangerous goods' according to the International Maritime Code of dangerous goods (IMDG Code), a prior declaration should be made, and precautionary measures should be taken, placing on board the mandatory signals in accordance with the aforementioned code. We insist that the shipment of the whole equipment should be detailed in the voyage plan to the ship owners and to the P&I Club.

In the case of oversized or dangerous cargo, the expedition manager must insure their equipment. Special relevance and care should be taken in the case of the use of isotopes that could be necessary in the research campaigns. In such case, it should be advised to the ship owners as well as to the P&I Club, who tends to be quite restrictive.

Environment
In general, the statements to be made by the managers of the research team include a description of the targets of the expedition and of the means to be used. Also, in most cases, preliminary, follow up and final reports are required. In the case of Spain, a report on the environmental impact of the work to be carried out is specifically required. In other cases, specific authorizations are required for expeditions of a seismological nature or that represent the emission of any type of radiation.

Special relevance arises in the case ships of a particular flag operate in waters of other countries. There are cases in which they require the presence of a member of the country holding the flag of the exploration area. Damages caused to the environment by research equipment will be assumed at your own risk, reason why it will be advisable to have your own insurance coverage. "

Sharing other resources and capacities

Ocean Best Practices

Ocean Best Practices System (OBPS) includes an open access, permanent, digital repository of community best practices in ocean-related sciences maintained by the International Oceanographic Data and Information Exchange (IODE) of the UNESCO-IOC as an IOC (IODE, GOOS) coordinated activity. Its organization, a partnership of IODE, GOOS and JCOMM, has collaborative relations with many of the prominent institutes, networks and organizations that are the source of ocean data and information. OBPS offers an array of services in discovery, access and training of Best Practices working with the technical communities that originate and use best practices. The best practices can be contributed in any format, e.g. standard operating procedure, manual or guide. The range of best practices can be sensors and calibration to data management to modelling and applications. This is the full range of the value chain from observation to information products. OBPS also offers the opportunity to submit Best Practice documents for peer review in the Frontiers in Marine Science Journal as a Research Topic: "Best Practices in Ocean Observing". The Research Topic includes a forum for community discussion about best practices. One of these topics has been a continuing debate – how is "best" determined. In practice, the repository allows multiple practice descriptions. For Essential Ocean Variables (EOV), it is better to have a methodology referenced in the EOV description and so GOOS, through its panels, is looking at a process for recommendations of best practices. In the end, the importance of practices is to improve interoperability and reproducibility of observations and

data, consistent with the objectives of AtlantOS Task 6.3. Collaboration with AtlantOS Tasks 6.2 and 6.4 have helped to move this aspect of interoperability forward.

Other capacities: software, calibration facilities

Open tools for implementation of OGC Sensor Web Enablement standards

The Open Geospatial Consortium (OGC) comprises over 400 companies, governmental agencies and universities and acts as a non-profit organisation. The main goals are the development of standards for data models and web services in a spatiotemporal area.

The Sensor Web Enablement (SWE) domain working group is a working group of the OGC which develops standards for sensor data and metadata in the geospatial web. Generally the standards in the SWE framework can be divided in *information* and *interface* standards. The *information* subgroup defines standards for data models and sensor web encodings while the *interface* subgroup are responsible for the different sensor web service interface specifications.

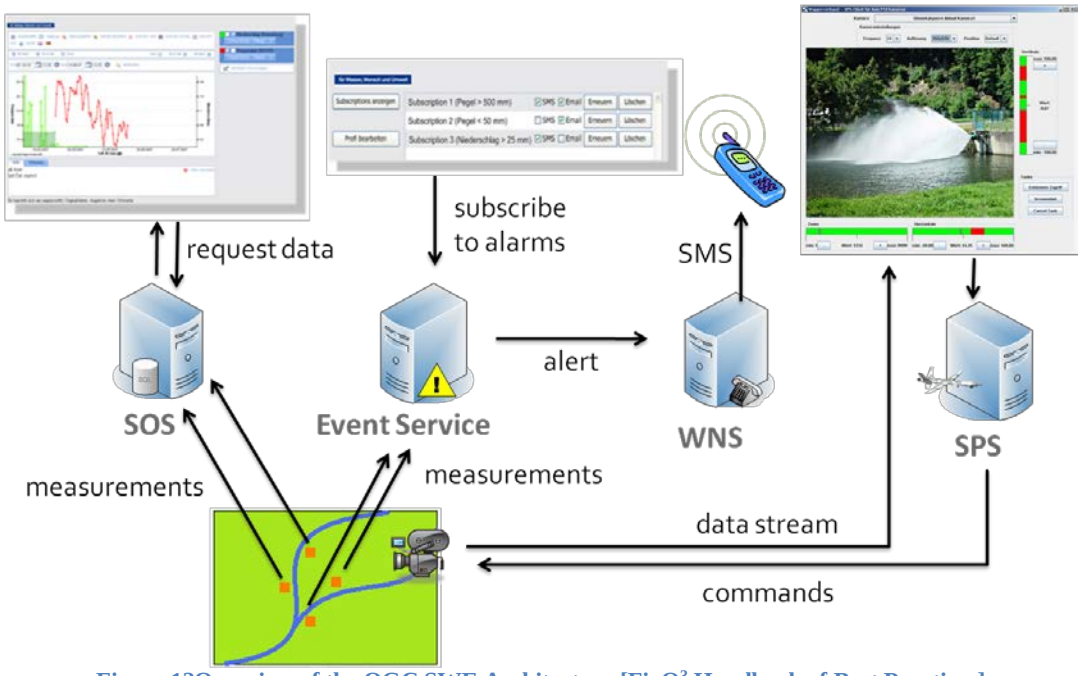

Figure 12Overview of the OGC SWE Architecture [FixO³ Handbook of Best Practices]

Figure 12 shows an overview of the OGC SWE architecture. It comprises the following components:

- Data Models and Encodings:
  - ISO/OGC Observations and Measurements models the gathered measurement data
  - OGC Sensor Model Language describes the sensors and processes which have acquired a certain observation data set (→ provision of metadata)
- Service Interface:
  - OGC Sensor Observation Service: interoperable access to measurement data and sensor metadata
  - OGC Sensor Planning Service: interface to send tasks and configurations to sensors
  - Event Services: subscription to defined events and alerting if the defined events are detected

URLs for standard definitions and the tools developed, available to the international community:

Standards
http://www.opengeospatial.org/standards/sensorml

http://www.opengeospatial.org/standards/om

Tool/SensorML Editor
https://github.com/52North/smle

Tool/Viewer
https://github.com/52North/helgoland

Technology testing with the Alliance for Coastal Technologies

There is a need from a regional and global perspective to have a resource to look at sensor and platform performance and calibrations. The US-based Alliance for Coastal Technologies (ACT) is a partnership of research institutions, resource managers, and private sector companies dedicated to fostering the development and adoption of effective and reliable sensors and platforms. Instrument performance demonstrations and verifications are necessary so that effective existing technologies can be recognized, and promising new technologies can become available to support coastal science, resource management, and ocean observing systems. To this end, ACT serves as an unbiased, third party testbed for evaluating sensors and platforms for use in coastal and ocean environments. Table 5 gives access to documents on current technology testing request and evaluations that have taken place and are made available to the community. More information on past and current calls and opportunities can be found on http://act-us.info. There are a number of ACT documents that are part of the OBPS repository mentioned above in the section on best practices.

Table 5:Links to ACT requests for technologies and current evaluations

HYDROCARBON	pH	DISSOLVED OXYGEN II
pC02	SALINITY	NUTRIENT
TURBIDITY	FLUOROMETER	DISSOLVED OXYGEN
ALGAL TOXINS (In Dev.)	FLUOROMETER II (N/A)	NUTRIENT II

Ocean Tracking Network (OTN)

The OTN is an interesting example of sharing. It is a recent capability, born in a time when sharing at a global level was appreciated. While focused initially in Canada, OTN is deploying Canadian-made acoustic receivers and oceanographic monitoring equipment in all of the world's five oceans. This global receiver infrastructure comprehensively examines the local-to-global movements of tagged marine animals such as sharks, sturgeon, eels, and tuna, as well as other marine species including squid, sea turtles, and marine mammals. OTN's underlying concept is to share costs, resources, expertise and data with global partners to enable the creation of a global acoustic telemetry network. OTN also includes work with other technologies, including satellite telemetry and data storage tags, which can contribute knowledge about animal movements and their environmental correlates. Joining the Ocean Tracking Network connects projects to a global community of telemeters, allowing your data to join the OTN database, where it can be cross-referenced, quality controlled, and made available in many highly useful formats for analysis and visualization. Find out more information to participate at http://oceantrackingnetwork.org/join-otn/ .

Figure 11 Ocean Tracking Network (OTN) global map of projects and data partners

OTN is attempting to cost-effectively deploy the acoustic receivers to cover areas that currently do not have acoustic receiver coverage. For relatively small cost, and with a very small physical footprint, an acoustic receiver can be added to many types of fixed moorings. This helps maximize the value of the mooring costs because it serves a broader scientific community. The ideal situation is to nest the sharing within pre-existing networks of moorings (e.g., PIRATA) where there is already an efficient governance and maintenance group in place. Looking at the North Atlantic Ocean, there is a lot of mooring systems but there is not yet an overarching governance structure to bring them together. Creating such a governance structure would be good.

Funding model

In a sense, OTN is built on a co-funding model. OTN has been supplying equipment free of charge, and OTN partners have been providing operations and maintenance support for the equipment as an add on to their existing funded programs. Canada is creating programs that could open up opportunities.

OTN-related developments in AtlantOS

D3.2 ETN Valued species Report: Provide operations and maintenance support to scientific teams initiating studies of valued species, such as bluefin tuna, European eel, sea bass, sea trout. To achieve this deliverable we will hold a workshop focusing on launching and networking activities (experimental design, funding, etc.).

D3.10 ETN Technical standards: Development of technical standards for specific European lines and tagging projects in the form of a report.

D3.21 EATN Database: Development of a European Tracking Network component of researchers and database, sharing common standards and protocols, data formats and platforms, and interlinked to other existing or developing Atlantic Ocean networks in Canada, the USA, Africa and South America (starting in Brazil) to provide a global Atlantic tracking network. Report is Due in December 2018

EnvriPLUS Recommendations on access to RIs

Of relevance to AtlantOS observing research infrastructures, the EnvriPLUS project has produced recommendations based on the existing policies in the European ESFRI forum and other Research Infrastructures (RIs), research institutions and international projects. They take into account the existing legal frameworks and policies related to the access to RIs.

The recommendations address the issue of physical access to RIs, the access and usage of data, also beyond basic research considering the commercial use of data for services with societal relevance which is particularly relevant for Environmental RIs. Scientific, legal, and organizational aspects are taken into account, aside from the possibly arising ethical issues.

The related deliverable will be available on the EnvriPLUS website shortly after the submission of this report on the following link: http://www.envriplus.eu/deliverables/

New protocols and technologies in instrument and data sharing

At Oceanology International 2018 a workshop was held to engage with the community to further demonstrate, in the field, new interoperability tools that have been developed and field-tested for ocean sensor and real-time data sharing, based on OGC standards. These software and firmware tools have been implemented on different platforms and sensors. They are available open-source and now require substantially less engineering time than in the past. A session was specifically dedicated to the training of workshop participants interested in participating in an interoperability experiment in the field, in the framework of AtlantOS, and in collaboration with other initiatives like EMSO ERIC, Seadatanet, EMODNet, ODIP, and ENVRIPlus. The workshop took place during the conference to facilitate industry participation. The workshop was open to ocean scientists, engineers and technicians dealing with in-situ sensor and observing systems, from academia or industry. Participants were offered presentations and demonstration of the latest interoperability technologies, and the opportunity to participate in a joint field experiment.

Mission description templates were produced to help candidates describe the planned field demonstration of their systems integrating interoperability technologies such as those presented at the workshop. All presentations of the workshop were made available on-line3 at and include links and contacts for the tools available to the community for the implementation of OGC Sensor Web Enablement and OGC PUCK software solutions.

[3] https://www.atlantos-h2020.eu/events/training-workshop-interoperability-technologies-for-sharing-ocean-instruments-and-real-time-data/

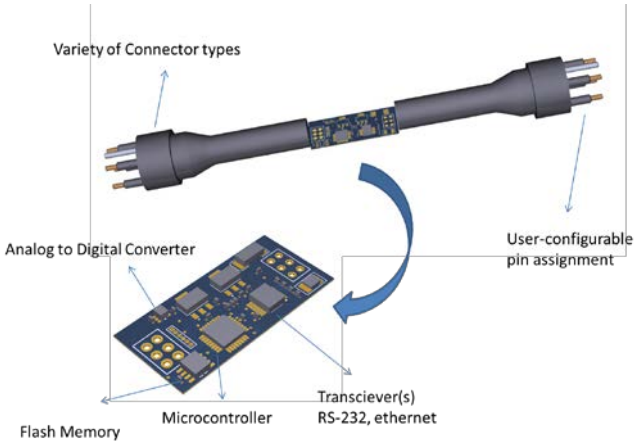

Figure 13 Smart cable from AtlantOS mission, led by Cyprus Subsea Consulting at PLOCAN facilities (see Annex3)

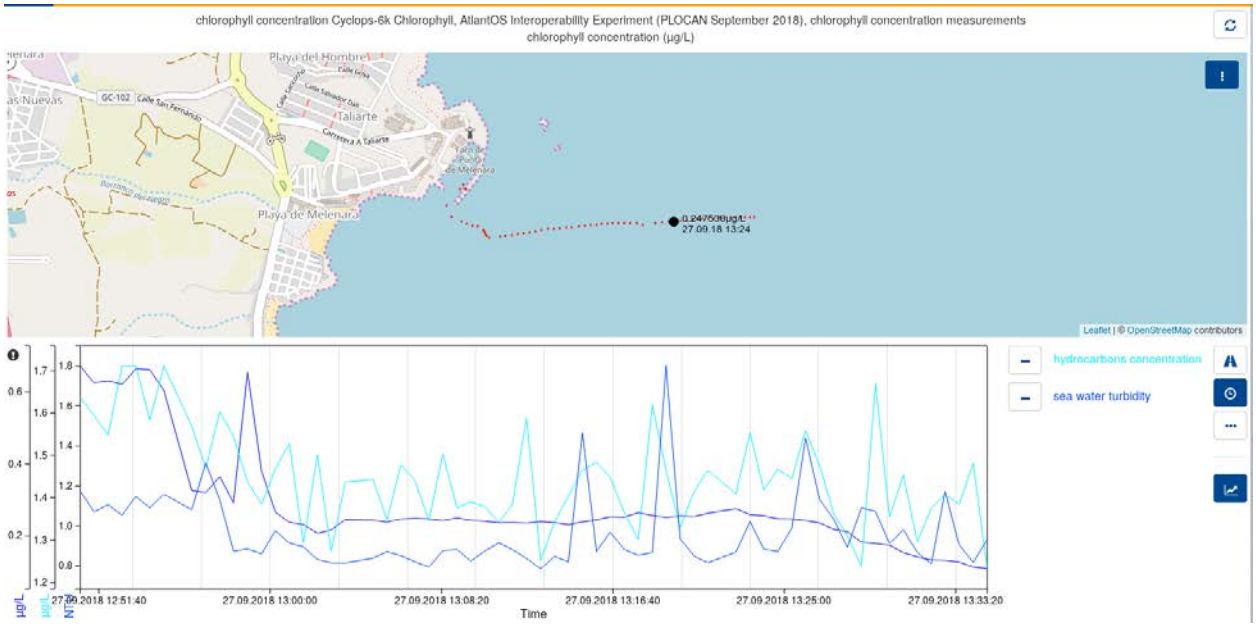

Figure 14 SWE viewer with fluorescence measurements from waveglider equiped with three Turner Design fluorometers and smart cables, off Taliarte harbour, Gran Canaria (September 2018).

Summary and Recommendations

Exchanges with the AtlantOS community and a good number of currently running projects and initiatives tell us that there are opportunities, mechanisms and new technologies available for sharing observing infrastructure in the Atlantic basin. The report has highlighted a subset: Infrastructure sharing mechanisms, such as European projects and initiatives with transnational access opportunities (Eurofleets, EMSO ERIC, the Ocean Facilities Exchange Group (OFEG)), the transnational operation of open-ocean observing systems (PIRATA, Ocean Tracking Network), umbrella initiatives (AORA), exchange of practices (Ocean Best Practices), and innovative technologies (Real-time data exchange through Sensor Web technologies, new mechanisms for instrument integration and traceability). The report also addressed the legal considerations that need to be accounted for at the time of opening infrastructure to external participants.

The reported opportunities would also benefit from further opening of those instruments to countries of the Atlantic rim, under the umbrella of Atlantic framework initiatives (e.g. the Galway statement). Further engagement of non-European countries in offering and disseminating similar initiatives as the ones presented in this report would also be of great benefit and encourage the European countries in strengthening the transatlantic collaborative programmes for ocean observing. The promotion of an "OFEG-Atlantic" also caught the attention of the community in both international workshops organised in AtlantOS (task 6.3), in particular for the bartering of ocean-going research vessel time.

From a technological standpoint, there would be important benefits in further developing networks of users for the testing of interoperability standards for instrument and real-time data services. These technologies are still in development and lack the desired level of adoption from users and instrument/platform manufacturers. Tools are open and accessible free of charge and have been supported by a number of communities beyond ocean observing, yet mainly in Europe and in the US. We therefore encourage and invite other countries to engage with the authors of the report and the developers of those technologies to explore paths of collaboration. Adoption of these innovations by the broader community (e.g. the Atlantic observing system operators) through interoperability experiments will foster interest from the sensor and platform manufacturing sector in enabling them.

Bibliography

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Annex 1

Report of the AtlantOS workshop on strategies, methods and new technologies for a sustained and integrated autonomous in-situ observing system for the Atlantic Ocean, supported by AORA-CSA

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Executive Summary

This workshop was held at PLOCAN, Gran Canaria (Spain) from the 2nd to the 4th of November 2016. The idea of this 3-day scientific and technical joint event was motivated by an attempt to better integrate activities in AtlantOS across work packages, as well as to better involve international participants in the process. The focus of the workshop was mainly on AtlantOS WP6 and WP3 activities, and aimed at better integrating the project's cross-cutting issues, emerging networks and technological innovation activities through the enhancement of the Atlantic network of autonomous observing systems, fixed and mobile. The event was open to all AtlantOS work-packages and task leaders interested in contributing. The event was also open to international participants who have an interest in joining and contributing to the AtlantOS community and initiative. Clear interest in better integration was substantiated by the attendance of participants from Brazil, Argentina, Canada and the United States, as well as from within Europe . Contributions of the Atlantic Ocean Research Alliance-Coordination and Support Action (AORA-CSA) were also important to the success of the workshop as these provided an overview of the strategy across the Atlantic Ocean, helping existing and planned observing networks to align with the requirements of the Galway statement. AORA-CSA contributions mainly included updating attendees of the AtlantOS community on the AORA-CSA initiative, the project's progress with respect to ocean observation (WP5) and the sharing of infrastructures (WP10) activities, and progress in better integrating international perspectives.

The specific objectives of the workshop were to:

- Contribute to the integration of European and international activities.
- Discuss challenges and opportunities to better integrate and enhance the network of autonomous observing systems.
- Produce recommendations for the contribution to the blue print.

Key concepts such as infrastructure sharing, autonomous systems operations, new technologies and maturity, best practices, were discussed.

To address these objectives and concepts, the workshop was organized into the following sessions:

Session 1: Overview and update of the AtlantOS and AORA-CSA projects.
Session 2: International presentations.
Session 3: Review of existing mature autonomous observation platforms.
Session 4: Overview and update on new sensors and platform integration developments in AtlantOS and Ocean of Tomorrow projects.
Session 5: Review of flagship initiatives/methods of sharing facilities.
Break-out sessions related to cross-cutting issues & opportunities:

- Capacity sharing: opportunities and methods.
- Best practices in autonomous systems.
- Data management, sharing and interoperability.

Break-out sessions related to guidelines towards the post-AtlantOS autonomous observation system and meeting new requirements from the international scientific community:

- Essential Ocean Variables (EOV) vs Technology Readiness Levels (TRL) for new variables.
- Geographic gaps and priorities.
- Among-networks data harmonization issues.

Common priorities and agreed actions for next steps that emerged from all themes were:

Capacity Sharing:

- Focus on significant assets that are either unique or costly, use unique identifiers and produce documentation (ships, research stations, observing equipment).

- Is there scope to build an Atlantic wide sharing mechanism? Create an Ocean Facilities Exchange Group (OFEG)-Atlantic?
- Include data sharing as part of the sharing mechanisms
- Propose an AORA strategic action to compare sharing methods and recommend more Atlantic-wide solutions.

Best Practices:

- Develop a bibliography of existing 'Best Practice / Standard Operating Procedures' for the AtlantOS work scope.
- Have splinter meeting on this topic at the next AtlantOS General Assembly.
- Think about some 'policy statement' for the Atlantic Observing community.

Data Management:

- Develop a 'descriptive document' on the role and functions of the various data centers (maybe a good action for a joint AORA- AtlantOS work).
- Encourage full metadata delivery with all data sets even if this is not required today.

Network Data Harmonization:

- Encourage the engagement of AtlantOS and similar projects in the EU-Science Data Cloud, to be joined up with South Africa.
- Also encourage a comparable engagement with US (Earth-Cube?) and Canadian projects.
- Encourage the establishment and promote the use of standard descriptors to allow best data harvesting. (Best practice agenda).

Essential Ocean Variables and the role of Technology Readiness Levels:

- Need to discuss the opportunity space for new Essential Ocean Variables over the next 5-10 years.
- Consider having a Transatlantic Dialogue on the sensor development road map in the context of future EOVs (e.g., nutrients, carbonate and microbes/omics as a focus).
- Include issues such as metrology, data compression, comparison of performance and establish review criteria.

Geographic gaps and ensuing priorities:

- Propose a meeting jointly with AORA to encourage more multidisciplinary observing in the tropical Atlantic arena, building on PIRATA, RAPID, ESTOC, CVOO, OTN and others. Maybe focus/use of the OSSE work?
- Which country has the possibility to engage in closing 'global' gaps which might be outside national/regional priorities? "Green Fund Opportunity"?

Information Sharing:

- Explore new opportunities through deep-learning to get information flow across variables.
- Expand the focus of capacity building: augment technical training, focused on using the available information for country-specific applications.

Use these activities to help build-up the national demand for more observing and hopefully increase engagement in sustained observing.

Attendees names and abbreviations

	Name	Last name	Institution	Abbreviation
1	Pedro	Afonso	IMAR - UAzores	PA
2	Daniel	Alcaraz	PLOCAN	DA
3	Carlos	Barrera	PLOCAN	CB
4	Leonardo	Barreira	IPqM	LB

5	Bourles	Bernard	IRD, FRANCE	BB
6	Erik	Buch	EuroGOOS	EB
8	Maria Paz	Chidichimo	CONICET	MP
9	Hervé	Claustre	UPMC- LOV	HC
10	Henk	de Haas	NIOZ	HH
11	Laurent	Delauney	Ifremer	LD
12	Eric	Delory	PLOCAN	ED
13	Joaquín	Hernández Brito	PLOCAN	JH
14	Francisco	Hernandez Lucas	VLIZ	FH
15	Felix	Janssen	AWI	FJ
16	Richard	Lampitt	NOC	RL
17	Julien	Legrand	IFREMER	JL
18	Edouard	Leymarie	UPMC- LOV	EL
19	Pascale	Lherminier	Ifremer	PL
20	Michele	Barbier	UPMC- LOV	M
B21	Matt	Mowlem	NERC	MM
22	Grigor	Obolensky	EURO-ARGO	GO
23	Jay	Pearlman	IEEE France	JP
24	Francoise	Pearlman	IEEE France	FP
25	Paul	Poli	Météo-France / EUMETNET	PP
26	Margaret	Rae	Marine institute/AORA-CSA	MR
27	David	Smeed	NOC	DS
28	Björn	Suckow	ttz Bremerhaven	BS
29	Victor	Turpin	CNRS/EGO	VT
30	Marimar	Villagarcía	PLOCAN	MA
31	Martin	Visbeck	GEOMAR	MV
32	Christoph	Waldmann	MARUM	CH
33	Fred	Whoriskey	Ocean Tracking Network	FW
34	Christian	Wolf	AWI	CW

Agenda

Wednesday 2nd: 10:00 – 17:00

Update on AtlantOS, AORA - CSA, International Perspective

TIME		
9:30-10:00	Shuttle from Las Palmas to PLOCAN	
10:00 - 10:15	Registration	
10:15 – 10:30	Welcome. **Joaquín Hernández**	
10:30 – 10:35	Logistics. **Daniel Alcaraz**	
10:35 – 11:00	Objectives of the workshop. **Eric Delory**	
11:00 – 11:30	Coffee Break	
11:30 – 12:00	AtlantOS Overview and update. **Martin Visbeck**	*Chair:* **Erik Buch** *CoChair*: **Carlos Barrera**
12:00 –12:30	AORA-CSA Overview and update. **Margaret Rae**	
12:30 -12:45	Observing systems, strategies and related aspects (WP5). **Joaquín Hernández**	
12:45 - 13:00	Infrastructure sharing (WP10). **Margaret Rae**	
13:00 – 14:00	Lunch	
14:00 - 16:00	International Presentations: The Oceanobs Research Coordination Network. **Jay Pearlman** Argentine capacities, activities and perspectives related to observations in the South Atlantic. **Maria Paz Chidichimo** Going global with electronic animal telemetry. **Fred Whoriskey** Recent advances on underwater acoustics soundscape monitoring systems in Brazil. **Leonardo Martins**	*Chair:* **Eric Delory** *CoChair*: **Daniel Alcaraz**
16:00 - 16:30	Coffee Break	
16:30 – 17:00	Day 1 Wrap-up & Action items. **Margaret Rae**	
17:00 - 17:30	Shuttle from PLOCAN to Las Palmas	

Thursday 3rd: 09:00 – 17:00

Autonomous in-situ Observation Platforms, new technologies

TIME		
8:30 – 9:00	Shuttle from Las Palmas to PLOCAN	
9:00 - 9:15	Day 2 introduction and expectations. **Hervé Claustre**	*Chair:* **Hervé Claustre** *CoChair:* **Félix Janssen** / **Michele Barbier**
9:15 – 11:15	Review of existing mature autonomous observation platforms: • Argo (Euro-Argo). **Grigor Obolensky** • Fixed-point open ocean observatories. **Richard Lampitt** • Transport Mooring Array. **David Smeed** • Gliders. **Victor Turpin** • Surface drifters. **Paul Poli** • Mooring Array in the Tropical Atlantic (PIRATA). **Bernard Bourles** • Animal Telemetry Network (EATN). **Pedro Afonso** / **Fred Whoriskey**	
11:15 – 11:45	Coffee Break	
11:45 – 12:10	Overview and update on new sensors and platform integration developments in AtlantOS and Ocean of Tomorrow projects. **Matt Mowlem**	*Chair:* **Jay Pearlman** *CoChair**:* ***Daniel Alcaraz***
12:10 – 12:30	SenseOcean Project. **Matt Mowlem**	
12:30 – 12:50	NeXOS Project. **Eric Delory**	
12:50 – 13:15	Enviguard project. **Björn Suckow**	
13:15 – 14:00	Lunch	
14:00 - 14:30	EMSO Generic Instrumentation Module developed in the EMSODEV european Project. **Julien Legrand**	*Chair:* **Carlos Barrera** *CoChair*: **Laurent Delaune**y
14:30 – 16:00	Review of flagship initiatives/methods on sharing facilities • Ocean Tracking Network: a shared cost concept Canadian initiative. **Fred Whoriskey** • Ad-hoc, Transnational Access, bartering concepts: AtlantOS framework agreement. **Eric Delory** and **Laurent Delauney** • A vessel of opportunity concept, a potential opportunity for ocean observing and the ship industry. **Martin Visbeck**	
16:00 – 16:30	Coffee Break	
16:30 - 17:00	Day 2 Wrap-up & Action items. **Hervé Claustre**	
17:00 - 17:30	Shuttle from PLOCAN to Las Palmas	

Friday 4th: 09:00 – 17:00

Enhancements and cross-cutting issues

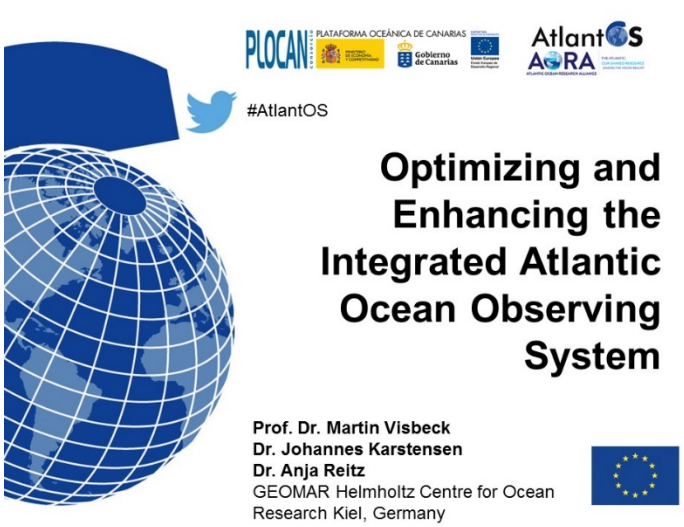
TIME	
8:30 – 9:00	Shuttle from Las Palmas to PLOCAN
9:00 - 9:15	Day 3 introduction and expectations for Theme 1. **Eric Delory**
9:15 – 10:45	**Theme 1**: Cross-cutting issues & opportunities o Break-out sessions ▪ Capacity sharing: opportunities and methods. Moderator: **Eric Delory** ▪ Best practices in autonomous systems. Moderator: **Jay Pearlman** ▪ Data management, sharing and interoperability. Moderator: **Christoph Waldmann**
10:45 – 11:15	Coffee Break
11:15 - 12:30	Break-out session conclusions. **Each Moderator**
12:30 – 13:15	Lunch
13:15- 13:30	Day 3 introduction and expectations for Theme 2. **Hervé Claustre / Michelle Barbier**
13:30 – 15:00	**Theme 2**: Guidelines towards the post-AtlantOS autonomous observation system New requirements from the international attendees and scientific community o Break-out sessions ▪ EOVs vs TRL for new variables. Moderator: **Hervé Claustre** ▪ Geographic gaps and priorities. Moderator: **Grigor Obolensky** ▪ Networks data harmonization issues. Moderator: **Christoph Waldmann**
15:00 – 15:30	Coffee Break
15:30 – 16:15	Break-out session conclusions. **Each Moderator**
16:15 – 16:45	Closing Workshop. **Martin Visbeck / Margareth Rae**
16:45 - 17:15	Shuttle from PLOCAN to Las Palmas

The following sections include the presentations and minutes about conclusions and actions to be taken.
Workshop announcement page:
http://atlanticworkshop.plocan.eu

Session 1: Welcome and overview of the AtlantOS and AORA-CSA projects.

This session was chaired by **Erik Buch** and **Carlos Barrera.** The session aimed to give an overview and update on the AtlantOS and AORA-CSA projects. During this first session **Joaquín Hernández-Brito** welcomes the attendees to PLOCAN, **Daniel Alcaraz** described the logistic details and **Eric Delory** introduced the objectives of the workshop.

Martin Visbeck presented an overview and update of the AtlantOS project.



Summary:
Martin Visbeck's presentation provided an overview and update on AtlantOS, addressing *inter alia* the requirement of integration of loosely coordinated activities; the involvement of EU, Canada, USA and the South Atlantic, the importance of ocean observation, the relationship between ocean and climate; the importance of the Deep sea – uses of the sea floor; marine services – safety, coastal and marine environment, marine resources, etc.; Sustainable development gaols – SD goal 14 – the need to conserve and make sustainable use of oceans, the importance of ocean information; Ocean governance: increased need of ocean information to meet a growing range of societal needs, can be fully realized if all elements of the value chain are resourced adequately. Increasing GOOS (60% completed); Make ocean observation (AtlantOS main

goal) more systematic; AtlantOS structure (workpackages); GOOS three main panels: Physics/climate, biology and ecology; AtlantOS framework with AORA, South Atlantic cooperation; Meetings: 30 Nov and 1 Dec South Altantic meeting in South Africa; G7 Science Minister Call for: Enhance Global Ocean Observing; Global Information Value Chain – AtlantOS Project Structure – 11 WPs – Detailed review from each one; OceanObs'19.

Margaret Rae provided an overview and update of the AORA-CSA project.

Summary:
Raised aspects were, Open Access to data, Future Reports, Future WP Meetings /Support, representation from WP leaders on each of those meetings, Priority areas – See AORA-CSA brochure; Engagement – Any existing gaps or ways to integrate with the Ocean Observing System; Importance of the BluePrint; Two areas where there is scope to join AtlantOS and AORA: Ocean Literacy and Engagement (cross-sectors).
Comments:
JP: Highlights flag-ships from National perspectives – well-known from the EU perspective , the need for more coordination from national bodies, the importance of the existing working groups.
FW: Canada – DFO (Fisheries and Oceans) is trying to organize the national community at national level.
MB: national priorities identification. Try to find end users –
MR: Three sections in AORA-CSA: EU-CAN-USA…but looking into southern countries signature of agreements (Brazil, SA, Namibia and other African countries).

Joaquín Hernández gave a presentation on the AORA-CSA observing systems, strategies and related aspects (WP5).

Summary:
WP5 refers to Ocean Observation as part of the research priorities. Objectives (liaison, mapping/assessment…) and impacts (assessment and mapping, agreement…) of WP5; Main output: mapping and connectivity assessment, contribute to aligning the planning and programming of trans-Atlantic activities. A detailed description of WP5 was provided (task 5.1 to task 5.6); Scope and Vision statement – Ostend declaration + Existing observational capacities (national/international). Requested inputs from Atlantic countries; AtlantOS is the main reference in Ocean observation for AORA-CSA WP5; Deliverables review (5.1 to 5.7); Review of the activities performed in regards to specifically from WP5; Review of the liaison with other EU projects and Research infrastructures.

Comments:
HC: commented on requests from WPx from AtlantOS – Not clear how and what AtlantOS itself can contribute to. Then, on AORA-CSA help, providing support. Answer from JH: to build frames at national level and then, collaborate at international level, instead of individually between scientist and/or sectors. Example of NASA Export project.
MV: (1) work on best practices and standards, (2) make recommendations at the national level and (3) AORA-CSA can act as JPI Oceans collaborator at EU-CAN-USA framework, as a tool for engagement.
Margaret Rae gave a presentation about Infrastructure sharing (WP10) in AORA-CSA.

Summary:
Margaret explained WP10 objectives; Aim – (Focus on Seabed mapping); Achievements – Short bibliography on relevant reports/databases describing European Marine Research; Matrix of relationship between WP10 and other projects; Capri Workshop on "MRI and the transatlantic cooperation on seabed

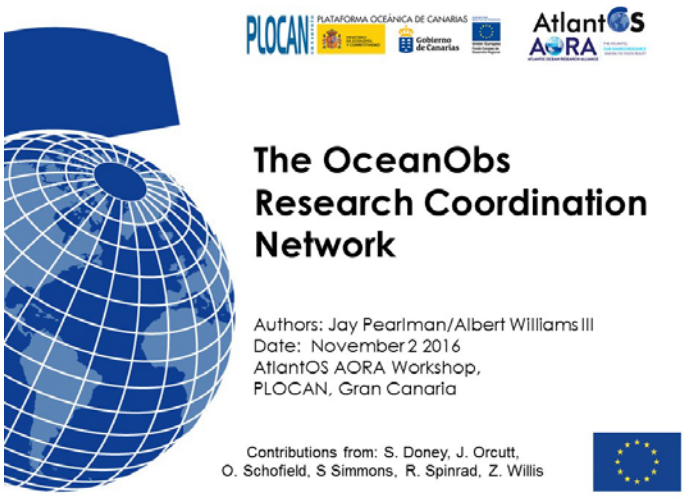
mapping ". Rationale, Goal and Tool (2016 IRSO). 20 experts and 11 countries. Output of the workshop: see picture + coordination is needed: AORA, IRSO, international organizations, policy makers, Report is being drafted by Aurélien Carbonniere.

Comments:
JH: We must explore collaboration options. Trans National Access and cooperation with other sectors between ocean and space/ Collaboration between EU and Canada with glider fleets/ EMSO ERIC.
ED: Regarding collaboration there are several initiatives: JPI Oceans, EMSO, …related to sharing data, infrastructures, equipment… But how to connect this? What kind of forum should be the more appropriate?

Session 2: International presentations.

This session was chaired by **Eric Delory** and **Daniel Alcaraz**. During this second session the following presentations were given:

The Oceanobs Research Coordination Network. **Jay Pearlman**



Summary:
Jay introduces the RCN and explains the objectives of the different working groups (Open Data, Insitu-RS Interfaces, Community Building, Biology EOVs, Biology Sensors, EOV Interoperability, Citizen observations). Gives an overview about the evolution of the EOVs and future priorities from the NOAA. He also speaks about the Ocean Challenges and opportunities for collaboration and the new blue economy.

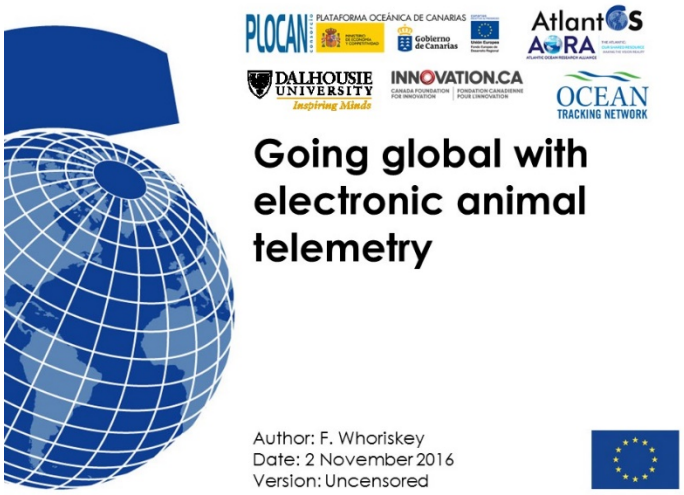
Comments:
FJ: States that EOVs for biology differ a bit from the ones on the GOOS webpages.
JP: In a recent meeting in New Orleans the EOVs were discussed. Future discussions will take place and an update will result.

Argentine capacities, activities and perspectives related to observations in the South Atlantic. **Maria Paz Chidichimo**

Summary:
Were presented: Argentina's capacities and observations related to the SAMOC (South Atlantic Meridional Overturning Circulation); the EPEA Time series station and the measured variables, the initiative PAMPA AZUL and its objectives and research lines; the Argentinian research vessels and the perspectives and needs they have.

Comments:
MV: Will there be anybody from Argentina in the Atlantos General Assembly that will be held at the end of November to talk about that?
MP: Yes. Someone from the ministry will be there.
GO: Which is the ratio between biodiversity and fisheries, how to assess the coastal area vs deep waters?
MP: In terms of measurements, there are more physical variables measured than biological.
JH: Pampa is being carried out in parallel with any other action?
MP: It is coordinated by the science ministry, but it is also supported by other institutions from Argentina.
VT: any strategy to make sure this programme contributes to the data management systems?
MP: Don't have a policy about what to do with the data collected. Each group manages it.
MV: What could groups like AtlantOS, etc. do to support your personal strategy? Maybe to hold a workshop there? What to do to support you?
MP: It is not easy to go international in Argentina sometimes. I think that what will help is to strategically state that Argentine data is quite important.
JP: How we can encourage collaborations with Argentina?
MP: Joint projects to work together. That's essential.
ED: I was asked by the commission about training opportunities which can be about observing, gliders, etc. Maybe we could start with the Glider School.
MP: That would be great. Because they don't have many technical people to use gliders or AUV.
CB: Is there any specific service to go to?
MP: The Hidrographic Service. It would be very useful to get home all that knowledge.

Going global with electronic animal telemetry. **Fred Whoriskey**



Summary:
Presentation addressed: the animal telemetry performed by the OTN, its contribution to ocean observation, how aquatic animals contribute to the global economy and the reasons behind animal tracking, the technology used in electronic tracking and its evolution, and some concrete cases of tracking. Finally, a video was shown.

Comments:
GO: Acoustics is one of the future variables of the ARGO program. Are they energy efficient?
FW: Yes they are, because the sensors are self-powered.
PP: Is there any form from governments to make tags?
FW: Not really. There are just two or three manufacturers, that make useful tags.
GO: What is the impact of the acoustic tags in terms of underwater noise?
FW: Tags acoustic range is in the order of kms. Signal pulse is generated 1 ms every several minutes, so it does not generate big underwater noise impact.
MV: Seems that the software plays an important role. Is it open-source, etc.
FW: There are open-source options for Apple and Microsoft.

Recent advances on underwater acoustics soundscape monitoring systems in Brazil. **Leonardo Martins**

Summary:

Were presented: the Brazilian Navy Research Institute capacities and resources. the projects they are carrying out at the moment and the technology used, future possibilities and opportunities.

Comments:
JH: Regarding the instruments for cooperation at European level. We'd like to know how to connect Brazilian researchers with H2020 programs.
LB: Brazil has a government agency in Sao Paulo in charge of this. They manage all the details related to collaboration.
GO: Which kind of float do they use for acoustic monitoring?
LB: The float is called PABLO which is a drifter and it is not recovered.
ED: Which is the band selected for noise monitoring?
LB: 10Hz to 10Khz is the band they choose in order to follow the EU policy.
ED: Do you have something written down as specification?
LB: It is something very new in the country. Still at definition stage. They found out about the noise monitoring needs from the EU MSFD Directive, and they use it as reference.

Day 1 Wrap-up & Action items.

Margaret Rae closed this first day with a question for the attendees: How to have a good observing network based on new technologies?
MV and **CW**: Names the Beaumont forum which is a club of different organizations from different countries. It is a group of funding agencies and they organize initiatives they would like to fund. The EC ask these what they want to fund, and adapt programs. They fund international projects, but the money never leaves the country. It is a mechanism to be considered.
JH: We must try to explore sharing capabilities.
MV: We must know from each other what you're already doing, and how you're doing it.
JP: There are two important levels related to what Martin said: policies and technologies.
VT: Considering gliders, there's a project called GROOM about sharing gliders, etc. But an 'umbrella' is needed from the policy side to cover these cases. Everybody agrees on the idea of sharing facilities, but we need rules to do that.
MM: One of the things received from the reviewers was about TRL. We need to do a sensors and instrumentation roadmap. See how to add a sensor on a platform easily. Because there are lot of levels of detail.
ED: It's clear that sharing infrastructures is a common problem we all want to solve.
MV: The problem we face is the working as a community is not a priority for the nations. Countries want to spend their money on their resources. The political climate to achieve that collaboration is a challenge.
ED: Small steps, not too ambitious regarding sharing capacities will demonstrate benefits.

Day 2 introduction and expectations.

Hervé Claustre gave an introduction for this second day sessions and expectations.

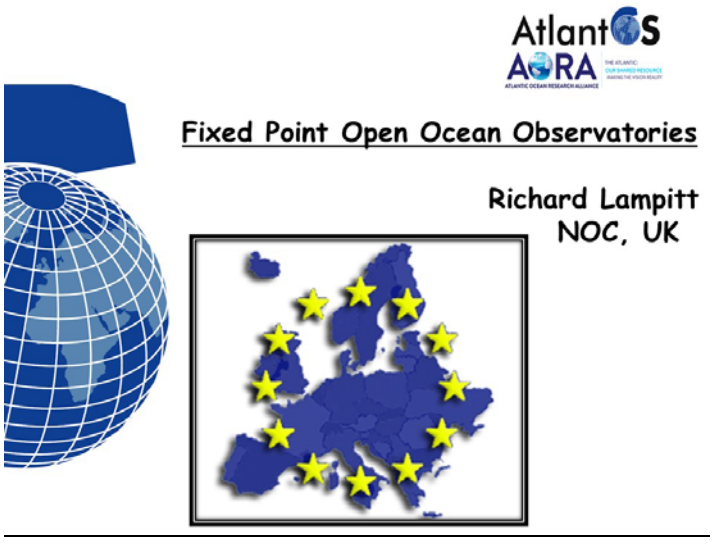
Summary:
Hervé points out societal needs for ocean observation, the need for an increased spatiotemporal resolution and the potential role of autonomous platforms. The seven networks / platform user communities represented in AtlantOS are briefly introduced as well as the three main general objectives identified for the networks in AtlantOS: network enhancement, improved data streams, and facilitating network sustainability. Hervé identifies the discussion of possible network enhancements as the focus of the session with special emphasis on the decisions that need to be taken to improve capacities of the platforms (e.g., by adding concept / pilot variables and implementing new sensors) in a way that matches scientific requirements (as reflected in EOVs) with feasibility in terms of costs and readiness. Hervé describes the process for the implementation of Biogeochemical Argo as an example of the process necessary for a sustained network enhancement. For Biogeochemical Argo, special emphasis is on the necessary community agreement (scientific focus, target variables, sensors), the associated governance (definition of 'approved Argo parameters') and data management issues (extend the data stream, QC etc. to new sensors without compromising the key variables). A Biochemical Argo Science and Implementation plan is currently being finalized and will be available soon at http://www.biogeochemical-argo.org.
Hervé also touches on potential innovations and other measures to make observing systems more cost-effective. Examples mentioned include (1) anti-biofouling measures, (2) assessing possible combinations with other networks (incl. ship-based networks) and legacy data to close observational gaps and facilitate QC, and (3) application of neural network technologies to identify the power of easily-measured parameters as predictors for less accessible variables. Apart from focusing on sustained and operational observations, the network needs to maintain the flexibility to allow for testing of new approaches and to support targeted science driven process studies. **Hervé points out that a careful assessment of required, feasible, cost-effective enhancements of the autonomous network is needed to provide informed recommendations for a fit-for-purpose post-AtlantOS integrated Atlantic observing system. To prepare for this the contribution of the current workshop should be followed timely with joint WP3&6 meetings.**
Comments:
In response to the EOV process, Biogeochemical Argo agreed on six core variables for which feasibility could be demonstrated in pilot studies at the regional scale, i.e., decisions were centered on the questions of readiness rather than on a prioritization of EOVs.
HC: agrees with a suggestion to involve more distributed units into the Argo data processing in order to avoid overburden of the centralized Argo data management and points out that for biogeochemical Argo QC requires expertise that is distributed anyway.

Session 3: Review of existing mature autonomous observation platforms.

This session was chaired by Mr. Hervé Claustre who is a research scientist from the Marine optics and Remote Sensing Lab from the Laboratoire d'Océanographie de Villefranche. This session aimed to review the existing mature autonomous observation platforms.
Argo (Euro-Argo). **Grigor Obolensky**

Summary:
Grigor introduces the status of the network in terms of (1) connection to international initiatives, (2) evolution of the number of Argo floats and the spatial coverage of observations during different implementation phases, (3) current target areas, (4) structure and evolution of the European partnership, and (5) EU deployment target (250 floats per year). The focus of enhancements in AtlantOS is on the deployment of seven deep and six biogeochemical floats. Key is to demonstrate feasibility in specific target areas in the north Atlantic where data from other Argo deployments and past and planned ocean observation networks (e.g.,gliders) and projects (e.g., 'EXPORTS') exist. Consequently, two first floats will be deployed soon in the PAP area.
Comments:
Discussions with manufacturers are underway to overcome the exclusion of measurements in the surface layer by Argo floats due to energy constraints (CTD cells are switched off). One solution could be to add additional SST and SSS sensors outside the cell that are solely dedicated to surface layer observations.

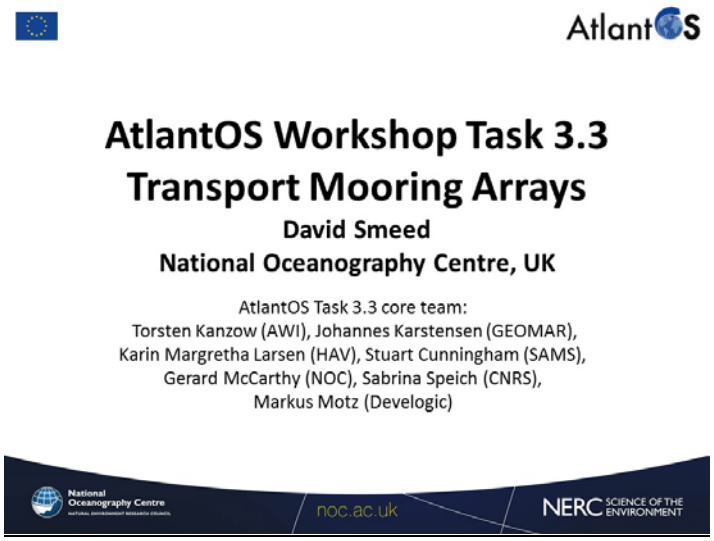
Fixed-point open ocean observatories. **Richard Lampitt**



Summary:
Richard provides an overview of the OceanSITES global network of fixed point observatories and how they overlap with observatories that take part in EU FP7 FixO3 and AtlantOS as full or associated partners. At present, all these observatories are operational but differ in terms of how EOVs are covered and standards of operation. Key tasks in AtlantOS are to improve observation capacities and to better integrate with the other

two fixed point observatory networks OceanSITES Transport Mooring Array and PIRATA, as well as with other programs (e.g., EMSO, JERICO NEXT, EuroGOOS). Other key targets of network enhancements started in AtlantOS include (1) common set of EOVs, (2) integration of additional variables (e.g., genomic observations, microplastics and pollutants), (3) compliance with common protocols and standards, incl. data management, (4) strengthen links to the Ship Of Opportunity Program. Three observatories are presented in some detail as examples for observational capacities and planned enhancements (1) PAP: surface to seafloor multidisciplinary measurements and automated sampling at PAP including NRT data access, microplastic observations, (2) FRAM: time series observations of microbial communities with automated sampling and molecular analyses - including plans for legacy sample analysis and best practice development in AtlantOS, (3) CVOO: combination of winched moorings and wave gliders for NRT data transmission. Richard also touches on aspects of data management and dissemination, the benefit of NRT data transmission to secure data, and spatial footprints of fixed point observatories.
Finally, Richard emphasizes the need to decide on a common strategy for the three fixed point observatory networks in order to improve spatial coverage and the potential role of a sustained EMSO-ERIC in this context.
Comments:
MV: is pleased with the progress (in the biogeo fixed point observatory network as well as in Argo) but urges the networks to also link to initiatives outside of Europe (e.g., during a side event at the next AtlantOS GA).

Transport Mooring Array. **David Smeed**



Summary:
David introduces the scientific motivation and societal benefits to obtain high resolution measurements of volume, heat and freshwater fluxes in boundary current regions to observe the Atlantic Meridional Overturning Circulation. The TMAs extend from the Faroe / Iceland region in the Arctic to the SAMBA array at 35°S with some (especially in the N Atlantic) being in operation for > 20 years. The measurements complement observations by other communities (e.g., Argo, GoShip, gliders) and are crucial to address large scale phenomena in the ocean and atmosphere (hurricanes, precipitation patterns, sea ice coverage) and feeds into climate models. Network enhancement goals include (1) improved coordination between the different TMAs, development of a common ‘one stop shop’ for easier data access, (3) extending observations to the near surface and beyond physical oceanography, (4) implementation of NRT data transmission to secure data flow feed into forecast modeling. For OSNAP, 53°N array, RAPID, and SAMBA, enhancements in the framework of AtlantOS and other programs (EU H2020 ATLAS, UK ABC) are described, e.g., in terms of the addition of new variables / sensors (e.g., O2, pH, pCO2, acoustic receivers for animal tracking), samplers, and tests of data telemetry systems.

Comments:
DS agrees to the suggestion of **MV** to make sure that the network includes all TMAs and OceanSITES transport moorings and to analyze their sustainability perspective (e.g., during a side event at the next AtlantOS GA).

Gliders. **Victor Turpin**

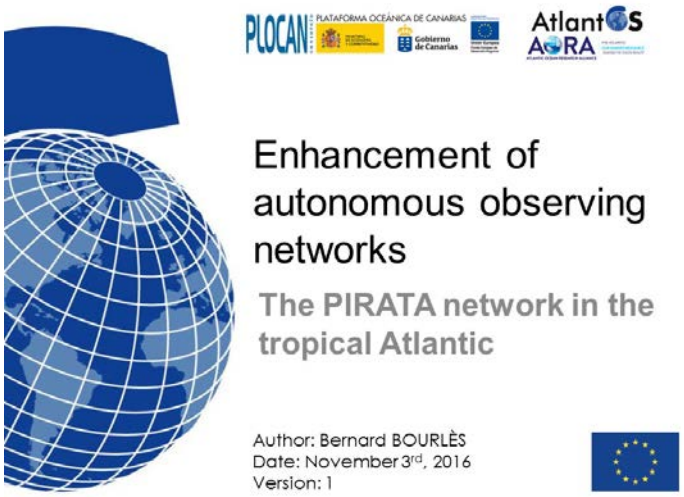
Summary:
Victor describes how the Everyone's Gliding Observatories (EGO) initiative (including the EGO website and EGO meetings) fosters the transition of a community of practice towards a true glider network that represents an established research infrastructure. Victor gives examples of benefits offered by the community regarding coordination (standardization, data management, outreach), training / capacity building and access to network facilities and software tools (data management, glider control). While the network adopts a bottom up approach with voluntary engagement, individual support is provided on a case by case basis to motivate new members (especially countries that start glider work) to join. In addition to extending the glider community, network enhancements include (1) close connection to projects and manufacturers advancing innovations in the field of technologies, (2) identification of glider observation targets by Observing System Simulation Experiments (OSSEs), (3) provision of tools to simulate deployments and assess associated risks, (4) improving network monitoring incl. data integration. In connection with international bodies, EGO aims to setup a global strategy that is tailored to key scientific questions and societal needs. To this end, issues to be solved (e.g., concerning harmonization of variables and data formats, global data management) to extend to a global glider network management are identified.

Comments:
Via Coriolis the glider community is already connected to data brokers like Copernicus and EmodNet.
So far, there is no central governance. The network is purely bottom-up and decisions on deployments and target areas are taken by individual glider teams. The aim would be to reach some level of harmonization by task team on specific scientific focus areas that motivate community contributions. This approach is endorsed by **MV** from the AtlantOS perspective who expects that different AtlantOS WPs will help to identify observation priorities while he expects that central governance and planning will naturally follow by other processes at a later stage.
The transatlantic glider lines shown in the presentation are not established but visualize scenarios tested with the OSSE approach.

Surface drifters. **Paul Poli**

Summary:
Paul introduces the standard drifter design including the sensors / variables addressed (atmospheric pressure, SST, currents via displacement) and the current status of the global drifter array. A gap in the tropical Atlantic that shall at least partly be closed by deployments carried out within AtlantOS. Funding is provided via operational agencies. Being the sole measurement platform able to provide atmospheric pressure observations directly at the sea surface, floats have a particularly high impact, especially in the context of weather forecasting. At the same time, individual measurements are particularly cheap compared to other platforms (e.g., ships and satellites). Funding and procurement (several manufacturers) as well as data transmission and processing are established but there is a need for additional locations to deploy drifters. A pressing issue is the implementation of procedures for the recovery and recycling of drifters after their lifetime, e.g., when systems are washed ashore. Solutions would allow for post deployment calibration to improved data quality and improve reputation of the drifter community. Paul mentions several other tasks for network enhancement including (1) stronger connection to other networks, e.g., for improved sharing of resources (e.g., ship time), (2) adding more sensors and addressing issues connected to this (governance, risks and responsibilities, funding, data management, assignment of specific frequency bands for ocean observation). Workshops for capacity building are carried out (especially in the Pacific region including Pacific island states) in order to sustain the global network. JCOMM's Data Buoy Cooperations panel represents the global framework for the drifter community where annual meetings are carried out and groups and task teams are established to address network needs. While most data management issues are addressed (including the data flow to Corolis, EmodNet, iQUAM) is largely organized but the provision of a quality-controlled delayed-mode integrated dataset that is traceable to the source and contains all relevant metadata is an open question that is addressed in AtlantOS in cooperation with WP7.
Comments:
Recovery and recycling of platforms is also an issue for Argo profilers. Refurbishing potentially saves costs and is important to show the recognition of environmental friendliness by the ocean observation community. Argo floats are tagged with individual numbers to facilitate identification of the owner.

Mooring Array in the Tropical Atlantic (PIRATA). **Bernard Bourles**



Summary:
Bernard introduces the history and the different phases of the implementation of the PIRATA network since it was initiated in 1996 to monitor physical oceanography in the tropical Atlantic. He presents the 'Atlas' Buoy platforms that are maintained by annual cruises of US, Brazil, and France and the variables addressed in the top 500 m of the water column. Bernard provides an overview of additional activities during maintenance cruises, how they provide mutual benefits for other observation communities and PIRATA itself (e.g., XBT-, Argo-, and drifter-deployments, CTD casts, nutrient, carbonate system, chlorophyll, downwelling irradiance and dust measurements). Bernard also touches on PIRATA management and governance as well as training and capacity building. He gives an overview of the data currently obtained in NRT. Current and planned network enhancements include (1) hosting of additional sensors, e.g., O2, CO2, turbulence, acoustic receivers, (2) replacing ATLAS with new T-FLEX moorings (more sensors, Iridium data transmission), (3) extending the Array in Southeast direction, and (4) adding ADCP moorings to address equatorial currents. **Concerning the sustainability of PIRATA Bernard emphasizes that enhancements create additional costs, efforts, and requirements in terms of power consumption and data transmission. It is therefore necessary to fully justify any additional sensors, e.g., in terms of scientific relevance and impact.**

Animal Telemetry Network (EATN). **Pedro Afonso / Fred Whoriskey**

Summary:
The EAATN represents an emerging European network that is levering of the existing global network OTN

with the aim to get a better understanding of key species' migratory routes and life history. Merging animal tagging activities at distributed institutions into a network is a requirement to cope with the wide range on many species and to share acoustic receivers to improve cost-effectiveness. Information on existing tagging activities (groups performing tagging activities, target taxa and regions) have been collected by means of a questionnaire. There are still groups that so far joined neither the EAATN nor the OTN community. Developments of instruments, e.g., tags that are equipped with additional sensors to serve other observation communities provide opportunities for technological innovation and have an economic potential that is relevant in the context of blue growth. Key objectives for network enhancements include (1) a coordinated extension of the areas covered (by establishing key acoustic receiver lines, e.g., in straits and extending activities into the open ocean), (2) fostering technical developments and establish standards (connect manufacturers, carry out tests in cooperation with OTN), and define common EOVs that the tagging community should address. Pedro reports on progress achieved within the EAATN. New coastal receiver networks have been developed and acoustic receivers have been added to moorings (e.g., PIRATA). A new database hosted at VLIZ (Oostende, Belgium) as part of EmodNet has been setup and already provides metadata of tagging activities. Within AtlantOS it will be extended to also include observational data of the EAATN network.

Comments:
Bringing together the different people working in different fields and with different technologies is key to foster discussions on general issues that extend beyond the respective fields of research.

Session 4: AtlantOS and Ocean of Tomorrow projects.

This session is chaired by **Jay Pearlman**.This session aims to give an overview and update on new sensors and platform integration developments.

This session is introduced with an overview on new sensors and platform integration developents in AtlantOS and Ocean of Tomorrow projects by **Matt Mowlem**.

SenseOcean Project. **Matt Mowlem**

Summary:
Matt introduces the SenseOCEAN project. He summarizes the tasks, the structure, and the schedule. Matt explains the demonstrations performed and the details and conclusions of the silicate electrochemical sensor. Then he speaks about the optodes and its integration and results. Several sensors and platforms are covered. And some practical demonstrations and tests of the use of these sensors are presented with results. Then the presentation focuses on the data flow and the software components.

Comments:
CH: Are Best Practices regarding calibration and operation of the sensors being addressed in SenseOcean?
MM: Not in SenseOcean, but Task 6.4 on WP6 of AtlantOS lead by Jay Perlman deals with best practices on sensors. So this is covered through this project.
GO: Do you have an integration policy to be sure the sensors developed are demanded by the observation

networks and AOVs. Is it integrated in your industrial process, or is it studied case by case?
MM: No. Currently it is a very 'ad-hoc' process. It is something we have to start doing in the project from both sides. We have to work in linking the developing programmes to what is required by the observation networks.
JP: Regarding the quality control. How is ocean of tomorrow addressing the cross calibration work?
MM: Is not been doing by now in OOT. We are trying to do it in AtlantOS. It doesn't need to be a very expensive exercise. We should be able to do this cross-comparison, as the standard techniques are very well developed.

NeXOS Project. **Eric Delory**

Summary:
Eric presents the objectives of the project. Then he talks about the sensors and technologies developed in the project. After that, the TRLs are reviewed for the different developments, and begins with a more detailed description of the different sensors and their applications. Then Eric talks about the web of things and how the sensors are ready for a smart sensor network, focusing on the software components of the project. Finally, Eric covers the testing and demo scenarios foreseen for the project, and the future steps that are expected.

Comments:
PA: What's the depth rated for the EAF Recopesca sensors?
ED: 300 m
PA: And the acoustic sensor?
ED: We have three versions because the sensitivity changes with depth. We have a version for 3.500 m for deep sea observatories. A 1.500 m for gliders. And a lower cost version for the profilers (still a disposable platform) which goes down to 2.000 m.

Enviguard project. **Björn Suckow**

Summary:
Björn introduces the EnviGuard project and ttz Bremerhaven, the research service provider he is working for. He explains the project focusing on the different sensors (toxic microalgae, pathogens such as E. coli and Betanodavirus and chemicals such as PCB, Saxitoxin and Okadaic Acid) that are developed. The EnviGuard Port is then covered talking also about its connectivity to FerryBox and web access. Then Björn talks about the outcomes and results of the project with its TRL status.

Comments:
JP: Regarding the user interfaces developed for EnviGuard, have you looked for adopting or adapting something that has already been developed in other OOT projects?
BS: At the moment we tried to work it out with HZG because they already have the FerryBox system there. So we are trying to incorporate that.

Session 5: New Technologies

This session was chaired by Mr. **Carlos Barrera**. It aimed to present a review of flagship initiatives and methods on sharing facilities.
EMSO Generic Instrumentation Module developed in the EMSODEV european Project. **Julien Legrand**

Summary:
Julien Legrand explained how EGIM is well-connected with AtlantOS in several key topics. EMSO status description. EMSODEV definition, description and goals. EGIM Guidelines: measure variables

homogenously, adapt to all type of nodes and new sensors; EGIM parameters overview Generic and Optional; List of sensors on EGIM prototype (Generic parameters and Industrial factors of the choice –High TRL, etc.); EGIC Test and Calibration (robustness test and Calibration); COSTOF2 (EGIC Electronic core) Following FIXO3 Developments – Main technical features highlighted; EGIM Data Power Interface – Main technical features highlighted; EGIC Data Management - Description and goals; EGIM 3D view - Main technical features highlighted and possible mode configuration (buoy, stand-alone observatory, cabled observatory, mooring line, …); EGIM Deployment Test – 2016 Test at OBSEA, 2017 – replication and deployment, COSTOF2 industrialization, call for tender, deployment (PLOCAN, EMSO Azores and NEMO).

Comments:
FW: What is the limitation in consumption and data storage capacity in sensors.
JL: In Cable mode there won't be a problem because we have a permanent link. In stand-alone mode we don't acquire data continuously due to the problems with the capacity, we define duty cycles accordingly.
LD: To facilitate interoperability (SWE and OGC Puck protocols) – How does EGIM work in this repsect?
JL: It is an objective in EMSODEV. There's a Spanish group (UPC/SARTI) working in that objective. It is not yet ready, but next year a sensor xml interpreter will be implemented and will make it compatible.

Review of flagship initiatives/methods on sharing facilities:
Ocean Tracking Network: a shared cost concept Canadian initiative. **Fred Whoriskey**

Summary:
Fred presented the OTN focusing on the Global Compatible Telemetry Activity concept; OTN Infrastructure: Supported CFI, International Joint Ventures Fund, 40/60 funding, only cost for infrastructure is funded, partner matches with cash or in-kind (eg. Installation support), very complicated rules for what are eligible matches.; OTN Science:

- 10M$ over 7 years,
- Separate nationwide research network award from NSERC Canada.
- NSERC: mandates for science, technology development, HQP, policy/management impact, supporting industry.

2000 OTN predicted receivers with 20K-25k active compatible receivers locally, Non OTN deployment typically maintained by small groups (Australia and Canada excepted), OTN equipment deployed strategically in key areas, leveraging for funding for local groups, local investigators do the science, equipment and detections are free provided local investigators link their data into a long-term repository.
DATA NETWORKS – open source architecture, common metadata and standards, coordinated regional nodes QA-QC, shared code for analytics, IODE-associated data unit, sharing requirements.
DATA PITFALLS – Investigators continually inventing new mechanisms to avoid carefully prepared, vetted, simple submission process for data; Investigator concern about data sharing (theft, lack of credit,

misinterpretation, lack of altruism, OTN Data Policy Remedies (2 years public access window, taggers own metadata, receiver owners own detections, thus data is not useable unless they work together).

Comments:
JP: Are you going to publish this?
FW: Yes, this is under revision right now.
LD: The philosophy of OTN is open-source architecture. This means in terms of SW, HW, data..?
FW: HW is hard as there are not many manufacturers, so no. We're really focused in SW.

Ad-hoc, Transnational Access, bartering concepts: AtlantOS framework agreement. **Eric Delory and Laurent Delauney**

Summary:
Eric started this presentation talking about Ad-hoc, Transnational Access (TNA), bartering concepts: AtlantOS framework agreement / AtlantOS Shared infrastructure test. Existing Methods: TNA, bartering, Ad-hoc, current implementations.
- TNA: Free access to infra from incentives (eg. FixO3, JERICO-Next); PROS: T&S covered and funding agency contributes to infra operation costs; CONS: complexity (cost assessment, reporting, calls-evaluations). FixO3 TNA description (partners and tasks). Description in detail of the TNA-FixO3 procedure. 1st Call results: 15 projects, 2nd Call: 09 projects.
- Bartering concepts brief description (see LD/OFEG and presentation, next).
- Ad-hoc concept description (sharing between AtlantOS entities, not generalizable for a specific purpose…) PROS: rapidity, clear mutual benefit.

Laurent Delauney, then talked about JericoNext TNA – Overview, observatories and facilities description, objectives and needs, WPs list description (TNA is WP7); TNA to Coastal Observatories – 1x Objective, 13xpartners and 35xinstallations; Map of the Jerico-Next locations for TNA
Ancillary Systems – Task and interfaces with other WPs – Main task: procedures for TNA provision (starting from JERICO), 3 open calls, Evaluation and support.; JERICO 1- 20x facilities, 14x requested 13x performed
Fix, gliders, etc.; JERICO-Next – 36 facilities; Some examples are: Field calibration: CEBIO, RTC, In-situ/research: MEDACID, Research: GABS, OXY-RY; PRO (free access to infra, original projects, new ideas, collaborations, opportunities...) and CONS (admin complexity, infrastructure dedication…) description list. Bartering: OFEG description: partners, goals, advantages (access to a wide range of facilities and equipment, reduce wasted time…), rules description; OFEG-TECH concept description; EuroFLEET – TNA Overview description; EuroFLEETS2 funded cruises map and website for evaluation systems;

Capacity building has to be one of the main key issues in regards to this topic of sharing infrastructures, specially for those groups with less opportunities.

Comments:
Discussions about: AtlantOS framework sharing methods – Capacity sharing (objective of the breakout session). Discussion/record opportunities and methods (Europe and beyond).
Break-out sessions – capacity sharing: opportunities and methods.
Plan test in the Canaries – implement a use-case of the AtlantOS framework agreement. Use-case: Deep-ocean…., test and demonstrate new technologies, geographical focus, application domains.
JP: Asks about data management and the inclusion of WP7 on this task.
ED: We want to focus on new technologies and emerging networks but data sharing principles will also key to AtlantOS infrastructure sharing.

A vessel of opportunity concept, a potential opportunity for ocean observing and the ship industry. **Martin Visbeck**

Summary:
Enhancing ship-based observing networks (VOS, CO2 uptake of the ocean,); Oceanic sink 250 t Co2/second). Comparison with tanker vessels; VOS main routes that form a basis for CO2 measurements; IMOS –VOS lines actually used for different parameter measurements; Marine Traffic Map; What does it cost to charter a vessel? ; What is on order? Container >12000 TEU=60% ; 40 years of container ship growth… ; Who are the big players (Maersk, MSC, Evergreen, CMA-CGM, …); How to make progress? Discuss a pilot project with some of the large actors…; Put in contact vessel companies (i.e. Maersk with science companies (i.e. Xylem,); CSR – Corporate Social Responsibility - Environment, society and workplace; Recommendation #2 for G7 – Establish a partnership between ship builders, certifiers, ship operators and ocean observers to provide an in-situ module option to all new built ships. Funding as part of the CSR of the commercial actors; Examples at regional-national level can be also very useful; Navy-ships could be an option, but not the main focus.

Comments:
Some links to be made with a project/initiative (IAGOS) dealing with atmospheric measurements where some scientific groups have managed to install scientific instruments on commercial planes.
MV: The regulation is different for ships and for planes, but it is more or less the same idea. Maybe the container fleet is also a good future opportunity for ocean observing. By now it is easier to work with the navy and cruise ships.

Day 2 Wrap-up & Action items.

Hervé Claustre closed this second day of workshop with the following presentation.

Summary:
Hervé summarizes his view of key opportunities and tasks to improve observation capacities and ensure sustainability of observation networks. Autonomous observation networks in AtlantOS are established and are all active to implement enhancements. Several projects are developing a range of new technologies that will improve and extend current observation capacities.
In order to ensure network sustainability after AtlantOS some key issues must be considered. One important aim is to build a strong end-user community that is aware of the relevance and benefits of ocean observation. For this aim, data access needs to be improved in close collaboration with AtlantOS WP7. Another key issue is to better connect and exchange between and within the individual networks. Within the networks practical aspects should be addressed in order to develop best practices – with respect to observations as well as data dissemination. Potential benefits of cooperation between networks include sharing of infrastructures (for example by adding acoustic receivers to physical oceanography platforms). Further, AtlantOS networks should foster connections to international partners to extend the networks, improve visibility and capacity building and secure sustained funding.
For drifting platforms, best practices for recovery and recycling have to be established potentially involving JCOMMOPS as an international body to reduce the amount of waste produced by the observation community.
Hervé closes with some considerations regarding the implementation of new variables that should be addressed in the breakout sessions on day 3. Issues mentioned include (1) the need to consider capabilities of the different platforms when developing new sensors and deciding on new sensors and variables to add, (2) the necessary balance between ever-growing capabilities of sensor technologies (driven by technical feasibility) and de facto requirements (e.g., accuracy) to address the observations targets (driven by scientific needs), and (3) the need for the development of best practices for calibration and deployment as well as for cross-calibrations of different sensor types, to ensure interoperability within and across networks.

Comments:
The discussion focuses mainly on the extension of the observing capacities by adding variables / sensors to existing platforms. It is important to consider the long-term availability of funding and dedicated experts for the new sensors and variables that are to be included. Additional sensors should not interfere with core measurements and care needs to be taken that data management is able to keep pace with the generation of additional data. Some factors that facilitate the integration of additional observation capacities are mentioned. Ideally, at least some of the suggested new variables should be relevant also for the community running the platforms. Successful pilot demonstration projects may motivate other communities to join in and also host additional sensors. Specific demonstration themes (e.g., oxygen minimum zones) should be developed to integrate network enhancements and demonstrate their benefit and foster engagement by the wider observation community. Platform locations are obviously selected according to the observational needs of a specific community (e.g., transport moorings in boundary currents) and are not necessarily best-

suited for the requirements of other communities (e.g., animal tracking network or OceanSITES biogeochemistry). In addition to the integration of additional sensors key locations and observational gaps may therefore be identified where additional monitoring platforms are needed.

Day 3 introduction and expectations for Cross-cutting issues & opportunities break-out sessions

This first break-out sessions are introduced by **Eric Delory**. The attendees are organized in three groups to discuss about the following themes:

Capacity sharing: opportunities and methods. Moderator: **Eric Delory**
Participants: MB, DS, PP, BB, LB, MP, LD, PA, MR, PL

Conclusion of the Break–out session:

- Capacity sharing: opportunities and methods
  - Comment on sharing methods and on common methodology(ies) (AtlantOS sharing framework agreement/methods), pros and cons, etc.
  - Establish a draft list of methods to be circulated amongst AtlantOS infrastructure networks
  - Suggest infrastructures, interests, methods and users for AtlantOS test
  - Identify AtlantOS platforms and sensors
  - Any other item of interest (scope, issues, gaps, etc.)
- TNA, Bartering and adhoc
  - TNA is very complex but provides funding and a framework, There is a well-defined frame.
- Bartering: in OFEG there are working rules and it is straightforward.
- Managers need clear frameworks

- The ad-hoc method is a learning by doing process
- Identify the capacities and the needs that we have would be useful. What can each offer and what does each need? What is stopping us doing this? Lack of information. Visibility of needs and opportunities.
- People explaining their science and their needs. How can AtlantOS help?
- A relation of trust is needed as well, and this comes with long term discussions and experience (learning by doing)
- International ship operators meeting: make a presentation to them would be useful: a web tool by Jcommops is being developed (Martin Cramp). The ship routes are being recorded but only with ship-time. Open to suggestions.
- Let's do a table with ship-time as a start, moorings, gliders.
- AtlantOS charter (rules) to be agreed in order to access.
- Metadata level is through OSCAR database in JCOMMOPS.
- Used by high-level decision makers to demonstrate their contribution, IPCC.
- Standard format is essential as well for metadata.
- Recommendation: standard protocols and formats for the future for hard and software. Even including connectors.
- Template repository: all will contribute to it.
- ERICs – check statutes (EMSO -> PLOCAN) -> Harmonize with?
- Can we extend the OFEG, join them? ->
- AORA-CSA can be of help (Margaret Rae). Joaquin Brito as PoC.
- On the long term: Keep in mind the capacity building (training aspect in particular). This is endangered because of a lack of sponsors. We need to let know the EC. In particular important for sustainability. Important for the maintenance of PIRATA for example. Recommend the EC to open a project for this. There are strong scientific motivations for doing this.
- There is a signed agreement between the EU and Brazil, one soon to be signed with South Africa. The EC will have to serve these agreements. Which again needs a tool for visibility and information. The mobility programme exists as well (Marie-Curie), also development courses (otherwise costs can be prohibitive). Joint degrees For example MARUM-DALHOUSIE. NOCS and Washington. Travel only gets funded. Registration fees only in one country.
- For a few identified strategic actions, for example the EC has programmes. Etc.
- We need to identify the opportunities at European Level. Like the RISE fund (underutilized), EUROMARINE, JPI Oceans, Supercomputing capabilities.

Comments of the break-out session:
ED: An interesting concept for sharing infrastructures is bartering.
MB: We need some visibility: a page on the AtlantOS website with the different sharing platforms. Making easy for the community to interact with them. Really simple info and a link to the existing networks.
PP: we need to know the capacity and the needs of each other.
DS: but we must define whether to build a central portal or link to distributed resources.
ED: We need to ask the question how can AtlantOS infrastructures help you achieve your objectives.
MR: Contact Martin Kramp IOC is important when talking about sharing vessels.
JH: Contact POGO
PP: OSCAR surface observing system capabilities database JCOMM - https://oscar.wmo.int/surface/index.html#/
ED: Another point is to find a standard data format for infrastructure descriptions.
MB: NAGOYA protocol. Is quite specific for genetic resources. Will be sent to Eric. EMBRC is another initiative that is still to be approved. (Check EMSO).
DS: Important to use the same protocols. As a recommendation for the future. OFEG.
BB: AtlantOS could help support existing capacity building. Let's keep in mind that they exist and they need to be supported.
ED: With respect to training, any existing examples or available capacities/ or needs?
MB: Example: The University Washington has signed an agreement to accommodate students without costs.
MP: Example: Argentina has a lack of gliders, maybe because of a lack of training.
JH: Example: PLOCAN can offer supercomputer time.

Best practices in autonomous systems. Moderator: **Jay Pearlman**

Participants: MA, RL, GO, FP, HH, CW, JL, MM, HC, EL, FJ, FW

Conclusion of the Break–out session:

Best Practice is a documented procedure that, through experience and research, has consistently shown results superior to those achieved by other means and can be used as a benchmark, particularly if advocacy can lead to it being widely adopted. Best practices are technical, cultural, cost and convenience.

Do we NEED Best Practices? If yes,

- what is the process to make them work for our community?
- how do we identify specific areas with potential for being a set of best practices? What areas do we recommend initially? Who are the potential adopters?
- how are best practices to be updated and kept current?
- are there specific areas that should be identified as pilots.

What is the process to make them work for our community?

- First thing we must document in writing best practices being used (not necessarily created) in each network. Outputs from networks may be a good starting place as this may be easily adopted. Publicly available documents that could then be reviewed by a "panel" - implies creation of a panel.
- Need some form of training and presentations at community fora
- Organization that can be a home for best practices
- For sensors, should there be a Library of factory and other calibrations
- Encourage manufacturers to track feedback on field operation
- Example: Build in calibration information in data metadata automated creation; similarly, provenance
- Adapt procedures from industry to science – expensive procedures may be overkill.
- Community practice peer review process
- Cost and staff time needs to be identified so there is adequate allocation of resources for implementation of best practices.
- **Is there room for journal of best practices?** This will encompass peer review opportunities (define it carefully) and citations;

Areas for best practices:

- Common sensors
- Identify what is being done in existing networks – then what is a network? Is it platform-based? Should we use the term community of practice?

- Is it discipline based – chemistry, physics, biology?
- **NEED to decide the matrix structure early**

Pilots:

- Geotraces joint workshop best practices – WP2 and 6.2
- Data management WP7
- Platform related – FixO3/ARGO – Implementation WP 3
- Oxygen (metrology of optodes) – sensor and platform combinations WP7??? WP3
- Downward particle flux (rate practices) WP3
- Quality assurance (space-agency work) – ask French space agency from CNES WP6.2
- Microbial genomics - WP3 6.2, 6.5

Data management, sharing and interoperability. Moderator: **Christoph Waldmann**
Participants: EB, VT, FH, MV

Conclusions of Break-out Session:

- Mature the idea of data sharing on all levels starting from collection to products
- Highlight the benefits of long-term data archiving (enabling the re-use of data from past missions)
- Merging data archives assist future users in operating observing platforms/stations and faciltate data re-analysis
- Making provisions right at the beginning to assign a complete set of metadata to the collected data set (issue of introducing standards)
- Agree on standards and protocols
- Facilitate data publication process by employing DOIs (example GBIF)
- Close the gap between data producers and data assembly centers (role of GDACS)
- Realize that there different mission types like more process oriented missions or missions with an operational character (this has consequences on the type of services that can be employed)
- Recognize the different missions of data assembly centers (EMODNET – Real-time, COPERNICUS

Operational Forecasting).

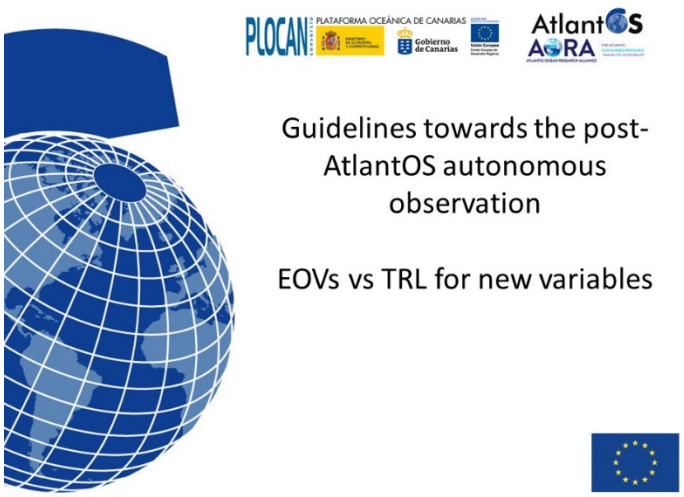
Break-out sessions comments:

Break-out sessions general discussion:

RL: Data sharing is a huge and complex matter. We must also think about the disadvantages of sharing data in order to address them successfully. Especially when talking about early career scientists that are publishing data, if some other people takes this data they are disadvantaged.
HC: I don't think early careers scientist represent a handicap, because they have not access to big funding to support that kind of observations, so we need to provide the data for such early career scientists to be useful for them to publish. The rest of the scientists must use the funding we have to put that data available in real time for them to be used.
MV: I think that publishing data sets is a very useful thing. We must differentiate an individual career which can be based on great publications, engineering communities and the one that we are discussing here which is the one that is doing some observing on the long run. And on this last one we have to define the problem we are addressing which is not the problem of science observing but the subset of sustaine long term observing which support the particular scientist, but also a fraction of the scientific community.
JP: Data being available and being open is important because we need to support young people, but I think a cultural change is needed in order to make them understand that they'll be credited in their academic career just by putting out good quality data.
MV: We have also to think on authority, quality and validity of information. This is becoming increasingly a challenge. Because unless you are a climate expert, you don't know what to believe. It must get somehow regulated, and when it comes to science it gets easy, but when it comes to policy this is really hard.
ED: I didn't open a discussion time for the sharing capacity so if you want to say anything maybe could be a good moment.
MV: We must decide what we want to share. There are so many well organized systems that we should check which ones to include in AtlantOS. Definitely the data sharing brings a problem which is the policies that are behind this process. This is the hardest part of the process. Also data quality standards are a concern when you have a huge amount of data from different sources. It is a big challenge to produce good data, and it is related to the best practices area. Seems that has been a lot of different levels of discussion regarding the sharing of capacities (ships, equipment, people, etc. How can we address it? It is important to support the global initiatives from AtlantOS, acting as a middleware.
MB: In WP3 there are a lot of groups with different research areas, measuring different variables. Suggests to link some/all of them to the AtlantOS webpage.
MV: That's hard. Doing that could be more confusing than actually helpful. Maybe provide some links could be a good initiative, but separating by variables can be inefficient.
ED: We need to have unique identifiers for sensors, ships, platforms, etc. A collection of links may not be consistent in time. There's an interesting tool called OSCAR (see breakout session on infrastructure sharing) that we should explore.
MV: It would be great to have a doc specifying the different kind of data/data networks available. Just some paragraphs for the AtlantOS family that helps to ease the navigation on that space. It is not an easy exercise but it's good to have this from the AtlantOS webpage.
ED: Get the South Atlantic included on the Map and motivate Europe to include them in the research programs. Taking science as a driver to include the south Atlantic on the research map.
MV: There are some integration programmes for the developing countries, but the experience with these countries is that once trained they have very limited capacity in gathering the data and also in using the data. We must focus in training them to use the information that already exists before they start to generate new ones.
EB: The Copernicus Marine Service actually has resources available for that kind of outreach, so there's a possibility to use that.
LB: In Brazil here is a good scientific community but there are lots of problems with the standardization of data. They have problems to produce well documented data to turn into usable information.

The second break-out sessions are introduced by **Hervé Claustre** and **Michelle Barbier**. The attendees are again splinted in three groups to discuss the following themes:

OVs vs TRL for new variables. Moderator: **Hervé Claustre**
Participants: RL, CW, MM, EL, LD, MV, JP, FJ, FW



Break-out session conclusions:

Essential Ocean Variables

- Relevance: The variable is effective in addressing the overall GOOS Themes – Climate, Real-Time Services, and Ocean Health.
- Feasibility: Observing or deriving the variable on a global scale is technically feasible using proven, scientifically understood methods.
- Cost effectiveness: Generating and archiving data on the variable is affordable, mainly relying on coordinated observing systems using proven technology, taking advantage where possible of historical datasets.

Discussion

- Christmas tree syndrome: impact vs feasibility
- EOVs- vs technology-driven choices
- Matching sensor development with network's specifications & requirements: approaching the problem by both sides
    - Need for reduction of data (transmission cost)
- Variety of sensors for the same variable: how to choose/ test them as soon as they reach the appropriate readiness?
- Metrics for evaluation

Metrics for evaluation / decision for implementation

- Fit to the requirements
    - Metrology: « If I improve the measurements, do I change my impact », can I address new questions?
        - Accuracy precision. Do you need the best? Response: It depends of the target
    - This is also true for the combination metrology + platform. Even if the metrology is not the best, the combination platform + metrology could change my impact just because improving the spatio/temporal resolution / filling the gaps.
- Data amount (size longevity)
- Cost measurements.
- Reliability assesment

To be pragamatic: some examples of what can be envisaged

- Nutrients: more feasible less impact
- Carbonates: biggest improvement/impact, but TRL lower at the moment
- Microbes / biodiversity: Ommics sampling making maturing (TL4)
- Fish: Evolution of tag = > less battery limitation => systems more cost-effective
  - No only tagging, not only oceanographic data acquisition but also physiology and behavior variables => and more ecosystem

Comments of the session:
MV: How will the next EOVs look like is the discussion to have. But it is not so clear. Also we have to know what people of other parts of the world think about this. We have to be more global.
ED: Which would be the correct forum to discuss this?
MV: We should go on with our discussions in EU, Canada, US, etc. Take notes of the discussions, and then go to GOOS and so.

Geographic gaps and priorities. Moderator: **Grigor Obolensky**
Participants: MB, DS, BB, EB, LB, JL, MP, MR, PL, PA

Break-out session conclusions:

Landscape:

- Various networks implies various approaches and requirements concerning their implementations
- Priorities first, or implementation first ?
- Geographic gaps analysis
- The Geographical gaps sources
- Filling the gaps
- interactions with operational infrastructures (Eurofleets, Ecord, Cabled Telecom community,..)

Various networks imply various approaches and requirements concerning their implementation

- Network dependant
  - Autonomous network: strategy Clearly stated from begining, global intentions and monitored
  - Fixed observatories: no formal group to identify/assess the geographical gaps but the concerns exist

- Technology dependant
  - Argentina: scientific need (Transbasin array) extended to the boundary currents (Arg. South Afr.) but no instruments
  - EATN: need additional platforms for acoustic

- Geographical area dependant
  - PIRATA: need for South Atlantic stations
  - EATN: 90% coastal/acoustics vs. 10% open ocean/satellite
  - DBCP: closed seas & coastal area excluded
  - modelling approach in OSSE framework could help for refining the areas of interest

- Geographic gaps analysis:
  - Need for relevant and understandable metrics
  - Some network (autonomous) rely on existing tools (JCOMMOPS, OSCAR…)
  - need to cross databases, maps for surface ship tracks
  - a lack of tool to analyse the data/gap

- The Geographical gaps sources
  - ageing networks:
  - for mobile network, currents play a role: modelling currents and refining the cycling starategy could improve in the time the geographical gaps filling
  - OSSE: modelling approach is important to identify holes, need to have some other instruments/technology that can fill in gaps. Mooring cycle
  - Changes in the scientific goals and priorities and associated funding opportunities: Political level implication is extremely important (ex: Brazil, Pirata started as a pilot project funded by noaa/ ship time by brazilian navy =>political decision was important to sustain the navy implication.
  - Historical unreached areas: still unreachable
  - Any observation network depends on national funding
  - Environmental effects (Climate change, harsh environment): opening of Austral and arctic oceans, but need from the scientific programs to « prove » that these areas are of a big importance

- Filling the gaps
  - Technology (more instruments/platforms) means funds/manpower: unreal
  - Use of emerging technologies: ASFAR (an AtlantOS driven improvement) for the Argo network
  - Piggy-back an instrument on another platform
  - Update sampling strategy
  - Opportunity measurements
  - Expand the deployment opportunities: existing unexplored paths? Contact with existing operational infrastructures (Ecord, Eurofleets, Telecom Cabling consortiums)
  - Alternative collaborations with coexisting networks (uniformization of datasets / data management)
  - Computational sciences (Neural networks, data mining/merging)

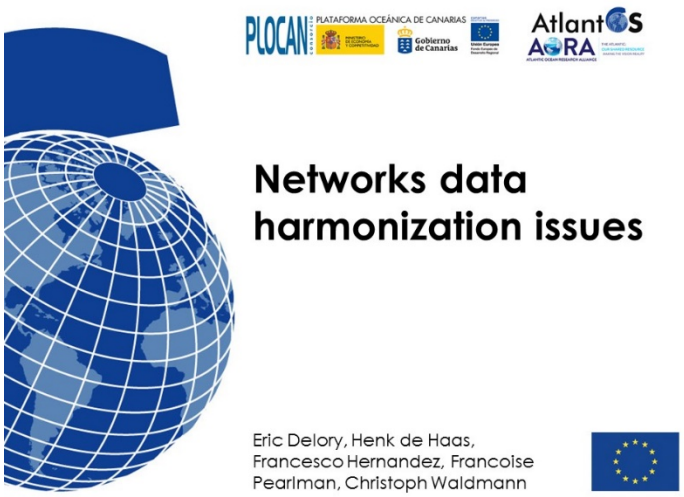
Recommendations

- From the 7 networks represented, the southern part of Atlantic is the target for a new implementation of the networks.
- The networks have to closely collaborate at the technological level for integrating common instrumentation and converge in a common data management system
- Strong need on a societal and Economical benefits analysis of our scientific programs to obtain some new regional fundings (southern Atlantic bordering countries)
- Need for a coordinated actions towards Alternative operational communities (ECORD, EUROFLEETS, TELECOM) to initiate collaborations: AORA through SeaBedMapping Group
- A fixed point station grouping the AtlantOS networks activities in the central part of south Atlantic would be a great challenge for the future

Comments:
MV: I think it's a good list of recommendations. But we looked for a list on the Atlantos context. And in this sense, in WP6 we identified 2 areas where we'd like to explore to work together. One is the North Atlantic

and the other is South Atlantics. It is clear what we are doing in these areas, but what it is not so clear to me is what is happening in the tropical areas. We have PIRATA, but I don't see it integrates or connects other activities we have around. So I was wondering if this topic came up in your discussion.
RL: We had a long discussion about that. Hopefully next year AtlantOS and AORA will work closer together and we can take a stronger role in the tropical area. It depends on some activities that will take place in the coming months.

Networks data harmonization issues. Moderator: **Christoph Waldmann**
Participants: ED, FP, HH, HC



Break-out session conclusions:

- **Harmonization** is necessary to allow for cross - thematic use of data
- Facilitates data discovery and access by broadening the range of users (decision makers, industry)
- Allow for traceability (provenance) of data
- Foster reproducibility of science
- Allow regional data to be integrated into a global system (data assimilation)
- Extends the availability of existing tools
- Being able to harvest the broad range of data bases
- How and What should be harmonized
    - Survey of standards/practices and harvesting protocols currently in use by data user communities and the networks
    - The data and metadata products that are presented to the end user
    - Specify transformation tools to map data produced by AtlantOS networks to user format requirements and identify gaps where there are no standards
- Outcome of harmonization
    - Support the sustainability of observing systems by ensuring flexibility of the data management system
    - Broaden data usage, enhance flexibility
    - Re-use existing data bases in different circumstances
    - Aim at building up a knowledge base

Comments of the break-out session:
MV: In the EU there's an emerging big activity around the data science cloud, also in South Africa there's a similar ambition. Maybe we can find some funding among AtlantOS and AORA-CSA to this aim.
JP: There are several H2020 projects working on virtual laboratories that could fit with the aforementioned data science cloud.
FW: In Canada we are adopting the European Glider standards. Regarding acoustics, they've just started a

project to find how to store these huge data repositories.

Workshop Closing

The workshop was closed with some final conclusions and recommendations from **Martin Visbeck** and **Margaret Rae**

Main Outcomes of the Workshop

After the workshop, through all these sessions the following main outcomes were concluded:
What has been agreed by the participants is:

- To propose an AORA strategic action to compare sharing modes and recommend more Atlantic wide solutions.
- To consider a 'policy statement' for the Atlantic Observing community.
- To encourage full meta data delivery with all data sets and to establish and promote the use of standard descriptors to allow best data harvesting.
- To include to the EOVs discussion issues such as metrology, data compression, comparison of performance and establish review criteria.

Moreover, the joint AORA-AtlantOS WP6/WP3 meeting has provided an excellent framework for fruitful discussions during 3 days and even afterwards. It has stimulated the incentive of AtlantOS WP3 group on Autonomous in-situ Platform to produce synthetic remarks after the end of the meeting. They are available in the Annex and include recommendations. This is an extension of the meeting and arises from the thoughts and questions highlighted during the joint meeting with AORA and AtlantOS WP6.


PLOCAN

Annex I: BluePrint- Synthetic remarks from autonomous observing platforms and Recommendations

BluePrint- Synthetic remarks from autonomous observing platforms and Recommendations[4]

M. Barbier, H. Claustre, P. Alonso, B. Bourlès, F. Janssen, R. Lampitt, G. Obolensky, P. Poli, S. Pouliquen, I. Salter, V. Turpin, F. Woriskey, H2020 AtlantOS WP3

I- State of the art of observation platform communities' integration in European and international activities – AtlantOS framework

The various autonomous observing platforms represented within AtlantOS WP3 are now integrated in European and international activities (AtlantOS Month 20):

Argo: The European Strategy is developed in coherence with the strategy of the international Argo for the Core mission and its extension to biogeochemistry and abyssal oceans. Its implementation is developed with the Euro-Argo ERIC and the Euro-Argo partners. Float procurement at European Level starts to be coordinated by the central Research Infrastructure (RI) facility, proposing a global solution for operational activities. Euro-Argo data are freely available through the Argo Global Data Centres and main European data services developed within Copernicus Marine Service (CMEMS), EMODnet, and the SeaDataNet network of National Data Centres. Service for operational users and scientific communities to Ago data and products are managed and documented through Euro-Argo. Euro-Argo is strongly involved in large European H2020 projects like AtlantOS or ENVRI+, ensuring the community for technological development survey, data management, availability and dissemination

Gliders: OceanGliders has become the new international program to address the gap in the GOOS framework with *inter alia* improvement of US and Australian collaboration to set up a Global data management policy in that context. AtlantOS is a use case and the results will be implemented in other European OS project such as IntarOS (or MedOS... call under review).

EAATN: Real progress on equipping existing mobile and fixed Atlantic observation platforms (gliders, moorings, European Glider Organization, PIRATA, OceanSites, Rapid Mooring Array, OSNAP) with international acoustic telemetry equipment (acoustic receivers) to support European telemetry researchers. The database system developed, continues to expand and is maintained by VLIZ for long term data storage and as the data curation tool.

Surface drifting buoys: The situation is well advanced within the Data Buoy Cooperation Panel (DBCP), which includes task teams for best practices and capacity building, and by synergy with PIRATA for deployments, and the Global Drifter Program (GDP) barometer upgrade scheme. The technology is mature and the funding and procurement situations are healthy, with sufficient competition to ensure rapid turnover and that equipment prices are not dictated by a few manufacturers.

[4] The joint AORA-AtlantOS WP6/WP3 meeting held in Plocan provided an excellent framework for fruitful discussions during 3 days and afterwards. The detailed remarks and recommendations presented here arise from the thoughts and questions highlighted during the joint meeting. This annex is an extension of the meeting between AtlantOS WP3 on Autonomous observing platforms with AORAC and AtlantOS WP6.

PIRATA is clearly already integrated in EU activities (*e.g.* FP7 PREFACE; CORIOLIS & MERCATOR and their EU components…) and international activities (PIRATA MoU between US, Brazil, France; CLIVAR Atlantic & TAV community; contribution to DBCP, GOOS, ARGO, GODAE, AMMA, CARBOOCEAN).
Transport Mooring Array: The network of TMAs and OceanSITES transport moorings will analyse their sustainability strategy.
OceanSITES Biogeochemistry: The observatories which contribute to this task are a subset of FixO[3] the funding for which ends in September 2017 and a subset of those currently in EMSO-ERIC which started in September 2016. The expectation is that EMSO will be the main organization for fixed point observatories in Europe and the progress made in AtlantOS in the engagement of observatories not managed by European organisations will be of great benefit.

Identified needs for autonomous observing platforms in AtlantOS for improving the integrated Atlantic observing system:
- Enhancements of the autonomous network has to carefully consider requirements, feasibility and cost-effectiveness to provide informed recommendations for a fit-for-purpose post-AtlantOS integrated Atlantic observing system that can be sustained on the long term.
-There is need to decide on a **common strategy for the three fixed point observatory networks** in order to improve spatial coverage. A geographic area could be the **Tropical area.** EMSO-ERIC is expected to become the umbrella organization of fixed point observatories in Europe and links between OceanSITES Biogeochemistry and PIRATA under EMSO have already developed very positively, largely as a result of the Joint AORA CSA-AtlantOS WP3/WP6 meeting. It is hoped that the TMA endeavours will become similarly involved.
=> A side event at the next AtlantOS General Assembly shall be carried out to link to initiatives outside of Europe
-There is a need for the different AtlantOS WPs to help to **identify observation priorities for some new communities and support any autonomous observation network to decide on new variables to integrate**.

II - General Key issues identified during the workshop for long term sustainability

The existing observing networks within AtlantOS WP3 have made great progress in the last 20 months. However, some common issues which affect multiple partners and institutions were identified that still need to be addressed.
Each network has clearly identified the need for **best practices documents** – with respect to deployments as well as data dissemination, some already have best-practice documents – buoys with the DBCP publications, and for biogeochemistry fixed observatories from FixO[3] which will shortly have a DOI[5].
Enhancement of infrastructures (e.g. by changing to new types of sensors that are being developed or by including new sensors and variables) remains challenging, especially when new user communities require sharing of infrastructures (for example by adding acoustic receivers to physical oceanography platforms). Some networks have governance structures and procedures in place to approve additional sensors to be integrated (e.g. PIRATA, Argo). Issues to be solved include **sensor compatibility** (e.g. in terms of energy consumption, data transmission)**, interference** and **change of procedures** (e.g. observatory maintenance, data management)**.** In case of sharing of infrastructures / hosting sensors from other communities' liability issues may need consideration. Although the added value (incl. implications for attracting funding and long-term sustainability of platforms) may be a clear motivation for the integration of new and additional sensors, difficulties and efforts connected to significantly change protocols of established and smoothly working systems also needs to be taken into account.
There is still a need to improve **connection and exchanges** between and within the individual networks. **For new networks, bringing the scattered community together** is a priority to define the scope and activities that will be undertaken by the community e.g. European Telemetry Network, European Glider Network) and to secure such funding at the national level in terms of contact point, procedure, strategy.

[5] http://www.fixo3.eu/download/Handbook%20of%20best%20practices.pdf

Coordination with other regional observing systems on the AtlantOS basis (IntarOS and future projects to be funded under H2020) needs to be fostered.
Some communities need support to better **connect with international non-European partners** in order to extend the networks, improve visibility, and foster capacity building (e.g. Efforts to link the European glider community to activities in **Canada and Brazil**) and make sure the same standards are applied. Furthermore, **global data management needs to be done in collaboration with international partners** (specifically USA, and potentially Canada and Brazil).

There is a clear need to secure sustained funding, and to develop research team cooperation to submit multi-nation funding requests. Also at the national level, there is a need to secure in terms of contact point, procedure, strategy for some communities. Moreover, for others with Open Data Policy and Global coverage, the only Business Model that can be envisaged for funding is to involve a third party to complement the National funding (e.g. Argo and its extension).
The **recycling of materials from platforms is a new identified issue** when for example profiling floats/drifters enter in End-of-Life mode and are washed to shore. Note this issue probably concerns other ocean observing networks including satellites. Each community makes best efforts but we are aware of no policies or practices worldwide that guides this.
Another identified issue is the **monopoly and/or market dominance** of some equipment by a single non-European manufacturer (floats, telemetry, animal tracking tags and acoustic receivers).*

III – Specific short-term recommendations from WP3

The autonomous observing platforms have identified specific short-term needs to sustain the observing system:

For new variables there are:

- Needs to **consider capabilities of the different platforms** and potential adaptation of existing procedures
- **Additional sensors should not in principle interfere with core measurements** of a platform, but some flexibility might be required or encouraged
- **Autonomous samplers for particles, water, biota will be required for the foreseeable future** and should be deployed in association with sensors when the platforms allow it**.**
- Needs for a **balance between ever-growing capabilities of sensor technologies** (driven by technical feasibility) **and de facto requirements** (e.g., accuracy) to address the observation targets (driven by scientific needs),
- Needs for the development **of best practices for calibration and deployment** as well as for **cross-calibrations of different sensor** types to ensure interoperability.
- **Ensure interoperability** within and across networks: Use the same protocols within the international community for calibrations, QC, data management
- **Address the emerging biological EOVs[6] through the integration of microbial community observation**, a promising field to extend the scope of observations and connect to new user communities. Observations based on samples from particle traps and automated samplers will not only allow to connect biogeochemical cycles with specific microbial groups and functions but also to improve knowledge on spatio-temporal patterns of community composition and effects of global change.

For Data management

- **Data access needs to be improved,** in close collaboration with AtlantOS WP7

[6] defined by the GOOS biology and ecosystems panel.

- **Need to develop coherent, integrated databases with the international community** (gliders, EATN)
- Care needs to be taken that **data management is able to keep pace with the generation of additional data**.
- **Need for human power** for the treatment maximum uptake (valorisation) of data acquired during yearly cruises.
- **Develop communication/outreach activities** on network monitoring and scientific data handling/use.

For Expertise and further networking

- Build a **strong end-user community** that is aware of the relevance and benefits of ocean observation
- **Long-term availability of funding** and **dedicated experts** to purchase, maintain and operate the new sensors and work with the data from the variables that are to be included. Scientific institutions or national commitments are important
- **Successful pilot demonstration projects** may motivate other communities to join in and also host additional sensors.
- **Specific demonstration themes** (e.g., oxygen minimum zones) should be developed to integrate network enhancements and demonstrate their benefit and foster engagement by the wider observation community.
- **Integration of some communities into new EU H2020 projects** such as IntarOS (Arctic) and its forthcoming equivalent in the Mediterranean (if funded).
- **Integration of some new sensors or concept into Research Infrastructures (PIRATA/EMSO)**

To fill in Geographic gaps

- **Platform geographical locations** are obviously selected according to the observational needs of a specific community (e.g., transport moorings in boundary currents) and are not necessarily best-suited for the requirements of other communities (e.g., animal tracking network or OceanSITES biogeochemistry).
- In addition to the integration **of additional sensors, key locations** need to be identified where additional monitoring platforms are needed or plans developed on how to use the existing platforms to provide necessary information. For example, the tropical area is of interest to the Fixed Point Observatories, and CO_2 sensors in the tropical area would be an asset, but this implies adoption of the same protocols in terms of calibrations, QC, data management, changing existing protocols.

IV- WP3 suggested recommendations for the Blue Print (long-term orientation)

For a sustained long-term Atlantic Observing system, the autonomous observing platforms are recommended to:

- Improve the **collaboration with large European infrastructures for ship time opportunities** (Eurofleets, ECORD, GO-SHIP) and develop opportunities offered during yearly dedicated cruises (vessel time optimization).
- **Foster the engagement of European SMEs for sensors** research and development activities by integrating them as partners. Where synergies might be achieved, explore the possibilities of linking European companies with international industry.
- **Develop collaborations with equivalent networks.** These include JCOMMOPS, Data Buoy Cooperation Panel (DBCP) for sustainable use of floats/drifters, ICOS Ocean to develop common joint strategies on pCO2, and GOOS to develop a Global Data Management for gliders.

- **Enhance access to data through unique single portal.** Note that a GDAC architecture is being defined in WP7 AtlantOS to improve the data management of drifting buoys.
- **Foster cooperation with tropical and south latitudes Atlantic bordering nations and through reciprocal exchanges** for capacity building, float deployment opportunities, and integration of scientific experts in the quality control management of the data. Engage more bordering nations to "own" more of existing observation programs.
- **Make initial steps towards an ocean acoustics governance**: it is probably too early to ask the International Telecommunication Union (ITU) to govern the ocean acoustics frequencies, but at minimum the community should list the acoustic frequencies used (for underwater data transmission, animal tracking), with a view to "protect" these frequencies and ensure their continued availability for use by the ocean observing community.
- **Develop a strategy to address the single manufacturer monopoly issue**
- **Maintain funding to pursue projects that integrate research communities** such as AtlantOS which fosters integration of the different platforms
- **The concept of "No littering from the research Vessels"** (*e.g.* no chemical products, plastics, etc. dumped to the ocean) has been in place for several years, but expendable tools are still currently unavoidable (*e.g.* XBT, weights, lost chains from moorings, etc.).
- For drifting platforms, Argo floats, establish **best practices for recovery and recycling**. This would reduce the amount of waste produced by the observation community and provides the opportunity of post-deployment calibration to quantify sensor drift. **Assess the impact of the float's array on the Environment, and develop a recovery- at- sea and waste management of the floats arriving to their End-Of-Life mode.** Develop a policy for recycling equipment that runs ashore.
- **Encourage the manufacturers** of expendable observing platforms or sensors to **reduce the impact on environment of their equipment by revisiting the design** and benefiting from opportunities offered by technological advances (sustainable and/or biodegradable materials, batteries, etc.)
- Define **the overall impact of the global ocean network** (shipping logistics, use of materials, waste management) and compare to the overall marine activities (commercial ships, drilling, leisure vessels)
- **Extend the concept of ship of opportunity to open sea polluting activities reporting.** On demand, dedicated scientific cruise (and why not extend to touristic/commercial ships) could potentially report on what could be called the "no blueprint" activities observed in the open sea, such as illegal fishing, microplastics, oil spill. They could also sample during some operations when vessel is stopped (*e.g.* plastics and microplastics, algaes, oil) and transfer samples to concerned scientific communities.

Annex 2

Interoperability Technologies for Sharing Ocean Instruments and Real-Time Data

March 15 2018

supported by the H2020-AtlantOS project and EMSO-ERIC.

Interoperability for sharing real-time data and instruments training workshop

Workshop Summary

With this workshop we engaged with the community to further demonstrate, in the field, new interoperability tools that have been developed and field-tested for ocean sensor and real-time data sharing. These software and firmware tools have been implemented on different platforms and sensors. They are available open-source and now require substantially less engineering time than in the past. The training also helped those interested in participating in an interoperability experiment in the field, with the Atlantic Ocean as a region of interest and deployment, in the framework of AtlantOS and EMSO ERIC. The workshop and training took place during the Oceanology International 2018 conference to facilitate industry participation. The workshop was open to ocean scientists, engineers and technicians dealing with in-situ sensor and observing systems, from academia or industry. These participants were offered direct experience with the latest interoperability technologies.

Oceanology international is a major international marine technology showcase event. The OI event offers one of the world's leading forums where industry, academia and government share knowledge and connect with the marine science and ocean technology communities. OI's exhibitions and conferences help organisations reach buyers from key market regions and sectors worldwide and help them improve their strategies for measuring, exploiting, protecting and operating in the world's oceans. OI is held in London every two years, now in its 49th year, it has firmly established itself as the world leading marine science and ocean technology exhibition and conference. Attracting visitors from a variety of industries including oil & gas, engineering, renewable and maritime security and marine science.

Sponsors:
Main sponsors: EMSO ERIC, AtlantOS (WP6)
Contributing Consortia & Initiatives: EMSO-Link, EMSODev, NeXOS, PLOCAN, IEEE, UPC, OBSEA, BODC, 52north, EMODNET, Marine Institute (Ireland), Ifremer, CSIS, SeaDataNet, EnvriPLUS, BRIDGES, ODIP II

All presentations are available at the following link:
https://www.atlantos-h2020.eu/events/training-workshop-interoperability-technologies-for-sharing-ocean-instruments-and-real-time-data/

Workshop Attendees

First Name	Name	Organisation
Ehsan	Abdi	Cyprus subsea
Pasquale	Andriani	Engineering Ingegneria Informatics S.p.A.
Pierre	Almeida	Ocean Sonics
Christian	Autesmann	52 North
Carlos	Barrerta	PLOCAN

Jèrôme	Blandin	Ifremer
Justin	Buck	BODC
Guillaume	Cladic	Ifremer
Claudia	Conan	Maris NL
Nuno	Cruz	INESC Tec/FEVP
Juanjo	Danobeitia	EMSO ERIC
Joaquin	Del Rio	UPC
Eric	Delory	PLOCAN
Laurent	Delauney	ENVRI +/IFREMER
Laurent	Dufrechou	RTSYS
Dina	Eparkhina	EuroGOOS – European Global Ocean Observing System
Corentin	Troussard	RTSYS
Paolo	Favali	EMSO ERIC
Hugo	Ferreira	INESC Tec
Deirdre	Fitzhenry	Marine Institute
Paul	Gaughan	Marine institute
Philip	Gibbs	swaletechnologies
Matt	Geldart	Marine Scotland
Valerie	Haiscoat	IFREMER
Steve	Jones	University of Bergen
Shane	Lavery	Slr consulting
Enoc	Martinez	UPC
Scott	McLean	UVic
Mathias	Meyer	Kongsberg Contros
Joan	Montero	INESC TEC
Bertrand	Moreau	IFREMER
Rajesh	Nair	OGS, Italy
Diarmuid	O'Conchubhair	Marine Institute
Nick	O'Neill	SLR Consulting
Francoise	Pearlman	IEEE
Jay	Pearlman	IEEE
George	Petihakis	HCMR
Kieran	Reilly	Marine Institute

Brice	Robert	CLS
Henry	Ruhl	CENCOOS/NDL
Dick M. A.	Schaap	Maris NL
Desirée	Stockermans	Ocean Sonics
Corentin	Troussard	RTSYS
Joe	Turner	Exocetus autonomous systems

All presentations are available at the following link:
https://www.atlantos-h2020.eu/events/training-workshop-interoperability-technologies-for-sharing-ocean-instruments-and-real-time-data/

Morning session

09h00 – 11h00 – Background: interoperability tools and initiatives

Moderators: Eric Delory & Jay Pearlman

Introduction, General considerations
09h00-09h15 Introduction, value proposition and technological maturity
Jay Pearlman (IEEE) & Eric Delory (PLOCAN, Spain)

Jay Pearlman

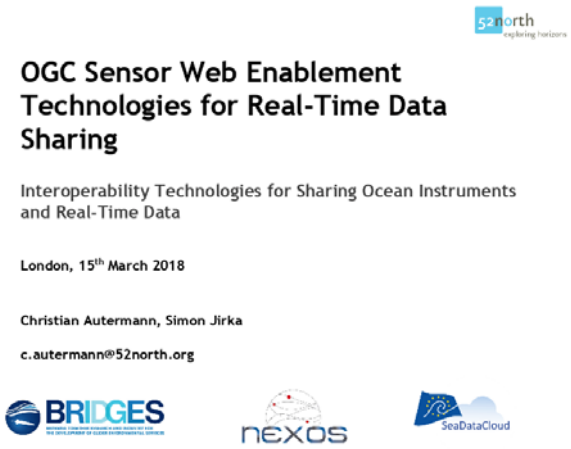
Jay Pearlman presented the agenda of the jointly organized event by AtlantOS and EMSO ERIC (EMSODEV, EMSO-Link) and underlines the importance of the maturity level of the technologies that will be presented. He introduces the objectives of an ocean observing system. A vast array of platforms is available, and new electronics are coming in. The machine to machine communication need has led to SWE, based on SensorML, SOS, from sensor to the user. He underlines that anytime the user or operator sees the data; there should be a way also to interact with the system.

https://www.atlantos-h2020.eu/download/event/atlantos_interoperability_training_workshop/09h00-09h15-AtlantOS-Pearlman-Introduction-Interop-workshop-March-15.pdf

Sensor Web interoperability

09h15-09h30 OGC SWE technologies for real-time data sharing, NeXOS project

Christian Autermann, Simon Jirka (52North, Germany)



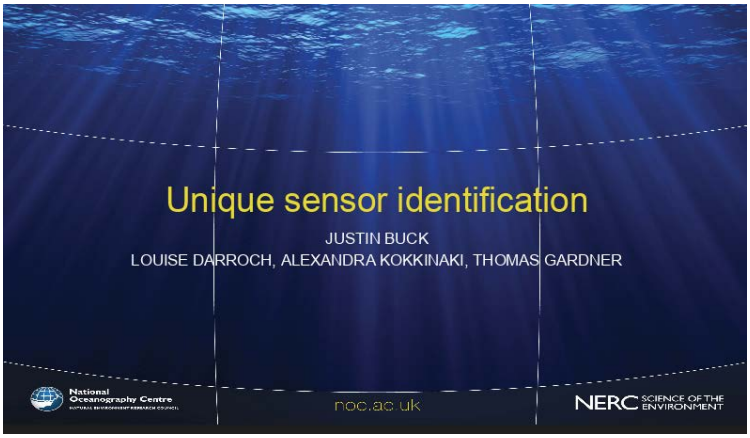
Christian Autermann

Presenter: Christian Autermann, illustrated the SWE, which provides an interoperable standard that connects different data visualization and analysis. Different standards are presented, as well as SOS that is a hub for data. Several components are presented as well as the necessity of Marine SWE Profiles.
In conclusion, an issue is to combine the different results from observation networks, in order to better exchange data. SWE is at a high maturity level in general, and is shown to be useful in marine sciences. Software solutions in open-source are available and data from different sensors can be integrated.

https://www.atlantos-h2020.eu/download/event/atlantos_interoperability_training_workshop/09h15-09h30-AtlantOS-SensorWebInteroperabilityAutermannJirka.pdf

Sensor interoperability

09h30-09h45 Unique Sensor IDs and sensor catalogs, SenseOcean project
Justin Buck, (BODC, UK)




Justin Buck

Presenter: Justin Buck, illustrated the practical issues related to metadata transmission: hardware, software and cost. The solution identified includes the provision of a Unique Identifier for each sensor, which is further described in a public deliverable with recommendation on data formats and standards. An example from SenseOcean was provided, with a SensorML instance. UID was put on sensors in SenseOcean, there will be another example in Envriplus. At NOC, end of this month there will be an extension on one of the gliders.

https://www.atlantos-h2020.eu/download/event/atlantos_interoperability_training_workshop/09h30-09h45-AtlantOSOceanology2018UniqueSensorId-Buck.pdf

09h45-10h00 OGC PUCK for sensor interoperability, NeXOS project

Joaquin del Rio, Dan Toma, Enoc Martinez, (UPC, Spain)

No ppt in Drive

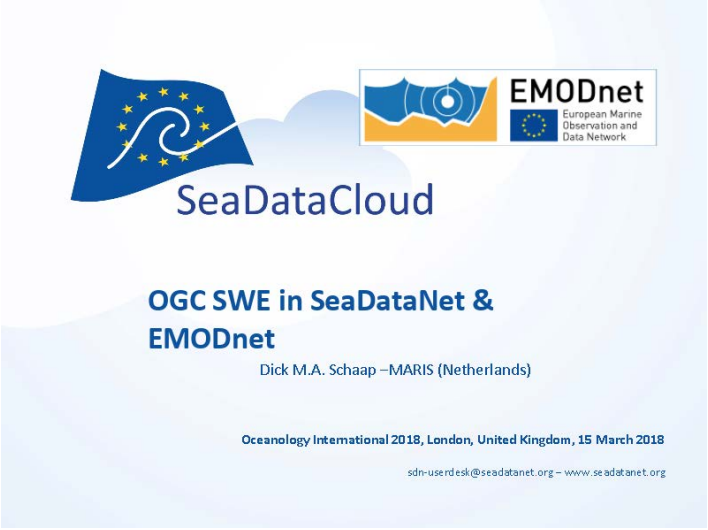
Enoc Martínez

Presenters: Enoc Martinez, Joaquin del Rio, co-presented the challenge related to interoperability of sensors. A driver for each sensor and platforms should be created. This is very time consuming and the cost for maintenance are very high. The solutions identified is to have a metadata file (identifiers, interface, protocol, etc.), produced with SensorML standard. The sensor metadata could be associated to a universal driver and embedded in the sensor to remove traceability problems. This can be done with OGC PUCK Protocol, an add-on to existing protocols. It provides auto-detection, auto-identification and access to memory.

https://www.atlantos-h2020.eu/download/event/atlantos_interoperability_training_workshop/09h45-10h00-OGC-PUCKMartinez.pdf

Related projects and Initiatives

10h00-10h15 OGC SWE in SeaDataNet & EMODNET
Dick Schaap (MARIS, Netherlands)



Dick Schaap

Presenter: Dick M.A Schaap. In Europe the acquisition of oceanographic and marine data is expensive; annual costs is estimated at 1.4 Billion Euro (1.0 = in-situ; 0.4 = satellites). He illustrates SeaDataNet, a pan-European infrastructure set up and operated for managing marine and ocean data which was started in the 90s. SeaDataNet portal gives access to standards, tools and a number of products. SeaDataNet also transfers the knowledge to the community with trainings. They have also set up a Data Discovery and Access Service which includes data from 650 originators. SeaDataNet is now moving towards the European Opean Science Cloud (EOSC). They cooperate with many stakeholder and in particular with EMODNET, with whom they developed a Bathymetric service mapping the bathymetry of EU seas.

https://www.atlantos-h2020.eu/download/event/atlantos_interoperability_training_workshop/10h00-10h15-OI2018-Schaap-SWE-SDC-March2018.pdf

10h15-10h30 Interoperability in the BRIDGES project

Ehsan Abdi & Dan Hayes, Cyprus Subsea Consulting and Services

Ehsan Abdi

Presenter: Ehsan Abdi, presented the SWE and PUCK developments in Bridges. Standardization is very important for integration as well as design. It will work on formatting standards using NetCDF, but it does not work with all the platforms – there is still work that has to be done. Identify the current state of each glider. Use OGC sensor web standards for piloting the glider (not yet available). The PUCK protocol is implemented via a smart low-power cable, which turns any commercial sensor into a puck enabled device, it stores and provides a sensorML file.

https://www.atlantos-h2020.eu/download/event/atlantos_interoperability_training_workshop/10h15-10h30-OI18_BRIDGES_Abdi.pdf

10h30 -10h45 EnvriPLUS – Research Infrastructure perspective in sensor interoperability
Laurent Delauney (Ifremer, France)

Laurent Delauney

Presenter: Laurent Delauney, illustrated the work on metadata management carried out inside ENVRI PLUS. We are working on metadata management. The requirements were identified by the actors of observation which request for computerized management tools for their piloting or maintenance activities. Two complementary strategies are now considered: one encompasses the adoption of tools shared by observation networks; the other one focuses on establish standardized interfaces for the exchange of information.

https://www.atlantos-h2020.eu/download/event/atlantos_interoperability_training_workshop/10h30-10h45-ENVRIplus_Interroperability-OI-London-2018Delauney.pdf

10h45-11h00 Coffee break (offered on-site)

11h00 12h30 EMSO EGIM Technology Workshop

Showcase of the EGIM technology to potential users of the equipment, including interoperability aspects

Chair: Paola Materia

11h00-11h15 EMSO ERIC introduction
Juanjo Danobeitia, Dir. Gen. EMSO ERIC

Juanjo Danobeitia

Presenter: Laurent Delauney, illustrated the work on metadata management carried out inside ENVRI PLUS. We are working on metadata management. The requirements were identified by the actors of observation which request for computerized management tools for their piloting or maintenance activities. Two complementary strategies are now considered: one encompasses the adoption of tools shared by observation networks; the other one focuses on establish standardized interfaces for the exchange of information.

https://www.atlantos-h2020.eu/download/event/atlantos_interoperability_training_workshop/11h00-11h15-EMSO-ERIC_OI_2018_Danobeitia_VFINE.pdf

11h15-11h30 Overview of EGIM: rationale, concept, future deployments
Henry Ruhl, NOC, UK

Henry Ruhl

Presenter: Henry Ruhl, illustrated the different challenges faced at global level, such as geo-hazards and plastics. The Sustainable Development Goals and also some EU mandates as the Marine Strategy Framework Directive (MSFD) also give directions on the requirements by the society and by policy-makers. Henry Ruhl presented the EGIM design concepts - the EGIM comes in two forms, stand-alone and cabled and be integrated into existing cabled observatories or deployed as part of a mooring-line. An EGIM prototype and two replications (3 EGIMs in total) are now in Southampton undergoing the acceptance test before deployment in PLOCAN and in Western Ionian Sea.

https://www.atlantos-h2020.eu/download/event/atlantos_interoperability_training_workshop/11h15-11h30-EMSO-ERIC_EMSODEV-EGIM-intro_ruhl.pdf

11h30-11h45 EGIM design and prototype

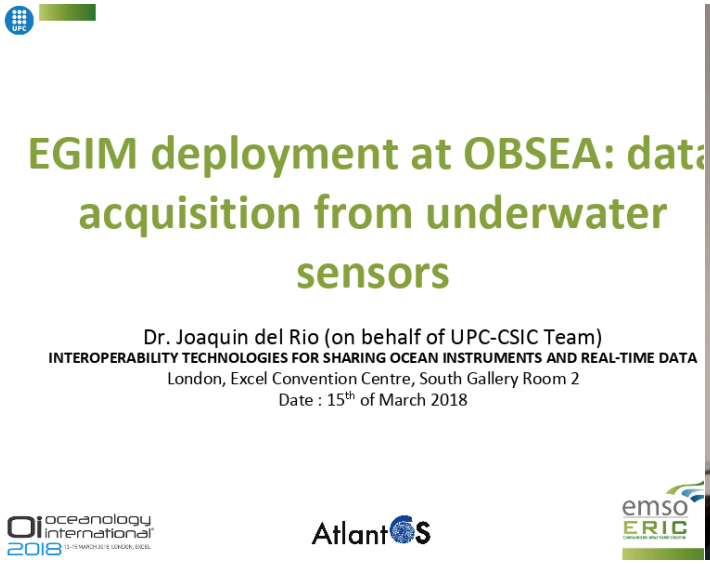
Bertrand Moreau, Jerome Blandin, Ifremer, France

Jérôme Blandin

Presenters: Bertrand Moreau, Jerome Blandin, co-presented on the EGIM (Figure 3), i.e EGIM requirements coming from EMSO community and designed to be adaptable to all types of Regional Facility and to host other sensors. The 7 core parameters covered by EGIM can be integrated with other sensors. The core of the control system is COSTOF2 which provides a generic interface, power control, accurate time stamping of data as well as many other features. The current development of COSTOF2 includes a new version of the firmware and the integration of SWE.

https://www.atlantos-h2020.eu/download/event/atlantos_interoperability_training_workshop/11h30-11h45-EGIM-design-and-prototype.pdf

11h45-12h00 EGIM deployment at OBSEA: data acquisition from underwater sensors
Joaquin Del Rio, UPC, Spain




Joaquin Del Rio

Presenter: Joaquin del Rio, presented on the OBSEA shallow water observatory and the related EGIM prototype testing that took place at the OBSEA facilities (Figure 4). Dry testing of EGIM components were done at the UPC labs before further pressure testing in their hyperbaric chambers – simulating EGIM deployment at depth. Wet testing was then carried out via deployment of the prototype EGIM at the OBSEA shallow water test facility for 6 months. Joaquin del Rio then presented the software infrastructure used and explained the rational for the data acquisition system, how each component is executed by virtual machines, and the same virtual machines will be on each site. Joaquin del Rio also presented how the data collected are sent to a SOS server and how all data are archived in PANGEA. Currently a graphical interface is being developed to configure the sampling strategy. Issues need to be fixed like ADCP and passive acoustics duty cycles need to be managed to avoid interferences. A sampling strategy is under development.

https://www.atlantos-h2020.eu/download/event/atlantos_interoperability_training_workshop/11h45-12h00-JdR-EMSO-UPC-EGIM-Obsea.pdf

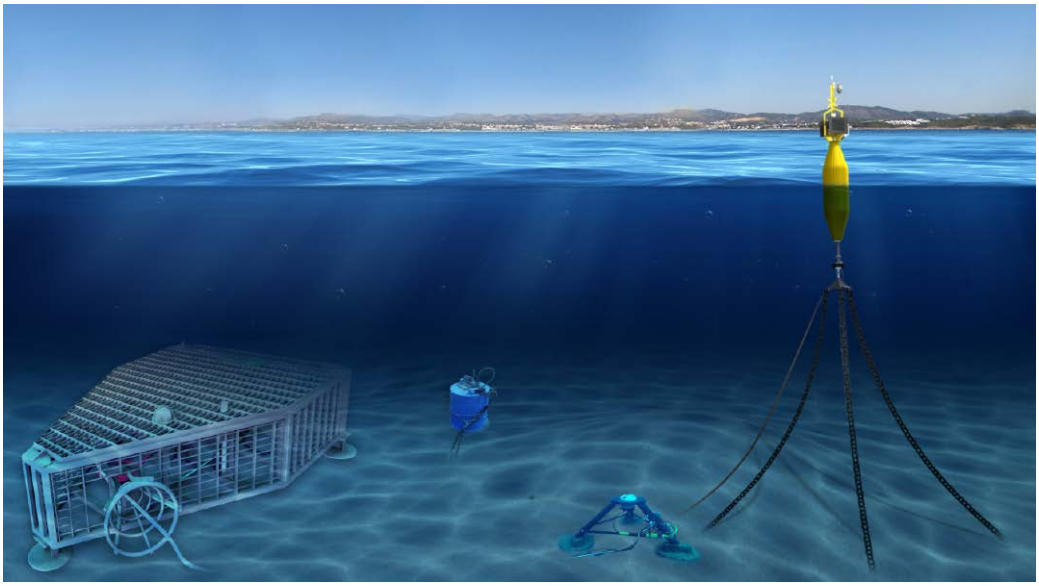


Figure 4: The OBSEA schema

12h00-12h10 EMSO Data Management Platform

Pasquale Andriani, Engineering ingegneria Informatica S.p.A., Italy

Pasquale Andriani

Presenter: Pasquale Andriani. He presents EMSO Portal and the high level architecture of the platform and the physical infrastructure in cloud. Difference open source products were integrated and they cover the entire ENVRI Reference map. Everything can be accessed through API and a standardized web interface. Requirements were availability, scalability and fault tolerance, in order to be able to properly perform data processing, acquisition, publishing, curation, and use. EGI federated cloud is used to host the infrastructure.
This is accessible at vo.emsodev.eu
A push-pull process is in place to communicate with SWE services.
Data are then output in the Open Data View (ODV) Standard.
OPenTSDB, Apache, Hadoop software are used in the development.

https://www.atlantos-h2020.eu/download/event/atlantos_interoperability_training_workshop/12h00-12h10-EMSO-Data-Management-Platform_London15032018_PAndriani_ENG_v1.pdf

12h10-12h20 Setting up an active forum between industries and EMSO ERIC
Nick O'Neill, SLR

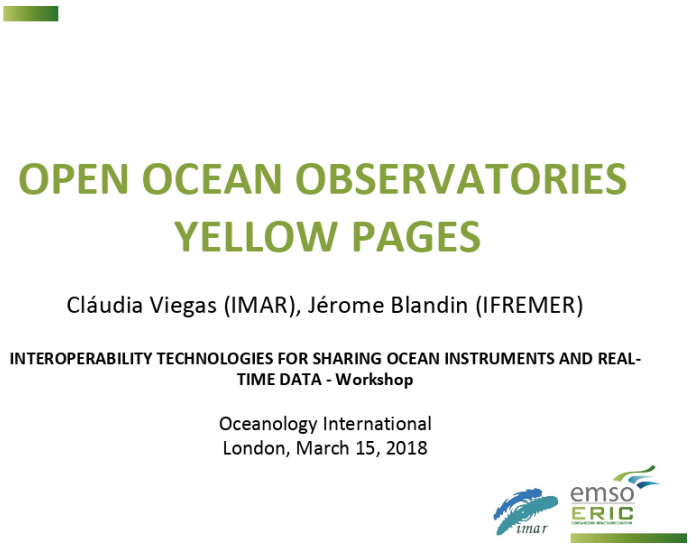
Nick O'Neill

Nick O' Neill introduced the process of interaction between industry and observatory developers and operators while at the same time dedicated crucial time for industry feedback. EMSO ERIC is a suitable platform for guaranteeing the sustainability that the industry needs as well as determining what the market is currently and will be into the future from the observing systems manufacturers. Interactions during the workshop are documented below.

https://www.atlantos-h2020.eu/download/event/atlantos_interoperability_training_workshop/12h10-12h15-EMSO-ERIC_IndustryForumOI2018-SLR.pdf

https://www.atlantos-h2020.eu/download/event/atlantos_interoperability_training_workshop/12h15-12h20-OI2018_March14_Improved-ToolsTechniques1_CostEffective_SLR.ppt.pdf

12h20-12h30 Open Ocean Observatories Yellow Pages
Jérôme Blandin




Jérôme Blandin

Presenter: Jerome Blandin, presented the Yellow pages, developed in ESONET and integrated now in EMSO. The open access catalogue is online and it is accessible to all manufacturers eager to register new sensor products for marine observatories. Fields need to be entered to document the sensor system. 268 sensors are registered at the moment, 214 hardware components, 180 manufacturers, etc. Use in observatories is also documented.

https://www.atlantos-h2020.eu/download/event/atlantos_interoperability_training_workshop/12h20-12h30-.2018-03-15-EMSO-ERIC_yellowpages.pdf

12h30-13h00 **Industry feedback**

Moderators:
Diarmuid O'Conchubhair (MI, Ireland), Henry Ruhl (NOC) and Nick O Neill (SLR)

EMSO ERIC strongly affirms the need to involve industry to establish and exchange to understand the market and to flow information to policy makers.

A discussion gathering some initial needs from the industries participating to the event is stimulated by Henry Ruhl, Diarmuid Ó Conchubhair and Nick O Neil:

- Laurent Dufréchou states that they can provide data coming from COSTOF2 that they are providing to local governments They can pass these data to the EMSO platform or other platforms H. Ruhl informs that the EMSO platform in currently under development. Dick Shaarp informs that EMODNET is in contact with several industries to enrich the data they provide, this could be another way to be considered. Eric Delory comments that it will be very easy to integrate the data as the SWE is integrated in COSTOF2. Juanjo Danobeitia comments that high quality data should be provided for important decisions for the society.
- Another important question raised by the participants is on the renting or the purchase of EGIM. Henry Ruhl informs that EMSO is now addressing the Intellectual Property Rights and the system will be soon on the market.
- A discussion of the specific sectors follows: oil-gas, deep-sea mining, aquaculture sector, offshore wind, renewable energy and passive acoustics.
- Diarmuid Ó Conchubhair made the point that the EGIM is a useful platform for Marine and Marine Renewable Energy test site operators for the purposes of monitoring the same set of variables at each site and being able to draw on the wider EMSO nodes for comparative data.

13h00-14h00 Lunch Break (light-lunch offered on-site)

Afternoon session

Interoperability experiments and field activities

14h00 14h30 EMSO Transnational Access

14h00-14.30 EMSO Regional Facilities as test beds for industrial equipment, methods or services. Introduction to TNA also (high-level details for each node)
Henry Ruhl (NOC)

Henry Ruhl

H. Ruhl shows the services provided by different RIs and initiatives (EPOS, COPERNICUS, ICOS, MSFD, integrative services, DOOS). He then presents the TNA available now from EMSO ERIC Regional Facilities in the frame of EMSO-Link and illustrates the possible access that could be carried out. The available Facilities are PYLOS, Smartbay and Nice (see slides for details). He also explains the TNA process and the key dates for this call.

https://www.atlantos-h2020.eu/download/event/atlantos_interoperability_training_workshop/14h00-14h30-EMSO-ERIC_EMSO-Link-TNA_ruhl.pdf

14h30 15h00 AtlantOS Interoperability Experiment

14h30-15h00 Platforms and support available at PLOCAN EMSO site for AtlantOS Demo
Carlos Barrera & Eric Delory, PLOCAN, Spain

Eric Delory presented the opportunity to access PLOCAN in the frame of AtlantOS. He presented an overview of PLOCAN, the gliderport facility and the glider operations that are currently being carried out. The experiment will take place from summer to December 2018.

https://www.atlantos-h2020.eu/download/event/atlantos_interoperability_training_workshop/14h30-15h00-PLOCAN-Platforms-O2018_AtlantOS-Workshop_Barrera_Delory.pdf

https://www.atlantos-h2020.eu/download/event/atlantos_interoperability_training_workshop/AtlantOS_InteropExpMIssionTemplates_1.3.docx

15h00-15h30 Industry feedback

A discussion on what PLOCAN is implementing on their regional facility is carried out. The links with industry were already brought in the construction plan so this is a core activity for PLOCAN.

Possible links with different sectors and topics are also explored:

- Energy
- Wind
- Aquaculture
- oil platforms decommissioning
- telecommunications (sub-sea cables)

15h30-16h00 **Plans, AoB, Closing**

Moderators:
Jay Pearlman (IEEE) and Eric Delory (PLOCAN, Spain)

Eric Delory summarizes the outcome of the workshop:

- the presentations of the activities carried out in different project for SWE
- the discussion about OGC PUCK
- the presentation of the EGIM
- the discussion on TNA and the interoperability experiment

Nick O' Neill underlined that industry should be encouraged to keep view us as customers and this will help determine the requirements expressed during this workshop. Sensor and platform manufacturers will listen if they feel this will go into their business. If they realise they can add value like provide a science service, they will be satisfied with adding their technologies

From left to right: Eric Delory, Jay Pearlman, Joaquín del Rio, Enoc Martinez

Conclusion and next steps

Although the driving force for the sensor market for many years, as addressed in the Market assessment and Competitiveness of European supply industry Report (Nexos Project, 2014), has been the Research and Development (R&D) marine environmental applications while industrial and legal uses where of lesser size, over the past years this balance has begun to shift in favour of demand related to industrial and legal purposes of using sensors. In the near and midterm future these two market areas are expected to grow even more and contribute the main volume of sensor sales.

An effective marine observation and data sharing system, delivering societal and economic benefits requires the coordination of efforts between multiple sectors in the value chain. These include the scientific community, oceanographic data centres, federated data

infrastructures, national and regional agencies and authorities with competency for marine environment and maritime economy, actors from civil society and the private sector.

One of the objectives of EMSO-Link is to promote interaction between the Ocean Observation research community and the commercial sector. Among the goals in WP7 is to establish an efficient connection with industry which is of paramount importance considering both the technology behind EMSO ERIC RI and the possibilities offered by the network.

The EMSO community itself has considerable experience and know-how gained from previous and ongoing projects. These projects show that there is a need for a system change in how marine observatories and associated data and information sharing initiatives engage with industry. Some actions that can be undertaken or improved in close collaboration with the EMSO ERIC Communication Service Group. In order to progress with these states of affairs:

- More efforts should be made to build upon early achievements and successes: presenting use case examples can trigger interest where there may previously have been none.
- Develop a more service oriented approach, learning new communication skills and language, being present and more visible in forums that attract industry and to exploit creative technologies.
- Industry representatives should be largely included in the governance and take part in the entire cycle of decision making, development and operation of marine observation and data sharing initiatives.
- Data, products and services offered by marine observation and data initiatives should be presented in a user-friendly, attractive and intuitive way which is adapted to the target users adjusting the interface adequately.
- Clear, succinct and open communication is critical: it should be instantly clear for industry what data, products and services are offered and what may be made available in the future. Equally important is to provide information on what is not available and the limitations of the resources offered.
- Maritime clusters are an important bridge between private and public sector as they deal with both and have a good understanding of their culture, language, needs and concerns.

It is clear that Implementation of the above mentioned recommendations requires increased commitment and investment of time and resources, both from industry and from marine observation and data initiatives, but should provide both with significant returns over time. In closing Juanjo Danobeitia, Dir. Gen. EMSO ERIC made a short speech with regard to how important this work is for the future of the planet.

Acknowledgements:
Thanks to Daniel Alcaraz (PLOCAN) and Paola Materia (EMSO-ERIC) for their support in organising the event.

Annex B: EMSO ERIC Workshop Agenda at OI - 15th March 2018, London, UK

Training workshop

INTEROPERABILITY TECHNOLOGIES FOR SHARING OCEAN INSTRUMENTS AND REAL-TIME DATA – MARCH 15 2018

Venue: London, Excel Convention Centre, South Gallery Room 2
Date: 15th of March 2018
Duration: 1 day

With this workshop we will engage with the community to further demonstrate, in the field, new interoperability tools that have been developed and field-tested for ocean sensor and real-time data sharing. These software and firmware tools have been implemented on different platforms and sensors. They are available open-source and now require substantially less engineering time than in the past. The training will also help those interested in participating in an interoperability experiment in the field, with the Atlantic Ocean as a region of interest and deployment, in the framework of AtlantOS and EMSO ERIC. The workshop and training will take place during the Oceanology International 2018 conference to facilitate industry participation. The workshop is open to ocean scientists, engineers and technicians dealing with in-situ sensor and observing systems, from academia or industry. These participants will benefit from direct experience with the latest interoperability technologies.

Organisers

- Eric Delory, PLOCAN, Spain
- Jay Pearlman, IEEE France
- Paola Materia, EMSO ERIC

Morning session

09h00 – 11h00 – Background: interoperability tools and initiatives

Moderators: Eric Delory & Jay Pearlman

Introduction, General considerations
09h00-09h15 Introduction, value proposition and technological maturity
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Sensor Web interoperability
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Simon Jirka, (52North, Germany)

Sensor interoperability

09h30-09h45 Unique Sensor IDs and sensor catalogs, SenseOcean project
Justin Buck, (BODC, UK)

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Related projects and Initiatives

10h00-10h15 OGC SWE in SeaDataNet & EMODNET
Dick Schaap (MARIS, Netherlands)

10h15-10h30 Interoperability in the BRIDGES project
Ehsan Abdi & Dan Hayes, Cyprus Subsea Consulting and Services

10h30 -10h45 EnvriPLUS – Research Infrastructure perspective in sensor interoperability
Laurent Delauney (Ifremer, France)

10h45-11h00 Coffee break (offered on-site)

11h00 12h30 EMSO EGIM Technology Workshop

Showcase of the EGIM technology to potential users of the equipment, including interoperability aspects

Chair: Paola Materia

11h00-11h15 EMSO ERIC introduction
Juanjo Danobeitia, Dir. Gen. EMSO ERIC

11h15-11h30 Overview of EGIM: rationale, concept, future deployments
Henry Ruhl, NOC, UK

11h30-11h45 EGIM design and prototype
Bertrand Moreau, Jerome Blandin, Ifremer, France

11h45-12h00 EGIM deployment at OBSEA: data acquisition from underwater sensors
Joaquin Del Rio, UPC, Spain

12h00-12h10 EMSO Data Management Platform
Pasquale Andriani

12h10-12h20 Setting up an active forum between industries and EMSO ERIC
Nick O'Neill SLR

12h20-12h30 Open Ocean Observatories Yellow Pages
Claudia Viegas

12h30-13h00 **Industry feedback**
Moderators:
Diarmuid O'Conchubhair (MI, Ireland), Henry Ruhl (NOC) and Nick O Neill (SLR)

13h00-14h00 Lunch Break (light-lunch offered on-site)

AtlantOS emso ERIC

Afternoon session

Interoperability experiments and field activities

14h00 14h30 **EMSO Transnational Access**

14h00-14.30 EMSO Regional Facilities as test beds for industrial equipment, methods or services. Introduction to TNA also (high-level details for each node)
Henry Ruhl (NOC)

14h30 15h00 **AtlantOS Interoperability Experiment**

14h30-15h00 Platforms and support available at PLOCAN EMSO site for AtlantOS Demo
Carlos Barrera & Eric Delory, PLOCAN, Spain

15h00-15h30 **Industry feedback**
Moderators:
Henry Ruhl (NOC)

15h30-16h00 **Plans, AoB, Closing**
Moderators:
Jay Pearlman (IEEE) and Eric Delory (PLOCAN, Spain)

16h00 **Adjourn**

Sponsors:
Main sponsors: **AtlantOS** (WP6), **EMSO ERIC**
Contributing Consortia & Initiatives: **NeXOS, SenseOcean, SeaDataNet, EnvriPLUS, BRIDGES, ODIP II, EMODNET**

Registration
You can **pre-register by sending an e-mail** to interop.workshop@plocan.eu with subject: "**OI2018 interoperability workshop registration**", indicating morning and / or afternoon session in the text. Please also include your organization, your position in the organization and your phone number.
Registration is free, on a first come first serve basis and will remain open until seats are filled. Pre-registered persons will have priority over **on-site registration** (see below).

Additional notes

Come and visit us on-site on our OI 2018 ICT Expo area pod for more information and **on-site registration**.

Private meeting opportunities, talk to us at our pod (R201) in the OI 2018 ICT Expo area

PLOCAN IEEE Marine Institute UPC OBSEA 52north BODC EMODnet Ifremer
AtlantOS emso ERIC ENVRI nexos OCEAN SENSORS CSIC SeaDataNet ODIP II

The outcomes of the workshop will be made available on the AtlantOS and EMSO-ERIC websites.

Acknowledgements:
Thanks to Daniel Alcaraz (PLOCAN) and Paola Materia (EMSO-ERIC) for their support in organising the event.

Annex D: Glossary

ABBREVIATIONS & ACRONYMS	DEFINITION
AtlantOS	Atlantic Ocean Observing System
COPERNICUS	Formerly GMES-Global Monitoring for Environment and Security
DOOS	Deep Ocean Observing Strategy
BRIDGES	Bringing Together Research and Industry for the Development of Glider Environmental Services
EGIM	EMSO Generic Instrument Module
EMODNET	European Marine Observation and Data Network
EMSODEV	EMSO implementation and operation: DEVelopment of instrument module
ENVRIPLUS	European research infrastructures for Environmental and Earth System sciences
ERIC	European Research Infrastructure Consortium
ESONET	European Sea Observatory-Network of Excellence
EOSC	European Open Science Cloud
EPOS	European Plate Observing System
ICOS	Integrated Carbon Observation System Research Infrastructure
MSFD	Marine Strategy Framework Directive
NeXOS	Development of new advanced sensors for ocean observation
RF	Regional facilities
RI	Research Infrastructure
TNA	Transnational Access
OBSEA	Expandable Seafloor Observatory
OGC	Open Geospatial Consortium
PLOCAN	Oceanic Platform of the Canary Islands
SWE	Sensor web enablement

Annex3

Interoperability Experiment
Background and Mission Templates

Prepared by:
Eric Delory (PLOCAN)
Jay Pearlman (IEEE France)

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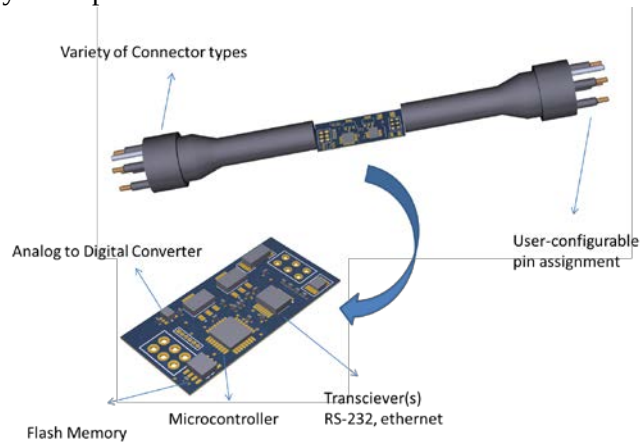
Interoperability Experiment Abstract

Sensor(s) name: Turner Designs Cyclops-6k: (1. Turbidity 2. Ch-a, 3. Refined Fuels)	Sensor owner(s): Cyprus Subsea Consulting and Services (CSCS)
Platform name: Waveglider	Platform owner: PLOCAN
Interoperability Methods Demonstrated: 1. PUCK 2. SensorML	
Mission leader(s): Dan Hayes (CSCS), Ehsan Abdi (CSCS), Eric Delory (PLOCAN)	Involved entities/partners: CSCS/PLOCAN

Experiment mission motivation (highlight new technologies)

This mission aims to demonstrate the capabilities of the Smart Cable developed as a part of BRIDGES project and aims to convert any commercial non-OGC PUCK-enabled sensors in a smart PUCK-enabled device, which can be easily integrated on an OGC sensor web platform. By using this cable, there is no more need to require from the sensor manufacturers to comply with SWE standards and any sensor can be turned into a plug-and-play interoperable device.



Sensor and Platform description (highlight new technologies and requirements)

The sensors demonstrated in this experiment will be commercial sensors from a well-known manufacturer (Turner Designs). In this experiment we aim to integrate three optical sensors (Turbidity, Chlorophyll-a and Refined Fuels) on a commercial wave glider (Liquid Robotics). PLOCAN will provide the sensor powering and transmission system. Three Smart Cables corresponding to each sensor with a SensorML onboard for demonstration of interoperability shall be provided by CSCS.

Interoperability method description (highlight new technologies or demonstration focus)

In this experiment the OGC PUCK protocol will be used to retrieve a SensorML file from the Smart Cable connected to a sensor. The SensorML is then parsed by the platform and a plug-and-work sensor integration shall be demonstrated. Additionally, the data from sensors shall be made available on a web client in real-time through a SOS server.

Logistics

Timeline (start and end): Any time after August 2018
Place of deployment and recovery: PLOCAN facilities
Support needed (e.g. human resources at PLOCAN, travel support): travel support

Interoperability Experiment Report

Date: 24 – 28 September 2018

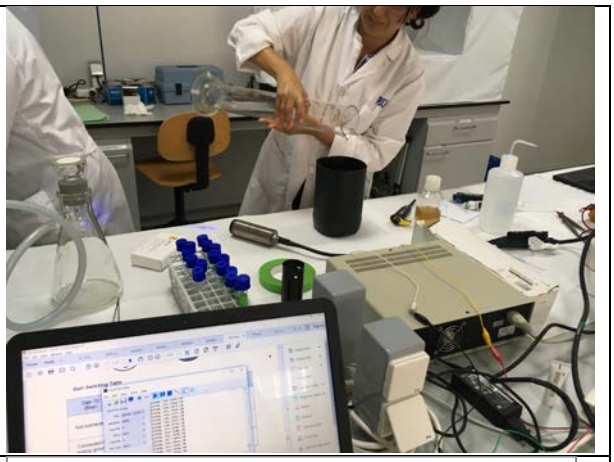
The aim of this experiment was to demonstrate the capabilities of the SMART cable developed by CSCS under the BRIDGES project to integrate some commercial sensors onto a Waveglider and using an SOS server to visualize the data.

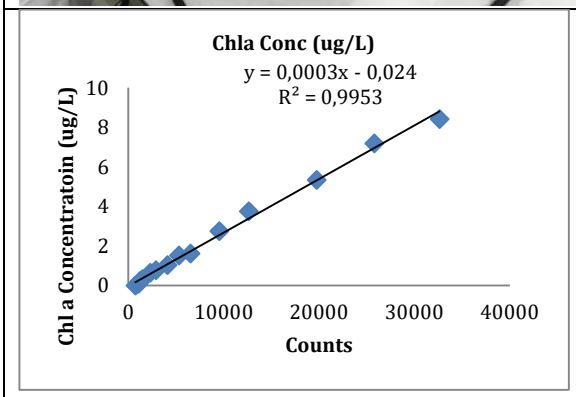
As for any observation mission, the first task was to verify/calibrate the sensors:

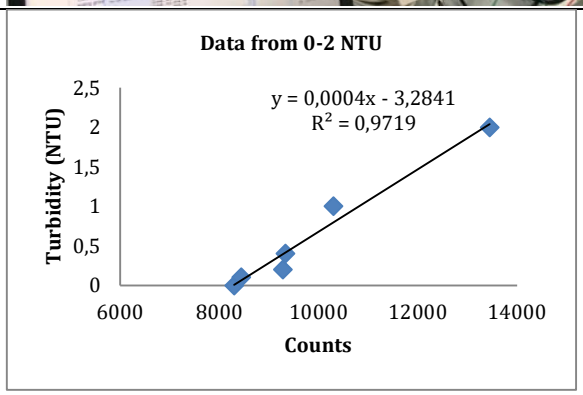
For **Chlorophyll** an algae culture was used (PLOCAN provided from ULPGC/BEA, Telde, Spain). It was diluted several times, then the count number was measured using the sensor. The sample was then filtered and analysed following EPA 445.0 protocol to know the real concentration.

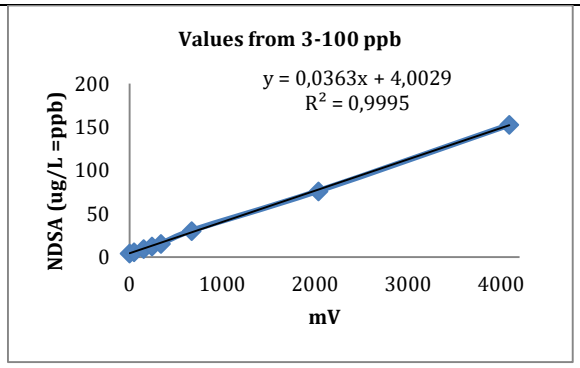
For **Turbidity** calibration, a Formazine turbidity standard was used with different concentrations. Using a bench Turbidimeter the number of counts were mapped to real NTU levels and the calibration formula was achieved.

For **Refined Fuels** sensor, different concentrations of a pollutant (NDSA) were used and the count number was measured with the sensor. Then the pollutant was extracted from water and samples were measured using a GC-MS to find the real ppb value.









After calibration, using the best linear fit a formula translating counts to scientific units for each sensor was generated and integrated inside the SensorML instance.

Issues identified and lessons learned

Some efforts were put in by the UPC team to fix bugs and improve the efficiency of the data flow from the PLOCAN SensorBox control system to the SOS server. The Iridium connection was slow and Iridium coverage could be problematic if files were generated faster than the transmission could take. The bottleneck came from the SBD protocol of the PLOCAN SensorBox, which should consider RUDICS instead. However and because all the files are stored locally on the Waveglider, a backup of untransmitted data was available on the Waveglider.

All data and related metadata (e.g. glider position) could eventually be visualised on the sensor web viewer as shown in Figure 15 and Figure 16.

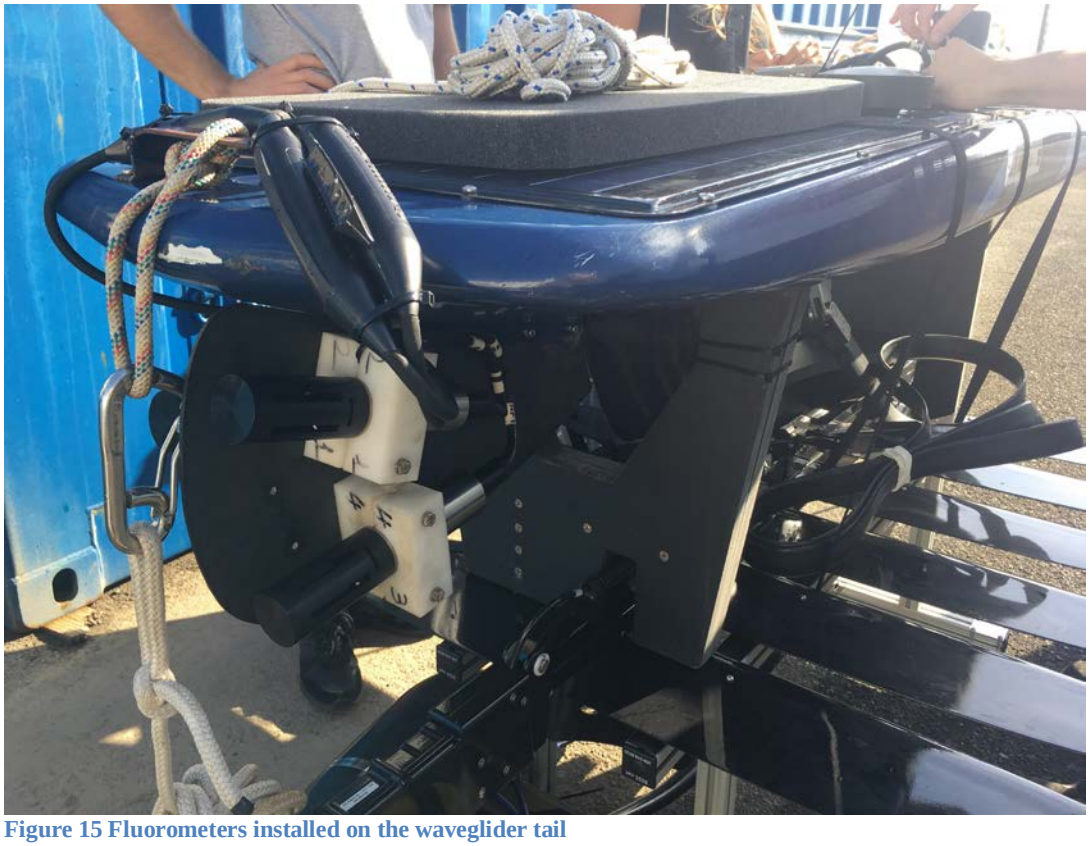


Figure 15 Fluorometers installed on the waveglider tail

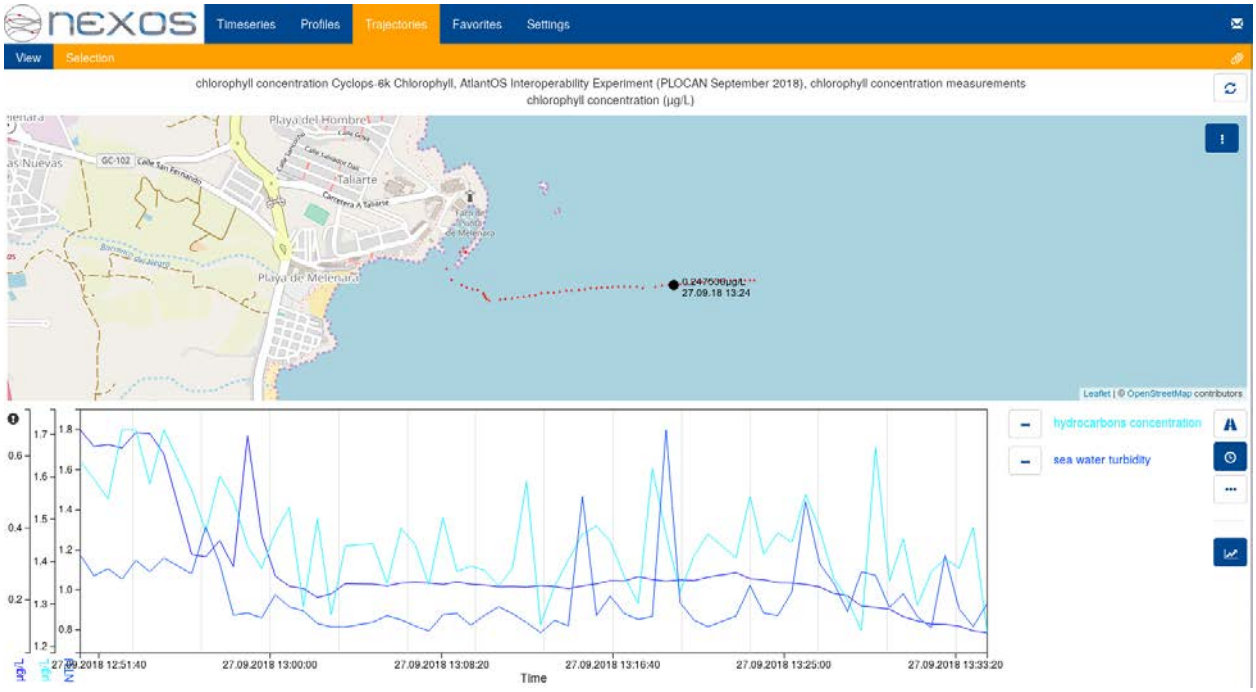


Figure 16 Realtime data and glider path showing up on a the open-source sensor web viewer

Annex4

INGENIERIA Y CONSULTORIA NAVAL

LRL INGENIERIA Y CONSULTORIA NAVAL S.L.
c/ Eduardo Benot 51 3ºA
35008 - Las Palmas de G.C.
España
Telf: (+34) 928 394 637
correo@LRLingenieria.com

Annex 4

STUDY OF CONTRACTUAL OR LEGAL BASIS FOR THE SHARED USE OF INFRASTRUCTURES AND RESEARCH "OCEAN GOING" VESSELS BETWEEN ATLANTIC OCEAN RIPARIAN COUNTRIES

Applicants: PLOCAN

Las Palmas de G.C. February 2019

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ATTACHED EXCEL FILE.

MATRIX FOR ACCES TO USE OF RESEARCH VESSELS "OCEAN GOING" OF ATLANTIC AREA

BACKGROUND

Via different organizations or associations that group together marine research institutions from different countries, actions have been taken in order to promote, not only cooperation agreements between research centres, but also the highest use of the means that each center have, sharing those or giving opportunities to members of other countries, for the realization of research programs, using the fleets or infrastructures of others, achieving the target of a highest rationalization, versatility and economy in the projects .

Actions in this regard have been proposed such as the International Research Ship Organization (IRSO) through the promotion of the exchange of ship time and equipment between countries and the program established between the University National Oceanographic Laboratory System (UNOLS) and the European Science Foundation Marine Board.

In regards European research vessels, the transnational access goes through a specific program established for Europe with financial support from the EC, launching the named EUROFLEETS + PROJECT, consisting in a consortium of 42 marine institutes, universities, foundations and SMEs from 24 countries with the same object, but for fixed ocean observing infrastructures the transnational access was implemented via the FixO3 project.

Another instrument used for this purpose has been Ship Time Bartering (OFEG), a system that has worked successfully in Europe for the last 20 years and that has a large database of ships with this possibility. In the case of USA, NERC (UK) is used as an intermediary to make its fleet available. It is an exchange of ships between member countries.

From a general point of view a wide range of associations have instruments and agreements of cooperation between different countries for the development of research programs.

SCOPE OF THE WORK

The object of this study is to make a database by countries as well as a research vessels information sheet to be used when sharing infrastructures or vessels classified as OCEAN GOING between the riparian countries of the Atlantic Ocean and with opportunities of access to citizens into research programmes.

Through this research vessel information sheet the following common European and non-European elements can be identified:

- Legislation by region / nation
- Legal framework in Brazil / South Africa / Argentina / Canada / USA, ...
- Europe (Directives, Eurofleets, OFEG, ERVO)
- Civil liability (operator / user)
- Heavy or dangerous equipment
- Environment
- Customs
- Personal injury and materials damages
- Protection and indemnity (P&I club)
- Civil liability (civil liability)
- Others.

Through this study, we intend to comply with the ATLANTOS project - 633211

> *Best practice document and review / inventory of current methods for sharing IAOOS components, such as ships, fixed and mobile observing systems, calibration facilities and support the use of the infrastructure for innovation testing, validation, or demonstration.*

Currently, most of the data bases have been done within the EEC scope, with agreements of sharing ships between research institutions owning this type of vessels.

Another target outlined for this report is to classify and to make applicable the results to all the countries bordering the Atlantic Ocean.

METHODOLOGY USED TO COMPLY WITH THE OBJECT OF THIS REPORT

The novelty that this work represents with respect to the databases and existing agreements between institutions of different countries for access to research vessels, is the creation of a summary of all the legal aspects existing in the fleets of the countries bordering the Atlantic Ocean in a single document. Thus in a fairly simple and reasonable way it can be possible to obtain information about the terms of use of the fleets of the OCEAN GOING type.

The method used for this purpose has been divided into the following steps:

- The issuing of a database of existing research vessels in coastal countries of the Atlantic, based on existing ones.
- The creation of a matrix that contains the ships by organizations, the agreements to which they are subject and legal framework for access to the use of vessels from other countries in campaigns or specific research projects.
- Hereinafter, establish the use of a research vessel information sheet in English, for ships and infrastructures that are intended to provide access, but do not have a proper form. In this sense, this document compiles with the most common elements, but at the same time, it also covers some other additional aspects that are more specific to each region. Therefore, the user of the research vessel information sheet, could choose at his/her criteria depending on his/her preference.

CONTENTS OF REFERENCE OF THE DATABASE

In order to meet the requirements, an Excel sheet has been generated as an instrument which can be converted in a MS Access document where all the relevant parameters of the fleet of Atlantic countries have been added.

In this list of vessels with OCEAN GOING research purposes designated in the Atlantic areas, the following parameters have been identified:

- **IMO number.** Identification number established by the Intergovernmental Maritime Organization and that uniquely identifies a vessel, independently of any changes of name, ship owner, flag, etc.
- **Present Name.** Current name of the Vessel.
- **Type of ship.** This work mainly refers to Research vessels, named Ocean Going. However, in some exceptional cases, we include in this list other vessels with a mixed function. Some of the cited vessels, work as an Icebraker but offers also research services.
- **FLAG.** Flag country.
- **Owner.** In this regard, we refer to Register owner.
- **Organization or agencies.** National organizations or agencies where owners belong or operate.
- **OFEG.** Vessels assigned to the system of barter ships that are under the OCEANIC FACILITIES EXCHANGE GROUP organization (link to the web is provided for more information).
- **Name of the ship operator**.
- **Classification Society**. Enable us to know the capacities of the ship from the point of design and construction.
- **P&I Club.** Enable us to know if the vessel has protection and Indemnity cover, which is important for the purposes of civil liability of the ship owners and its limitation against third parties.
- **Application forms.** Gives information about the application form to access the vessel when needed. When are available through an online platform, link is provided.
- **Time Schedule / time slot.** Indicates whether it is required to provide specific dates to request a vessel.
- **Route map (writing proposal).** Indicates whether a route map about the investigations to be carried out is requested.
- **Deadlines for submission of proposals any given year.** Indicates whether there is a deadline to present applications within the current year, as there are cases

where they are very strict in this regard. In some cases, it is a requirement to present applications one year ahead.

- **Map of the proposed working area.** Refers to the case when it is requested to include maps of the areas in which it is intended to operate.
- **Work permit to work in foreign waters (if necessary).** In the case of Spain, they request this documentation if the work to be done is in non-national waters.
- **Environmental impact report (for maritime protected areas).** Indicates whether the research is to be carried out in protected areas.
- **Notify the vessel operator**. It is a requirement from COCSABO.
- **Daily rates in Euros.** Refers to the daily rate to use a vessel. (links are provided explaining the economic protocol).
- **Terms and conditions.** Indicates whether the conditions to access the ships to are clearly specified.
- **Operational information.** Indicates whether you need to specify certain information regarding the use of equipment and specific needs.
- **Chief Scientist must be a citizen of the country.** In the case of UNOLS, in the USA, it is mandatory that, verbatim; "Chief Scientist to be an American citizen, but then have Co-Chief scientists from any country"
- **Contact details to apply.** Contact email addresses are provided.
- **Links of organization or websites to apply.** Links of the organization where the vessel belongs are provided.
- **Links for submission or guidelines.** Direct links for the application forms or to the guidelines to be followed to apply for a vessel.
- **Other links.** Links related to ship specifications, or relevant webpages
- Compliance with IMO international regulations.

LEGAL FRAMEWORK

From a general point of view, and according to this document, legal framework refers to all those regulations that control the contractual relationships between researchers who wish to have access to fleets of other countries. However, we proceed to carry out a brief analysis of the frame where the ships from different geographical areas operate.

Europe

In this study the following countries that have research vessels in the Atlantic Ocean have been taken into consideration:

- Norway
- France
- Spain
- Germany
- Great Britain
- Ireland

Except for the case of Great Britain in the evolution of the Brexit, and Norway with special agreement with the EEC, all countries are within the range of the European economic community and have very similar legal systems. In all cases, ships with flags in these countries belong directly to public administrations or to agencies that depend on those administrations. The management of these vessels is carried out through the agencies or institutes, in agreement with their own regulations and with a similar management of owned private vessels. There are only exceptions in case the ships belong directly to the navy of different countries. In this cases, vessels do not usually have an IMO number and are exempt from compliance with international treaties, although most of them comply with due diligence in terms of standards of conduct.

– **MO Regulations and Classification.**

For all purposes, except for the ships belonging to the Navy of any of these countries, the rest of the research ships, even if they are considered public ships, they comply with the international conventions of the IMO, with instruments such as SOLAS, MARPOL, STCW, etc. From the statutory point of view, they are subject to be inspected by the administration of each country, unless they authorize or delegate in a classification society, such is the case of Norway. Likewise, its built has been carried out under the supervision of a classification society, which allows us to know the scope of its certifications and limitations of navigation areas for its use. Having this type of classification, allows to have advantages in everything related to the

insurance of the boat and the scope of their terms. In the case of European countries all ships, except the military, are classified in a classification society.

- **Port State Control and MOU**

  With the same exception, all European research vessels will be subject to the regulations of the MOU of Paris, or to the MOU that corresponds in the area or country where the work is carried out. This indicates that all comply with all the guidelines of the agreements that result from the issuance of their statutory certificates, may be inspected and detained if they do not comply with the mentioned regulations, or it may be the circumstance of detention in another country that is not of her flag until the deficiencies observed are amended.

- **Crews and plan for researchers**

  All ships have their minimum crew table according to the rules of the flag state administration and the crew will have the qualifications required by the flag according to the position held in that table. Except in the case of military vessels, all these vessels must comply with the SCTW agreement and in case they call to other ports, that are no the port of their flag, they have to comply with the MLC agreement, since crews not need to have a military status, being recruited through Crew Management Companies.

  Now, under what rules are included the researchers who use the vessel for their campaigns? In this regard, it should be noted that these are not passenger ships and that there may be circumstances in which the boarding of more than 12 non-crew members could occur, which limit could be considered as a passenger ship. In this regard, it should be noted that the vessel considers these researchers as "non members of the crew". their boarding is made under their own personal responsibility or under the organization for which they provide their services. However, the vessel must provide with sufficient means of rescue according to safety regulations (eg, SOLAS) for the number of researchers that are on board. According to what it has been observed, although each country has its own regulation, the rules is the same as for the crewmembers

  We have found certain exceptions for the case of the two vessels assigned to United Kingdom, in which, although complying with the mentioned regulations, it makes exceptions in some of the points mentioned for vessels of the EEC. The training of the personnel of the National Marine Facilities Sea Systems (NMF-SS).

- **Personal injuries and material damages.**

  Regarding the regime of responsibilities in the relationship between ship owner or operator and the members of the expedition that embark for a campaign, we can divide them it in two parts for the EU countries.

  - Material damages.
  - Personal injuries of non-crewmembers

  In this regard, except for military vessels, all EU countries, except United Kingdom and Ireland, have Protection and Indemnity Insurance coverage, also known as P&I, under the single premium concept or those with a "mutual" concept through a P&I Club

  In an analysis of the coverages in both modalities, the ship owner face the responsibility of his ship to third parties, personal injuries of his own crew, damages by pollution damages to cargo, possible damages by collision during navigation (most common is ¼ of those from the results responsible) damage to fixed objects, damage to the cargo from which his direct liability refers, wreck removal and other damages to third parties. The limit of liability in the policy is € 500,000. They can limit their liability in case of pollution. According to the rules of the Clubs of P&I companies of the European research vessels, their coverage does not cover the possible research campaigns carried out in the USA and Canada. This means that, in some exceptional circumstances, these vessels could not operate in these latter two countries except under their own risk.

  On the other hand, because the nature of the research campaigns may involve risks that involve the responsibility of the vessel, according to the rules of the Club the members that form part of the campaign of investigation must inform the Club giving details about the nature and risk of the investigation to be carried out. This is what in terms of insurance is called a "warranty", that is, its default implies the nullity of the contract or insurance.

  It is evident that the operators of these kind of ships must comply with the due diligence in all their operations and in the care of their vessel. One of the first obligations is to maintain its class condition with the Classification Society, reason why we have tried to identify which ships have it or not. Normally the maintenance of the class is another warranty.

  Finally, in this regards other of the most important warranties for the Club is the updated maintenance of the statutory certificates, certificates that can only be issued by the state of the flag or by an entity authorized by the flag. Among the certificates

issued by the state is the Blue Card, antipollution certificate and the Wreck Removal certificate, required in foreign ports where the vessels operate.

Being update with the statutory certificates corroborates that the ship complies with all the conventions or instruments of the IMO as those already described.

Considering all the exposed, the liability of the scientific equipment of the campaign, lies on the researchers, who have been declared according to the rules of the Club and they are risks covered according to their rules.

From our point of view, the researchers should have their own insurance policy for their equipment for the possible risks at sea or against possible pollution problems that can happen with them, since the Club restrict a lot its coverage to them. In the practice, the best solution is to recover any compensation for damages directly from the insurer of the equipment and if those result to be of owner's responsibility, it is more practical that the insurance of the equipment does the necessary formalities for any recovery action from the P&I Club.

- **Personal injury of non-crew:**

  In the case of non-crew members, the P&I Insurance coverage of responsibility for this kind of vessel is extremely. Limited. To avoid surprises in case of illnesses or accidents, it is still advisable to have your own health insurance. In the same way, in regards of the equipment, a declaration must be made to identify the number of people that make up the expedition. It is also usually requested their corresponding medical certificates in order to authorize them to board the vessel.

  It is quite recurrent that an evacuation is necessary as a result of illnesses or accidents. For that reason, the insurance of the members of these expeditions must include coverage for this possible evacuation. In this regard it should be noted that the evacuations are usually done with helicopters of public ownership and that due to its cost, the evacuation should be authorized by CIRM (The International Radio Medical Centre), after making a primary diagnosis with the help of the crew of the vessel. This is very important, since if the relevance of the disease does not justify this kind of evacuation, the vessel should proceed to the nearest port to make the disembarkation of the member of the expedition, with all the inconveniences that may arise from it. In the case of making an evacuation contravening the diagnosis of the CIRM, the full cost of the operation, which would be of a commercial nature, should be paid by the own Insurance of the crew member.

  In the cases of the Republic of Ireland and the UK, the particular terms for the researchers or scientists on board, as in the previous cases, involves filling out a

certain number of questionnaires similar to those submitted to the P&I Clubs. In the links included in the database, all these particulars can be found.

As we have already explained, all this kind of vessels are public ownership and could be exempt from many IMO agreements and could operate unilaterally. However, most of them have considered more cautious to work as a commercial vessel.

- **Vessels OFEG (Ocean Facilities Ship Group)**

  As can be seen in the research vessel information sheet that contains the database, all the European ships registered, except for six of them, are registered in the OFEG (Ship Barter) Ocean Facilities Ship Group. In the case of Irish vessels, they do not belong to this group already set up. The exchange program also covers other types of facilities for marine research. On the web you can verify all the existing programs and availability of equipment and vessels. In the database you can find a large range of links for the exchange process. In the forenamed case of Ireland, although it is not in the OFEG, within the specialized Marine Services of the Government, scientific and logistic operations are offered that are world-leading worldwide, including The Antarctic, Australia, the Pacific, Middle East and the North of Europe. For this purpose, they have two vessels and a wide range of information to request entry into the research programs.

- **Vessels EUROFLEETS +**

  Finally, in a European context, from January 2019 the integration within the European fleets of research vessels in the EUROFLEETS agreement has begun. Although this is not the main object of this work about the research vessels Ocean Going and the Atlantic watershed, they are included as long as they are countries of the EU.

- **Customs**

  The installation of equipment on board ships of another nationality on a temporary basis will be subject to temporary imports regimes. All the procedures will be carried out through the local agent of the ship where the installation will take place, so it will be coordinated if it is in transit or with return through the country. All the equipment will be subject to its admission on board the ship depending on their limitations imposed both by the export and import customs of the country of the flag.

  In the specific case of countries of the European Community, the transits between countries of the community will have free circulation by road of the equipment to be

used in the research programs. However, the difficulties could arise at the time of boarding this equipment or at the moment they have to embark them. and in which country this is carried out. In this regard, apart from the information provided in the forms by the operators of the ship, the visit to the customs office should be asked with a customs agent or freight forwarder, depending on the port where it is intended to embark or return later. All the equipment under temporary import system must be returned to its origin to recover the guarantees that must be deposited. In cases where the demob is carried out through the country of origin of the equipment, the use of the ship's agent, freight forwarder and / or customs agent will always be necessary.

- **Heavy or dangerous equipment**

We understand that some of the necessary equipment for a research campaign could be heavy, dangerous or oversized. In such cases, they must be shipped and stowed in the same manner as any general cargo that is declared as heavy or dangerous in a commercial vessel. In this respect we must make a synthesis of all the exposed from the normative point of view and even being a vessel from a public administration, they must keep the duly diligence and the good practices. As explained, the research team must make a detailed statement of all the equipment that will be used, detailing its weight and size.

Usually, vessels have a manual of stowage in which lashing terminal points and lashing equipment are described. The crew of the vessel or its managers should deal with the equipment, if its weight and position on board would affect the stability of the vessel as well as if its installation would require additional benches or structures. All this should be reviewed by a team of naval architects or captains' specialists in stowage on board. The cost of all these calculations should be assumed by the charterer, and it will be under their responsibility and acceptance of the P&I Club.

In the case that the equipment or cargo to be transported is considered as 'dangerous goods' according to the International Maritime Code of dangerous goods (IMDG Code), a prior declaration should be made, and precautionary measures should be taken, placing on board the mandatory signals in accordance with the aforementioned code. We insist that the shipment of the whole equipment should be detailed in the voyage plan to the ship owners and to the P&I Club.

In the case of oversized or dangerous cargo, the expedition manager must insure their equipment. Special relevance and care should be taken in the case of the use

of isotopes that could be necessary in the research campaigns. In such case, it should be advised to the ship owners as well as to the P&I Club, who tends to be quite restrictive.

- **Environment**

  In general, the statements to be made by the managers of the research team include a description of the targets of the expedition and of the means to be used. Also, in most cases, preliminary, follow up and final reports are required. In the case of Spain, a report on the environmental impact of the work to be carried out is specifically required. In other cases, specific authorizations are required for expeditions of a seismological nature or that represent the emission of any type of radiation.

  Special relevance arises in the case ships of a particular flag operate in waters of other countries. There are cases in which they require the presence of a member of the country holding the flag of the exploration area. Damages caused to the environment by research equipment will be assumed at your own risk, reason why it will be advisable to have your own insurance coverage.

Canada

The Canadian fleet belongs entirely to the Government, specifically to the Department of Fisheries and Oceans (Canada). As in the case of EEC vessels, all ships comply with national regulations and in extension, apply the same agreements regarding safety.

For the Atlantic area, the control of the fleet of the above-mentioned department is assigned to the Bedford Institute of Oceanography through ATLANTIC ZONE SCIENCE PLATFORMS COMMITTEE.

From the information obtained from the fleet and the mentioned organizations, it is observed that Canadian vessels are quite versatile in their use, since most of them are used in the winter season solely as icebreakers, but given that they are prepared for the installation of research equipment, during the summer season they are used in research campaigns in their own Canadian waters. For this reason, the legal framework where this type of vessel is registered is in the Canadian Navy's own regulations.

However, all the vessels focused in oceanography have been built under the rules of the American Bureau of Shipping (ABS) Classification Society. Two of them as Medium

Icebreaker and one heavy Icebreaker. The others two have ABS class and another LR (Lloyd's Register).

At first, the fleet is open to host ocean research projects in its waters. The requirements for senior scientists and research campaign program can be found in the following link for the solely Atlantic fleet.

- **Personal injuries and material damages**

  In this regard, as we mentioned in the database that accompanies this report, the ships in this fleet do not have coverage of P&I, this means that the researchers that go on board these vessels must pass several medical examinations and the members of the team should have a medical insurance and the equipment should have also a cargo insurance The level of requirements will be the same as the one already explained for European vessels.

- **Customs**

  In general, the installation of equipment on board ships of another nationality on a temporary basis will be subject to temporary imports regimes. All the procedures will be carried out through the local agent of the ship where the installation will take place, so it will be coordinated if it is in transit or with return through the country.

  Obviously, all the equipment will be subject to its admission on board the ship depending on their limitations imposed both by the export and import customs of the country of the flag.

USA

Although the fleet of North American research vessels is numerous, after a careful examination, we have selected three, in the Atlantic and with the condition of Ocean-Going vessels.

It is known that these vessels, although owned by federal organisations, are assigned to different universities in their operations. From this point of view, all the research vessels that wish to enter in the University National Oceanographic Laboratory System (UNOLS) must comply with certain requirements contained in a guideline for requesting / becoming to UNOLS Vessel. This means that the safety rules and way of operating of these boats are dictated by the own UNOLS according to the UNOLS Research Vessel Safety.

On the other hand, the Research Vessel Operators Committee (RVOC) promotes cooperation, fleet standards, marine safety, efficiency, and quality of service among marine science research and educational institutions. The RVOC provides members

with a forum to address issues of interest such as federal regulations, security, technology, procedures, and public relations as those affect their research fleets.

In general, we include a complete guide and documentation of the regulations of the UNOLS.

The inspection program with a statutory, to comply with all the security requirements of the ship, is carried out by the US Coast Guard within the territory of the United States. However, the safety inspections carried out in foreign ports are carried out in compliance with the MOU of Paris in the European zone and with the Tokyo MOU in the applicable countries. When traveling abroad, they comply with the IMO regulations, especially about SOLAS and crew qualifications with the STCW agreement

In the case of these North American ships, the built practice is to be carried out according to the rules of the American Bureau of Shipping.

Although the general cruising plan process is similar to all vessels of the US Academic Research Fleet, each vessel has its own regulations and procedures. It is important to understand these regulations. Clicking on the name of a ship in the Excel sheet in the below link you can have access to the page of cruising plan for each ship.

- **Personal injuries and material damages**

  PASSENGER: Every person other than the crew or other persons engaged on board a vessel in the business of the vessel. However, on oceanographic research vessels scientific personnel are not considered to be passengers. Research vessels may not carry passengers for hire, since this would constitute engaging in "trade or commerce." (46 CFR 24.10)

  SCIENTIFIC PERSONNEL: "Scientific personnel on oceanographic research vessels are not considered to be seamen or passengers, but are considered as persons when requirements are based on total persons on board." and "Scientific Personnel – This term means those persons who are aboard an oceanographic research vessel solely for the purpose of engaging in scientific research, or in instructing, or receiving instruction, in oceanography or limnology, and shall not be considered seamen under the provisions of Title 46, United States Code." (46 CFR 188.10-71 and 46 CFR 188.05-33)

In this regard, as we mentioned in the database that accompanies this report, the ships in this fleet do not have coverage of P&I, this means that the researchers that go on board these vessels must pass several medical examinations. The members of the team should have a medical insurance and the equipment should have also a cargo insurance.

The level of requirements will be the same as the one already explained for European research vessels.

For American ships, one of the managers of the Scientific Personnel should be of United States nationality.

- **Customs**

  In general, the installation of equipment on board ships of another nationality on a temporary basis will be subject to temporary imports regimes. All the procedures will be carried out through the local agent of the ship where the installation will take place, so it will be coordinated if it is in transit or with return through the country.

  Obviously, all the equipment will be subject to its admission on board the ship depending on their limitations imposed both by the export and import customs of the country of the flag.

- **Environment**

  In general, the statements to be made by the managers of research teams contain a description of the of targets of the expedition and of the means to be used. In the same way, in most cases, preliminary, follow up and final reports of the campaign are required.

- **Heavy or dangerous equipment.**

  We understand they are necessary equipment for a research campaign and that due to their size they should be shipped and stowed as any other kind general commercial cargo. Similar considerations as those done for European research ships. Considerations of cargo under the code of dangerous goods are mandatory by the IMO.

Argentina

According to the identification of research vessels that has been carried out in Argentina, two units have been found in accordance with the requirements of this study, one belonging to the Argentine Navy and the other assigned to IADO. As in the rest of the countries treated up to this point, the vessels are of public ownership and they operate under a regime of similar use belonging to the "Instituto Argentino de

Oceanografía". The vessels are operated through the National Scientific Research Council CONICET, and international programs are done through the International Research Group (GII).

These are partnerships between researchers from one or more national institutions with one or more foreign institutions to implement joint research programs, with two components: research projects and the training of doctors and young researchers. In the framework of the GII, interdisciplinary networks are created at national and international levels. The GIIs are made up of a minimum of 4 national research projects that are carried out with international groups. The projects are framed within common problems and pursuing a final objective.

The GIIs are established for 4 years and could be extending for 2 more years. The annual financing depends on the number of groups that integrate it. The funds cover travel, accommodation of researchers and scholar ship researchers (up to 6 months per year) in the counterpart institution, in addition to inputs.

Funding for the foreign party may come from own or third institutions with similar programs resources. For example: Germany: DFG: Research Training Groups; Francia: CNRS: Groupement de Recherche International; Chile: CONICET: International Networking.

The presentations are under the requirements of CONICET and the institutions that take part of them. CONICET conducts calls for the financing of research projects with foreign parts. Every year calls are opened in the terms agreed with each of the partner institutions.

The number of projects to be financed is set between CONICET and each counterpart prior to the opening of the call. The projects must be presented at both institutions and their financing is subject to approval by the evaluating organisms of CONICET and the counterpart.

CONICET finances travel and expenses for the accommodation of its researchers, counterpart institute and foreign researchers that travel to Argentina.

- **Class.**

  Only the M/V AUSTRAL has a class registry, which is the DNV-GL (NG).

- **Personal injury and material damages**

  In the case of M/V Austral, it has the same considerations as for European vessels, since it has P&I coverage.

- **Customs**

In general, the installation of equipment on board ships of another nationality on a temporary basis will be subject to temporary imports regimes. All the procedures will be carried out through the local agent of the ship where the installation will take place, so it will be coordinated if it is in transit or with return through the country.

Obviously, all the equipment will be subject to its admission on board the ship depending on their limitations imposed both by the export and import customs of the country of the flag.

- **Environment**

  In general, the statements to be made by managers of research teams should contain a description of the objectives of the expedition and the means necessary. In the same way, in most of the cases are required previous, intermediate and final campaign reports.

- **Heavy or dangerous equipment.**

  As some of the necessary equipment for a research campaign could be heavy or dangerous or oversized, they must be shipped and stowed in the same manner as any general cargo that is declared as heavy or dangerous in a commercial vessel.

  Similar considerations should be made as for European vessels.

  The considerations for dangerous cargo listed International Maritime Code of dangerous goods (IMDG Code) are mandatory.

South Africa

South Africa has a vessel (S.A. Aguilhas II) with an extensive research program and activity as Icebreaker. As in most of the cases, it is a vessel of public ownership, owned by the Department of Environment Affairs (Chief Directorate Sea Fisheries).

The vessel has classification DNV-GL (NG) (ICE). It does not have P&I Club; however, it should proceed in a similar way as other vessels regarding personal injury, cargo, etc. The S.A. Aguilhas II usually works in oceanography campaigns in the Antarctic, works under polar research protocols.

In Las Palmas

Jesús Alarcón Prieto

Naval Architect & Marine Consultant

IMO	Vessel	Type	Flag	Owner	Organization	OFEG (ship barter)	Operated by	Class	P&I Club	Application forms	Time Schedule / timeslot	Roadmap (writing proposal)	Deadlines for submission of proposals any given year	Map of the proposed working area	Permission to work in foreign waters (if applicable)	Environmental impact report (for marine protected areas)	Notify vessel's operator	Daily Rate in Euros	Terms and conditon	Operational Information	Chief Scientist must be a citizen of the country	Contact details for apply	Links to organization or apply websites	Links for submission or guidelines	Other links	Other links
8803563	Hesperides	oceanographic research	ESPSpain	Government of Spain	COCSABO	X	ARMADA		NO	x	x	x			x	x	x					info@utm.csic.es	http://www.ciencia.gob.es/portal/site/MICINN/COCSABO	http://www.ciencia.gob.es/stfls/MICINN/Investigacion/FICHEROS/ProtocoloAcceso.pdf	http://www.ofeg.org/np4/30.html	
9335238	Sarmiento de Gamboa	oceanographic research	ESPSpain	Government of Spain	COCSABO	X	CSIC	BV	CARINA	x	x	x			x	x	x					info@utm.csic.es	http://www.ciencia.gob.es/portal/site/MICINN/COCSABO	http://www.ciencia.gob.es/stfls/MICINN/Investigacion/FICHEROS/ProtocoloAcceso.pdf	http://www.ofeg.org/np4/30.html	
9524645	Angeles Alvarino	oceanographic research	ESPSpain	Spanish Institute of Oceanography (Instituto Espanol de Oceanografia)	COCSABO		IEO	BV	BRITANNIA	x	x	x			x	x	x					SolicitudTiempoBuqueIEO@st.ieo.es	http://www.ciencia.gob.es/portal/site/MICINN/COCSABO	http://www.ciencia.gob.es/stfls/MICINN/Investigacion/FICHEROS/ProtocoloAcceso.pdf		
9524633	Ramon Margalef	oceanographic research	ESPSpain	Spanish Institute of Oceanography (Instituto Espanol de Oceanografia)	COCSABO		IEO	BV	BRITANNIA	x	x	x			x	x	x					SolicitudTiempoBuqueIEO@st.ieo.es	http://www.ciencia.gob.es/portal/site/MICINN/COCSABO	http://www.ciencia.gob.es/stfls/MICINN/Investigacion/FICHEROS/ProtocoloAcceso.pdf		
8905880	Alkor	oceanographic research	DEUGermany	Federal State of Schleswig-Holstein	KDM	x		DNV GL (ICE)	SKULD		x	x	x	x									https://www.portal-forschungsschiffe.de/en/cruise-proposals/gidelines	https://www.portal-forschungsschiffe.de/submission	http://www.deutsche-meeresforschung.de/en/alkor	http://www.ofeg.org/np4/30.html
8806113	Heincke	oceanographic research	DEUGermany	Ministry of Education and Research	KDM	x		DNV GL Ice Classed	SKULD		x	x	x	x								gpf@dfg.de	https://www.portal-forschungsschiffe.de/en/cruise-proposals/gidelines	https://www.portal-forschungsschiffe.de/submission	http://www.deutsche-meeresforschung.de/en/heincke	http://www.ofeg.org/np4/30.html
9274197	Maria S.Merian	research	DEUGermany	Federal State of Mecklenburg-Vorpommern	KDM	x	GRFCC German Research Fleet Coordinator Center	DNV GL Ice Classed	SKULD		x	x	x	x								gpf@dfg.de	https://www.portal-forschungsschiffe.de/en/cruise-proposals/gidelines	https://www.portal-forschungsschiffe.de/submission	http://www.deutsche-meeresforschung.de/en/maria-s-merian	http://www.ofeg.org/np4/30.html
8411279	Meteor	research	DEUGermany	Federal Republic of Germany, represented by the Ministry of Research	KDM	x	GRFCC	DNV GL Ice Classed	SKULD		x	x	x	x								gpf@dfg.de	https://www.portal-forschungsschiffe.de/en/cruise-proposals/gidelines	https://www.portal-forschungsschiffe.de/submission	http://www.deutsche-meeresforschung.de/en/meteor	http://www.ofeg.org/np4/30.html
8013132	Polarstern	research	DEUGermany	Ministry of Research	KDM	x	AWI Alfred Wegener Institute	DNV GL Ice Classed	STEAMSHIP		x	x	x	x								gpf@dfg.de	https://www.portal-forschungsschiffe.de/en/cruise-proposals/gidelines	https://www.portal-forschungsschiffe.de/submission	http://www.deutsche-meeresforschung.de/en/polarstern	http://www.ofeg.org/np4/30.html
7427518	Poseidon	research	DEUGermany	Federal State of Schleswig-Holstein	KDM	x		DNV GL Ice Classed	SKULD		x	x	x	x								gpf@dfg.de	https://www.portal-forschungsschiffe.de/en/cruise-proposals/gidelines	https://www.portal-forschungsschiffe.de/submission	http://www.deutsche-meeresforschung.de/en/poseidon	http://www.ofeg.org/np4/30.html
9633927	Sonne	research	DEUGermany	RF Reedereigemeinschaft Forschungsschifffahrt GmbH Bremen	KDM	x	GRFCC German Research Fleet Coordinator Center	DNV GL Ice Classed	SKULD		x	x	x	x								gpf@dfg.de	https://www.portal-forschungsschiffe.de/en/cruise-proposals/gidelines	https://www.portal-forschungsschiffe.de/submission	http://www.deutsche-meeresforschung.de/en/sonne	http://www.ofeg.org/np4/30.html
D-20	Puerto Deseado	Oceanographic research	ARGArgentina		Conicet																	mailto:convocatoriascoopint@conicet.gov.ar	https://proyectosinv.conicet.gov.ar/buques-oceanograficos/	https://convocatorias.conicet.gov.ar/cooperacion-internacional/		
6909777	Austral	Research	ARGArgentina		Conicet			DNV GL (ng)	MS AMLIN													mailto:convocatoriascoopint@conicet.gov.ar	https://proyectosinv.conicet.gov.ar/cooperacion-internacional/	https://convocatorias.conicet.gov.ar/cooperacion-internacional/		
7803061	Atlantico Sul	oceanographic research	BRABrazil	FURG Instituto de oceanografía																				no hay referencias para su uso, flota muy limitada	https://io.furg.br/	
9244439	Celtic Explorer	Reserarch	IRLRepublic of Ireland	P&O Maritime Services Ireland Limited - Summary	MARINE INSTITUTE			LR (ICE)	NO	x	x	x	x	x				€ 18.000,00	x	x		rv@marine.ie.	http://www.marine.ie/Home/site-area/infrastructure-facilities/research-vessels/vessel-schedules?language=en	https://www.marine.ie/Home/sites/default/files/MIFiles/Docs/ResearchVessels/Vessel%20Charter%20Guidelines%202019_2020.pdf?language=en	https://www.marine.ie/Home/site-area/infrastructure-facilities/research-vessels/foreign-vessel-surveys/foreign-vessel-observer?language=en	
9154842	Celtic Voyager	Fishery Protection	IRLRepublic of Ireland	P&O Maritime Services Ireland Limited - Summary	MARINE INSTITUTE			LR	NO	x	x	x	x	x				€ 8.000,00	x	x		rv@marine.ie.	http://www.marine.ie/Home/site-area/infrastructure-facilities/research-vessels/vessel-schedules?language=en	https://www.marine.ie/Home/sites/default/files/MIFiles/Docs/ResearchVessels/Vessel%20Charter%20Guidelines%202019_2020.pdf?language=en		
8716071	L'Atalante	research hauturiers	FRAFrance	Institut Pour La Recherche et le Development	IFREMER	x		(BV) (Ice Classed)	LODESTAR MARINE	x		x		x					x	x			wwz.ifremer.fr/Recherche-Technologie/Direction-Flotte-Oceanographique	http://cnfc.dt.insu.cnrs.fr/docfiches.html	http://www.ofeg.org/np4/30.html	
9050814	Marion Dufresne	research hauturiers	FRAFrance	Institut Pour La Recherche et le Development	IFREMER			BV	GARD	x		x		x					x	x			wwz.ifremer.fr/Recherche-Technologie/Direction-Flotte-Oceanographique	http://cnfc.dt.insu.cnrs.fr/docfiches.html		
9285548	Pourquoi pas?	research hauturiers	FRAFrance	Institut Francais de Recherche Pour L'Exploitation de la Mer (IFREMER)	IFREMER	x		BV	LODESTAR MARINE	x		x		x					x	x			wwz.ifremer.fr/Recherche-Technologie/Direction-Flotte-Oceanographique	http://cnfc.dt.insu.cnrs.fr/docfiches.html	http://www.ofeg.org/np4/30.html	
9070307	Thalassa	research hauturiers	FRAFrance	Institut Francais de Recherche Pour L'Exploitation de la Mer (IFREMER)	IFREMER	x		(BV) (Ice Classed)	LODESTAR MARINE	x		x		x					x	x			wwz.ifremer.fr/Recherche-Technologie/Direction-Flotte-Oceanographique	http://cnfc.dt.insu.cnrs.fr/docfiches.html	http://www.ofeg.org/np4/30.html	
8814419	Thomas G.Thompson	Global class ship	USAU.S.A.	Navy	UNOLS		Universidad de Washington	ABS (ICE)	NO												x	Jon Alberts <jon@unols.org, office@mail.unols.org, projects@unols.org	University of Washington	THOMAS G. THOMPSON	https://www.unols.org/document/research-vessel-safety-standards-rvss	
7604300	Endeavor	Ocean /intermediate class ship	USAU.S.A.	NSF	UNOLS		University of Rhode Island	ABS	NO												x	Jon Alberts <jon@unols.org, office@mail.unols.org, projects@unols.org	University of Rhode Island	ENDEAVOR	https://www.unols.org/document/research-vessel-safety-standards-rvss	https://techserv.gso.uri.edu/About?SectionId=Cruise_Planning
8120014	Atlantic Explorer	Ocean /intermediate class ship	USAU.S.A.	BBSR	UNOLS		Bermuda Institute for Ocean Sciences	ABS	NO												x	Jon Alberts <jon@unols.org, office@mail.unols.org, projects@unols.org	Bermuda Institute for Ocean Sciences	ATLANTIC EXPLORER	https://www.unols.org/document/research-vessel-safety-standards-rvss	
8904496	James Clark Ross	research/supply ship	FLKFalkland Islands	Natural Environment Research Council (NERC)	NERC	x	BAS	LR (Ice)	NO													ranies@bas.ac.uk	https://www.bas.ac.uk/polar-operations/sites-and-facilities/facility/rrs-james-clark-ross/	https://nerc.ukri.org/research/sites/facilities/marine/using/		
9114256	Ernest Shackleton	research	FLKFalkland Islands	Polar Queen AS	NERC	x	BAS	DNV GL (ICE)	NO													ranies@bas.ac.uk	https://www.bas.ac.uk/polar-operations/sites-and-facilities/facility/rrs-ernest-shackleton/	https://nerc.ukri.org/research/sites/facilities/marine/using/		
9798222	Sir David Attenborough	research	FLKFalkland Islands	Natural Environment Research Council (NERC)	NERC		BAS		NO													Partnerships@bas.ac.uk	https://www.bas.ac.uk/polar-operations/sites-and-facilities/facility/rrs-sir-david-attenborough/			
9588029	Discovery	research	GBRU.K.		NERC	x	NOC	LR	NO													cdy@noc.ac.uk	https://nerc.ukri.org/research/sites/facilities/marine/using/			
9338242	James Cook	research	GBRU.K.		NERC	x	NOC	LR (Ice)	NO													cdy@noc.ac.uk	https://nerc.ukri.org/research/sites/facilities/marine/using/			
9062934	Kristine Bonnevie	research	NORNorway	Havforskningsinstituttet (Institute of Marine Research)	INSTITUTE OF MARINE RESEARCH	x	IMR	DNV GL (NG)	SKULD	Online	based on scientific relevance		08/ year before									per.nieuwejaar@imr.no	https://toktsystem.imr.no/applications	https://www.hi.no/en/hi/cruises-and-field-work/imrs-research-vessels-department	https://www.hi.no/en/hi/about-us/facilities/our-vessels/kristine-bonnevie	
9260316	G.O.Sars	research	NORNorway	Havforskningsinstituttet (Institute of Marine Research)	INSTITUTE OF MARINE RESEARCH	x	IMR	DNV GL (NG) (ICE)	NO	Online	based on scientific relevance		08/ year before									per.nieuwejaar@imr.no	https://toktsystem.imr.no/applications	https://www.hi.no/en/hi/cruises-and-field-work/imrs-research-vessels-department	https://www.hi.no/en/hi/about-us/facilities/our-vessels/g.o.-sars	
9739587	Kronprins Haakon	research	NORNorway	Havforskningsinstituttet (Institute of Marine Research)	INSTITUTE OF MARINE RESEARCH	x	IMR	DNV GL (NG)	SKULD	Online	based on scientific relevance		08/ year before									per.nieuwejaar@imr.no	https://toktsystem.imr.no/applications	https://www.hi.no/en/hi/cruises-and-field-work/imrs-research-vessels-department	https://www.hi.no/en/hi/about-us/facilities/our-vessels/kronprins-haakon	
9762716	Dr. Fridtjof Nansen	research	NORNorway	Direktoratet For Utviklingshjelp Norad	INSTITUTE OF MARINE RESEARCH		IMR	DNV GL (NG) (ICE)	SKULD	Online	based on scientific relevance		08/ year before									per.nieuwejaar@imr.no	https://toktsystem.imr.no/applications	https://www.hi.no/en/hi/cruises-and-field-work/imrs-research-vessels-department	https://www.hi.no/en/hi/about-us/facilities/our-vessels/dr.-fridtjof-nansen	
5405279	Hudson	oceanographic research	CANCanada	Department of Fisheries and Oceans (Canada)	BIO (Bedford Institute of Oceanography)			ABS mediun Icebraker	NO	x			Autumn of the year preceding									Jay.Barthelotte@dfo-mpo.gc.ca <Jay.Barthelotte@dfo-mpo.gc.ca>;		http://www.bio.gc.ca/facilities-installations/azsv-nsza/srs-srt-en.php	http://www.bio.gc.ca/facilities-installations/azsv-nsza/index-en.php#MarMSS	http://www.bio.gc.ca/index-en.php
7510846	AMUNDSEN	oceanographic research	CANCanada	https://inter-j01.dfo-mpo.gc.ca/fdat/vessels	BIO (Bedford Institute of Oceanography)			ABS mediun Icebraker	NO	x			Autumn of the year preceding									Jay.Barthelotte@dfo-mpo.gc.ca <Jay.Barthelotte@dfo-mpo.gc.ca>;		http://www.bio.gc.ca/facilities-installations/azsv-nsza/srs-srt-en.php	http://www.bio.gc.ca/facilities-installations/azsv-nsza/index-en.php#MarMSS	http://www.bio.gc.ca/index-en.php
8320420	John P tully	oceanographic research	CANCanada	https://inter-j01.dfo-mpo.gc.ca/fdat/vessels	BIO (Bedford Institute of Oceanography)			LR	NO	x			Autumn of the year preceding									Jay.Barthelotte@dfo-mpo.gc.ca <Jay.Barthelotte@dfo-mpo.gc.ca>;		http://www.bio.gc.ca/facilities-installations/azsv-nsza/srs-srt-en.php	http://www.bio.gc.ca/facilities-installations/azsv-nsza/index-en.php#MarMSS	http://www.bio.gc.ca/index-en.php
6705937	LOUIS S. ST-LAURENT	oceanographic research	CANCanada	https://inter-j01.dfo-mpo.gc.ca/fdat/vessels	BIO (Bedford Institute of Oceanography)			LR Heavy Icebraker	NO	x			Autumn of the year preceding									Jay.Barthelotte@dfo-mpo.gc.ca <Jay.Barthelotte@dfo-mpo.gc.ca>;		http://www.bio.gc.ca/facilities-installations/azsv-nsza/srs-srt-en.php	http://www.bio.gc.ca/facilities-installations/azsv-nsza/index-en.php#MarMSS	http://www.bio.gc.ca/index-en.php
8714346	TELEOST	oceanographic research	CANCanada	https://inter-j01.dfo-mpo.gc.ca/fdat/vessels	BIO (Bedford Institute of Oceanography)			ABS	NO	x			Autumn of the year preceding									Jay.Barthelotte@dfo-mpo.gc.ca <Jay.Barthelotte@dfo-mpo.gc.ca>;		http://www.bio.gc.ca/facilities-installations/azsv-nsza/srs-srt-en.php	http://www.bio.gc.ca/facilities-installations/azsv-nsza/index-en.php#MarMSS	http://www.bio.gc.ca/index-en.php
9577135	S.A. Agulhas II	Icebraker/research	ZAFSouth Africa	Department of Environment Affairs (Chief Directorate: Sea Fisheries)	Department of Environmental Affairs (DEA).		Department of Environment Affairs (Chief Directorate: Sea Fisheries)	DNV GL (NG) (ICE)	NO													callcentre@environment.gov.za	https://www.environment.gov.za/saagulhasii			
7922142	Ary Rongel	Icebraker /research	BRABrazil	Ministerio da Marinha do Brasil			Government of Brazil (Commissao de Marinha Mercante)	DNV	NO													ouvidoria@gnho.mar.mil.br	https://www.marinha.mil.br/gnho/naoaro			