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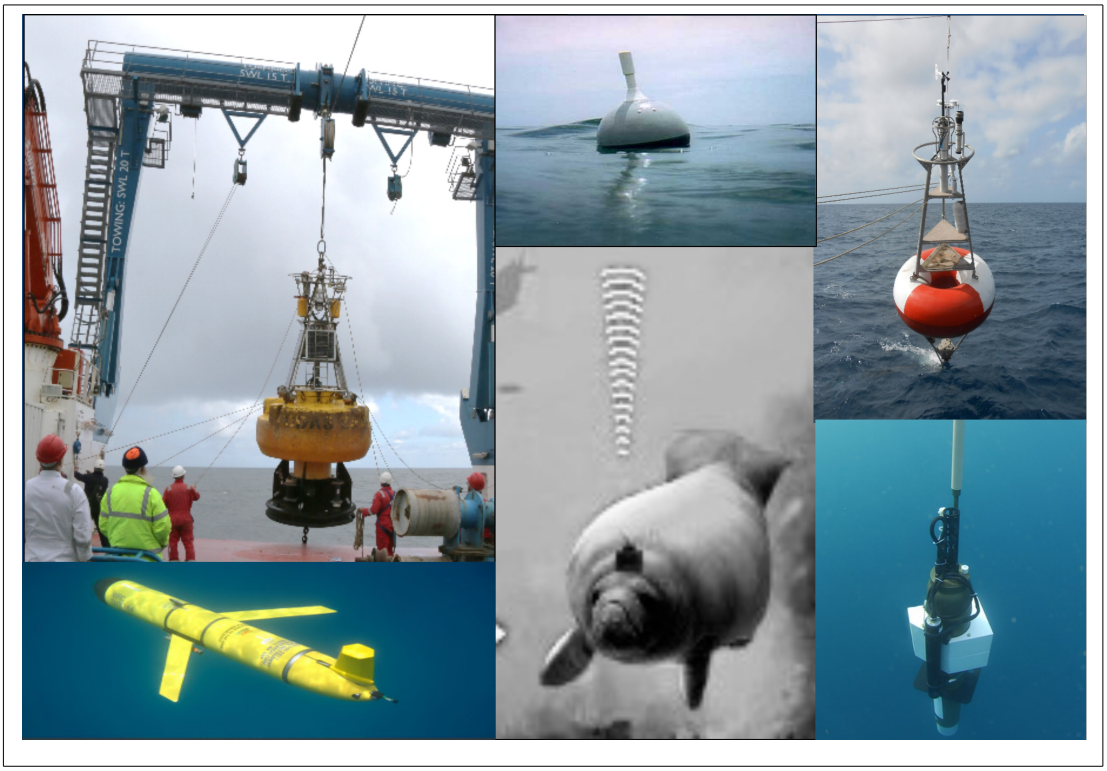
# WP3 Enhancement of autonomous observing networks



*Several autonomous observing system deployed in the Atlantic Ocean in the framework of AtlantOS*
*From left to right on the top: Fixed-point observatory, Drifter, PIRATA buoy,*
*Beneath: Gliders, Animal Telemetry system, BioArgo float,*

**Executive Summary**

Within the AtlantOS (Optimising and Enhancing the Integrated Atlantic Ocean Observing Systems) H2020 project, the work package 3 is dedicated to development of existing autonomous observing networks. We promote the use of the most cost-effective way to measure Essential Ocean Variables and the integration of all mature autonomous observing networks. It is based on innovative platforms with multidisciplinary sensor modules. 7 networks are integrated into this WP3: Argo led by Sylvie Pouliquen, Euro-Argo ERIC, OceanSITES Biogeochemistry Observatories led by Richard Lampitt, NERC; OceanSITES Transport Mooring Array led by Torsten kanzow, AWI; the Glider Network led by Pierre Testor, CNRS; PIRATA led by Bernard Bourlès, IRD; Surface Drifters led by Pierre Blouch and Paul Poli (EUMETNET; Météo france) and the European Animal Aquatic Telemetry Network led by Pedro Afonso, UAC.

This work package is built on both sides of the Atlantic on existing capacities for autonomous observing networks. Overall, it aims to improve the systematic collection of ocean observations recorded in-situ, and will enhance integration with other observational systems, including ship-based platforms and remote sensing. The objective for the autonomous ocean observation technologies is to reduce the costs of in-situ ocean observation, but so far there is a need to optimize them to integrate the biological and ecosystem dimensions into observing systems. For the autonomous platform networks of this work package, the work is thus organized along the key objectives, including the enhancement of the data acquisition capabilities by upgrading observatories with new sensors and improving telemetry (near-real time availability), by increasing the spatio-temporal coverage of the measurements and the availability of derived (high level) data products, and finally by linking to the biological dimensions. The coordinated enhancement of spatial and temporal resolution improves the data flow substantially, with a focus on key environmental pressures and societal challenges defined in GEO. All networks are differently organised and structured and are consequently differently advanced. In this first 18 month, each network adjusted its platform according to its own key objectives.

**For Argo,** the oceanographic profiling floats' global array, the improvement of the network capabilities is foreseen through several development and deployment items: (1) the close to be achieved purchase of 7 Biogeochemical-Argo floats and 7 O2-Deep Argo floats enhancing the extensions to the Argo Core program, (2) integrating new designed sensors for pCO2/pH measurements, essentials for the Ocean acidification / Carbon cycle studies, (3) the development of an Autonomous System For Argo Float Release (ASFAR), allowing a scheduled from the bottom deployment of floats in areas with a high escape rate (strong currents) and a low visiting period by surface ships, and (4) the upgrade of the satellite communication capacity of the platforms to better transmit the increased amount of data, within a lowered budget.

**The OceanSITES Biogeochemical Observatories** provides a multidisciplinary time-series observation from sea surface to seafloor through sensor based observations (Meteorology, Temperature, Salinity, Currents, Nutrients, Chl-a, CO2, O2 or through autonomous Sampling (for Particle flux, Benthic biology, Water & Zooplankton sampling). The measurement of new variables have been integrated on the observatories and tested: the microplastics, which unfortunately did not work

(the manufacturer recognized the misfunctioning of the sensors). The microorganisms such as protist and prokaryote communties are now measured using genomic methods and approaches. This latest development has been really valuable to follow the long-term trends in magnitude of peak spring and summer export fluxes with more detailed and thin observation of abundances. As an example, the community abundance of Stramenopiles and Alveolata species are completely different and opposite. Moreover, new platforms have been deployed: ASVs such as waverider and profilers. More generally, the network ensured that the EOVs were observed more widely.

**The OceanSITES Transport Mooring Array** is based on observations from 10 TMA sites from the Atlantic meridional over-turning circulation based on time series of volume, heat & freshwater fluxes. One of the main objectives was to provide access to the TMA status information and products overview collected from partners and to facilitate access to derived data products' through a 'one-stop-shop‘ web site. The web based one stop shop is currently under development but is not yet finalized due to some human resources constraints and it was agreed that OceanSites will host data product archive and JCOMMOPS will host web-based ‘one-stop- shop’. In parallel, the TMA capacities were enhanced through the integration of oxygen sensors on the mooring and the improvement of the subsea real-time data telemetry systems. Demonstrations of these new capacities have been done at RAPID 26N and OSNAP sites.

**For the** Gliders network, the main objective was to be connected with European individual activities but also with similar networks across the Atlantic. The monitoring of the glider activities has been done in connection with GDAC & WP7. A Glider Steering Committee has been established at WMO/IOC and the gliders are now a component of GOOS, and a glider Data Management Team is set up at JCOMM. The Gliders network can be considered now as an established International Program. International collaborations and capacity building are now enhanced thanks to the Glider meeting during the 7$^{th}$ EGO meeting, in Sept 2016 and through the implementation of Glider Schools.

**PIRATA** comprises 18 meteorological-oceanic buoys, the ATLAS system measuring atmospheric parameters together with T, S, current down to 500m and at some sites CO2. The network progressively replaces the ATLAS systems by the T-FLEX systems with already 3 new T-Flex systems implemented. To the 2 ADCP moorings measuring equatorial under current, a new ADCP mooring has been added in cooperation with Preface. ATLAS is now considered as platforms of opportunities for OTN/EAATN since acoustic receivers have been integrated to all buoys, Xpods sensors measuring turbulence have been integrated at 2 sites as well as O2 sensors. Morover, AtlantOS allowed the enhancement of 3 currentmeters, 2 T/S, 1 CO2 and the measurement of O2 in real time.

**For the drifters,** FOR THE DRIFTERS, three main axes were developed. First, the horizontal geographical coverage has been enhanced to include the Tropical Atlantic, where 19 buoys have been deployed (on average, 13 buoys are deployed each year by the project). The variables measured are sea surface temperature (SST), surface

current, and air pressure. Second, efforts have been made to develop a cost-effective solution to measure the sea surface salinity (SSS). Prototypes are under construction. Third, a vertical profiling of sub-surface temperatures in the upper ocean layer - several times daily, offering complementarity with Argo floats that revisit every few days -, is possible from drifting buoys fitted with bathythermic chains. The study of such data collected by past experiments will start soon.

**The Animal telemetry Network** aimed to integrate individual activities into a European Aquatic Animal Telemetry Network through the Compilation and standardization of metadata on animal tagging activities. One of the objectives was to establish key 'lines' of acoustic receivers, and already 2 "lines" from Scotland and England are now integrated into EAATN. Another objective was to expand the network to the open ocean adding receivers to existing platforms. PIRATA buoys and the Glider network in EU have integrated such receivers (established for PIRATA, under development for gliders). Soon the OSNAP buoy network in the North Atlantic will receive these sensors. The future objective is to integrating sensors on tags for measuring additional variables. The database will be hosted and managed at VLIZ.

Progress are also made on data streams of each network in order to standardize and make them transparent to improve data accessibility. The autonomous observation networks is promoted to a wider user community to enhance cross-system integration and to achieve the sustainability of such integrated networks in the future.
Different levels of data flux management are observed across these 7 autonomous platform networks, and each would adapt the data stream process to established International procedures or focused on monitoring activities or made advance in metadata management to compile observation activities. For most of networks, there was development or improvement of real-time data flow and quality control procedures, and for all of them an improvement of the delayed-mode data provision and quality procedures.
The data Dataset interoperability as well as the data sharing protocols are under progress in close collaboration with WP7**.**

Each network also defined the priorities for the long-term sustainability: for all of them, It is necessary to secure funding and human resources at national levels. The International partnerships with non EU countries (Argentina, Brasil, Canada, USA, South Africa…) in framework of GOOS are essential and mandatory to ensure the sustainability. The collaboration or consolidation with other international programs /projects such as FixO3, JERICO, EGO, Argo, DBCP … AORA are also important to ensure a long-term vision for each network. For those less structured network, various disseminating activities have been developed such as editing the Implementation Plan (with details on EOVs, geographic coverage, scientific context..), developing network documentation and website, implementing summer schools, mobile app. for outreach, or workshop and proposals.
A proven positive impact on forecast and analysis is already clearly established for this WP3 as the observations enters into climate change monitoring and into the Numerical Weather and Ocean Prediction systems

Further standardization, integration and innovation in sensing and sampling capacities across these networks provide tremendous innovation potential for SMEs and the cooperation between the private and public sector has been very smooth. Several SMES in France, Germany and USA are very well integrated into the AtlantOS WP3.

# I Explanation of the work carried out per WP3 “Enhancement of autonomous observing networks”

## a. Summary of progress towards objectives

Within Argo, during this reporting period, seven floats of each type have been purchased, their delivery will occur in fall 2016 for tests and deployments during the year 2017. The engineering work on the new sensors is still in progress by the industrial partners of this work-package, with some delay announced so far and a shift of about 6 to 8 months foreseen for the first prototypes delivery. In the meantime, extended inter-comparison exercises will be held on the bench and at sea to assess the final quality of the materials. For both type of floats, the specialists’ recommendations concerning O2 measurements using optodes have been implemented, now integrating air-measurements for calibration purposes. The ASFAR system with 2 prototypes already deployed is currently under improvement at sea, for a finalized version ready within AtlantOS for the next year. All these enhancements will have their data transmitted through the Iridium satellite network, having already implemented the last solutions available for the data fluxes overpassing the capacities of the commercial modems. All floats purchased within AtlantOS will benefit of this “over-the-full” developments.

Regarding the OceanSITES network and the implementation of genomic measurements into existing observatory platforms the work is progressing well. Two sites have been identified that have long-term (>10yrs) records of archived sediment trap samples: PAP, NE Atlantic (NOC), Fram Strait, Atlantic-Arctic gateway (AWI), and a potential third is to be added: Cape Blanc, Uni. Bremen. The objective has been defined to sequence these samples for major eukaryotic and prokaryotic groups. A post-doc has been recruited from AtlantOS funds to manage this objective. The aim to provide standardized workflows for –omic observations from existing fixed point platforms is underway. The definition of a modularized workflow

is in progress, with the overall aim that different members of the Atlantic observing community can plug into this workflow to enable some degree of standardization for base level comparisons of sequencing data originating from multiple platforms.

The Ocean Sites Transport task is working towards its first delivery, namely, a development of a web site for the presentation of the overarching data products of the transport mooring array (TMA) network. As agreed during a joint workshop in February 2016, in order to lay the foundation for the establishment of the web site, the task members have agreed to submit the high level data sets to the Ocean Sites archive. The coherent integration of oxygen sensors among the TMAs is under way, as are two demonstrators for subsea real-time data telemetry systems.

The Atlantic glider network is strengthening in the perspective of sustained activities. With the set-up of an international Glider Steering Team under the auspices of WMO/IOC JCOMM, there is now an official glider component in the GOOS and collaboration across the Atlantic is fostered. In addition, progress has been made towards a better integration of the glider metadata and data in the data system management across the AtlantOS glider network. Jointly with WP7, enhancements on the EGO data exchange format are being made for a better data management. Specifications for the glider app have started to be discussed among the partners and the analysis on the Eastern Boundary surveys is on its way.

EUMETNET/Meteo France is on track to fulfill the deployment objectives of minimum 13 buoys per year. Over 15 drifting buoys have been deployed so far in the Tropical South Atlantic and are still operating today, covering an area seldom explored by these sensing platforms so far. NKE (SME) foresees a 3 month-delay in the development of the salinity drifter. MY is not carrying out the development work related to bathythermic string drifters because this partner was excluded from the consortium. CNRS has not started to analyse data collected by past bathythermic chains.

The PIRATA network is principally composed with 18 met-ocean buoys in the Tropical Atlantic. Their maintenance induces yearly dedicated cruises ensured by Brazil, US and French partners. The meteo-oceanic ATLAS buoys observations (oceanic: temperature and salinity from the surface down to 500m depth; meteorological: wind, air temperature, precipitation, radiations at the surface) are daily transmitted via ARGOS and made available in quasi-real time through internet.

PIRATA enhances its network through the deployment of different kinds of additional sensors, i.e. “classical” (with quasi-real time data transmission) T/C sensors (SBE37 IMP) and currentmeters (Aquadopp), and other “O2” and “CO2” sensors that until now use independent and not real-time data transmission systems. Other opportunities for additional measurements from the PIRATA buoys are also encouraged and ensured if possible.

Finally, he European Tracking Network (EAATN) was launched during the first year of AtlantOS. An email survey of the telemetry community was conducted to determine the desired structure for the network, and a first workshop was organized at the 3rd World Fish Telemetry Conference. We began development of a common animal telemetry database resource to be made available to European researchers. The data system is being designed by VLIZ (Belgium) with technical input from the OTN, and is being articulated with EMODNET. Its structure should permit the rapid and efficient exchange of information among researchers, and also among other international telemetry data nodes. Dissemination activities for EAATN included various talks at international fora.

## b. Progress towards objectives per task

### Task 3.1 – Argo [Lead: Euro-Argo ERIC; Sylvie Pouliquen]

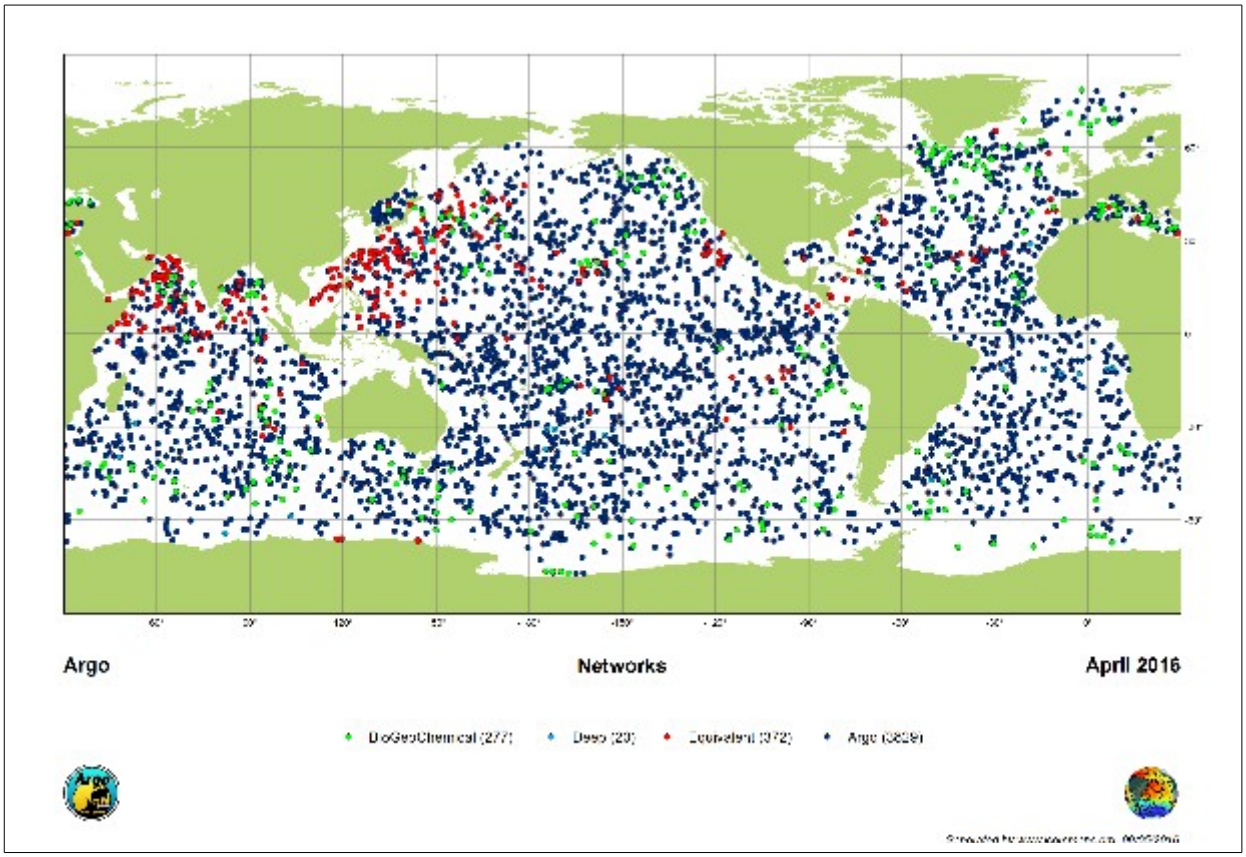
**Partners: Euro-Argo ERIC, IFREMER , CNRS/UPMC (LOV) , GEOMAR**

Argo is an international array of 3000 profiling floats that measure temperature & salinity throughout the deep global oceans, down to 2000 m. It is the single most important global in-situ observing system for the Copernicus Marine Service. Euro-Argo counts about 750 floats, the Biogeochemical-Argo and Deep-Argo floats are currently deployed for global and regional ocean observations.

**Tasks 3.1.1 Deployment of Bio-Argo and O2-deep floats and improvement of the network capabilities:** The procurement process for 7 biogeochemical floats and 7 deep floats started in November 2016 with the publication of a European call for tender. Only NKE provided an answer on the 24th of December 2015. The proposal was reviewed and was technically acceptable. The price offered for the DEEP floats was acceptable and the floats were ordered on the end March 2016 and will be delivered end July 2016 for deployment before the end on the year. A particular emphasis has been held on air O2 measurements to meet the community recommendations.

For the BIO floats the price offered was 30% higher than what was planned in the proposal and as such would allow to buy only 4 floats. The ERIC project office will declare the present lot not attributed and two separate calls, one for the hull + CTD and one for the sensors were issued on mid April 2016. The Euro-Argo ERIC expects a decrease in the price because the ERIC has a clearance of taxes when performing direct purchase of the extra-EU goods and the integration of the sensors will be done without specific design for a specific float. Moreover the Euro-Argo ERIC expects that a direct deal through a contract framework with the sensor manufacturers would help negotiating volume pricing and multi-annual visibility in a scope wider that the AtlantOS project itself. The answer are expected early June 2016.

Concerning the improvement of transmission capabilities, an analysis of the on-going improvement of RUDICS (Router based Unrestricted Digital Interworking Connectivity Solution) has been performed. NKE has already implemented a




software based and a hardware based solution on their CTS4 platforms for an “over-the full” capacity of the Iridium performances if RUDICS is used. Other manufacturers will be required to produce an equivalent work if selected as providers for the floats.

Improvement of Bio-Argo float capabilities by adapting new sensors: in partnership with Seabird, LOV foresees a delivery of the first pH sensor for the second half of 2016. Significant advances have been proved on calibration issues, next step in progress is to integrate this sensor on floats and test it in situ. Concerning O2 sensor enhancements, the partnership with Contros company came out on the provision of one prototype sensors in June 2016 for an inter-comparison with existing Aanderaa optodes, and with Seabird sensors.

Development of an Autonomous System for Argo float Release (ASFAR) [Ifremer]: Two prototypes have been deployed outside AtlantOS. Some issues occurred on the first scheduled launch, still under investigation. The project waits for the second scheduled release, enhancements on the prototypes will come out in 2016, next launch of ASFAR systems scheduled for 2017.

Deployment plan for the Deep and Bio are under discussion at the Euro-Argo ERIC Management Board and the first deployment are scheduled for the end of the 2016 year for the Deep and in spring 2017 for the BIO. These plans will take into account the recommendations issued by the Euro-Argo ERIC documented in the “Strategy for extension of Argo in the next Decade” that the ERIC is finalising. It will also take into account the recommendations from the OSSE meeting (link to WP1, WP5) organized in Toulouse end of December.

**Tasks 3.1.2 Argo Dataset production: Real-time data-management and delayed-mode qualified dataset for $O_2$, Chlorophyll *a*, backscattering and $NO_3$.**

- Data distribution and real time process is already organized following the International Argo Data Management Team recommendations.
- Delayed Mode management has to be refined with a working plan shared between the scientific partners.
- The Production of a consistent Argo and Bio-Argo validated dataset will take place after the floats deployments. First discussions with the involved partners ([Ifremer], [ACRI]) have to be planned in the second half of 2016 for the Dataset specifications.
- **Tasks 3.1.3 Organisation of the post-AtlantOS Bio-Argo and Deep-Argo sustainability in the context of the Euro-Argo ERIC.** The Management Board of the Euro-Argo ERIC has finalized a document called “Strategy for the Evolution of Argo for the next Decade” in December 2015 that includes the extensions of the Core Argo program to the Biogeochemical measurements and the exploration of the deep ocean. This document took into account the international recommendations that came from the meeting organized in January in Villefranche which gathered about 30 experts willing to develop and implement a global Bio-Argo plan through a white paper. This International event was organized by Hervé and Ken Johnson (MBAR, USA) will led to a Bio-Argo strategy is connected to Euro-Argo ERIC activities The Strategy document has been reviewed by the Euro-Argo ERIC Scientific and Technical Advisory Group and the recommendations will be provided to the Euro-Argo ERIC before end of June 2016 . Three areas have been identified for the deployment plan: North high latitudes, Marginal seas (Mediterranean, Baltic, Black Sea) and South Atlantic.

## Task 3.2 OceanSITES biogeochemistry [Lead: Richard Lampitt, NERC]

**Funded partners: NERC, GEOMAR, AWI, PLOCAN & Ribocon,**

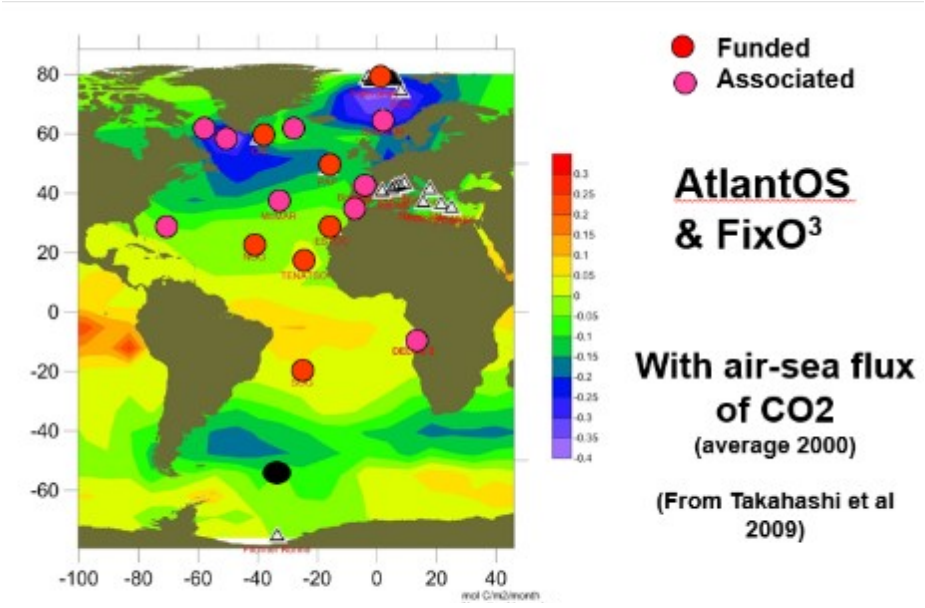
The network of fixed-point biogeochemical observatories addresses major observational gaps in terms of variables central to the MSFD. In particular, time series data will be obtained on biological EOVs such as zooplankton, phytoplankton, particles and metagenomic diversity to assess the structure and function of the

biological communities**.** Progress to date on this task has been made in purchasing equipment, employing staff, and developing analytical capability. This is to address the three associated deliverables (3.8, 3.13 and 3.17) and other work described in the DOA.

**Task 3.2.1 Network enhancement** Personnel: At NOC Dr Katsia Pabortsava who has expertise in chemical cycling and downward particle flux has been employed as a post-doc to work on microplastics and Ms Lucy Dickinson will now be the main data manager for the task. At AWI recently appointed Dr Ian Salter who has considerable expertise in fixed point observatories and in particular downward particle flux will now be working on this task and in addition a post-doc position has been advertised.

Equipment procurement: PLOCAN is organising public tenders to purchase phytoplankton, zooplankton and microcat sensors, as well as a deep ocean sediment trap to enhance ESTOC. Unfortunately the McLane Zooplankton sampler planned for deployment in 2016 has a fundamental design flaw which the manufacturers have just announced. As a consequence deployments cannot take place as planned at PAP

Fixed-point biogeochemical observatories ( AtlantOS and FixO3 network)




by NOC and ESTOC by PLOCAN until a replacement sampler has been identified.Analytical capability preparation: Ribocon has started to explore and optimize data analysis strategies for genetic-based microbial community profiling which can be done with minimal computational resources available to enable on-site (on board) diversity monitoring. A proof of principle (prototype) is envisaged for mid of 2016. NOC has collected a variety of types of deep water particulate material from the PAP observatory and various methods are being examined for analysis of microplastics

The Handbook of Best Practices (lead by Laurent Coppola/CNRS) developed within FixO3 is almost ready and will be circulated to the public shortly. The Handbook describes recommended procedures for calibration, pre-deployment, deployment and recovery of instrumentation. The Handbook will be most helpful for operations at fixed-point observatories within AtlantOS and OceanSITES.

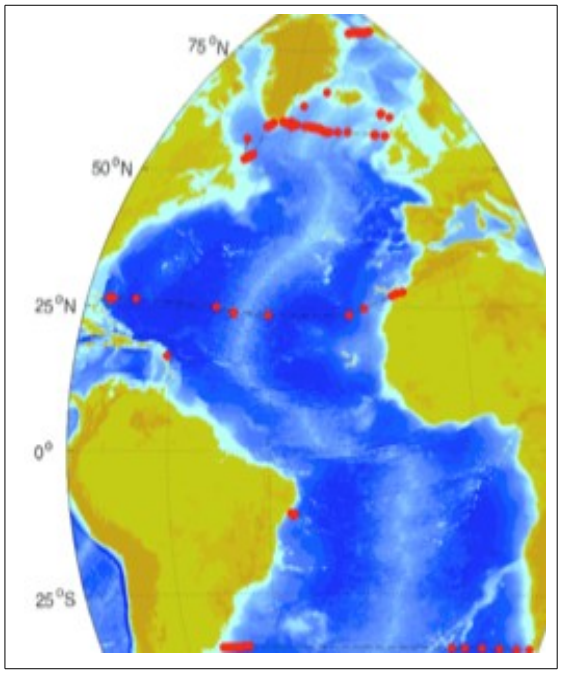
**Deliverables: D3.8 OceanSITES Networking Report:** Report and linked workshop on the European and Transatlantic plan for sustaining ocean observation by biogeochemical Eulerian Observatories. PM36 (May 2018). The workshop

identified for this deliverable will take place following a relevant conference such as the annual OceanSITES conference in order to reduce travel costs. This will most likely take place in September 2017 allowing time for a substantive report to be written before the due date. A preparatory meeting will take place during EGU, Vienna (18-22nd April 2016) or OceanSITES, Southampton (25-29th April 2016). During this meeting, Richard Lampitt (NOC), Femke De Jong (NIOZ/Duke University) and Andres Cianca (PLOCAN) showed results from the Atlantic (PAP, CIS and ESTOC observatories respectively). Wilken-Jon von Appen (AWI) presented results from the Arctic (FRAM) and gave also a presentation on AtlantOS contribution to OceanSITES

**Task 3.2.2 Data flux:** Appropriate data flow procedures are under discussion with emphasis on the importance of metadata

## Task 3.3 - Ocean Sites Transport, [Lead: Torsten Kanzow, AWI]

**Partners: AWI, GEOMAR, HAV, NERC, DSS, SAMS, CNRS**




The great value of Transport Mooring Array (TMAs) is the acquisition of long time series of volume, heat & freshwater fluxes in key locations of strong flows, all of which are related to the Atlantic meridional over-turning circulation. The TMAs enable the reliable estimate of these fluxes, including long time-series in the deep ocean**.** The challenge is to conduct the *research and innovation activities* necessary to increase performance and efficiency of the observing system, building on existing capacities around the Atlantic and also to fill the observational gaps through the optimization of existing systems by better coordination, harmonization and integration and the use of new ocean observation technologies.

**Task 3.3.1 Create and present network overarching products and analyses**

One stop shop web site for the transport mooring arrays (TMAs) is under development. The development had been started by Katharina Müller who unfortunately left AWI in January 2016. This has somewhat delayed the progress. During 2015 a prototype of a website design had been developed at AWI in order to serve as a discussion point on how to create and present higher level TMA data sets.

This included (i) collecting contact information from the partners and (ii) proposing examples of higher level TMA data sets, and (iii) ways of how to display them.

Following on to that, during the Ocean Sciences conference in New Orleans, a task 3.3.1 side meeting was held on 25 Feb 2016. The overarching aim was to lay the foundation for developing of a website, that shall serve as a „one-stop-shop for TMAs“. During the workshop, a discussion was held on how the TMA activities should be presented in a coherent way, so that the international science community has i. an easy time to access information on the joint scientific goals (e.g. Atlantic Overturning Circulation), ii. obtain both scientific results and technical details on the moored arrays, and iii. access high-level data products (such as heat transport time series). The following conclusions were reached.

- A questionnaire should be developed by AWI and be sent to all TMA partner to gather both status descriptions of the TMA and an overview on the high level data products in order provide a first general overview over TMAs.  Meanwhile the questionnaire has been completed by the partners attending the workshop and returned to AWI.

- Since TMA projects are funded on both sides of the Atlantic (by national and EU funding), it was agreed that a data server for archiving the high level TMA products should be used that is not tied to a certain institute nor a specific national program. The Ocean Sites archive was identified as a promising option. It was explained that Ocean Sites recently developed a data format suited for derived (higher level) products. A joint (and established) format for all TMA data sets would drastically increase the accessibility of the TMA products for external users.  During the Ocean Sites work shop in Southampton in April 2016 we presented our vision for a collaboration with Ocean Sites. The presentation was well-received.

- the TMA web site should also be hosted by an independent body (i.e. not linked to a national program). One option to be considered was to have the web site hosted by the Clivar Atlantic Regional Panel. In addition, seeking assistance from JCOMMOPS in setting up / maintaining the web site was also endorsed.  During the Ocean Sites work shop in Southampton in April 2016 we initiated a discussion with the JCOMMOPS representatives in order to prepare steps to set up the web site.

- AtlantOS aims at evaluating the impact that the individual observing networks have within the overall Atlantic Observing system, in terms of providing critical ocean information. In order to come up with recommendations and evaluations for an efficient and sustainable future observing system, observing system simulation experiments (OSSEs) will be carried out within AtlantOS. It was discussed, how we can define the impact / importance of TMA-based observations in this context. It was concluded that we as TMA group should define specific needs & critical information regarding the characteristics of boundary currents and the MOC that an observing system

should be able to observe.  As part of the questionnaire mentioned above AWI has meanwhile collected some information on this issue from the TMA partners.

This TMA website will be the first deliverable and is designed as an easy access web presentation.

**Task 3.3.2 Network enhancement/Technical Innovation**

**D3.18 Report on the observational potential of the Transport Monitoring Arrays and Synergies with the Wider Atlantic Observing System** - One workshop will be held to prepare the report and foster the cooperation on cross-TMA analyses. PM45 (December, 2018).

1. Assessment of the impact of upper-ocean measurements: no progress so far with respect to close to surface measurements

2. Coherent integration of O2 measurements for transports and fluxes in the Atlantic TMAs:

RAPID 26N : A deployment for the first time of biogeochemical sensors across the array was carried out on the latest cruise (part of the ABC fluxes project lead by Elaine McDonagh, NOC). They make measurements of oxygen, Ph and take remote samples from RAS instruments (Remote Access Samplers) for unique observations of biogeochemical time series.

Enhancement of the Transport Monitoring Arrays (OSNAP). We will add oxygen sensors - which have demonstrated a high readiness level (TRL6) - to existing moorings to coherently monitor the overflow water masses at four key TMA sites: Denmark Strait; Faroe Bank and Shetland Channels; Wyville Thomson Ridge Overflow.

Synergies with the Wider Atlantic Observing System: Four oxygen Optodes for the OSNAP array (NIOZ Reykjanes Ridge array & SAMS Rockall Trough Array). The Rockall Trough OSNAP array will also be instrumented with oxygen, pH, alkalinity and nutrient sensors as part of ATLAS (A Trans-AtLantic Assessment and deep-water ecosystem-based Spatial management plan for Europe, BG-01-2015-2, H2020-BG-2015-

Enhancement of the Transport Monitoring Arrays: Three oxygen optodes have been purchased by HAV and will be deployed at the next mooring turn around in spring/summer 2016 at the Faroe Bank Channel central overflow mooring (HAV) and two overflow moorings in the Denmark Strait (UHAM, MRI). It turned out that the AtlantOS funding did not fully cover the costs of the oxygen optodes. A MoU was made between AtlantOS and NACLIM on cost-sharing for the oxygen optodes.

**Task 3.3.3 (D3.7) Technical enhancement of a TMA site for data safety & cost efficiency.** The objectives are to work on the timely availability of TMA data by demonstrating the implementation of subsea real-time data telemetry systems. The

definition of the requirements of a subsea telemetry system has been done and transferred to Develogics Inc. who will design and develop the system. Plan to come: There will be a deployment of the system in the subpolar North Atlantic in summer 2016 (in conjunction with WP5 “Regional Observing”) on cruise MSM54. Release and Transmission tests will be done in the months following the deployment

RAPID 26°N: Current NERC-based funding includes money to deliver telemetry from the array, which links in with objectives 3.3.3— enhancing the observational potential of TMAs. The new NOC telemetry system has been deployed on one mooring for the first time on the cruise we have just returned from. If this works, we will roll it out to enough of the array to deliver near realtime AMOC estimates in 18 months.

## Task 3.4 Glider [Lead: CNRS; Pierre Testor]

**Partners: CNRS, SAMS, BRUNCIN, NERC, UIB, GEOMAR, PLOCAN**

Gliders are ideal platforms to fill the observational gap with autonomous surveys between the open ocean and the coastal/shelf. The “Everyone’s Glider Observatory” (EGO) initiative deals with scientific, technological coordination around field operations and data management. Gliders are considered as innovative platforms able to welcome multidisciplinary sensor modules.

**Tasks 3.4.1: Toward glider app' for public dissemination** : 2 meetings have been hold since the beginning of the project (03/09/2015 and 21/01/2016) to define the content of the app'. It has been decided that it will be a responsive web app' with a database back-end which will use the EGO data repository as the source for visualization. EGO format file parsers and possibly the initial database itself may come from CORIOLIS. The discussion on how to pilot glider with the app' is still open.

**Tasks 3.4.32: Consolidation of Atlantic EGO Network Activities Report :** Meetings with CORIOLIS, NOC, PLOCAN, GEOMAR, UiB, PROOCEANO have been hold since the beginning of the project. Reports are available on the EGO website. One main objective for the glider community is too secure the data flow. To reach that goal, tools have been developed to help partners for format conversion. GDAC process have been clarified.

Specific meeting with PROOCEANO, glider University/company join

Gliders deployment in the Atlantic

venture in Brazil has been hold. Collaboration starts and data will soon be accessible.

An EGO meeting will be held in Southampton by the end of September. This meeting will be a great occasion to reinforce our community and show off new development concerning science, but also data management and data flow.

At the international level, glider Task team in EuroGOOS and Glider steering committee and glider data management team in JCOMMOPS have been set up.

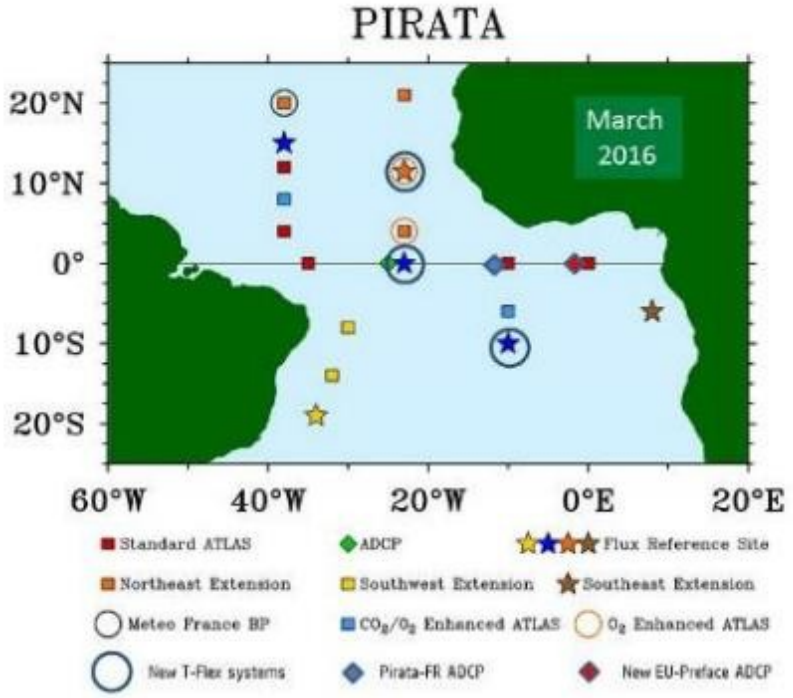
**Tasks 3.4.3 : Eastern boundaries survey** : Nothing to report.

## Task 3.5 - PIRATA [Lead: Bernard Bourlès, IRD]

**Partners: IRD, GEOMAR, CNRS**

PIRATA network is principally composed with 18 met-ocean buoys in the Tropical Atlantic. Their maintenance induces yearly dedicated cruises ensured by Brazil, US and French partners. The meteo-oceanic ATLAS buoys observations (oceanic: temperature and salinity from the surface down to 500m depth; meteorological: wind, air temperature, precipitation, radiations at the surface) are daily transmitted via ARGOS and made available in quasi-real time through internet.

One first priority was to ensure the yearly servicing of the PIRATA network, as successfully achieved thanks to a close collaboration between partners (US/NOAA, Brazil/INDP & UFPE, France/IRD) that ensure the yearly dedicated cruises. As not expected at the early stage of AtlantOS, PIRATA decided to progressively replace the classical ATLAS meteo-oceanic systems by new T-FLEX systems from 2015. These changes induce the insurance that new sensors can be installed on T-FLEX, keeping in mind that new sensors have to be installed to relevant positions/depths, from a scientific point of view. The present PIRATA network (March 2016) is schematized in the figure below:




In April 2016, the new AtlantOS sensors have not been yet installed, as explained and detailed below. But additional measurements have however being carried out, thanks to different collaborations and opportunities. Also, thanks to AtlantOS (and the EU PREFACE program too), some data sets (acquired during French PIRATA cruises form several years but not treated yet) have begun to be treated and validated.

**Task 3.5.1 Network enhancement**

"Classical sensors" component (PI: Bernard Bourlès, IRD/LEGOS):

The PIRATA Scientific Steering Group (SSG) met in Cape-Town, South Africa, (Aug 27th, 2015), during the joined PIRATA-PREFACE yearly meeting. There, the SSG discussed about the best locations and depths for additional sensors to be installed on the PIRATA moorings, taking into account i) the already existing sensors and scientific priorities, ii) the progressive ATLAS system replacing by T-FLEX systems, and iii) the 100k€ made available by AtlantOS for their purchase. The SSG decided to:

i) add, at the 0N-10W site where an ADCP mooring is maintained, 2 T/C sensors at 5m and 10m, along with 1 current meter at 10m;
ii) add, at 8N-38W, where Amazon plumes are present, 2 current meters at 10m and at about 40-50m depth (*i.e.* in and below the mixed layer);
iii) if possible, add one current meter at 0N-35W.

Each one has to be purchased in double for yearly servicing (replacing), thus SSG suggests a need of 10 sensors (4 T/C and 6 current-meters). As sensors are paid in US$, the feasibility depends upon the $/€ change rate…
These additions will only be possible from 2017 for the earliest, when ATLAS system will be progressively replaced by new T-FLEX system at these precise locations. Furthermore, T-FLEX systems induce specific sensors for T/C and currents, *i.e.* respectively SBE37_IMP (Seabird) and Aquadopp (Nortek). At now, the cost (quotes demanded in early 2016 to EMS and NortekMed) could allow the purchase of 4 T/C and 4 Aquadopp. The purchase administrative process, that induces to launch commercial call offers, should be initiated soon, in order the sensors to be delivered to NOAA/PMEL (Seattle, USA) by late 2016 (*note: PMEL is in charge of all technical aspects of the met-ocean buoys sensors, including the sensors preparation and data calibration*).

During this last 2015 PIRATA meeting, the PIRATA SSG also decided the locations of the new T-FLEX installation that will progressively replace the ATLAS ones. This operation began in late 2015 during the US PIRATA-NE cruise carried out in October-November 2015 with the deployment of the 1st T-FLEX at 11.5°N-23°W, and continued in early 2016 during the PIRATA-FR26 cruise carried out in March-April 2016 with the deployment of two T-FLEX at 0°N-230°W and 10°S-10°W (for more details, see https://www.atlantos-h2020.eu/2016/04/13/pirata-fr-26-cruise/).

O2 sensors component (PI: Peter Brandt, GEOMAR):

GEOMAR is responsible for the maintenance of oxygen loggers at two PIRATA buoys, located at 4°N,23°W and 11.5°N, 23°W, at 200m & 500m depth, for the OMZ monitoring. GEOMAR will continue to maintain these sensors and plan to deploy additional oxygen loggers with inductive link only with the new T-FLEX system (*i.e.* from 2016 & 2017).

(A) work done from April 2015:
- i development and construction of oxygen logger software and hardware for online moored observations;
- ii development for processing of online data.

(B) ongoing/future work:
- i development/construction and test of oxygen logger software and hardware;
- ii software development for processing of online data;
- iii data analysis and manuscript preparation.

CO2 sensor component (PI: Nathalie Lefèvre, IRD/LOCEAN):

A CO2 monitoring is realized at two PIRATA moorings at 6°S-10°W (from 2006) and 8°N-38°W (from 2008) using CARIOCA CO2 sensors.
At 8°N-38°W the CO2 sensor was installed on the 1st of November 2015 with old lithium batteries as new lithium batteries could not be transported to Brazil. The sensor transmitted hourly data but stopped working on the 31st of December 2015.
At 6°S-10°W the CO2 sensor was installed on the 6th of April 2015, showed some drift from August 2015 and stopped working on the 16th of November 2015 probably due to electronic problems. A new sensor has been installed on the 14th of May 2016 during the PIRATA-FR26 cruise and is still working.

A CO2 sensor and its spare are in construction by the French company NKE to enhance the autonomous observation network, as contribution of PIRATA to AtlantOS. The sensor will be installed on the PIRATA mooring at 6°S-8°E, which will contribute to increase the temporal and geographical coverage of CO2 data in the tropical Atlantic. The plan is to deploy the sensor next year during the PIRATA FR27 cruise.

**Task 3.5. 2 Data flow:** Another tasks is about treatment and dissemination of in situ data acquired during the yearly PIRATA-FR cruises carried out in the eastern tropical Atlantic.

From 2015, the PIRATA-FR yearly cruises are carried out onboard the R/V THALASSA. Such a vessel is now needed due to: i) piracy activity in the Gulf of Guinea that prevails any call in West African coasts located around this particular area; thus, the vessel needs a 40 days autonomy at sea as cruises have now to be made in one leg only; ii) the volume of material to be embarked, for 6 met-ocean buoys and ADCP moorings. This vessel is equipped with surface fluorimetry and acoustic sensors that allow measurements all along the vessel track-line. Acoustic tools allow a simultaneous acquisition of quantitative and qualitative data at different spatio-temporal scales, providing information about biotic and abiotic ecosystem components. Several potential scientific analyses could be carried out using such data in a particularly poorly sampled oceanic area. Such measurements are of particular interest in the Eastern tropical Atlantic Ocean, where are encountered specific patterns as the oxygen minimum zones « OMZ », and contrasted environment (fronts, upwellings), expected to impact pelagic organism spatial organization, the planktonic biodiversity, as well as upper trophic level marine organisms. Such measurements could be systematized during PIRATA cruises and contribute to their optimization.

Data from the PIRATA ADCP mooring maintained by France at 10°W-0°N suffer of a lake of human power to be properly treated/validated. In order to finalize their data

treatment and make these data available for the whole community, this work will be initiated soon.
For these two data sets, the recruitment of Jérémie Habasque, as junior post-doc, thanks to AtlantOS fundings has been done from April 1st 2016 (to December 31th, 2016). J.Habasque already contributed to the two last PIRATA-FR cruises (2015 and 2016) and in charge of acoustic data acquisition onboard (in addition to his contribution to CTDO2-LADCP profiles.

A more operational CTD-O2 data treatment software is in phase of elaboration (based on the Ifremer Cadhyac software) at the IRD-Brest (by Jacques Grelet). Such a software should make the CTD-O2 data treatment more efficient, and thus reduce the delay for their dissemination.

All PIRATA data are made available for free through different websites:

- http://www.pmel.noaa.gov/pirata/ for the meto-ocean buoys data sets;
- http://pirata.ccst.inpe.br/en/home/ for the in situ Brazilian cruises data sets;
- http://www.aoml.noaa.gov/phod/pne/index.php for the in situ US cruises data sets;
- http://www.brest.ird.fr/pirata/ for the in situ French cruises data sets. This last website has recently been renewed and all PIRATA-FR cruises are now linked to a DOI number.

At least, a researcher post-doc will be recruited from July 1st, 2016 for 12 months, thanks to AtlantOS fundings, Gaëlle Herbert. These last two years, G.Herbert worked as PREFACE senior post-doc and notably worked about the Ship-ADCP data treatment of the PIRATA-FR cruises, now available through the PIRATA-FR website. From July 1st, 2016, she will work on the Lowered ADCP data profiles acquired systematically down to 2000m depth during the PIRATA-FR cruises CTD-O2 casts.

### Task 3.6 – Surface Drifters, [Lead: Pierre Blouch and Paul Poli, EUMETNET]

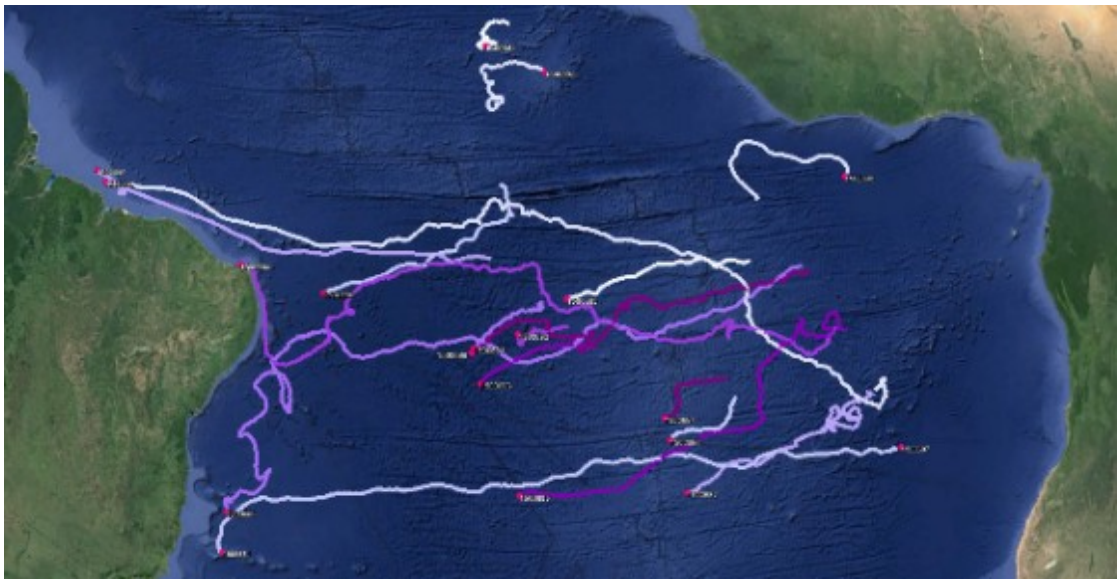
**Partners: NKE, EUMETNET, CNRS**

**Task 3.6.1 Network enhancement** The work carried out has started to patch the gap in terms of sea-surface observations made by drifters in the Tropical South Altantic, for water temperature, air pressure, and currents. At time of writing, EUMETNET has deployed 19 drifters so far, and 17 are still operating (more tha anticipated).

Half of the standard SVP-B drifters funded by AtlantOS (52 in all) to fill up a gap in the east of 20°W (spatial coverage increase) were purchased. Their deployment started in April 2015 thanks to a container carrier sailing between Le Havre and Cape Town. A second deployment occurred in August and next is planned at the beginning of 2016.

A new ship must however be found. The opportunity of PIRATA network maintenance cruise in February will be also seized. It is planned to regularly launch 4 to 5 buoys every 4 months.

In parallel, NKE has progressed towards the development of a salinity sensor for drifting buoys. CNRS has not started analysis of bathythermic chain data. NKE proposed a conductivity sensor that could be suitable for the project. The specifications for a prototype of drifter fitted with this sensor have been defined. The study on existing bathythermic string drifter data will start in 2016.



Map of all the buoys deployed in the south Atlantic from April 2015 to April

**Task 3.6.2 Data from AtlantOS funded drifting buoys** are sent in real-time onto the GTS (BUFR template TM315009). Near real-time quality controls are performed every day as for EUMETNET buoys and from there archived into major international archives. Measurements are acquired by AOML and MEDS for delayed mode distribution. Discussions are ongoing on the possible set up of a JCOMM GDAC for drifting buoys at Coriolis (interaction with WP7).

**Task 3.6.3 Network sustainability** Eumetnet may be able to provide 13 drifters per year for the South Atlantic, at the end of AtlantOS, if studies show beneficial impacts. Paul Poli will take over the task lead by next autumn. Paul already works with Pierre Blouch to prepare the transition (concerns E-SURFMAR too). Paul was formerly working on data assimilation at ECMWF. He was attend the meeting organized by P.-Y. Le Traon in Toulouse, on OSSEs in december 2016.

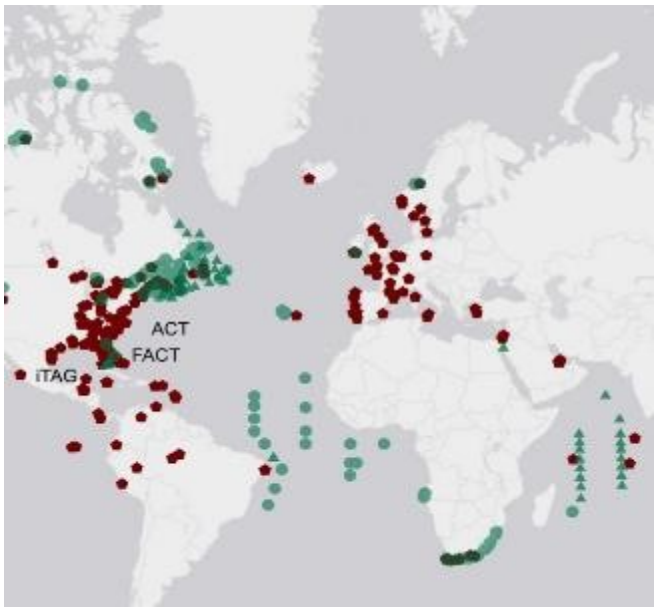
## Task 3.7 European Animal Telemetry Network (EATN) [Lead: Pedro Afonso, IMAR]

**Partners: IMAR, VLIZ, DAL**

The Ocean Tracking Network (OTN) is a world leader in the use of acoustic telemetry and currently maintains the world's two most extensive telemetry lines in the western Atlantic continental shelf, with coastal deployments in South Africa and Angola, and in preparation for Brazil;

**Task 3.7.1 Creating and developing the network - the European Tracking Network (ETN),** now being termed the European Aquatic Animal Telemetry Network (EAATN), was launched during the first year of AtlantOS. A survey to over 500 European based researchers was conducted via email by OTN and IMAR. The results were presented at the first EAATN workshop that took place in the 3rd World Fish Telemetry Conference, held in Halifax, Nova Scotia. Fifty persons attended a workshop which addressed community interest in the proposed network, and how researchers would like to structure its activities. In parallel a prototype electronic telemetry database for European researchers was developed and tested at VLIZ (Flemish Institute for Marine Sciences), in collaboration with OTN. VLIZ will host the EAATN database once it is in full service. Although not initially previewed, there will be a participation of WP3.7 in WP 7. Therefore, VLIZ represented the OTN/EAATN regarding the data developments at the WP7 meeting in Paris December 2015. Protocol and Data standards are being developed in collaboration with the OTN data management committee. The lead scientists of the two task leading partners (IMAR-UAz and OTN/Dalhousie) participated in several international meetings where EAATN, OTN and the links with the AtlantOS project were publicised, including invited talks at fora in the EC and a Brazil-EC joint mission. A concept paper led by IMAR is in preparation for publication during the second year of the project.

**Task 3.7.2. Establish key 'acoustic lines' in Europe and expand operations to the open ocean -** Several acoustic receivers arrays in Europe were enlarged or created with the support of OTN, which will be a major contribution to the potential network enlargement. These included coastal arrays with partners in Scotland and the UK for tracking salmonids and eels, as well as oceanic (e.g. PIRATA buoys) arrays that will document the movements of valued highly migratory aquatic species tagged in Europe and which use European waters seasonally (e.g., tuna). Initial discussions have also occurred with the European Glider network about deployment of mobile acoustic receivers on gliders. A technician to support the network member activities (deploying and maintaining acoustic receiver lines, database handling, etc.) was hired by IMAR and trained at OTN and IMAR.




Various receiver networks that are potential nodes of EAATN were recently ensured or deployed, including trans-Atlantic observation nodes (e.g. East coast of Scotland, UK, oceanic PIRATA buoys, Mid-Atlantic Azores array).

**Task 3.7.3. Leverage resources leverage resources to European researchers to acoustically tag valued species**. Several project proposals of ETN members were already developed/submitted/approved during year 1 that include aquatic telemetric activities and use EAATN/OTN as an infrastructure to be provided to tag valuable species. These included an InterReg V proposal to add additional arrays in the Celtic Sea (P. Boylan, Ireland, PI) and a H2020 proposal for oceanic pelagic fisheries (Laurent Dagorn, France, PI), and an ICCAT project approved for large scale tagging of tropical tunas in the Atlantic (Josu Santiago, Spain, PI).

## C Cooperation and interaction with other projects and initiatives

An international partnership and long-term agreements with the Euro-Argo members for the organization and funding of these new phases of Argo are under development. Once the strategy document is adopted, the Euro-Argo Implementation Plan will be written. It will describe how the strategic plan will be applied, with the respective contributions of the national facilities and the ERIC specific ones. This plan will be

discussed inside Euro-Argo member states, and the implementation regarding AtlantOS will be discussed with the teams implicated (UPMC-LOV, Ifremer, etc). The release of the first version of the Implementation plan is scheduled for the end of 2016.

Hervé Claustre with several AtlantOS partners have submitted a Marie Curie ITN project ‘Argonauts” on Bio-Argo development, based on cooperation. Another international consortium on Biogeochemical-Argo is under development, co-lead by Hervé Claustre, UPMC and Ken Johnson, MBARI, USA.

AtlantOS has been presented to the EU-FP7 project MicroB3, Simon Claus outlined how Micro B3 integrates well with the recently started H2020 project AtlantOS. Many scientists collaborating in MicroB3 are also collaborating in AtlantOS.

The gliders community has strong interaction with ENVRI+ H2020 project through the development of collaboration with marine research Infrastructure such as FIXO3, EuroARGO, EuroGOOS and the satellite community.

Data collected by the AtlantOS drifters have been circulated to WP7. The value of data collected has also been considered for impact study analysis in WP7 and will be proposed as candidate impact studies to EUMETNET Observation Scientific Expert Team (Obs-SET).

EAATN is intimately linked to the OTN initiative, and has collaborated directly during year 1 to develop the actions undertaken. The collaboration with EMODNET and Lifewatch through VLIZ for the database hosting was also developed during year 1.

OceanSITES is collaborating with related programmes such as UK-OSNAP, NACLIM.

PIRATA interacts with several international projects and initiatives.

1) It is an important component for the observations carried out in the frame of the EU PREFACE program. PREFACE ensured the resources for the purchase of a 2$^{nd}$ buoy needed to maintain the met-ocean buoys located off Congo at 6°S-8°E, that is now ensured from 2013. The yearly servicing of this buoy constitutes Milestones for PREFACE. Also, PREFACE made possible the installation of a new ADCP mooring at 0°N-0°E, achieved during the PIRATA-FR26 cruise (initially expected in 2015), and its maintenance also constitutes Milestones for PREFACE. Such a mooring, along with the two other ones already serviced at 23°W-0°N and 10°S-0°N by PIRATA (with contribution of GEOMAR for the one at 23°W), will allow some current measurements at three longitudes along the equator, needed for the EUC studies. This new ADCP mooring should be maintained several years, and could contribute to a new extension of PIRATA (if funding and human resources make this possible)…
2) PIRATA SSG endorsed the future installation of 9 additional T/C sensors at 8°N-38°W, 4°N-38°W and 0°N-35°W proposed by FUNCEME (Fortaleza) in Brazil. These additional sensors will increase the vertical resolution of the

temperature and salinity observations at these locations, from the surface until 140m depth. They will be installed on new T-FLEX system (from 2017 or 2018) and will contribute to the future extension of PIRATA.

3) PIRATA contributes to a 5 years US program (Oregon State University, Corvallis, USA ; PI: Jim Moum) supported by NSF through the servicing of turbulence sensors (Xpods) installed from 2014 at 23°W-0°N and 10°W-0°N (5 on each mooring between 20m and 80m). Such sensors are yearly serviced during the PIRATA-FR cruises.
4) PIRATA contributes, from 2014, to the OTN program (Dalhousie University, Halifax, Nova Scotia, Canada ; PI : Frederick G. Whoriskey) through the installation and yearly servicing of acoustic receivers (OTN), installed at the 18 PIRATA buoys (one per site at 200m depth). This operation could be continued in the future.
5) PIRATA contributes, from its early steps, to ARGO and CORIOLIS, through the deployment of ARGO profilers. 6 profilers were deployed during the last PIRATA-FR26 cruise, three of them with double programming (so allowing some profiles every two days during three months from the surface down to 300m depth).
6) PIRATA-FR also contributes from 2005 to ARGO through the realization of 0-2000m depth CTD profiles, *i.e.* down to the depth of ARGO profiles, made available for the ARGO profilers' data calibration.
7) During the last PIRATA-FR25 (March-April 2015) and FR26 (March-April 2016) cruises, PIRATA-FR contributed to the Meteo-France participation to AtlantOS (WP3.6) through the deployment, in the eastern Tropical Atlantic, of 16 (1 in 2015 and 15 in 2016) drifting buoys (SVP-B) and 3 SVP equipped with a 0-80m chain with temperature sensors (in 2015).
8) PIRATA also contributes to CORIOLIS and data dissemination in real time through the transmission in quasi-real time of CTD and XBT profiles carried out during the dedicated cruises. During the last PIRATA-FR25 (March-April 2015) and FR26 (March-April 2016) cruises, a total of 58 CTD and 179 XBT profiles obtained in the eastern tropical Atlantic have been transmitted.

## II. Achieved main results

The main results achieved are

For Argo, Deep Argo Floats have been ordered, new biogeochemical sensor implementation is on-going, data management procedure for biogeochemical variables have been strengthen.

For Ocean site biogeochemistry, Preliminary tests have been carried out to extract sequence information from preserved sediment trap samples in the Fram Strait.

Targeting phylogenetic marker genes, these data are needed to better understand the microbial component of biogeochemical processes in the water column. The possibility to extract and sequence DNA from these samples has been successfully demonstrated, and perspectives on the optimization of these processes gathered for future evaluation. Additionally, Ribocon's bioinformatics pipeline has been shown to provide workable results and detect issues in sequence length and quality, hindering more complete results. Numerous important methodological points and decisions were informed by this work, including (i) the need for a common extraction protocol to generate eukaryotic and prokaryotic DNA, (ii) the requirement to choose between different primer sets, each with somewhat different phylogenetic coverage, to amplify eukaryotic DNA, (iii) an estimation of the sequencing depth/effort required to detect the key groups of eukaryotic organisms with varying proportional abundance, (iv) the importance of internal replication and cross-validation of the results and (v) the need to make transparent and improve the quality control of sequence data prior to submission to Ribocon's pipelines or general release. These tests have served to establish a preliminary workflow with Ribocon as a precursor to defining standard workflows and bioinformatic pipelines that could serve as a blueprint for future omic-type observations in the Atlantic. The future products of these approaches will provide a baseline for partners in the network to compare their results to, supporting clear dialogue towards future improvements. Importantly, workflow modularization will allow partners to interact with Ribocon's data products at multiple points, thus permitting innovative variations without the need to duplicate effort and resource use.

Regarding OceanSITES transports, it was agreed that the data server to be used for archiving the high level TMA products will be the Ocean Sites archive.

For gliders, the main results are the development of tools for data management, a new partnership with Brazil has been developed; and a Glider Steering Team and a Glider Data Managment Team within JCOMMOPS as well as a glider Task Team within EuroGOOS have been established.

The drifting buoys have been deployed in an area normally devoid of such platforms and a novel salinity sensor is nearing integration into drifting buoys.

For PIRATA, None new sensors initially announced have been deployed yet (ie new sensors purchase and installation: see above). However several activities and actions have been achieved and initiated (see above)

For EATN, the main result achieved in year 1 was the launch of the EAATN. The online survey provided a useful overview of the European-based acoustic telemetric research community and their expectations towards an organized network while allowing EAATN to reach that same community as a starting point. The workshop allowed over 50 researchers to discuss the future network objectives and structure. The database and the hired technician are two main assets to offer to the network

members starting in year 2. Initial definition of EOVs was achieved. Several project proposals of EAATN members are already being developed/approved during year 1 that include aquatic telemetric activities and use EAATN/OTN as supporting infrastructure.

## III. Identified risks

Risks are identified only for some networks

**For gliders,** the main difficulty is to access data from UK. The team is progressing but it will be a long process. The data management process is still confused and need to be extremely robust. EGO meeting will rovide the opportunity to clarify this point. The team is planning to make a deployment registration system to evolve and this evolution has to be secured. The IT infrastructure has to be strong enough to support new comers and more efforts have to be done to improve the system

Monitoring tools and index need to be developed in the next years to accurately access the evolution of the glider activities.

**For PIRATA**
The issues identified are:

i) direct one: $/€ rate that could limit the number of purchased new sensors;

ii) indirect one: piracy in the Gulf of Guinea that prevents any in situ measurements in a large part of this oceanic area during the PIRATA-FR cruises.

**For EATN**
A potential risk is related to the current difficulties in the incompatibility of the acoustic tracking equipment of different manufacturers. Tags and receivers produced by one company are not yet fully able to be used with the equipment manufactured by other firms. EAATN/OTN as made the disadvantages of this clear to the manufacturers who were present at the workshop held at the first meeting of the network, and will continue to do so during the course of the project. However, currently the vast majority of telemetrists are using compatible equipment, and it is this opportunity that is enabling the creation of EAATN, and of the database that will share information among investigators. Network participants will benefit from an expanded science capability resulting from the increased detection probability of their tagged animals on the receivers of other members of the network, and the

collaboration potential generated by data sharing and the closer contact among telemetrists.

## IV. Deviations from Annex 1

### a) Tasks

For **Argo**, during this reporting period, seven floats of each type have been purchased, their delivery will occur in fall 2016 for tests and deployments during the year 2017. The engineering work on the new sensors is still in progress by the industrial partners of this work-package, with some delay announced so far and a shift of about 6 to 8 months foreseen for the first prototypes delivery. In the meantime, extended inter-comparison exercises will be held on the bench and at sea to assess the final quality of the materials.

**Drifters:** The delay in the development of the salinity sensor comes from the time necessary to make modifications to integrate it on board a buoy. There is no perceived risk, at time of writing, of failing to deliver what was planned by project's end. A meeting was held at NKE to review progress and the Task 3.6 leader is in regular contact with NKE to monitor advances. Progress so far has enabled to use a new analog-to-digital converter and to develop a new data acquisition electronics that applies calibration. All these developments are essential to guarantee good measurement quality meeting scientists' expectations. The deliverable D3.4 "Design a buoy fitted with a low cost salinity sensor", a "Demonstrator" deliverable, due month 24 (March 2017), will be on track if partner NKE manages to deliver a prototype by October 2016 (leaving time for evaluation by CNRS as planned by March 2017). It will be tight and everyone will do its best.

The delay with CNRS not analysing past bathythermic chain data comes from the removal of partner MY which has desorganized the expected workflow. Indeed, the initial anticipated partner MY is not carrying out the development work related to bathythermic string drifters because this partner was excluded from the consortium. The milestone related to this specific task has to be revised.

Other sources of observation data from such platforms have to be found. Progress is expected over the next period. The deliverable D3.5 "Development of bathythermic string drifters", a "Report" deliverable, has been renamed in the Grant Agreement, because partner Marlin-Yug was excluded from the consortium (information detailed in the 'History of changes' of the Grant Agreement), into "Study of the potential for existing bathythermic string drifters". Partner CNRS is in the hiring process at the moment and unless otherwise indicated (administrative delays are possible over the summer) the target date (month 24 = March 2017) is still relevant.

As a consequence, the milestone MS8 "Drifters fitted with bathythermic chains and the salinity drifter prototypes deployed" should have been renamed for the same reason as D3.5 to drop the bathythermic chain drifter deployments. The new proposed milestone name is: "Prototype salinity drifters deployed" Planned for month 20 (= November 2016), it CANNOT be met. The date should be moved to align with.

**TMA:** the website development had been started by Katharina Müller who unfortunately left AWI in January 2016. This has somewhat delayed the progress of this task and the deliverable D3.1. It is postponed until the end of the year.

**EATN:** The deliverable **D3.2** EAATN Valued species Report on a workshop initially planned at Month 18 is delayed. The dates of the workshop will most probably will only take place in December 2016-January 2017 (M21-M22). Deliverable D3.2 (workshop report) will therefore be 3 to 4 months delayed. This delay is related to the fact that the scope and scale of the newly created network and the resulting list of invited senior scientists is currently being assessed and defined.

### b) Use of resources

- AtlantOS partner HAV (nº 23) realised that the estimated budget of 30,000 € for three oxygen optodes for the planned moorings is lower than the actual cost which seem to sum up to about 38,000 € (42,890 US$). Accordingly, we developed and memorandum of understanding (MoU) amongst the 2 projects that profit from the results that will be gained by the oxygen optodes. These projects are AtlantOS and NACLIM (FP7). Partner nº 23 (HAV) declares the percent to be used in each of the projects as well as the amount to be covered by the project, respectively. This way they assure that the measurements will be performed and both projects will be able to fulfil their duties. Attached please find the MoU.
- AtlantOS partner CSIC (nº 13) realized that the according to the GA DoA their participation is 20 person month, however, their correct number of PM is 27.7. Their budget as given in the GA is based on the 27.7 PM, accordingly it is a calculation error with no financial impact.
- AtlantOS partner UPMC (nº 7) noticed some inconsistence in the DoA regarding their number of person month per WP. UPMC will be involved in WP3 with up to 43 PM and not with 36 PM as given in the

DoA and in WP5 they will be involved with 24 PM and not with 26 PM as stated in the DoA. UPMC verified and recalculated their budget according to the correct number of PM and assured that the changes will have no financial impact.

- AtlantOS partner PML (nº 43) is according to the DoA of the GA under task 2.2 required to perform intercomparison between existing and emerging technology $pCO_2$ devices. During the proposal writing and grand agreement preparation phase beneficiary nº 43 acted on the assumption that they will source the instrumentation freely or via existing equipment pools. Regrettably, it turned out that this will not be the case; accordingly, they had to purchase the $pCO_2$ optode system. The PML budget for task 2.2 according to the GA foresees 'other direct costs' split in € 14040 for 'travel' and € 7800 for 'other goods and services'. Due to the changed situation PML needed € 15000 for the optode system. Hence, they split the 'other direct costs' as follows: € 3420 for 'travel', € 15000 for 'equipment' and € 3420 for 'other goods and services' and consequently, avoid any financial impact.
- AtlantOS partner PLOCAN (n°15): According to GA (page 50) and Task 3.2 OceanSITES biogeochemistry, PLOCAN has the commitment to purchase some specific equipment: 1x Sediment Trap, 1x Fitoplancton sampler and 1x zooplacton sampler.
  However, after several discussions between the provider (only one worldwide), task 3.2 leader (in Cc) and PLOCAN, in order to find a right technical solution, the situation so far regarding the availability for purchase of the zooplancton sensor/sampler is that this equipment is not longer commercially available due to technical reasons. Based on this situation, PLOCAN modified the purchase of equipment as follows: 2x Sediment traps and 1x Fitoplancton sampler instead of initially stated in the GA: 1x sediment trap, 1x fitoplancton sampler and 1x zooplancton sampler.
- AtlantOS Partner EUMETNET (n° 26) : MY is not carrying out the development work related to bathythermic string drifters because this partner was excluded from the consortium (before grant signature). The milestone related to this specific task has to be revised. CNRS has not started to analyse data collected by past bathythermic chains.
- AtlantOS partner Euro-Argo ERIC: an amendment is under progress to transfer the budget to buy 7 Argo floats to AtlantOS Partner UPMC to buy the floats: this partner in close connection with the manufacturer can negotiate better prices..

### c) Unforeseen subcontracting

### d) Unforeseen use of in kind contribution from third party against payment or free of charge

## V. Dissemination and exploitation of results

Few activities have been developed : A videography on fixed-point observatories and their importance has been created within FixO3 and available at https://www.youtube.com/watch?v=EQFWz3clW1s (new version to be distributed shortly)

A Wikipedia entry on fixed-point observatories is being developed within FixO3 and will be available soon to receive input from the public

### [a) Scientific publications:

- **Lacour L**, **Claustre H**, **Prieur L**, **D'Ortenzio F** (2015). Phytoplankton biomass cycles in the North Atlantic subpolar gyre: a similar mechanism for two different blooms in the Labrador Sea. Geophys Res Lett 42 | doi: 10.1002/2015GL064540.

- **Lefèvre N., D. Veleda, M. Araujo and G. Caniaux.** (2016) Variability and trends of carbon parameters at a time-series in the Eastern Tropical Atlantic. Tellus B, in press.

- **Johnson K.S. & Claustre H.,** Planning for a global Biogeochemical-Argo Program, (2016) EOS, under review

### [b) Dissemination and communication activities

- **Scientific highlights**

Herbert, G., C. Kermabon, J. Grelet, and B. Bourlès, French PIRATA cruises S-ADCP data processing, *MERCATOR Ocean-CORIOLIS Quarterly Newsletter-Special Issue*, 52, mai 2015.

- **Meeting**

- Bremen, May 23 2016 meeting on “planning standardized workflows”: Representatives from AWI and Ribocon met to discuss results from the trial sequencing of archived sediment trap material. Outcomes included an agreement to formulate a modularized workflow for the analysis of

sequencing data. Modularized workflows will aim to support the creation of both standard data products and a structured means to accommodate novel methods without duplicating effort. This task is currently underway. Another outcome was the identification of the requirement to survey the Atlantic observing community to synthesise what genomic observations are underway and from which types of observational platforms. This will provide a foundation to better standardize our efforts and share expertise.

- Villefranche sur mer, January 11-13, 2016, meeting on ”Planning a global Biogeochemical-Argo network” to in to design the Implementation plan of the Biogeochemical-Argo network. Twenty-four scientists from Australia, Canada, China, Japan, France, Germany, the United Kingdom and the United States met in Villefranche for 3 days to formalize the planning of a global Biogeochemical-Argo network. A white paper describing the implementation plan of this network is under process. Several AtlantOS partners are contributing to the development of this autonomous ocean observing system.

- Villefranche sur mer, 27-28 October 2015 to design and submit a project to the Horizon2020 International Training Network, Marie Curie Scklodowska grant. Several partners from AtlantOS are contributing to this project.

- **Conferences (talks & posters)**

- 24-28 August 2015: participation (and contribution to organisation) to the PREFACE/PIRATA/CLIVAR TAV meeting in CapeTown (B. Bourlès, P.Brandt).

- 2nd to 5th November, 2015, participation to the EU-FP7 MicroB3 final conference, Brussels, (I. Salter, Ribocon)

- 21-26 February 2016, Ocean Sciences Meeting, New Orleans, Louisiana, USA,

- 2-4 March 2016: participation to the GCOS science conference, Amsterdam, Poster (M. Barbier)

- 17-22 April 2016: participation to the European Geophysical Union General Assembly in Vienna: Lefèvre N., D. Veleda, M. Araujo and G. Caniaux. Quantifying the air-sea CO2 flux at a time-series in the Eastern Tropical Atlantic. Poster.

**Conferences participation**

Ian Salter (2015) Innovative sampling infrastructure for improved temporal and spatial resolution of microbial biogeochemistry, EU-FP7 MicroB3 final conference, Brussels, 2nd to 5th November, 2015

Bourlès, B., M. Araujo, P. Brandt, E. Campos, H. Giordani, F. Hernandez, R. Lumpkin, M.PcPhaden, P. Nobre and R. Saravanan, an overview and highlights of PIRATA, conférence PIRATA/PREFACE/Clivar-TAV, Cape-Town, South Africa, 24-28 août 2015.

Bourlès, B..: PIRATA French national report and status to PIRATA SSG, *PIRATA/PREFACE/Clivar-TAV, Cape*-Town conference, South Africa, 24-28 août 2015.

Bourlès, B.: Etat des lieux relatif aux programmes PIRATA, PREFACE et AtlantOS, regional colloquium TACCOVAR, Cotonou, Benin, 5-9 octobre 2015.

Habasque, J., B. Bourlès, E. Machu, and P. Brehmer, Multifrequency acoustics measurements during the PIRATA FR25 cruise in the Eastern tropical Atlantic Ocean, poster presentation at the *PIRATA/PREFACE/Clivar-TAV conference, Cape-Town, South Africa*, 24-28 août 2015.

H. Claustre, A. Boetius, M.Barbier, P. Testor, S. Pouliquen, R. Lampitt, T. Kanzow, B. Bourlès, P. Blouch, P. Afonso, G. Obolensky, F. Whoriskey, F. Janssen, I. Salter, V. Turpin, P. Poli (2016) Enhancement of autonomous ocean observation networks in the Atlantic Ocean. Gobal Climate Observation System science conference, Amsterdam , NL, 2-4 March 2016

Briggs N, Claustre H, Dall'Olmo G, Bittig H (2016) Bio-Argo float data suggest that disaggregation is a major driver of flux attenuation during large phytoplankton blooms in the North Atlantic. Ocean Sciences Meeting, New Orleans, Louisiana, USA, 21-26 February 2016.

Bittig H, Claustre H, Körtzinger A (2016) Constraining the Biological Pump on Seasonal Scales through Autonomous Oxygen Observations from Profiling Floats. Ocean Sciences Meeting, New Orleans, Louisiana, USA, 21-26 February 2016.

Claustre H, Boetius A, Testor P, Pouliquen S, Lampitt R, Kanzow T, Bourlès B, Blouch P, Afonso P, Obolensky G, Whoriskey F, Barbier M, Janssen F, Salter I, Turpin V, Poli P (2016). Enhancement of autonomous ocean observation networks in the Atlantic Ocean, (AtlantOS H2020 project). Global Climate Observation: the Road to the Future, Amsterdam, Netherlands, 02-04 March 2016.

Johnson KS, Sarmiento JL, Claustre H (2016). The prospects and rationale for a global biogeochemical Argo system. Global Climate Observation: the Road to the Future, Amsterdam, Netherlands, 02-04 March 2016.

Organelli E, Claustre H, Bricaud A, Schmechtig C, Poteau A, Serra R, Mangin A, Xing X, D'Ortenzio F, Prieur L, Obolensky G, Dall'Olmo G, Barbieux M, Uitz J, Leymarie E, Penkerc'h C (2015). Bio-optical product validation. International Ocean Colour Science Meeting, San Francisco, California, USA, 15-18 June 2015.

Organelli E, Claustre H, Serra R, Mangin A, Bricaud A, Schmechtig C, Poteau A, Xing X, Prieur L, D'Ortenzio F, Obolensky G, Dall'Olmo G (2015). Radiometric measurements by Bio-Argo floats as a resource for bio-optical product validation.

International Ocean Colour Science Meeting, San Francisco, California, USA, 15-18 June 2015.

Organelli E, Claustre H, Serra R, Bricaud A, Schmechtig C, D'Ortenzio F, Poteau A, Mangin A, Leymarie E, Obolensky G, Prieur L, Dall'Olmo G, Xing X (2016). Radiometry from Bio-Argo floats: A new strategy to validate ocean color products at the global scale. Ocean Sciences Meeting, New Orleans, Louisiana, USA, 21-26 February 2016.

Sauzède R, Claustre H, Jamet C, Uitz J, Dall'Olmo G, D'Ortenzio F, Poteau A, Schmechtig C (2015). Extending surface bio-optical properties to depth: a neural network for merging ocean color and Argo data. International Ocean Colour Science Meeting, San Francisco, California, USA, 15-18 June 2015.

Sauzède R, Claustre H, Jamet C, Uitz J, Dall'Olmo G, D'Ortenzio F, Gentili B, Poteau A, Schmechtig C (2016). Merging Ocean Color and physical Argo data to extend bio-optical properties to depth using neural networks: A global 3D view of phytoplankton biomass and phytoplankton communities composition. Ocean Sciences Meeting, New Orleans, Louisiana, USA, 21-26 February 2016.

## [c) **Intellectual property rights** resulting from the project