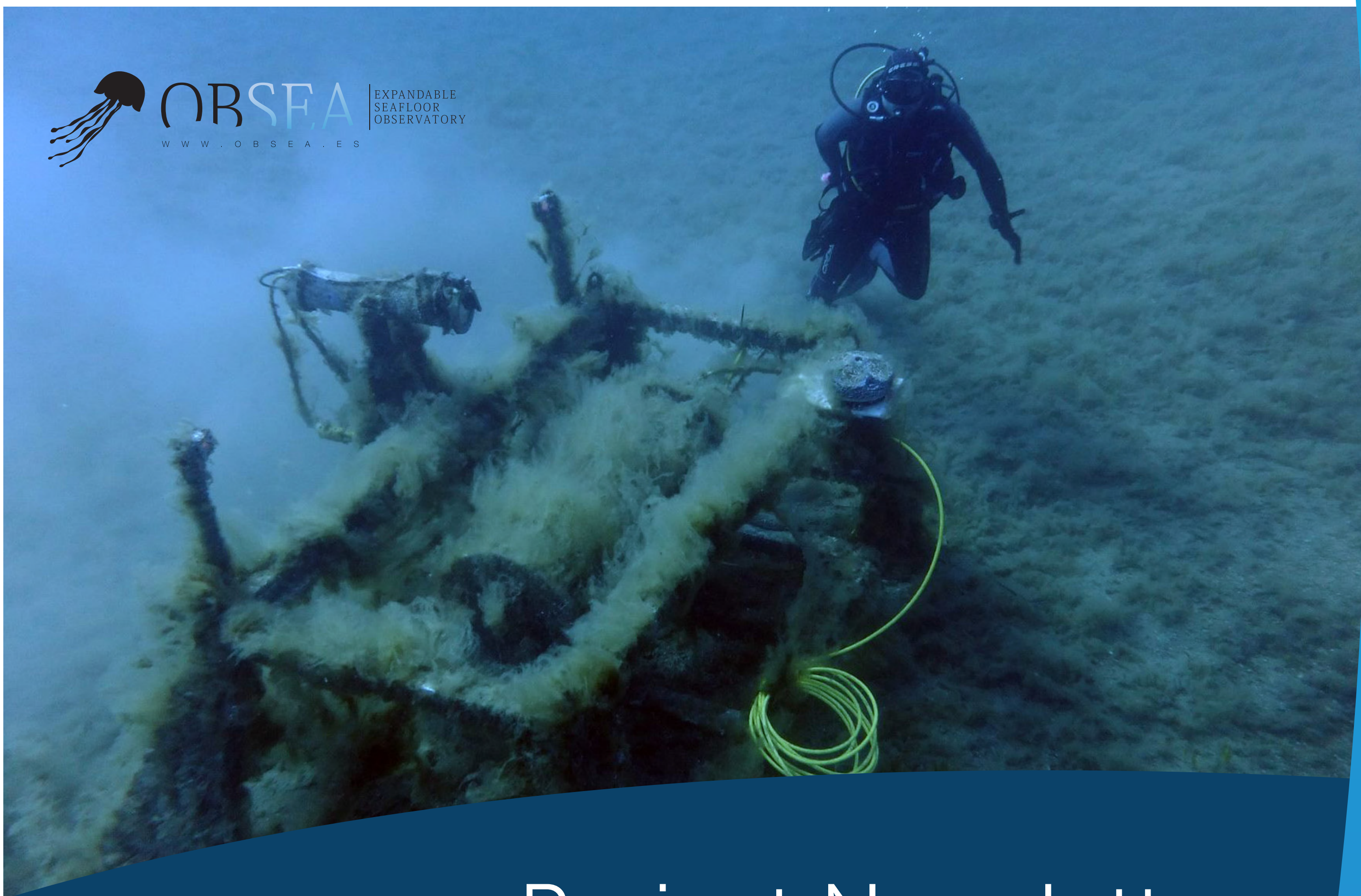
FixO3

FIXED-POINT OPEN OCEAN OBSERVATORIES

The Fixed point Open Ocean Observatory network (FixO3) seeks to integrate European open ocean fixed point observatories and to improve access to these key installations for the broader community.



Project Newsletter

SERVICE ACTIVITIES SPECIAL

Volume 3 - Issue 1

29 partners, 11 European countries, 23 fixed point observatories, 12 work packages, 4 years, 7 million Euros.

Find out more **Web:** www.fixO3.eu **Twitter:** @fixO3Project

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FixO^3
FIXED-POINT OPEN OCEAN OBSERVATORIES

Coordinating author:

Luisa Cristini (NOC)

Editors:

Luisa Cristini (NOC)
Kathryn Keeble (Blue Lobster)

Design & Graphics:

Simon Keeble (Blue lobster)

Cover Image:

OBSEA cabled observatory maintenance July 2016. Image courtesy of Joaquin Del Rio Fernandez (UPC)

FixO^3 Project Management Office
National Oceanographic Centre
European Way
Southampton SO14 3ZH

Tel: +44 (0)23 8059 6429
Email: fixo3@noc.ac.uk
Website: www.fixo3.eu

Editorial: The purposes of ocean observation

Richard Lampitt

National Oceanography Centre Southampton

There are two broad reasons why we need to make sustained observations of the planet's oceans. The first is to generate data of sufficient temporal and spatial resolution on variables of critical relevance to the Earth system so that we can determine how the oceans are changing over time and space. The second reason is to obtain simultaneous data on a range of relevant variables so that we gain a better understanding of how these variables relate to each other and hence obtain a deeper picture of the way the system functions. The cost of making these observations is modest in comparison to that of comparable observing endeavours such as astronomy, but the benefits, although difficult to quantify objectively, are substantial (see for example Cristini et al. 2016 in Marine Policy). These benefits may depend on short term observations when applied for instance to recreational activities, maritime transportation efficiency or to target commercial fishing effort. Alternatively they may depend on being sustained over many years to determine for instance the consequence of anthropogenic perturbation on the climate of the planet. One of the massive benefits of the observing systems we now have in place is that the same suite of deployments can be used for a wide range of purposes and on different time scales and as they develop in terms of reliability diversity and accuracy over the coming decades, we should anticipate major advances in our understanding of system function at a time when the oceans will change in a fundamental manner.

There are several platforms for making ocean observations; transect ships, research vessels, gliders, floats, satellites, autonomous surface vehicles, benthic crawlers and, as is the focus of FixO^3, fixed point or eulerian observatories. All platforms have strengths and weaknesses and the crucial issue with all of them is that they must generate data which is intercomparable and can be assimilated by computational models such that an understanding of the entire system and its variability can be generated.

There is a wide range of sensors and samplers which are deployed on these platforms and all require expert technical support if they are to function effectively for the period of deployment, often for over a year. Behind this simple word "intercomparable" lies a plethora of methodological detail which cannot be skipped or done in part. For a start the sensors deployed need to have sufficient accuracy and precision, the samplers must retain the collected material without contamination of degradation. Calibration of sensors is essential prior to deployment

and after recovery, the data must then be managed and curated in such a way that all relevant metadata is permanently stuck to the data. Data must then of course be readily available so that access is simple and clear and with the appropriate attribution.

It is with this mind-set that data products (or Service Activities, as we call them) were developed within the FixO^3 project. The aim of this action is to make data, maps, and trends from FixO^3 observatories readily accessible in a centralised way to be used for a wide range of research such as ocean physics and climate change, carbon cycle and acidification, biodiversity and ecosystem assessment, geophysics and geodynamics. This year's issue of FixO^3 Newsletter is focused on data products, where they come from and why are they important. We give an overview of the data products (Service Activities) provided by the FixO^3 project, their importance and their uses ("Service activities at a glance: Services for Science and Society" by Ingo Schewe) we then give examples of the service activities from four observatories within the FixO^3 Network: CVOO, FRAM, Station M and MOMAR. We also present our efforts in training young scientists and data users on how to access and validate data to deliver products for a wide range of uses ("Acquisition, validation, quality control and access to data - a FixO^3 training course for less experienced users of data products" by Herman Hummel).

Thank you for your interest

Looking Back

Main activities and events of the third project's year: September 2015 – August 2016

Month	Event	Description
September 2015	Project's technical review started	An external reviewer appointed by the European Commission has reviewed the project's first two years to assess the work that has been done and the use of resources.
	Workshop: practical introduction to marine monitoring hardware and procedures (15-17, Trieste)	A fully-funded workshop for early career scientists with an interest in a career in ocean monitoring, observation and forecasting was organized by FixO^3 partner OGS. Read more about this in the project's deliverable 8.10 and on the project website http://www.fixo3.eu/
	Newsletter 2	The year 2 project newsletter is focussed on the current challenges of data management and sharing in Europe and on FixO^3 contribution. The newsletter (project deliverable 8.6) can be accessed from the project website http://www.fixo3.eu/
October 2015	FixO^3 General Assembly 2015 and Technical Review (12-14, Brussels)	The annual project's General Assembly (GA2015) took place at the Thon Hotel Brussels and included the Technical Review meeting where an external reviewer and the project officer from the European Commission provided feedback on the project. Read more about the meeting and access the summary and all presentations from the project website http://www.fixo3.eu/
	Data management workshop (15, Brussels)	A workshop for data managers took place right after the GA2015
	EMODnet conference & jamboree (20-22, Ostend)	The open conference and jamboree discussed standards for harmonization of marine data, products and metadata throughout Europe to make these fragmented resources more available to public and private users.
	D2.4	INGV coordinated a summary of new sensors development and their suitability for different applications
	D5.5	SLR describe five innovative products outcoming from the FixO^3 community
	MS16	Innovative products developed
November 2015	D7.10	TNA leader PLOCAN provided a summary of the evaluation process and results of the second call for transnational access to FixO^3 observatories.
January 2016	11th SC meeting	The project's Steering Committee met via videoconference to discuss the project's status and work plan.
February 2016	MS12	Guidelines and recommendations from TNA users have been collected and published on the project website http://www.fixo3.eu/
	Ocean Sciences Meeting (21-26, New Orleans)	The world's largest conference on ocean sciences provided opportunity to showcase the project achievements and discuss with the international community what next steps are needed towards a sustained network of fixed ocean observations. Read more about FixO^3 contribution to the conference on the project website http://www.fixo3.eu/
March 2016	Oceanology International (15-17, London)	The world's leading forum where industry, academia and government share knowledge and connect with the marine science and ocean technology communities was the stage from where FixO^3 partners discussed the role of industry and the benefits of an integrated network of ocean observatories. Read more about FixO^3 contribution to the event on the project website http://www.fixo3.eu/
April 2016	EGU General Assembly (17-22, Vienna)	FixO^3 convened a session on advances at fixed ocean observatories at the largest European conference on geosciences. The session was well attended and provided the opportunity to discuss latest scientific and technological results. Read more about the EGU general Assembly on the project website http://www.fixo3.eu/
	OceanSITES Conference 2016 (25-29, Southampton)	Conference on data Management and Steering Committee Meeting. Read more about the OceanSITES conference on the project website http://www.fixo3.eu/
	12th SC meeting	The project's Steering Committee met via videoconference to discuss the project's status and work plan.
May 2016	7th AB meeting	The project's Advisory Board met via videoconference to discuss the project's status and recommendations to increase impact of outcomes.
	10th GEO EU Projects Workshop (31 May – 2 June, Berlin)	Representatives from science, business and public administration met in Berlin to discuss how European Earth observation initiatives can contribute to the Global Earth Observations System of Systems (GEOSS). FixO3 was represented at the workshop by the Project Coordinator Richard Lampitt.

Month	Event	Description
June 2016	D2.5	INGV prepared the preliminary version of a useful handbook for project partners with information about sensors and devices tested.
	Handbook of best practices published!	The handbook establishes optimal ways for users to implement fixed stations in open ocean region. It describes all procedures used within the network, such as maintenance, service, sensors calibration, pre and post deployment operations as well as data transfer and data qualification necessary to operate an open sea observatory. The handbook can be freely accessed and downloaded from the project website at http://www.fixo3.eu/
July 2016	D8.4	IMAR delivers three high impact visual outputs related to FixO^{3} and ocean observatories: a poster and an accompanying fact sheet on the achievements at half way, a videography on ocean observatories and their importance available on YouTube and a Wikipedia entry.
	D8.12	NIOZ organised a 2-day course for less experienced users of data products on acquisition, validation, quality control and access to biodiversity data. Read more about the course on the project website http://www.fixo3.eu/
	MS14	Information on the second round of TNA projects published online!
August 2016	End of second project reporting period	The second project period (started on the 1st March 2015) ends this month and reports on activities and finance need to be submitted to the European Commission by October 2016.
	D3.3	Ifremer has developed a FixO^{3} label for ocean observations
	D6.2	INGV ensured inclusion of FixO^{3} time series in ESFRI projects
	D6.4	HCMR ensured recognition by the European Marine Board of the role of FixO^{3} time series in European marine and maritime policy
	D11.2	UiB evaluated capabilities of the actual observational network
	D11.3	ULPGC carried out a cross-over analysis of parameters between platforms
	MS15	Harmonization of standards and data formats for marine observatories reached
	MS22	Harmonization of standards and data formats for marine observatories reached

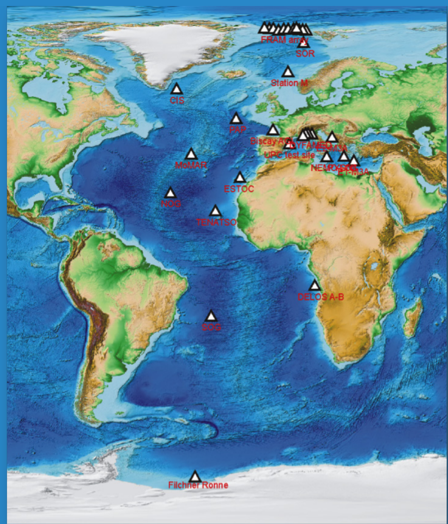
What is FixO^{3}

The Fixed-point Open Ocean Observatories Network (FixO^{3}) is a collaborative project between 29 partners in 11 European countries drawn from academia, research organizations and small and medium enterprises (SMEs) coordinated by the National Oceanography Centre in Southampton, UK.

The project started in September 2013 for four years with a total funding of 7 million Euros from the European Union Seventh Framework Programme (FP7/2007-2013) under grant agreement 312463.

The project aims to:

- integrate the 23 open ocean observatories operated by European organizations spread in the Atlantic ocean from the Arctic to the Antarctic and the Mediterranean Sea
- improve access to these key installations by the broader community
- provide multidisciplinary observations from the air-sea interface to the deep seafloor



Service activities at a glance

Ingo Schewe
Alfred Wegener Institute - Helmholtz Centre
for Polar and Marine Research

One important goal of FixO³ is to provide easy access to fully-processed multidisciplinary data services and products. Within the project this aim is realized by so-called Service Activities (SA) providing scientific knowledge derived from most of the observatories which comprise the FixO³ network. This includes the entire oceanic environment, from seafloor to the air-sea interface (Fig.1). The SAs comprise high quality data products from 12 fixed-point multidisciplinary open ocean observatories included in the FixO³ network. These sustained open ocean observatories cover a broad geographical range from the Polar Regions to the Atlantic and Mediterranean. They demonstrate direct applications, such as maps of ecosystem indicators over European seas, or model validations with respect to in-situ data. In addition, SAs provide highly derived information products such as regional trends in ecosystem function and diversity.

Ocean physics and climate change

Biodiversity and eco-system assessment

Carbon cycle and ocean acidification

Geophysics and geodynamics

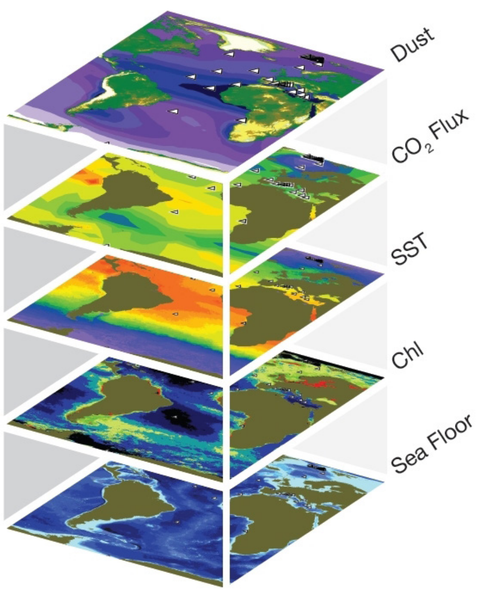


Figure 1: The oceanic environment, from seafloor to the air-sea interface

Some of the delayed mode data and especially the "interventive data" address the temporal variability of ecosystems and their biodiversity. In some cases (e.g. physical datasets) these are uploaded daily for operational users (e.g. through COPERNICUS and the Global Telecommunication System). FixO³ SAs take open ocean data services beyond the current state-of-the-art, offering data products that cover a broad range of science themes with high societal relevance and impact. These include carbon and ocean acidification, climate and ocean physics, biodiversity and ecosystem assessment and geo-hazard monitoring. Many of the products offered by these service activities are also of value for maritime policy. The trans-observatory integrated service builds on the EarthVO data visualisation tool operated by FixO³ partner Blue Lobster IT, which offers various tools to easily display different types of datasets in a standardized format.

The integrated data services offering regional scale visualisation of datasets and products from open ocean observatories have been selected according to their relevance to the Global Earth Observation System of Systems (GEOSS, Fig.2) as well as their compliance with SeaDataNet standards (SeaDataNet is the Pan-European Infrastructure for Ocean & Marine Data Management) and COPERNICUS, the European system for monitoring the Earth. FixO³ SAs build on the current fixed-point open ocean data services and the progress made in previous European projects such as EuroSITES, HYPOX, ESONET and CARBOOCEAN which integrated and enhanced European observatory data streams. As a result of these endeavours, many of the FixO³ observatory sites are utilising standardised data management and quality control procedures and are transmitting data in near real-time.

The FixO³ SA web pages give end users the opportunity to directly access data-sets, derived data and data products from a central access point. They can be selected either by selecting the overall scientific themes defined by GEOSS or via choosing one of the particular FixO³ observatories directly.

http://www.fixo3.eu/service-activities/

Cape Verde Ocean Observatory: Data products from a multi-platform ocean time-series station

Péricles Silva

National Institute for Fisheries Research (INDP)

Long-term observation is fundamental to understanding global climate change. Atmospheric change impacts marine ecosystems, and the atmosphere is influenced by ocean physical and biogeochemical processes. Many impacts and feedbacks within the climate system are centered in the Tropics and although these areas play a key role in air-sea interactions, observational data remains scarce.

The Cape Verde Ocean Observatory (CVOO) is located at 17.6°N 24.3°W and consists of operational atmosphere and ocean monitoring sites for various climate-relevant environmental parameters in the tropical Eastern North Atlantic Ocean. The observatory has three main components: a moored observatory, a research vessel and a marine laboratory.

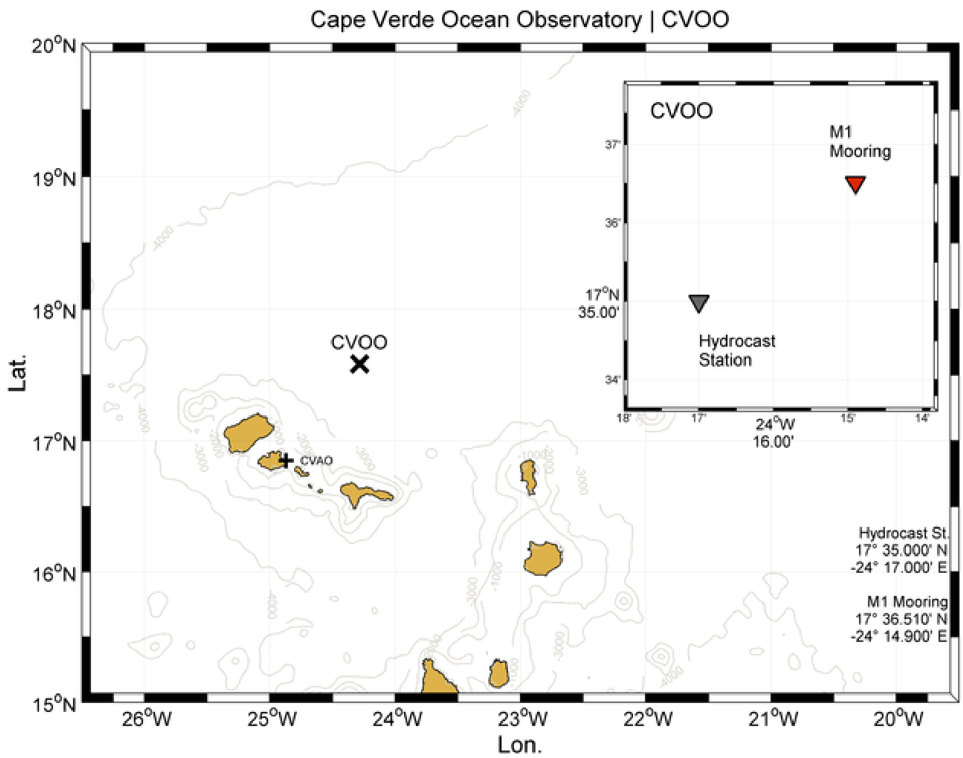


Figure: CVOO Location

The observatory has been collecting data since July 2006 from 3600 m of depth up to surface. It comprises sensors measuring salinity, temperature, pressure, oxygen, pCO2, ADCP, and currents. It includes a sediment trap, and a telemetry buoy for collection of near-surface data of salinity, temperature and oxygen. Since November 2012, the observatory transmits also temperature, salinity and oxygen measurements from the upper 50 meters. Data products from CVOO can be accessed from the FixO³ webpage at: http://www.fixo3.eu/service-activities/cvoo-service-activities/ where a direct link to the observatory data portal is also available.

The research vessel RV Islândia is a small fishing vessel for pelagic and bottom trawls built in 1993 in Iceland and later donated to the Cape Verdean Government. It is now under INDP's operational responsibility. The ship has been converted from a fishing vessel to a multidisciplinary research vessel. It is equipped with a CTD rosette with twelve 5L niskin bottles. CTD sensors collect data for salinity, temperature, chlorophyll, turbidity, dissolved oxygen and light in the water. Water samples provide other parameters such as dissolved inorganic carbon, total organic carbon, total alcalinity, particulate organic carbon (POC), particulate organic nitrogen (PON) and Nutrients. The ship is has stopped operations since July 2014 due to lack of funds.

The marine laboratory is located the at INDP headquarters in Mindelo. It is operational since July 2007, and is composed of a wet and a dry lab. The laboratory is equipped with Milli-Q water, a laminar flow hood, spectrophotometer and fluorometer. It is possible to carry out analyses of dissolved oxygen, nutrients (autoanalizer), and chlorophyll.

The Ocean Science Information System (OSIS) provides meta data for all expeditions such as date, location, collected parameters and a lot more. Registered users may also access the collected data (such as CTD data) as soon as it published. The CVOO recently developed a Niskin data base implemented into OSIS and providing direct access to the calibrated bottle data. With the integrated search function the desired data can be directly accessed (e.g. "all Oxygen measurements from 2010-today north of 10°N").

The next development of the observatory is the Ocean Science Center of Mindelo (OSCM). The OSCM is a multi-purpose facility to support the international science community in conducting marine and atmospheric research in and around Cape Verde and in hosting workshops, conferences, summer school and other meetings. Support includes, provision of laboratory facilities, offices, meeting rooms, workshop and storage spaces, access to the RV Islândia, transportation, as well as logistical services associated with housing, travel, shipment etc. issues.

Higher life at the Arctic deep seafloor: a new data-product to present results of long-term image analyses from a towed camera system

Melanie Bergmann & Ingo Schewe
Alfred Wegener Institute - Helmholtz Centre for Polar and Marine Research(INDP)

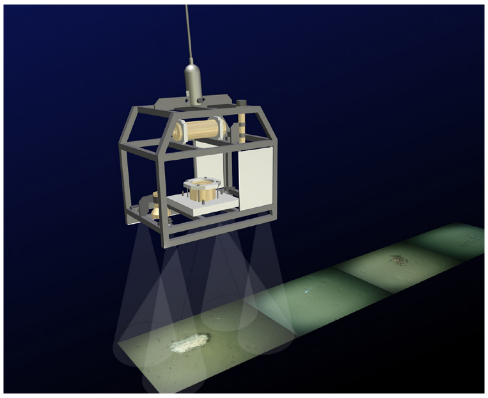


Figure 1: The towed ocean floor observation system (OFOS) on the sea floor

Benthic biota, the organisms living at the bottom of the sea, play an important role in the global carbon cycle through the continuous redistribution of organic matter, oxygen and other nutrients in superficial sediments by breaking down organic matter into its simplest inorganic forms (a process called remineralisation), reworking soils and sediments (bioturbation) and burial of sunken matter. The organisms that inhabit the sediment–water interface at the bottom of the sea and have dimensions larger than 1 cm are called epibenthic megafauna. They contribute considerably to respiration at the sea floor and have a strong effect on the physical and biogeochemical environment at micro scales. These organisms create pits, mounds and traces that enhance habitat heterogeneity and thus diversity of smaller sediment-inhabiting organisms in otherwise apparently homogenous environments. Erect biota, the organisms growing vertically such as sponges or corals, enhance three-dimensional habitat complexity and provide shelter from predation. They may alter the small-scale flow regime on the seafloor affecting the distribution of smaller-sized organisms. Furthermore, megafaunal predators control the population of their prey and therefore shape benthic food webs and community structure. An understanding of megafaunal dynamics is therefore vital to understand of the fate of carbon at the deep seafloor, the Earth's greatest carbon reservoir.

Recent technological progress has driven the development of camera-based monitoring methods from various platforms (towed systems, remotely operated vehicles, autonomous underwater vehicles, and stationary platforms such as benthic landers) which have increasingly been used to characterise epibenthic communities and habitats on the seafloor. Such methods are less invasive than trawls and enable large-scale distribution assessments allowing the description of larger habitats. Recently, such tools have also been used to quantify pollution on the deep seafloor.

Inevitably, such methods generate 'big data', often inaccessible to researchers from other institutes or to the general public and can therefore not be used to their full potential. As part of FixO³ Service Activity 1.2 'Fram Strait, Arctic: time series on megafauna density and diversity' we developed a tool to access photographs from the HAUSGARTEN observatory along with geographic information and scientific data products. The seafloor of selected stations of the HAUSGARTEN observatory is surveyed regularly by the towed Ocean Floor Observation System (OFOS; Fig. 1). The vertically facing camera system is used to assess large-scale distribution patterns of megafaunal organisms and other objects on the deep seafloor (e.g. dropstones, garbage). The system is lowered to approximately 1.5 m above the sea floor using a fibre optical cable for data, video and energy transfer, and then towed along a set transect at a speed of 0.5 knots.

Images and data of these observations are stored in the scientific database PANGAEA. However, relevant information might be difficult to retrieve in such data repository, especially by the general public. A new GIS-based web-viewer (Fig. 2) was developed to facilitate access to the collected images and data. The tool also shows the locations on a map where the images were taken and provides data for organism abundances, which are based on scientific image analysis. This product gives the users the extremely rare opportunity to get an idea of how benthic communities inhabiting the deep Arctic seafloor look like and evolved during the years of investigation. The data can also be used to calculate benthic biomass (the total quantity of organic matter on an area of the sea floor) as a baseline to assess the impact of global warming and anthropogenic threats to the Arctic ecosystem such as fishing, litter pollution, cruise tourism and shipping.

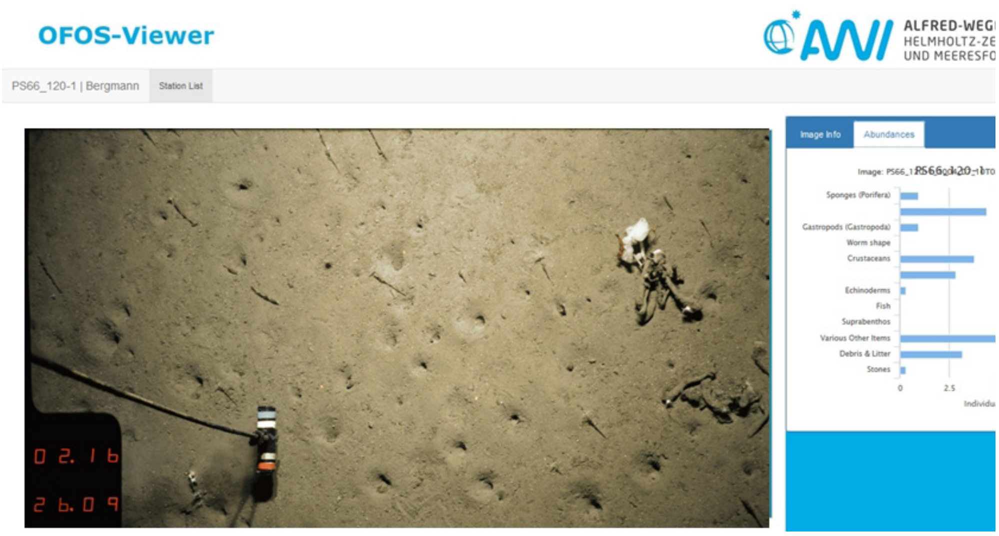


Figure 2: Screenshot of the AWI OFOS-Viewer; seafloor picture with associated data from image-analyses

Looking Forward

Main activities, events and deadlines planned for the last project's year: September 2016 – August 2017

Month	Event	Description
September 2016	Challenger Conference 2016 (5-8 , Liverpool, UK)	The 2016 Challenger Conference promises to provide a fantastic showcase of marine science and technology, covering all areas of ocean research. $FixO^3$ poster will be presented by the project coordination team.
	41st CIESM Congress (12-16, Kiel, Germany)	The 41st meeting of the Mediterranean Science Commission integrates a broad spectrum of marine disciplines, encompassing geo-physical, chemical and biological processes, along with high-resolution mapping of the sea-bottom at the scale of the whole Basin. $FixO^3$ will be presented by Steering Committee member Vanessa Cardin (OGS).
	$FixO^3$ General Assembly 2016 (18-21 Gran Canaria, Spain)	The $FixO^3$ General Assembly 2016 will be hosted by $FixO^3$ partner PLOCAN in Gran Canaria, Spain, and take place from the 18th to 21st September 2016. The aim of the General Assembly is to update on project activities and discuss any issues that have arisen during the previous year and to plan the work for the last project year. The meeting will include specific sessions on the Work Packages, Steering Committee and Advisory Board meetings, as well as offer networking opportunities (i.e., a snorkelling/scuba diving tour and a networking dinner).
	ICOS Science Conference 2016 (27-29, Helsinki, Finland)	This year's conference will address some of the key topics in the greenhouse gases and biogeochemical cycles research and is open to all scientists interested in research on greenhouse gases, biogeochemical cycles and climate change.
	Newsletter 3	The year 3 project newsletter focuses on data products and service activities from $FixO^3$ observatories. The newsletter (project deliverable 8.7) can be accessed from the project website fixo3.eu.
October 2016	Second project report due	Reports (activities and finance) on the project period 1 March 2015 to 31 August 2016 are due from each partner.
	A Connected Ocean International Conference (11-13, Brest, France)	The challenge for future ocean knowledge and data integration sets the stage for this conference which will include sessions on new autonomous approaches to the measurement of biogeochemical rates; interoperability standards for the marine environment; multimodal synergies in ocean studies; big data infrastructure and analytics in ocean science; and integrated observations of upwelling systems.
	7th International Workshop on Marine Technology (27-28, Barcelona, Spain)	The main objective of the MARTECH Workshop is to show latest investigations and exchange of information and points of view on current research in MARine TECHnology.
November 2016	Time series analysis in environmental science and applications to climate change (8-11, Tromsø , Norway)	Times-series analysis is the future for environmental sciences to understand natural processes and their dynamics. To support these technical developments, the "Time series analysis in environmental science and applications to climate change" conference aims to promote transfer of knowledge between researchers from various environmental fields. This will be achieved by both training courses (8-9/11) and conference (10-11/11) presentations based on application examples and actual case studies from field experiments.
December 2016	M17	Training Achieved! All course materials from three $FixO^3$ training workshops available on the project website (Lead: BLIT)
	D2.9	Final update of the Open Ocean Observatories Yellow Pages Website (Lead: IMAR)
	D2.10	Technical Guidelines of standards of acceptability for common sensor interoperability protocols (Lead: PLOCAN)
	D4.2	$FixO^3$ Standardisation workshops and status report (Lead: INGV)
	D4.8	Final report on Service Activities (Lead: AWI)
	D12.7	Prototype of non-cabled platform tested during a cruise. Proposed methodology of fast deployment (Lead: Ifremer)
	Christmas closure (17 December to 2 January)	The project management office will close over Christmas 2016 and New Year's Day 2017)
January 2017	14th SC meeting	The project Steering Committee will meet via videoconference to discuss the project status and the work planned for the next months
February 2017	D6.5	$FixO^3$ time series referred in regional and global conventions and assessments (Lead: UiB)
	D12.3	Long term deployment (Lead: UGOT)
March 2017	9th AB meeting	The project's Advisory Board will meet via videoconference to discuss the project's status and recommendations to increase impact of outcomes.
	D4.3	Agreement to establish $FixO^3$ data Dissemination to marine infrastructures (Lead: NERC)

Month	Event	Description
April 2017	EGU General Assembly (17-22, Vienna)	FixO³ will convene a session on advances at fixed ocean observatories at the European largest conference on geosciences. The session will provide the opportunity to discuss latest scientific and technological results.
	D2.6	Updated version of the "Handbook" on relevant info about sensors and devices tested (Lead: INGV)
	D5.7	Description of innovative products and services (Lead: MI)
May 2017	15th SC meeting	The project Steering Committee will meet via videoconference to discuss the project status and the work planned for the next months
June 2017	D12.6	Conclusions on the operational prototype, the long term experiments and recommendations on the large network of passive acoustic observatories (Lead: UPC)
	M18	Presentation of FixO³ label, common protocols and standards and best practices for ocean observatory
July 2017		
August 2017	D1.10	Report on gender balance across the Consortium (Lead: NERC)
	D1.11	Report on the distribution of financial support by beneficiary (Lead: NERC)
	D7.11	TNA access, recommendations and guidelines (Lead: PLOCAN)
	D8.8	Final project newsletter (Lead: NERC)
	D11.4	Publication of optimum observational network (Lead: UNEXE)
	M23	Evaluation of the observational network complete
	End of 3rd project period	The third project period (started on the 1st September 2016) ends this month and reports on activities and finance need to be submitted to the European Commission by October 2017.
September 2017	Final Consortium meeting (4-8, Southampton) incl. last AB and SC meetings	The third and final Consortium Meeting will be hosted by the Project Coordinator and include a Science & Technology Day showcasing the projects implemented through the TNA action
October 2017	Third project report due	Reports (activities and finance) on the project period 1 September 2016 to 31 August 2017 are due from each partner.

Acquisition, validation, quality control and access to (biodiversity) data: a FixO3 training course for less experienced users of data products.

Herman Hummel
NIOZ Royal Netherlands Institute for Sea Research

Participants and lecturers to the FixO3 training workshop at Vlissingen, the Netherlands, 14-15 June 2016. (photograph by J. van Houte)

A fully-funded training course on data products was held on 14 and 15 June 2016 in Vlissingen, the Netherlands organized by Herman Hummel and Joke van Houte of the Netherlands Institute for Sea Research (NIOZ), with help from Sarah Faulwetter (HCMR), Nicolas Bailly (HCMR, Fishbase), Matt Frost (MBA), Pieter Provoost (OBIS, IODE), and Sander Wijnhoven (NIOZ, EcoAuthor).

The course was designed to introduce less experienced users to methods and techniques for processing biodiversity data, integrating physico-chemical and biodiversity data, and delivering data products that may be required to meet policy needs such as GES descriptors.

The course instructors were all experts in the field of data management and marine observation of biodiversity and they trained nineteen international participants through a series of lectures on theory, practical examples, and hands-on sessions. The participants had been selected out of seventy applicants from twenty-nine countries all over the world.

The theoretical and practical classes included introductions to scientific concepts and theoretical models; examples on the practical use of biodiversity and environmental data in the frame of European research projects and global programmes; an overview of data repositories and current statistical packages; hands-on sessions on data treatment and analyses, using the (previously explained) repositories and packages; and finally an overview of the use of biodiversity data in policy and legislation.

The participants valued the training course unanimously as well organized and very useful, and rated it with a very good to excellent score. The quality of the lectures and the venue were judged excellent. The friendly atmosphere during the course encouraged interactions among the participants and with the trainers. Several participants stated they wished the course lasted longer.

The participants will use the acquired knowledge to improve their work and research as they now have the tools to handle complex oceanographic datasets on biodiversity and environmental factors, and are now better able to test hypotheses in their projects and to solve practical problems with mathematical and statistical programs.

Altogether, the organizers, lecturers as well as the participants to the FixO[3] training workshop in Vlissingen enjoyed an eminent, pleasant and instructive event.

The beach of Vlissingen under a raincloud (© V. Macovei 2016)

Carbon cycle and ocean acidification in the northern North Atlantic

Ingunn Skjelvan
Uni Research and University of Bergen

Station M is one of the $FixO^3$ observatories providing data related to the marine carbon cycle and ocean acidification. The site is located in the northern North Atlantic at 66ºN 2ºE, approximately 200 nautical miles from the Norwegian coast, and its history dates back to the late 1940's when there was a need for improved weather forecasts due to the increased air traffic between Europe and North America. More than a dozen weather ships were established in the north Atlantic and one of these was situated at Station M, from where oceanographic and meteorological data was monitored since 1948. Hydrographic data from the deep water at Station M is among the longest time series in the world, and based on these data it was discovered that in the mid 80ties the Norwegian Sea deep water started warming from a relative stable low temperature.

In 2011 autonomous instrumentation replaced the weather ship at Station M and since then partial pressure of carbon dioxide (pCO_2) and pH have been measured continuously in the surface water as well as in the mixed layer. A variety of data, such as air temperature, dissolved oxygen, and CO_2 in sea surface and atmosphere, is publicly available in real time at http://talos.nodc.no:8080/stasjonm/index.html?lang=en. This data is used to study ocean acidification and its temporal variability. The term ocean acidification describes the ongoing decrease in pH of seawater and depletion of carbonate concentration of the Earth's oceans, caused by uptake of CO_2 from the atmosphere. The acidification affects the ecosystems in the oceans, but to what degree and in which form is not yet fully understood. Thus it is important to monitor trends both on annual and seasonal scale to keep track of the acidification process. Ocean acidification is detected by monitoring the inorganic carbon system in sea water. pCO_2 and pH measurements from Station M are used to calculate the saturation state for carbonate in its two crystal forms calcite and aragonite (Ω_{Ca} and Ω_{Ar}).These two parameters indicate how "corrosive" the sea water is for carbonate, either in form of planktonic skeleton or solid carbonate deposits on the sea floor. Saturation state of carbonate, Ω, larger than 1, indicates that the water is over saturated with respect to carbonate, while Ω less than 1 indicates under saturation of carbonate. When Ω is well above 1 there is sufficient amount of carbonate for the organisms to form shells and skeletons, but when Ω is approaching 1 the environment is getting harsh and it is difficult for organisms to maintain sound and solid shells.

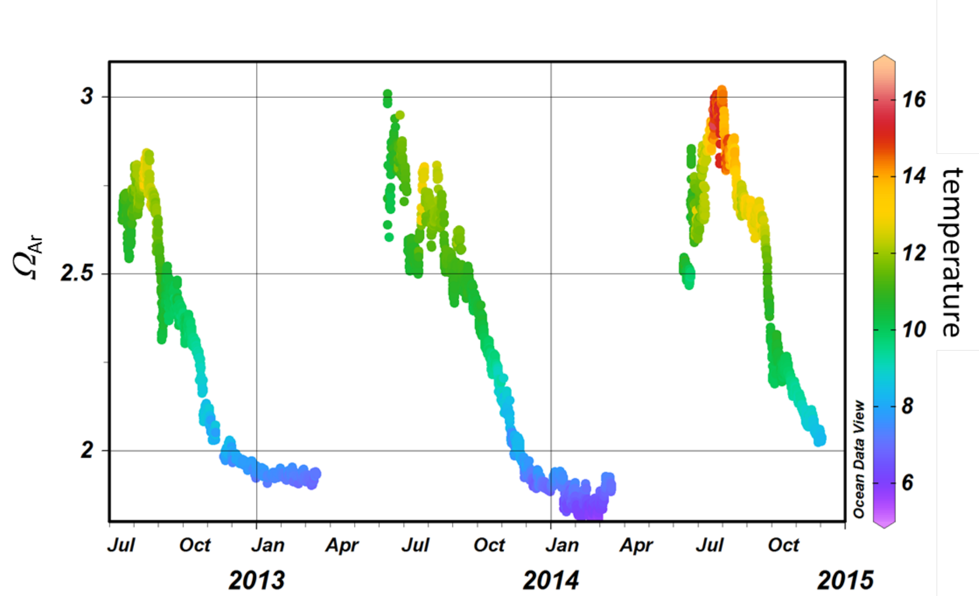


Figure: Station M - temporal variability of aragonite saturation state (Ω_{Ar}), which changes with temperature and biological production.

The figure shows the temporal variability of aragonite saturation state (Ω_{Ar}), which changes with temperature and biological production. In summer, the Ω_{Ar} values are at a maximum (between 2.85 and 3.05), when surface water is at the warmest and primary production is reasonable large. This means that the abundancy of aragonite at the site is large during summer season and organisms build shells and skeletons as usual. In fall the temperature decreases, the mixed layer deepens, and Ω_{Ar} decreases towards winter concentrations. During wintertime, when the surface temperature is at a minimum, the Ω_{Ar} in surface water is also at its minimum of approximately 1.8, meaning that there is still sufficient amount of aragonite for organisms dependent on this substitute to survive, but the amount has decreased a lot since summertime. The current time series is too short to determine interannual trends; however, other studies in the northern North Atlantic have shown that the surface value of Ω_{Ar} is decreasing over years. Therefore it is of vital importance to continue the observations of the carbon cycle to determine the changes in the ocean acidification in the future. From other studies it is known that the transition zone between over saturated and under saturated water with respect to aragonite is found at depths between 1800 and 2000 m in the eastern part of northern North Atlantic. It is expected that this zone will shoal in the future, which will have implications for the carbonate dependent organisms living in that area.

EMSO-Azores : Monitoring seafloor and water column processes at the Mid-Atlantic Ridge

Mathilde Cannat[1], Pierre Marie Sarradin[2], Jérome Blandin[2], Valérie Ballu[3], Thibaut Barreyre[1 2] Valérie Chavagnac[4], Ana Colaço[5], Wayne Crawford[1], Romuald Daniel[1], Javier Escartin[1], Julien Legrand[2], Marjolaine Matabos[2], Céline Rommevaux[1], Guillaume Roullet[6], Gilles Reverdin[7], Jozée Sarrazin[2]

1 CNRS - Institut de Physique du Globe de Paris; 2 Ifremer Brest; 3 CNRS-Laboratoire LiENS, La Rochelle; 4 CNRS- Géosciences Environnement, Toulouse; 5- University of the Azores, Horta; 6 IUEM Brest; 7 CNRS-LODYC, Paris

EMSO-Azores is a fixed-point buoyed observatory with a multidisciplinary approach (from geophysics and physical oceanography to ecology and microbiology) that acquires time-series data at and around active hydrothermal vents at the Mid-Atlantic Ridge south of the Azores Islands. Fluid fluxes that feed these vents are controlled both by km-scale hydrothermal systems powered by magmatic heat, and by smaller-scale near-surface fluid circulations and mixing between seawater and hydrothermal fluids. Currents in the water column near the seafloor also affect these fluxes. The primary aim of the observatory is to provide data for research on the impact of changes in hydrothermal fluid fluxes, fluid chemistry, and water column processes on the microbial and faunal compartments of deep sea vents, at a range of spatial (km to microbial habitats) and temporal (seconds to several years) scales.

The current observatory setup (Figure 1) has been operated since 2010. It is composed of two seafloor nodes with connected instruments for sea monitoring (SeaMon), and of a transmission buoy that communicates acoustically with the seafloor stations and relays data (detection of seismic events, pressure at seafloor, video snapshots of hydrothermal fauna, turbidity, fluid temperature and chemistry, system status) via satellite every six hours to the EMSO data center hosted at Ifremer in Brest, France.

The FixO³ project supported the observatory by making data available online in the form of two Service Activities: SA 14-1: MoMAR biology, and SA 14-2: MoMAR-geophysics. These SAs are described in the FixO³ webpages (http://www.fixo3.eu/observatory/momar/). Data is available online in the EMSO-Azores site: http://www.emso-fr.org/EMSO-Azores (provisional address).

Ecological monitoring focuses on the Tour Eiffel vents (Figure 1), a ca. 15 m-high and up to 40 m-wide sulphide mound. Two sensor packages are currently connected there: a module with HD video camera (transmitting several snapshots), optode, dissolved iron analyser and turbidimeter, and a colonizer and low-temperature fluid sampler for microbiology (CISICS; Figure 1).

The geophysical component of the observatory is composed of a seismometer and two pressure gauges, installed within 200 m of the vents (Figure 1). It transmits a catalogue of detected seismic events, including information on their apparent local magnitude, as well as pressure and temperature data. HD video and seismometer data are stored locally and collected during the yearly maintenance cruises.

The observatory also comprises arrays of autonomous devices: ocean bottom seismometers, pressure probes, temperature probes set in venting chimneys, colonisation devices for both fauna and microfauna, and an oceanographic mooring (temperature, salinity, pressure and currents from seafloor to a depth of 900m). This is complemented by sampling of macro- and micro-organisms, rocks and fluids and by the acquisition of short time series on diffuse fluid properties, and CTD measurements in the water column during the yearly cruises devoted to maintenance of the observatory.

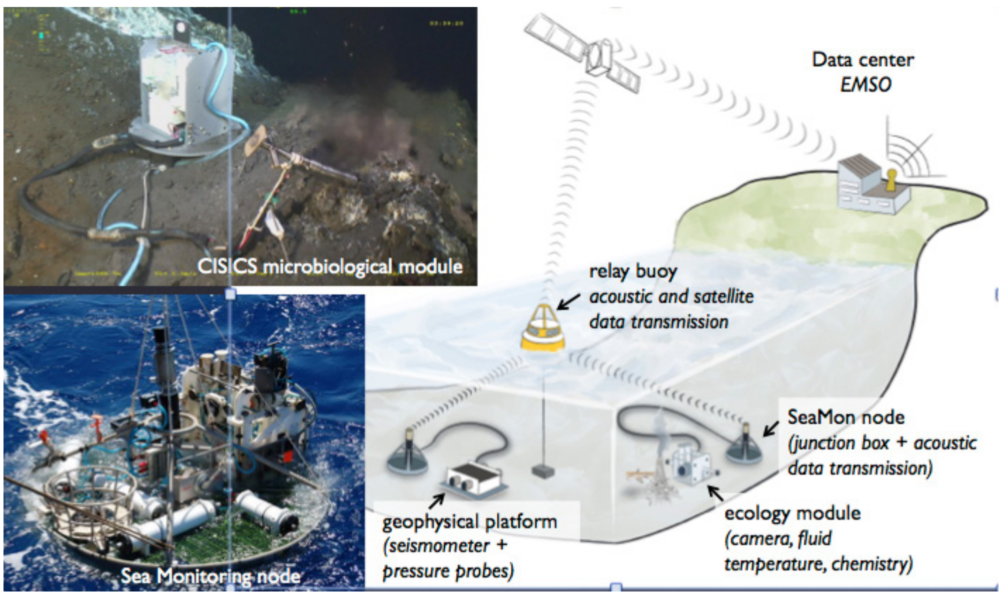
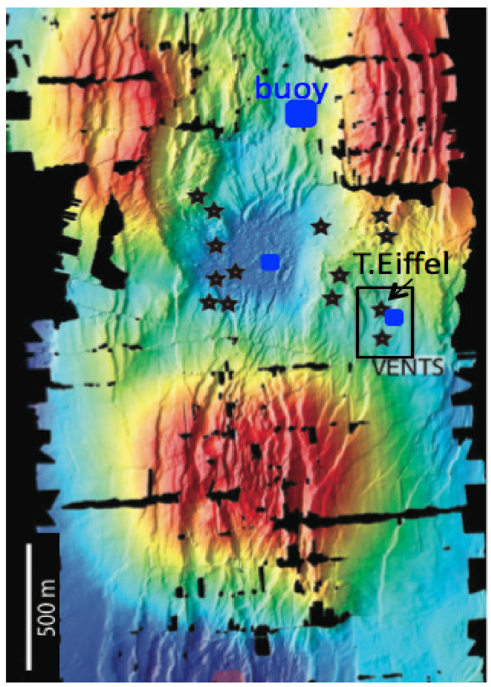


Figure 1: Current EMSO-Azores observatory setup. This setup is nested in a wider array of autonomous instruments (see text).



(Right): detailed bathymetric map of the volcano summit with the different hydrothermal vent sites (stars), the location of the Tour Eiffel edifice, of the 2 SeaMon nodes and of the relay buoy (blue squares). Seafloor depth are between -1550m (red) and -1770m (dark blue).

Opinion

Kate Moran

President and Chief Executive Officer, Ocean Networks Canada

Bio-sketch

Dr. Kathryn (Kate) Moran joined the University of Victoria in September 2011 as a Professor in the Faculty of Earth and Ocean Sciences and as Director of NEPTUNE Canada. In July 2012 she was promoted to the position of President & CEO, Ocean Networks Canada. From 2009 to 2011 Moran was seconded to the White House Office of Science and Technology Policy where she served as an Assistant Director and focused on Arctic, polar, ocean, the Deepwater Horizon oil spill, and climate policy issues.

Moran co-led the Integrated Ocean Drilling Program's Arctic Coring Expedition, which was the first deepwater drilling operation in the Arctic Ocean. This expedition successfully recovered the first paleoclimate record from the Arctic Ocean. She also led one of the first offshore expeditions to investigate the seafloor following the devastating 2004 Indian Ocean earthquake and tsunami.

Previously, Moran was a scientist at Canada's Bedford Institute of Oceanography where one of her major research focus areas was the Arctic Ocean. She also served as the Director of the international Ocean Drilling Program in Washington DC; managed mission-specific drilling platform operations in the North Atlantic and Arctic; designed and developed oceanographic tools; participated in more than 35 offshore expeditions; and has served as Chair and member of national and international science and engineering advisory committees and panels.

1. What are in your opinion the main benefits of developing data products from ocean observatories (such as ONC's State of the Ocean plots) and sharing them with the public?

It is important for all ocean observatories to invest in the development of data products that benefit a wide range of stakeholders for broader benefit. The reason for this imperative is because most observatories are funded with pubic money, hence multiple uses of these data should be part of normal operations. As an example, Ocean Networks Canada is developing a series of Smart Ocean Systems™ products that are produced by combining several types of observing data with models and/or algorithms. These products will provide benefits to the public by contributing to marine safety (e.g. realtime sea state alerts), environmental monitoring (e.g. ocean health reports in areas where there are multiple human stresses at the coast), and public safety (e.g. earthquake early warning). One could also consider educational products as part of these efforts by producing data sets that are readily used by teachers in classrooms and producing ebooks (e.g., see the Marine Life Guide at the iTunes store.

2. How can international collaboration between different initiatives such as FixO³ and ONC be instrumental towards data products development and sharing?

The approach for developing data products does not typically change when crossing borders, but the manner in which the product is delivered may need to be tailored to the ways in which different countries' various stakeholders would use the product. For example, in some countries, it might be best to tailor the delivery of products solely over a cell phone platform.

That said, the approaches and methodologies for producing these products represent most of the work and these can be readily shared. Of course the foundation of all of these products is high quality data from sensors that undergo regular calibration and are associated with robust metadata.

3. How do you see ocean data products evolving in the next 10 years?

That's a great question. The data products I mentioned above are just the start. One can imagine, as climate change continues to throw surprises at us in terms of extreme events, data products that provide short-term forecasts and even alerts of impact events along many coasts will become critically important. Our tsunami data product will evolve to be tailored to local, densely coastal areas for storm surge alerts. Also, the marine shipping industry (which delivers over 90% of the world's goods that are traded) will see continued pressure in two areas: upgrading their systems to be more like the airline industry with realtime ocean conditions delivered 24/7 for improved safety; and using ocean current, combined with weather data to plan and modify their routes in realtime to reduce fossil fuel emissions. In terms of education, Ocean Networks Canada is working to connect schools to the coastal ocean. As a start, we've installed community observatories in remote locations along Canada's coast and are working with schools in these communities to connect with each other so that, e.g., students in the Arctic can share (in realtime) their changing ocean environment with students in a fiord or inland sea in northern British Columbia. Our vision is to see these classrooms begin to share these experiences with landlocked classrooms so that kids who have never experienced the sea can connect with the ocean through their peers.

New & updated resources to check out

FixO³ Network website - Updated

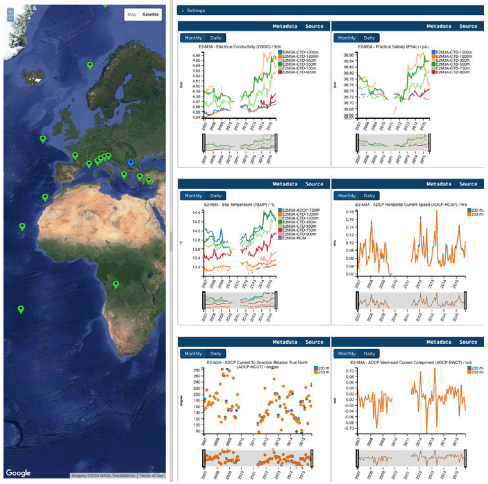
Everything you need to know about the project, the observatories, and the partners involved.

http://www.fixo3.eu

Earth Virtual Observatory (EarthVO) - Updated

Graphical visualization of all available data from FixO³ observatories.
Free to access!

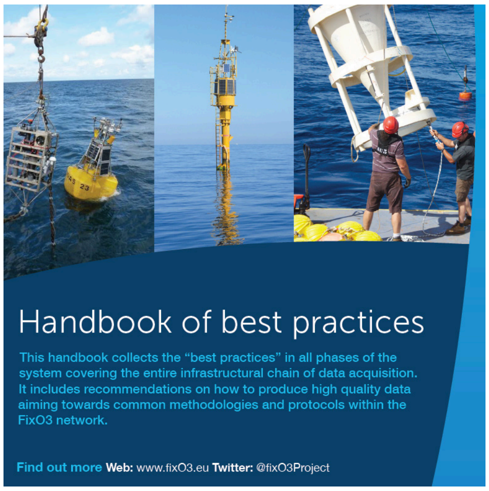
http://earthvo.fixo3.eu/



Handbook of best practices - New

This handbook describes best practices currently implemented to carry out operations at fixed-point observatories.
Free to download!

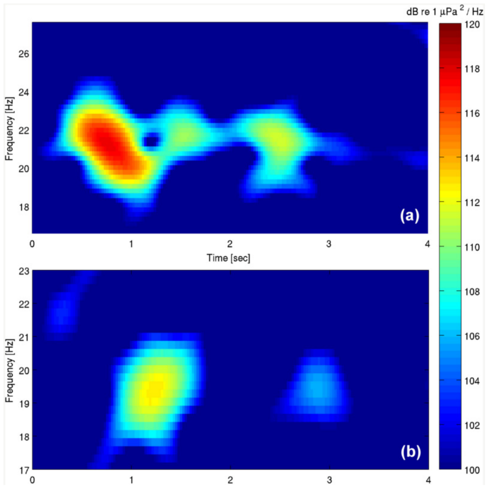
http://www.fixo3.eu/2016/07/07/best-practices-for-operations-at-fixed-point-observatories/



FixO³ Service Activities - New

All data products from FixO³ observatories divided by topic.
Free to access!

http://www.fixo3.eu/service-activities/



ESONET Yellow Pages - Updated

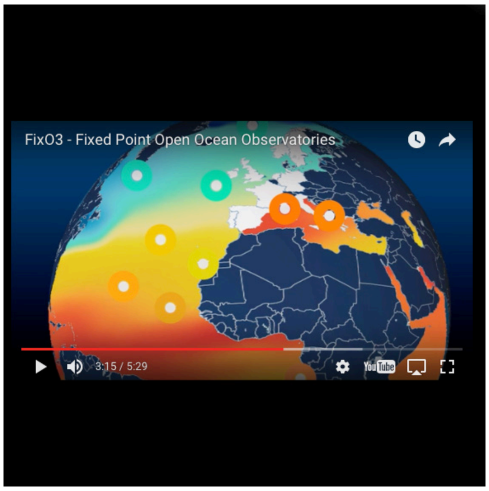
Tool for Interoperability and Standardization contains information concerning on-the-shelf products for the development and maintenance of deep sea observatories provided by the private sector.

http://www.esonetyellowpages.com/

YouTube video on ocean observatories and their applications - New

A 5-min video explaining what are ocean observatories and why they are important.

https://www.youtube.com/watch?v=EQF-Wz3clW1s



Wikipedia article on ocean observatories - New - Collaborators wanted!

A general introduction on ocean observatories, their components and uses. Open to the public to edit.

Can you contribute to this important knowledge resource?

https://en.wikipedia.org/wiki/Fixed-point_ocean_observatory

FixO^3, a European tool to improve ocean observation capabilities, outputs and impact.

FixO^3 will provide access to open ocean observatories, data products and knowledge to feed science, inform policy and stimulate industry.

Mid-way of a four year project, more than half of the planned deliverables have been achieved.

FixO^3 FIXED-POINT OPEN OCEAN OBSERVATORIES

Data Harmonisation

To harmonise data management standards and improve access to observatory data.

Key Achievements
- Data policy common to all FixO^3 observatories
- Standards & service registry accessible from the project webpage
- Searchable metadata catalogue

Technological Harmonisation

To harmonise observatory technology and processes in place.

Key Achievements
- Review of current operational status of network observatories
- Handbook on best practices for observatory maintenance, calibration, service and data transfer

Industry

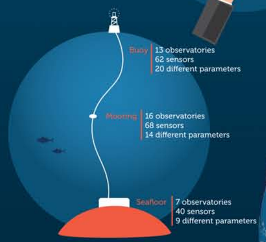
To promote & strengthen interaction between the observatory research community and the commercial sector.

Key Achievements
- Establishment of technology clusters to stimulate innovation & identification
- Development of an Intellectual Property Rights (IPR) agreement
- Identification of commercial sectors needs/ requirements over the next 5-10 years

Optimisation of Observing Capability

To research a specification for an optimum observational network of FixO^3 platforms, integrated and complemented by other platforms.

Key Achievements
- Evaluation of optimum integrated Virtual Observing Networks
- Inter-comparison studies addressing the different measuring and analytical techniques



Policy

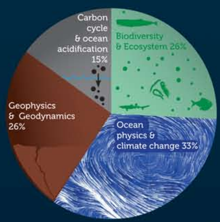
To ensure long-term support to fixed-point observatories.

Key Achievements
- Cost-benefit analysis estimating the costs of observatories and highlighting features of Eulerian observatories
- Links strengthened with European entities and programs (EuroGOOS, European Marine Board, ESFRI and European Commission)

Service Activities

To provide access to data products and knowledge from 18 observatories.

Key Achievements
- Access to 10 SAs on the four main disciplines addressed by the observatories



International Networking

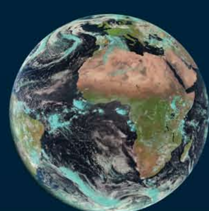
To enhance international and European collaboration.

Key Achievements
- Consolidation of links between European and non-European counterparts of FixO^3
- Synchronisation and harmonisation of label definitions, such as ESONET-EMSO label

Outreach & Training

To engage, inform and train public, scientific and policy users.

Key achievements
- High quality data visualisation tool for data from observatories (EarthVO)
- High-impact visual outputs for distribution to the public
- Two oversubscribed training workshops for early career scientists



Transnational Access to Infrastructures

To support external users by providing coordinated, free-of-charge, access to fixed open-ocean observatories.

Key Achievements
- Two calls for TNA launched with 24 applications from research institutions and private companies to access a total of 13 out of 15 observatories

Research & development

To enhance the observatory capability for high quality observations and to develop a new platform design.

Key achievements
- Laboratory and at sea testing of technology of the standalone platform
- Intercomparison of pCO_2 sensors to evaluate performance
- Evaluation of pH sensors

What's next?

- Complete status of European fixed observing sites
- Second TNA call information dissemination, as well as training courses and workshops information
- Updated library of instruments, techniques and guidelines
- Development of innovative products
- Recommendations for optimisation of ocean observing capacity

Earth seen by Meteosat © Eumetsat Courtesy of ESA

Integration | Harmonisation | Innovation

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www.fixo3.eu

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