# FixO$^3$ - Milestone MS8: First round of TNA projects information disseminated online

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| **Project** | 312463 – Fixed Point Open Ocean Observatories Network |
| **Work Package number** | WP7 |
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| **Milestone number** | MS8 |
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## Summary

This report provides the information to be disseminated online about the projects evaluated favourably and to be funded under the First TNA call. A description of each accepted project after granted permit from authors is provided in Annex A. This document also includes some statistics on gender, composition and country of the teams involved in the proposals.

# I First TNA Call

The first FixO$^3$ call for TNA opened on the 15$^{th}$ of June and closed on the 31$^{st}$ of July 2014. Details about the call definition and selection criteria are described on this portal under TNA menu.

A total of 15 infrastructures included in FixO$^3$ participated, of which:

- Fourteen ocean surface, water column and seafloor observatory installations and systems
- One shallow water test site (OBSEA) able to make practical and fast tests of instruments, systems, procedures and new technologies applicable to fixed open-ocean observatories

A TNA office e-mail address managed by PLOCAN (fixo3.tna@plocan.eu) attended the different enquiries and provided an electronic tracer from which all the steps related to the call procedure could be executed. The text box below includes the call timeline as stated in the different documents.

Opening of the call: **15th of June 2014**
Signed submission forms shall be sent in PDF to **fixo3.tna@plocan.eu**
Submission deadline for the first call : **31st of July 2014 17h00 GMT**
Evaluation and selection phase : from call opening **date to 31st of October**
Feedback to applicants : **15th of November 2014**
Project implementation planned **to start in 2015**

From the fifteen infrastructures offered for free access, nine received proposals indicating a success rate of 60% of the infrastructures. A total of fifteen proposals where received, 6 of the observatories received only one proposal, whereas 3 of the infrastructures received 2, 3 and 4 applications respectively (Figure 1).

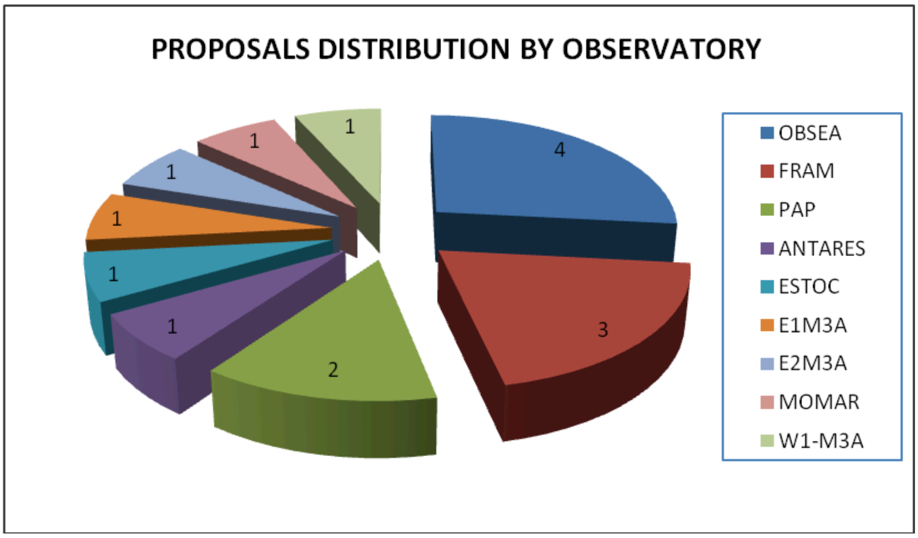


**Figure 1. Distribution of the fifteen proposals by infrastructures.**

The list of projects that finally passed the evaluation is included in the table below, indicating the reference according to the order of arrival, the infrastructure and its main operator, the applicant as main investigator, the title of the proposal and the acronym if one was provided. A more detailed description is included in Annex A.

**Table 1. List of projects including the proposal, applicant and infrastructure involved.**

| | Infrastructure Operator | Applicant | Proposal title- Acronym |
|---|---|---|---|
| ANTARES | French Marine Research Institute (IFREMER) and National Scientific Research Centre (CNRS), France | Per Hall University of Gothenburg, Sweden | Fixed-point Open Ocean Observatories ($pCO_2$ and pH) -FIXO3 |
| E1-M3A | Hellenic Centre for Marine Research (HCMR), Greece | Spyridon Volonakis ALS MARINE CONSULTANTS, Cyprus | Ageing of composites in Deep water environment – AGE-CO-DEEP |
| E2-M3A | Istituto Nazionale di Oceanografia e di Geofisica Sperimentale (OGS), Italy | Anders Tengberg, Aandera Data Instruments, Norway | Combined testing of new acoustic profilers with Biochemical optodes in the Adriatic sea - COMBO |
| ESTOC | Oceanic Platform of the Canary Islands (PLOCAN), Spain | Oliver Zielinski University of Oldenburg- ICBM, Germany | UV Photometer operation and improvement in the top pelagic layer of an oligotrophic station |
| FRAM | Alfred Wegener Institute Helmholtz Centre for Polar and Marine Research Bremerhaven, Germany | Henry Ruhl National Oceanographic Centre, United Kingdom | Benthic ecology and biogeochemistry using bathysnap and sediment oxygen profiling in the Arctic - ArcEcoBio |
| FRAM | Alfred Wegener Institute Helmholtz Centre for Polar and Marine Research Bremerhaven, Germany | Sinhue Torres Valdes National Oceanographic Centre, United Kingdom | Dynamics of nutrients using autonomous instruments in FRAM strait - DYNAMITE |
| FRAM | Alfred Wegener Institute Helmholtz Centre for Polar and Marine Research Bremerhaven, Germany | Bénédicte Ferré Centre for Arctic Gas Hydrate, Environment and Climate-CAGE, Norway | Ocean chemistry and acoustics in the gas hydrate-charged FRAM strait - GASFRAM |
| MOMAR | French Marine Research Institute (IFREMER), France | Heinrich W. Villinger, University of Bremen, Germany | MOMAR-Tilt |
| OBSEA | Universtitat Politècnica de Catalunya (UPC), SARTI Research Group, Barcelona, Spain | Emanuela Fanelli, ENEA, Italy | Analysis of FISH community structure and trophic relationship by AUTomated video imaging at a coastal cabled observatory - FISHAUT |
| OBSEA | Universtitat Politècnica de Catalunya (UC), SARTI Research Group, Barcelona, Spain | Pasquale Daponte, Laboratory of Digital Signal Processing and Measurement Information, University of Sannio. Piazza Guerrazzi, 1, 82100 Benevento, Italy | Electrochemical corrosion measurements in deep seas -ELCOMEDES |
| OBSEA | Universtitat Politècnica de Catalunya (UPC), SARTI Research Group, Barcelona, Spain | Pierre-Jean Bouvet, ISEN-Brest, France | Underwater acoustic modem with time Synchronization Capability test at obsea platform - UAMSync |
| OBSEA | Universtitat Politècnica de Catalunya (UPC), SARTI Research Group, Barcelona, Spain | Rogério Chumbinho SmartBay, Ireland | SmartBay sensor testing and validation at OBSEA - SmartSEA |
| PAP | Natural Environmental Research Council (NERC) - National Oceanography Centre (NOC), Southampton, United Kingdom | Morten Hvitfeldt Iversen, Alfred Wegener Institute, Germany | Seasonal food web interactions with the biological pump at the PAP site - SEAPAP |
| PAP | Natural Environmental Research Council (NERC) - National Oceanography Centre (NOC), Southampton, United Kingdom | Frank Wenzhoefer, Alfred Wegener Institute, Germany | Benthic organic matter cycling dynamics at PAP – PAP-Dynamic |
| W1-M3A | National Research Council of Italy, Italy | Christos Tsabaris Hellenic Centre for Marine Research- HCMR, Greece | Underwater sound and radom measurements of rainfall and wind at sea |

## II Next Steps towards implementation

Next steps for implementation are: to sign an agreement between the Infrastructure Operator and the End User involved for each proposal before receiving funding; then to organize, manage and implement the TNA project.

After the proposal has been executed, a report will be produced and the data will be provided in agreement with the $FixO^3$ policy, except if a moratorium has been requested and justified in the submission form.
From $FixO^3$ we believe this first TNA call has been a success and we acknowledge the fantastic work executed by the Panel of Experts, as well as their availability to participate to the consensus meetings when needed.
All developments have been carried out in strict compliance with Annex III of the Grant Agreement.

## III Statistics

In this part we include some statistics related to the persons who participated to the First FixO3 TNA Call. Note worthily, out of 15 proposals, only two had a woman as principal investigator. Concerning teams, the situation is similar and only 8 women are part of the teams from a total of 41 people (Figure 2). This seems to emphasize the small number of women involved in ocean science.

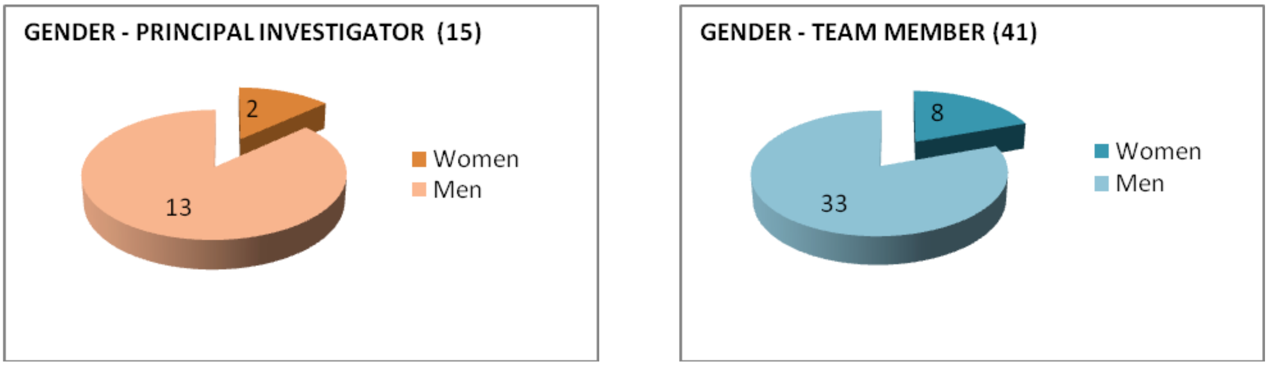


Figure 2. Gender distribution per principal investigator and team member.

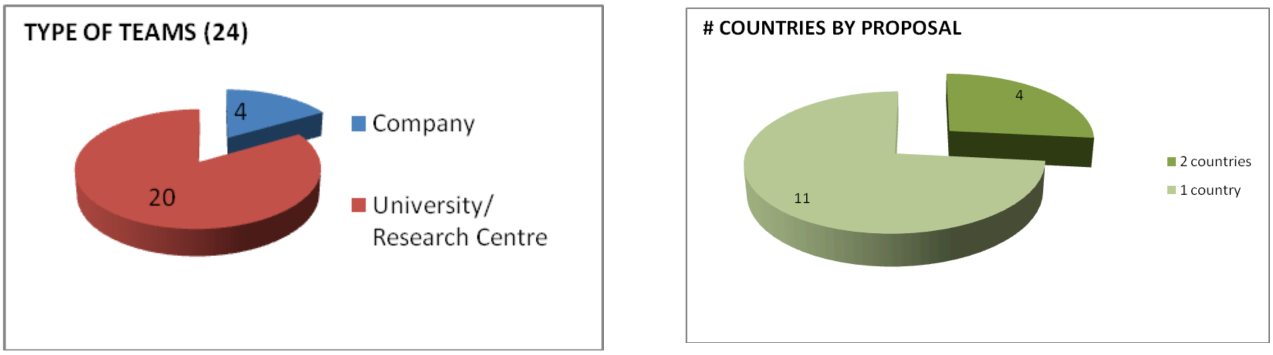


Figure 3. Type of teams and number of countries per proposal.

With respect to the type of teams, only 4 companies (16%) out of 24 teams are involved in the proposals, indicating the need to better disseminate the next TNA call among the industrial sector. Most of the proposals include only teams from one country, and in 4 cases the team came from 2 countries (Figure 3).

The number of people per proposal is depicted in Figure 4. Most of the teams from the proposals have been composed of 3 or 4 people.

Teams from nine different countries have participated in the First FixO3 TNA call (Figure 5), appearing Germany, Greece and Italy in 5 proposals. Other three countries (Spain, Sweden and United Kingdom) are included in 2 proposals and other three (France, Ireland and Norway) only in one proposal.

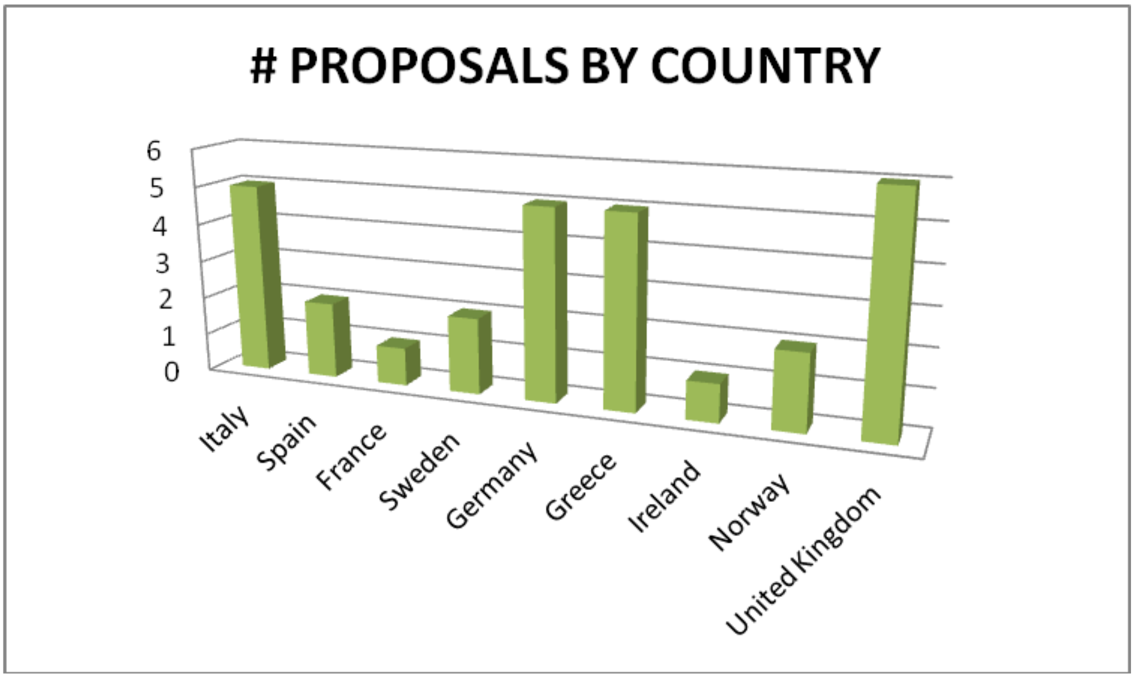


Figure 4. Number of proposals presented by each participant country.

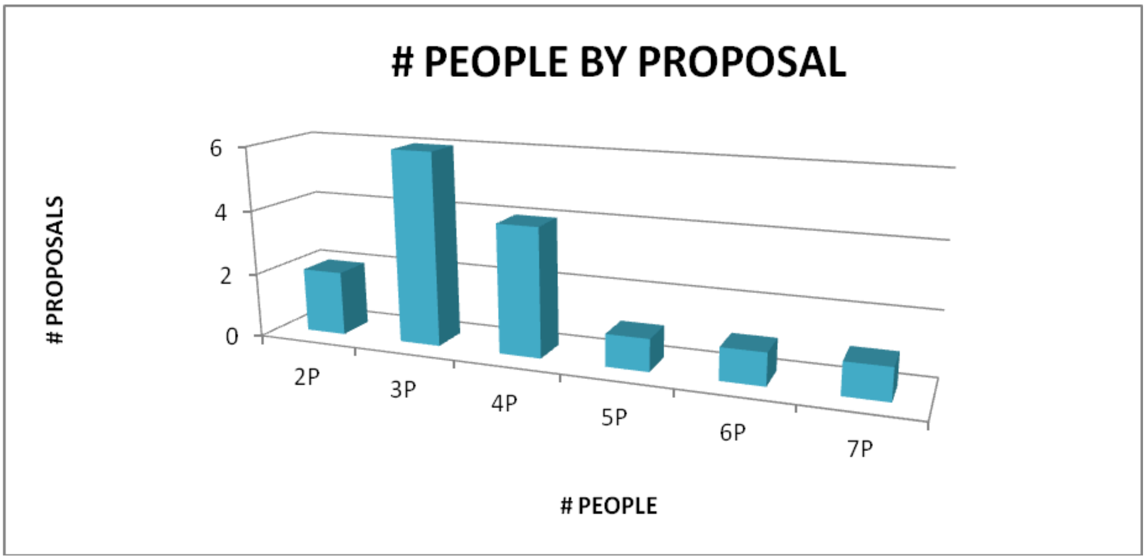


Figure 5. Number of team members per proposal.

## Annex A – Information on approved TNA projects - 1st call

For each proposal which has passed the evaluation and for which the corresponding observatory has agreed to host the proposed project, we include the following information: project title and acronym, host facility, modality of access and description of the proposal; text has been directly extracted from the application form received at proposal stage.

### Project title and acronym

Fixed-point Open Ocean Observatories (FIXO$^3$)

### Host facility

ANTARES

### Modality of Access

MoA2 – Partially remote (the presence of the user is required at some stage, e.g. for installing and uninstalling an instrument)

### Description

The proposed project is intended to test sensors and instruments measuring partial pressure of carbon dioxide ($pCO_2$) and pH at deep sea conditions (2500 m) during a (minimum) of one year deployment at the TNA observatory ANTARES. The experiment requires real-time data communication, which will be provided through secondary junction box (BJS), a part of the ANTARES infrastructure. This TNA action is a follow-up of the recently conducted shallow water (4.5 m) intercomparison exercise of $pCO_2$ and pH instruments (project FixO3, WP12, RT1 and RT2).The two months deployment at the Koljo Fjord Cabled Observatory (http://kojofjord.cmb.gu.se), which was performed in spring 2014 on the Swedish west coast in collaboration with partners from Europe, Japan and the USA, was overall successful and showed how feasible different pCO2 and pH sensors are for autonomous unattended measurements in dynamic coastal environments.
A total of 15 instruments/sensors were tested: 4 different technologies from 5 different manufacturers for $pCO_2$ and 4 different technologies from 5 different manufacturers for pH measurements. For deployment at the Koljo Fjord Observatory a special module, which multiplexed the mentioned instruments into one unit (one power and communication line), was designed and set up (see the Methodology section for further description). Only depth-rated instruments from those tested during the coastal deployment will be used. The main aim of the proposed TNA action is to assess the performance of various $pCO_2$ and pH instruments at high pressure and relatively stagnant conditions, to test long term stability of the technologies and feasibility for measurements of the carbonate system parameters in the deep sea.
Quality of the measured sensor value will be assessed through comparing with water samples data collected with CTD rosette and Niskin bottles. Another objective of the proposed study is to record a long-term multiparameter time-series ($pCO_2$, pH, $O_2$, salinity, T, currents, turbidity, etc.) and to use the measurements for observations of deep-water formation and related processes in the NW Mediterranean Sea (Diurrieu de Madron et al., 2013; Tamburini et al., 2013).

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### Project title and acronym

Ageing of Composites in Deep-water Environment (AGE-CO-DEEP)

### Host facility

POSEIDON E1-M3A (Hellenic Centre for Marine Research)

### Modality of Access

MoA2 – Partially remote (the presence of the user is required at some stage, e.g. for installing and uninstalling an instrument)

### Description

Composites materials are used in the marine, offshore and underwater industry for decades, due to their intrinsic properties, e.g. lightweight structures compared to metallic ones of equal strength, corrosion resistant, etc. More specifically, the demand for composite materials in deep-water applications and in primary applications within the Offshore Oil & Gas industry and deep-water vehicles (e.g. Automated Underwater Vehicles) has been increasing rapidly the last 10 years. This trend is expected to continue in the aforementioned sectors, but also in other sectors such as
Oceanography for deep-water exploration, as further integration of composite materials in underwater structures is rigorously pursued. With respect to the composite materials used, the constituents are, mainly, glass or carbon fibres mixed with a matrix material (polymeric resin). Glass fibre composite material is the most widely used, due to the combination of low cost to adequate strength, but carbon fibre composites are gaining market share in the deep-water applications, especially due to their excellent high strength and low weight combination. These features along with other specific advantages (facilitation of easier underwater deployment, buoyancy, thermal isolation, non-corrosive, etc.) strongly favour the use of composites. Nevertheless composite materials can be affected by degradation mechanisms, like:

- Structural damage due to static loading under hydrostatic pressure, sometimes combined with creep, dynamic and impact loads
- Ageing due to absorption
- Biological attack.

More particularly, in a scenario of prolonged underwater use of composite material structures, the physical and mechanical properties can be degraded by the attacks on the matrix material (resin) and/or the fibres, which can be manifested in the degradation of the interface between matrix and fibre, reinforcement, the interface between two adjoining plies (delimination), etc. The phenomenon is called ageing of composites and is very critical for composite underwater structures that operate for prolonged periods of time. Studying ageing effects of composites may address many of the uncertainties, related with the long-term performance of composites under conditions encountered in service.
In this context, the long-term behaviour of composite materials in the deep-water environment will be studied. Environmental parameters of the deep-sea that affect durability will be measured in situ, and the structural behaviour of composite specimens will be monitored for a period of 18 months. Moreover the aged specimens will be recovered after the end of 18 months and tested in laboratory environment and quantify the effect of ageing on mechanical properties of the studied composite materials.
The POSEIDON infrastructure of the Hellenic Center for Marine Research provides the necessary environmental information and the appropriate operational and technical facilities for an 18 months ageing study of a series of composite specimens in the depth of approximately 1.000 meters. The POSEIDON M3A station monitors at several depths environmental parameters like sea temperature, salinity, dissolved oxygen, currents, biogeochemical parameters and sediment composition including deposition rate.
The advantage that is offered by conducting these experiments linked with the POSEIDON infrastructure is, that the degradation mechanisms and the recorded data from the specimens can be linked to the environmental parameters that the POSEIDON station monitors and useful correlations can be deducted which can aid in the identification and quantification of the ageing mechanisms which promote the degradation of the mechanical properties of the tested composites specimens.
The long-term environmental and load effects to the composites will be examined and measured. The results will be used from ALS in order to excide its material knowledge and experience beyond the existing state of the art. The ageing of the composites is an open and unexplored research field especially for the deep-water environment.

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## Project title and acronym

**COM**bined testing of new acoustic profilers with **B**iochemical **O**ptodes in the Adriatic Sea [**COMBO**]

## Host facility

E2-M3A

## Modality of Access

MoA2 – Partially remote (the presence of the user is required at some stage, e.g. for installing and uninstalling an instrument)

## Description

A new type of Acoustic Doppler Current Profiler (SeaguardII-DCP) was recently developed at Aanderaa. It has unique acoustic features including: Broadband and Narrowband, Automatic 3 beam/4 beam selection for optimal data quality and object avoidance, Simultaneous Upward and Downward profiling by connecting two acoustic sensors, Spread or Burst mode and the ability to remotely measure the top cm surface currents. This technology has not been properly evaluated in clear/oligotrophic waters, which is known to decrease the acoustic range and performance. We suggest adding one self-recording unit with two acoustic sensors to the underwater cage of E2-M3A and collecting at least one full year of data. Apart for evaluating the technology the instrument will give valuable information about seasonal dynamics of the upper mixed layer. We also suggest to add sensors to this and to another similar instruments placed close to the bottom on the Sub-surface mooring. The suggested sensors are Aanderaa optode prototypes for pH and $pCO_2$ complemented by standard sensors for $O_2$, Salinity, Wave/Tide, Temperature and Current. The rationale behind the deeper instrument is a better assessment of the Adriatic Deep Water formation and spreading, and how they contribute to change the deep and bottom water conditions in the entire South Adriatic, both on a short and long time-scale. Here, high frequency data of pH/$pCO_2$/$O_2$ will add important information about the carbon cycle, the origin and age of the dense waters flowing along the bottom into the deeper parts, which origin is attributable to local phenomena acting in the northern Adriatic. In addition, the accuracy and stability of the new sensors will be evaluated.
The sensors placed on the SeguardII-DCP, attached to the cage few meters under the sea surface, will be side-by-side compared with existing sensor for pH and $pCO_2$ but would also open new possibilities to study rapid changes in the carbon cycle in the upper mixed layer because the optode technology can be sampled much faster than existing technologies which are power hungry and complex (e.g. pumps, equilibrators, scrubbers, reagents).
In addition to piggybacking two compact self-recording instruments to the E2-M3A observatory, we suggest to take advantage of the OGS Oceanographic Calibration Centre for pH, $pCO_2$ and $O_2$ to improve/verify sensor calibrations before and after the deployment.

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## Project title and acronym

UV photometer operation and improvement in the top pelagic layer of an oligotrophic station

## Host facility

European Station for Time series in the Ocean Canary Islands (ESTOC)

## Modality of Access

MoA2 – Partially remote (the presence of the user is required at some stage, e.g. for installing and uninstalling an instrument)

## Description

In order to investigate biogeochemical cycling and dynamics of nutrients, measurement capabilities with sufficient spatial and temporal resolution are required. Nitrate as one of the most relevant nutrient in aquatic ecosystems is by now a standard parameter for marine observations and regulations. Optical measurements utilizing ultraviolet (UV) *in-situ* spectrophotometers have promised to be an excellent method for nitrate sensing, since their operation is fast, reagent-free thus providing a powerful tool as they are applicable to long- term observations. Particularly in coastal waters the determination of nitrate by optical methods is very challenging due to various influencing of present water constituents, especially coloured dissolved organic matter (CDOM) and suspended particulate material (SPM). Furthermore physical properties of seawater, e.g. salinity and temperature, have a strong influence on the computation of nitrate concentrations from absorption spectra. Having this in mind, new approaches in the computation of nitrate in coastal waters have been achieved by reducing the degrees of freedom via a stepwise simplification of the spectra considering all influencing parameters by different correction approaches before calculating nitrate concentrations. Within various field campaigns a rapid and high-resolution mapping of nitrate was possible with good correlation to reference sampling. Thus it demonstrates the potential for in-situ observations and regulatory actions as well as for long-term monitoring observations. Detailed information of the current methodology of nitrate calculations regarding temperature and salinity dependencies of instrumentation and surroundings can be found in the listed and available relevant publications (see below section). Processing methods will be constantly validated and improved in different study sites, e.g. in estuaries with steep salinity gradient and in open ocean observations with low nutrient seawater proofing the detection limit. The ESTOC station will offer a good opportunity to test and validate the implemented methods to determine temporal nitrate fluxes within an oligotrophic/subtropical region enabling a comparison to so far investigated shelf sea and coastal areas. Besides the determination of nitrate the usage of an UV process spectrophotometer with a spectral wavelength range in the deep UV (200- 360 nm) allow the calculation of further parameters from the absorption spectra afterwards, e.g. the spectral absorption coefficients at 254 nm (SAC254). This parameter can be related to water quality assessment and organic pollution and is strongly correlated to present DOC concentrations.

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## Project title and acronym

Benthic ecology and biogeochemistry using Bathysnap and sediment oxygen profiling in the Arctic (ArcEcoBio)

## Host facility

FRAM - FRontiers in Arctic marine Monitoring

## Modality of Access

MoA2 - Partially remote (the presence of the user is required at some stage, e.g. for installing and uninstalling an instrument)

### Description

We propose adding a Bathysnap sea floor observing system to the lander-type long term benthic observatory at FRAM for a period of one year. Combining Bathysnap visual information with oxygen microprofile time-series and other measurements carried out in the Benthic Boundary Layer with the same instrument would enable quantification of the arrival and fate of seasonal pulses of carbon-rich phytodetritus at the seafloor, as well as how the activity of benthic fauna relates to this process. This 'phytodetritus' is made up of sunken algae, microbes, as well as zooplankton and their fecal pellets and exuvae and represents the principal component of downward carbon transport over ecological time scales.
Bathysnap collects time-lapse photography of the seafloor at 4 hr intervals covering an area of a few square meters with the effectively viewed area dependant on object type (Bett et al 2001). This is because different objects types have differing visibility depending in part on their size and coloration where larger brighter objects tend to have a larger effectively viewed area (see Buckland et al. 1994). While originally in film format, the system now uses a digital camera and flash system with a Deep-Sea Power & Light battery. The system is self-contained and does not need network integration and is deployable and recoverable as a free vehicle lander system with mooring above and is deployable from any standard research vessel without specialized equipment such as an ROV. At FRAM, Bathysnap will be mounted at the same lander frame that is used for time series observations of diffusive oxygen uptake (DOU) of the seafloor carried out by AWi by means of long term microprofiler measurements. DOU measurements serve as a proxy to quantify rates of microbial remineralization of organic matter. Equipped with stable fiberoptical microsensors the microprofiler repeatedly records
oxygen micro profiles for up to one year and complements Bathysnap imagery to simultaneously address dynamics in Phytodetritus supply as well as remineralization.Bathysnap systems have previously been used at the Porcupine Abyssal Plain (PAP; another Fix03 site) on a regular basis since 1989. Benthic time-lapse photography systems have also been deployed for similar research at Sta. M in the northeast Pacific since 1989. These systems have proved to be reliable and informative tools. Discovery has aided understanding processes related to pelagic benthic coupling, as well as connections between climate, surface conditions including productivity and the transport of sinking particulate organic carbon (POC) flux from the upper ocean to the deep sea and seafloor. Ultimately these systems can monitor the fate and influence of that POC on the seafloor. These tools can be used to document the variation in movement speeds of bioturbating megafauna and changes in physical features on the seafloor. On several occasions these systems have captured never before seen behaviours of seafloor life such as the laying down of an entropneust fecal cast, the formation and gradual breakdown of echiuran burrows, or other behaviours (Lampitt 1985, Smith et al. 2005). These photographic systems have also been able to disentangle the origin/composition of intense POC fluxes that were otherwise not observed by standard conical sedimentation traps (e.g., Parflux Sediment Trap, see Smith et al. 2008, 2013, 2014). They have also been used to document the activity rates of megafauna including their movement speeds and patterns (behaviours), the area of bioturbated seafloor over time for each taxon (Vardaro et al. 2009), and the time taken to process and repackage the seasonally deposited phytodetritus (Bett et al. 2001). Long term patterns of benthic megafauna communities at FRAM have been studied intensively based on imaging surveys and samples (e.g., Bergmann et al., 2011). This provides the required information to accompany the proposed high resolution time-series of seafloor dynamics and benthic activity patterns that is so far missing for this Arctic site.
Several questions of societal interest can be addressed when data are available synoptically from polar and temperate areas for particle fluxes studied with sediment trap moorings, photographic time-series observations, and variations in organic matter remineralisation obtained with a sediment oxygen microprofiler (see also Ruhl et al. 2011). For example, how do processes of pelagic-benthic coupling differ between polar and temperate seas in terms o the timing and intensity of visible phytodetritus coverage? How do the observed communities differ in terms of how they process this coverage via ingestion and bioturbation? What portions of the overall POC flux might be being missed by Parflux Sediment Traps and

similar systems? How tightly does the arrival of visible phytodetritus correlate to benthic organic matter remineralisation over periods of days to months?
Remineralisation rates at the seafloor determine the share of organic carbon supply from the upper water column that is returned to the sea and eventually the atmosphere as inorganic carbon and the share that is sequestered in the sediments and removed from earth's active carbon pool. Organic matter supply to the deep sea is not constant but changes seasonally and even from day to day as pulses of POC reach the seafloor during episodic export events. We expect that coupling the above methods at both PAP and FRAM using identical methodologies will provide an unprecedented insight in the questions posed.

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## Project title and acronym

DYnamics of Nutrients using AutonoMous lnsTrumEnts in Fram Strait (DYNAMITE)

## Host facility

FRAM - FRontiers in Arctic marine Monitoring

## Modality of Access

MoA2 - Partially remote (the presence of the user is required at some stage, e.g. for installing and uninstalling an instrument)

## Description

**Rationale:** Nutrients supplied to the Arctic Ocean (AO) from the Atlantic via Fram Strait and the Barents Sea Opening, Pacific via Bering Strait, and Rivers, support primary production in Arctic shelf seas, leading to a net C02 sequestration via the biological carbon pump (MacGilchrist et al., 2014). Furthermore, the AO is a source of nutrients to the North Atlantic, supplying nutrients via Davis Strait and Fram Strait. Changes in the hydrological cycle at high northern latitudes has modified the input of fresh water, and consequently, the quality and quantity of nutrients to the AO. We do not understand present-day AO budget closure, and so we do not know how the AO biogeochemistry will respond to future climate change and how this will impact transports to the NAti.

**Background:** Torres-Valdes et al. (2013) provided a physically mass-balanced budget of dissolved **inorganic nutrients,** nitrate [N], silicate [Si] and phosphate [P] for the AO. This study identified the AO as a net exporter of P and Si to the NAtl, but found the N budget to be balanced In spite of large N loses via denitrification there. The relevance of these transports is that P supports the P demand for N fixation in the Atlantic Ocean and supply 90% of the Si fluxes to the NAtl. Most of the Si originates in Arctic rivers, implying that future impacts to the watersheds surrounding the AO will directly impact transports to the NAtl. In the case of P and N however, non-oceanic sources were found inadequate to account for the imbalances.

**Previous work:** The foregoing analyses lead to the hypothesis that oceanic transport of dissolved **organic nutrients -** nitrogen (DON) and phosphorus (DOP) - may account for the imbalances of N and Pin the budget. Recent work (Torres-Valdes et al., in prep.) suggests DON may account for the N lost to denitrification, with high DON transports via Fram Strait and the Barents Sea Opening. Although P remains an open question; DOP seems to account for only ~1s% of the imbalance. Furthermore, the transformation of organic nutrients by microbial communities from organic to inorganic forms during transport may influence composition.

**Gaps in knowledge and solution:** The scarcity of data and temporal resolution hinder our understanding of changes in nutrient transports. This arises primarily from the difficulties in accessing AO gateways year round. Instrumenting the FRAM observatory with recently developed in situ nutrient sensors and commercially available autonomous samplers provides the best solution at hand to deepen our knowledge of nutrient exchanges to/from the AO at Fram Strait. The National Oceanography Centre (NOC) 's Ocean Technology and Engineering group have developed state-of-the-art nitrate [Beaton et al. 2012] and phosphate [Legiret et al. 2013] lab-on-a-chip sensors that offer analytical performance equivalent to laboratory methods, and can be configured to perform two measurements per day for up to a year. The sensors have been tested in month-long deployments in coastal waters [Beaton et al. 2012], in rivers, on benthic landers, and are due to be trialed on oceanic gliders in August 2014. In this project we propose to deploy these instruments on the FRAM moorings to evaluate their performance whilst also providing critical data to answer questions of scientific interest.

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## Project title and acronym

Ocean chemistry and acoustics in the gas hydrate-charged Fram Strait (GasFram}

## Host facility

FRAM

## Modality of Access

MoA2 - Partially remote (the presence of the user is required at some stage, e.g. for installing and uninstalling an instrument)

## Description

**Context and objectives**

Today's global warming development has turned the cold Arctic regions to a "hot spot" for energy, environment and climate research. Methane is known as a powerful green-house gas, 25 times more potent than C02 in terms of trapping heat in the atmosphere over a timeframe of 100 years. Scientists at the Center for Arctic Gas Hydrate, Environment and Climate (CAGE) based in Trornse (Norway), together with colleagues at NGU (Norwegian Geological survey) and Akvaplan-niva, aim to find out the role of methane from Arctic gas hydrate in past, present and future climate change.
Seepage of methane gas bubbles released from the seabed has been observed in shallow water (<400m depth) offshore Svalbard (Knies et al., 2004; Hustoft et al., 2009; Westbrook et al., 2009; Berndt et al., 2014), and one of the goals of CAGE is to monitor these methane seeps and provide the link between potential sources of elevated methane concentrations and the reasons for variations. For this purpose, a long-term observatory will be deployed on the seafloor on one of the seepage areas for a period of ten years. This CAGE observatory will integrate a CTD recorder for temperature and salinity measurements, an ADCP for current measurement, pH and C02 sensors for acidification monitoring, and fluorometer, oxygen and methane sensors. In addition, a hydrophone will record and quantify bubble releases. Moreover, the hydrophone frequency ranges will allow for detecting marine mammals.
Access to the central HAUSGARTEN site within the FRAM observatory (79° 04,16'N / 4° 04,59'E, N2500m depth) will mainly serve as a reference site for the CAGE observatory in an area where no deep-water gas hydrate has been found. Concretely, we wish to add to the central HAUSGARTEN site at FRAM, for one year: 1) a self-logging methane sensor for local methane measurement (mainly background), 2) a CTD recorder for temperature and salinity time-series and 3) a self-sustained hydrophone for hydro-acoustic background. In addition, material/samples/data obtained from the long-term lander-based benthic observatory in the central HAUSGARTEN site as well as temperature and salinity data from CTD casts, plankton net samples and sediment samples from the multicorer (MUC) during the 2015 cruise will be shared between scientists from both institutions as part of scientific collaborations by mutual agreement.

**Rationale**

*Sea-floor and water column observations*

Evidences already show the impact of water temperature increase in the modification of the gas hydrate stability zone (GHSZ), potentially releasing methane in the pore water and ultimately in the water column (Westbrook et al., 2009; Ferre et al., 2012). This highlights not only the importance of monitoring temperature changes and methane concentration, but also other parameters in order to understand the interaction between oceanographic changes and methane fluxes. Depending on the release rate, at least *N50%* of the methane that dissolves into the sediment pore water could be retained inside the seafloor by microbial anaerobic oxidation of methane (Treude et al., 2003; Knittel and Boetius, 2009). This process may essentially influence the benthic organisms living at and within the surface sediments of the sea floor. One way to reconstruct past marine methane emissions is by carbon isotope (613() analysis of benthic foraminifera (e.g. Kennett et al., 2000).

Negative carbon-isotopic compositions of foraminifera tests have been reported from methane seep environments, and it has been suggested that some of these species record distinct 13C-depletions inherited from methane (Sen Gupta et al., 1997; Rathburn et al., 2000; Hill et al., 2004; Panieri et al., 2009, 2014).

Thus, benthic foraminifers in methane seep environments likely preserve geochemical information from which past methane events may be reconstructed. *Planktic foraminifera* Methane rising through sediments as free gas could bypass the benthic methane filter (Knittel and Boetius, 2009) and, depending on the water depth, reach the atmosphere (McGinnis et al., 2006). In the water column, aerobic oxidation of methane converts methane with oxygen into C021 which can impact the pH of water masses. Prediction of pH decrease due to the anthropogenic C02-uptake is about 0.3-0.5 units until the end of this century (Caldeira and Wickett, 2005), and methane-induced acidification could nearly double this decrease (Biastoch et al., 2011).

Planktic foraminifera live in the upper 200m of the water column and their shells record various oceanographic conditions and sea surface properties such as the extent on sea-ice cover and changes in position of the oceanic fronts (e.g. Pflaumann et al., 2003; Rasmussen et al., 2007). More important, their shells may provide information on changes of ocean carbon chemistry due to shifts in both atmospheric and methane-induced C02• Planktic and benthic foraminifera shells obtained from plankton net samples, sediment trap, and sediment surface samples from 2012 and 2013 will supplement sampling campaign planned for summer 2015. The ocean acidification project ("Effects of ocean chemistry changes on planktic foraminifera in the Fram Strait: Ocean Acidification from natural to anthropogenic changes") by Tine Rasmussen is already in progress with cooperation with AWi (project partner from AWi: Dr. Eduardsauerfetnd) regarding sediment traps. The collaboration between the two institutes will be strengthened through this proposal.

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## Project title and acronym

MOMAR_Tilt

## Host facility

MOMAR  EMSO Azores

## Modality of Access

MoA2 – Partially remote (the presence of the user is required at some stage, e.g. for installing and uninstalling an instrument)

## Description

The Lucky Strike hydrothermal vent field is one of the most prominent vent sites on the Mid-Atlantic Ridge. Some of the most important processes that control local geology and sediment deposition, fluid chemistry and biology are tectonics and hydrothermally driven fluid circulation, which are both well known to be related to sea-floor deformation. These deformation processes can be monitored by ocean bottom pressure and seafloor tilt measurements.
The Bremen OBT (ocean bottom tilt station) and the Bremen OBP (ocean bottom pressure station) have been developed, built by the group of the PI and successfully deployed several times over period of up to one year. The OBT uses a tilt sensor (Applied Geomechanics) which consists of two orthogonal bubble sensors with a range of ±10° and a resolution of 1 µrad. The OBP uses a high resolution Parascientific Digiquartz sensor and a PPC (Bennest, Canada) with a resolution of 0.7 Pa (0.07 mm) at 0.5 Hz sample rate. Both instruments record their data autonomously for a time period of one year. In conjunction with other long-term measurements at Lucky Strike Hydrothermal Field like seismicity, hydrothermal activity, temperature and salinity of bottom water, we will be able to contribute to a critical data set for the assessment of hydrothermal and magmatic activity.

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## Project title and acronym

FISHAUT: Analysis of FISH community structure and trophic relationships by AUTomated video imaging at a coastal cabled observatory

## Host facility

OBSEA

## Modality of Access

MoA1 – Remote (the presence of the user is not required at any time during the access period)

## Description

Coastal-cabled observatories have been indicated as new and promising technological tools to monitor fish assemblages in marine systems (Aguzzi et al., 2013). In addition, these devices can be successfully employed to monitor and to understand the responses of fish species to both environmental drivers and human stressors. Recent long-term monitoring data in temperate areas have demonstrated community changes over periods ranging from days to entire seasons (Condal et al., 2012; Aguzzi et al., 2013). Large amount of data can be acquired allowing explore species interactions and behavioral components along with temporal variability. Yet, Mediterranean fish biodiversity is undergoing rapid changes due to the rise of water temperature and because of the increasing success of thermophile biota (e.g. Azzurro et al., 2011), Thus, a continuous and long-term monitoring of fish assemblages may offer significant advances to interpret and foresee these ongoing changes under a climate change scenario. So far long-term data obtained by cabled observatories have been only little exploited due to methodological difficulties to analyze such amount of information. In this context, we propose to undertake a systematic monitoring of a coastal Mediterranean fish assemblage in order to enforce biological objectives and associated technological implementations.
Biological objectives are: 1) Explore multispecies temporal variability, as a product of activity rhythms and environmental forcing; 2) Analyze prey- predator interactions.
Specific technological implementations will be: 1) Integrate another video camera (AXIS P1346) deployed at 800 m distance from the OBSEA platform into a monitoring network, enforcing temporally coordinated image acquisition; 2) Develop automated video imaging procedure to classify and count fishes in different

habitat context (one per video camera). Part of the proponent group (ENEA-CNR) is involved in the future EMSO node (European Multidisciplinary Seafloor Observations: www.emso.org) of the Eastern Ligurian Sea (ELIOS; 500 m depth) and the video-expansion of already exiting NEMO SN-1 branch (Sicily, 2300 m depth; CREEP-2 Project: Univ. London-UCL), which are planned to be deployed by the end of 2015. Since these deployments are enforced with ICM-CSIC members and SARTI-UPC personnel is expanding the OBSEA, this proposal may constitute the first benchmark for the establishment of data collection and analysis protocols for future studies to be carried out at greater depths within the framework of EMSO.

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### Project title and acronym

*Electrochemical Corrosion Measurements in Deep Seas (ELCOMEDES)*

### Host facility

*OBSEA*

### Modality of Access

MoA2 – Partially remote (the presence of the user is required at some stage, e.g. for installing and uninstalling an instrument.

### Description

There is a general agreement that deep sea corrosion studies are urgently required for a safe technology development. Recent incidents in Offshore platforms and wells revealed the lack of knowledge about long term materials behaviour in this aggressive environment. Although corrosion rates for most alloys can be are four times less than surface corrosion rates in the open sea, a failure in service can be catastrophic. Therefore, there is a need to monitor the corrosion rate. The project here proposed will try to develop a method for in situ test data on the performance of metallic materials in deep seas. For that, it is necessary to start the trials inside a controlled marine observatory which will make possible to measure the corrosion rate at higher in the future at considerable depths. This is the general frame under which the Electrochemical Corrosion Measurements in Deep Seas (ELCOMEDES) proposal will be carried out.

The team is composed by two research groups:
**LESIM** is in charge of the electronics design of the equipment to be deployed.
**CENIM** has the knowledge about the corrosion processes, evaluations methods and materials to be tested.

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### Project title and acronym

Underwater Acoustic Modem with Time Synchronization Capability Test at Obsea platform - UAMSync

### Host facility

OBSEA

### Modality of Access

MoA2 – Partially remote (the presence of the user is required at some stage, e.g. for installing and uninstalling an instrument)

### Description

Synchronization in underwater communications systems is still now a challenge. Time synchronization is a field in continuous development due to the interest of both industry and academia of sharing a common base time between instruments for developing collaborative tasks.
Nowadays, wireless networks have drawn increasing attention due to the ease of development and low maintenance cost for studying big areas. Analogously to terrestrial networks, there is the necessity to study our oceans, and cover huge areas with sensors for satisfying scientist's necessities.
The Project team is working on the development of new algorithms for time synchronization for underwater networks. Tests have been done in water tanks and now the team is ready to start testing on real environments.
The project team has developed a prototype of acoustic modem with synchronization capabilities based on a cRIO platform. This compact platform is designed to be able to be deployed in an observatory with Ethernet connection with a real time communication to shore.

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## Project title and acronym

SmartBay sensor testing and Validation at OBSEA *(SmartSEA)*

## Host facility

OBSEA

## Modality of Access

MoA2 – Partially remote (the presence of the user is required at some stage, e.g. for installing and uninstalling an instrument)

## Description

**Context**

SmartBay Ireland Ltd. is a not for profit SME with responsibility for supporting Marine/ICT Research and Testing. It provides services to both the research and innovation community with specific focus on the preparation and deployment of data and sensors solutions in the sea. It has the engineering and project management capability to provide the physical and cyber resources necessary to deploy and operate the test and demonstration of new Marine and/or ICT solutions and services, across a range of marine related sectors including renewable energy, aquaculture, environment, transport, and marine tourism.
SmartBay Ireland operates the Irish National Test and Demonstration Site, Galway Bay, for testing advanced marine technologies and ¼ scale ocean energy conversion devices in Galway. This involves marine engineering and technical support for industry and research focused marine activities.

A sub-sea cable observatory is currently being manufactured and configured for installation at the Galway Bay's test-site in Quarter 1 2015. Facilities will include:
- 4.5km of hybrid optic/electrical cable for data and 400v DC, 6 kW of power
- High speed communications via 4pairs of optical fibers

- Sub-sea cabled sensor platform (hosting a variety of sensors and equipment which can be tested and demonstrated in near real-time)

The cabled observatory will have a range of sensors and equipment including CTD, ADCP, an acoustic array and a HDTV camera and lights. A sea laboratory will be installed at the site which will test novel marine equipment and components. This platform is expected to be operational by Quarter 2 2015.

**Rationale**

SmartBay is currently designing and planning the operation procedures for the new Cabled Observatory; this includes a wide range of activities, among them the selection of underwater cables, connectors, equipment, maintenance, data communication and data processing procedures, calibration and quality assurance according to best practices.

To better develop these activities, SmartBay has been establishing contacts with a number of different parties to gather as much experience and best practices as possible. This has enabled SmartBay to, among other things, select a basic initial set of equipment for installation in the observatory; this set includes an ADCP, a CTD, a DO2 sensor and a combined Fluoremeter/Turbidity sensor. These instruments have been re-engineered to accommodate the same connector, cable and pin-out on all of them, enabling easier deployment and maintenance operations.

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## Project title and acronym

SEAsonal food web interactions with the biological pump at the PAP site - SEAPAP

## Host facility

*PAP (ID No. 5) - Porcupine Abyssal Plain*

## Modality of Access

MoA2 – Partially remote (the presence of the user is required at some stage, e.g. for installing and uninstalling an instrument).

## Description

The objective of the proposed work is to study ***food web interactions with the biological pump at high temporal resolution (hours to days) on long-term time scales (year(s))***. The PAP site has long-term measurements of vertical particle flux for over 20 years and has observed clear inter-annual and seasonal variation in the mass fluxes (Lampitt et al. 2001; Progress in Oceanography 50: 27-63). Still, no link between surface ocean processes and deep ocean flux was so far established (Lampitt et al. 2010; Deep-Sea Res II 57: 1267-1271). This shows the need of detailed process oriented studies investigating the biologically mediated particle transformations occurring in the twilight zone - the depths between the surface ocean and the deep ocean. The proposed work will study how food web induced changes in sinking aggregate composition and size spectra influence the export flux to the deep ocean. This will be done through the deployment of a novel Multi-Sensor-Platform (MSP) with the already existing PAP#1 and PAP#3 deep ocean sediment trap moorings. The MSP quantify *in situ* particle abundance and size distribution at high temporal resolution (hours to days) and collect and preserve intact fragile sinking organic aggregates. The deployment of the MSP together with the PAP#1 and PAPä3 deep ocean traps provide long-term information on how changes in particle types and size distribution influence the export flux on high temporal resolution. The infrastructure at PAP site offers a unique study site where the link to the long- term monitoring of the surface ocean processes such as temperature, salinity, $CO_2$, chlorophyll, and irradiation will make it possible to relate the fluxes and particle composition in the deep ocean to the surface properties shaping the flux. Additionally, combining long- term data sets from the time-series measurements with snap-shot studies during the deployment and recovery cruises will allow in-depth process studies of both short and long- term controls on the biological pump. The short-term processes will focus on the relative importance of particle transformations such as aggregate sinking velocities, microbial degradation and zooplankton flux feeding for POC flux attenuation and export to the epipelagic, mesopelagic, and deep ocean. The findings from the short-term processes will be related to the aggregate transformations obtained from the MSP, the PAP#1 and PAP#3 moorings, and the biological, chemical, and physical sensors deployed as part of the PAP site infrastructure (moorings and gliders) to identify the controlling processes for the biological pump.

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## Project title and acronym

Benthic organic matter cycling dynamics at PAP (PAP-Dynamic)

## Host facility

Porcupine Abyssal Plain Observatory (PAP)

## Modality of Access

MoA2 – Partially remote (the presence of the user is required at some stage, e.g. for installing and uninstalling an instrument).

## Description

We propose to add time series of seafloor oxygen microprofiles to the established long term benthic observatory at PAP. Based on this we would address seasonal changes in benthic carbon mineralization and connect it to seasonality in organic matter supply t o the deep-sea floor. Benthic organic matter remineralization is a bulk measure of the metabolic activity of seafloor communities. It is considered a key function of abyssal ecosystems with strong implications for the global carbon cycle. Remineralization rates at the seafloor determine the amount of organic carbon supply from the upper water column that is returned to the s ea and eventually the atmosphere as inorganic carbon and the amount that is sequestered in the sediments and removed from earth's active carbon pool. Organic matter supply to the deep sea is not constant but varies with seasonal and interannual forcing. For the PAP region this has been shown with sediment trap studies of vertical fluxes of sinking particles and marine snow imaging (Lampitt et al., 2001, Smith et al., 2009). Time-lapse photography series of the sediment surface at PAP obtained with the free vehicle camera system 'Bathy snap' proved the occurrence of phytoplankton bloom-related sedimentation events at the seafloor and documented the immediate utilization of the food supply by the seafloor megafauna community. *In situ* 'food pulse experiments' have shown the ability of the sediment community at PAP to quickly respond to organic matter input and the transfer of biomass trough the sediment infauna community's food chain (Witte et al., 2003). The quantification of overall benthic remineralization in response to natural sedimentation events, however, is still not fully achieved. This knowledge is relevant for a general understanding of temporal dynamics in benthic activity and a prerequisite in order to determine annual organic matter turnover and close the carbon budget for the deep ocean. Uptake of oxygen by the sediment is a standard measure to quantify organic matter remineralization because oxygen as the terminal electron acceptor integrates any metabolic pathway involved. Traditionally, oxygen uptake is measured by benthic enclosures (chamber incubations) or by assessing oxygen distribution in the diffusive boundary lay er (DBL) at the sediment water interface and in the pore waters of the uppermost sediment horizon based on oxygen microprofiles (Fig. 1). Although the microprofile approach misses the contribution of the macrofauna, the flux rates obtained with the two methods in deep sea environments are typically very similar as the microbial communities largely dominate benthic remineralization (Wenzhöfer & Glud, 2002). Moreover, previous studies have also found no clear influence of macrofauna on sediment community oxygen consumption (Ruhl et al., 2008). A big advantage of the microprofiler approach is its minimal invasiveness that allows for repeated measurements at almost the same spot which reduces the influence of spatial variability. Additionally, microprofiles provide information on the oxygen distribution within the sediment (oxygen penetration depth) which may reflect varying food availability during a seasonal cycle. Connected to this, the effort needed for repeated flux measurements is comparably small. While repeated chamber incubations call for mobile platforms (i.e., benthic crawlers) time series of microprofiler measurements may be obtained using simple translating or rotating units attached to stationary benthic installations.

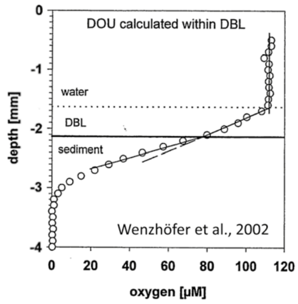


**Fig. 1: Example of an oxygen microprofile. The thin line marks the oxygen gradient across the DBL**

We propose to deploy an oxygen microprofiler at PA for a full year or longer to study seasonality in diffusive benthic oxygen fluxes as a proxy of organic matter remineralization (4-8 replicate 20 cm long profiles at weekly intervals). Results obtained would be compared to studies of seasonality in organic matter supply carried out at NOC. This includes quantifications of particle fluxes studied with trap moorings and qualitative time series observations of dynamics and occasional peaks in organic matter supply and benthic megafauna activity obtained with Bathysnap.

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## Project title and acronym

Underwater Sound and Radon Measurements of Rainfall and Wind at Sea

## Host facility

Western 1 – Mediterranean Moored Multi-sensor Array (W1 – M3A)

## Modality of Access

MoA2 – Partially remote (the presence of the user is required at some stage, e.g. for installing and uninstalling an instrument)

## Description

Understanding the distribution and change of oceanic wind fields and rainfall patterns is a major component of global/regional water cycle and climate change. In addition to rainfall rate a detailed knowledge of type and drop size distribution (DSD) is needed for particular scientific applications and this characterization is extremely important in area subjected to flood hazards. Satellite-based measurements provide global coverage of wind and rainfall distribution, but these measurements need to be verified by surface measurements.

The most common instruments used to measure rainfall are rain gauges, which however represent a point measurement. On the other hand, a more advanced technique for quantifying rainfall in larger spatial and temporal scales is the meteorological radar. Radar observations can support hydro-meteorological and flood forecasting modelling due to the distributed rainfall estimation. Typically, both instruments are used on land and limited are the types of rain gauges used to measure precipitation over the oceans. At sea, they are usually installed on moored buoys and even though extended research has focused on removing errors caused by the movement of the platform due to the sea state conditions, they are still not reliable when installed on small and discuss-shaped buoys.

Underwater acoustics can contribute to improve our capability of measuring rain over the oceans since rain falling onto water and the break of the surface waves (strongly correlated to wind blowing over the sea) are two of the loudest sources of underwater sound. They produce sound underwater by their impacts onto the ocean surface and, more importantly, by sound radiation from any bubbles trapped underwater during their splashes. In addition, because different raindrop sizes produce distinctive sounds, the underwater sound can be inverted to quantitatively measure drop size distribution in the rain.

Consequently, underwater acoustic measurements can be used to detect and classify rainfall type and subsequently quantify the wind speed, rainfall rate and its drop size distributions. Other physical processes that can be measured are sea state (bubbles) conditions as well as sounds generated from biological and human activities. Developing and verifying an advanced real-time system for recording and interpreting the underwater acoustic signal will allow all of these processes (rain, wind and bubbles) to be measured from sub-surface platforms, facilitating all weather and all season data collection. A collateral result of this project will be to better monitor the marine sound budget to provide fundamental baseline data to allow informed decisions regarding management of sound-producing human activities in the ocean. On the other hand, radon progenies in the atmosphere are transported to the sea surface by the scavenging effects of rainfall. Radon can be detected via its daughters ($^{214}$Bi and $^{214}$Pb) which are gamma-ray emitters. The continuous monitoring of gamma radiation in the marine environment provides significant information on various environmental processes where radon and thoron can be applied as a tracers. $^{222}$Rn (half life 3.825 d) is a noble gas and is found in aerosol particles in accumulation-mode. It has been observed qualitatively after rainfall from the short-lived radon daughters ($^{214}$Bi and $^{214}$Pb). However, the variation of radon activity is not constant mainly due to rainfall intensity, rainfall type and humidity. It has been measured (using the lab-based method) that the volumetric activity of radon decay products in rainwater amounts up to $10^5$ Bq/l.

This phenomenon causes the environmental gamma ray intensity at the sea surface to increase significantly, anywhere from several to tens of percentage points of intensity compared to dry conditions. The study of radon progenies is necessary in order to correctly assess rates of precipitation. Furthermore, the radon progenies in rainwater are useful when studying the atmospheric scavenging of harmful substances and aerosols because these progenies behave as tracers that reveal the dynamics of the process. The vision of the proposed technology is to apply effectively autonomous, robust, low power consumption and cost-effective in-situ sensors for real-time measurements of rainfall tracers and to correlate the results with wind speed monitoring data over ocean.