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OBSEA, a marine sensor testing site for metrology

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***Abstract* – Marine sensors needs to be tested in real and controlled environments in order to assure, both, proper functionality of the sensor and good enough measurements. Most of times is not enough testing on the lab. Field tests and an inter-comparison with similar sensors can help instruments manufactures, platform operators and scientist to validate instruments. This abstracts introduce OBSEA (Expandable Seafloor Observatory, www.obsea.es), a permanent underwater cabled seabed observatory located in front of the Catalan's coast near Barcelona, at 20 m depth. Further, some of the current activities where the observatory is used as a test site for different experiments related with marine sensors metrology are presented.**

I. INTRODUCTION

Nowadays, science community is paying more attention at the sea because it is a huge storage of heat on the earth. Therefore, changes in the state of the seawater can produce modifications in the weather. To know the characteristics of the seawater, parameters as temperature, salinity, acidification among others are important. This necessity has been solved with oceanographic measurements, but the traceability of the instrumentation used in the marine science is particularly new.

For this reason, the opportunities given by a permanent observatory in the real field can give worth to the studies in the metrological field

II. OBSEA

OBSEA [1], [2] is an underwater observatory cabled to the coast with a 4 km hybrid cable that offer power and real time communication. It is placed in front of the coast of Vilanova i la Geltrú, near Barcelona, in a fishing protected area at 20 meters' depth.

Figure 1 Obsea structure

The first remarkable strength of OBSEA's observatory, as other cabled ones, is the capacity to feed a large range of instruments from the land with up to 3.6kW, and the high bandwidth communication link of 1Gbps uninterruptedly. That avoids the dependence of batteries and storage systems. Through an optical Ethernet network, oceanographic data is always available to monitor marine environment.

Obsea offers a wide range of data produced by different sensors that should be acquired and treated in many different ways; multifunction is a must at underwater observatory systems. OBSEA largely achieves this function. As it can be seen at Figure 2, which is a real disposition of the observatory at June 2016, different instruments as AWAC's, a seismometer, underwater ip cameras were connected at the same time. This shows its capability to feed the instruments, acquire, transmit and treat the data of all-them uninterruptedly.

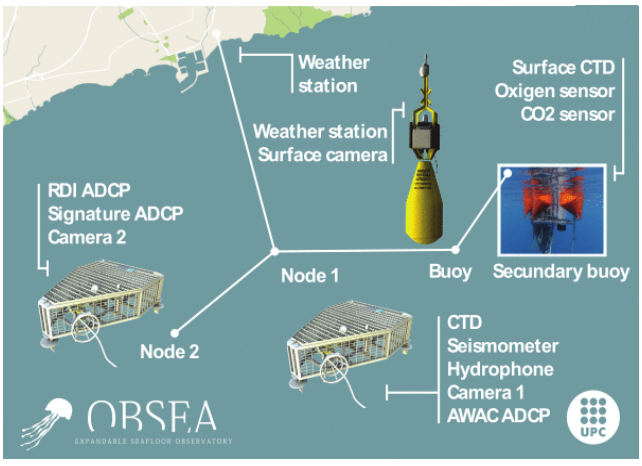

Figure 2 Components placed at OBSEA on June 2016

This underwater observatory is composed of 2 main nodes or junction boxes, each of it offers 8 instrument ports (data and power connection). Both are at 20 meter's depth and at a distance of 150 meters one from the other.

Connected to the first node there is the surface buoy. See Figure 3. It is another OBSEA's strengths because it brings the possibility to deploy surface instruments. It has its own weather station and ip camera and there is the possibility to

connect other instruments like the CTD, the oxygen and pCO2 sensors attached with an auxiliary buoy.

OBSEA is located at the Mediterranean Sea and operations are done by scuba divers and small boats. SARTI-UPC members are always available for new deployments and to share their know-how [3], taking care of the installation through an online system of alarms from the land.

Figure 3 OBSEA's buoy

III. WORKS ON

Nowadays, OBSEA-UPC is one of the test site observatories of EMSO-ERIC (http://www.emso-eu.org/). European Multidisciplinary Seafloor and water-column Observatory (EMSO) is a large scale sea research infrastructure of distributed fixed point observatories which serves marine science researchers, marine engineers, policy makers and the public. EMSO consists of ocean observing systems for the sustained monitoring of environmental processes and their final interactions.

Being a test site at EMSO's network has allowed SARTI group (Sistemes d'Adquisició Remota i Tractament de la Informació) from UPC to participate with OBSEA platform in many European research projects (FP7, H2020 and EMRP) that are described below.

A. FP7 calls

In 2017, 2 European projects financed by FP7 ended their period; Nexos (http://www.nexosproject.eu/) and FixO3 (http://www.fixo3.eu/).

The main purpose of **NeXOS** [4] is to deploy new sensor systems that are multifunctional, integrated, profitable and compact in a wide range of applications (optical, acoustic and for a fishing ecosystem). That sensor systems must be deployed in both mobile and fixed platforms, and should contribute to the evaluation of the European ecological state and the Marine Framework Strategy Directive [5]. SARTI group has participated in the developing of several sensors. One of them consists in a passive acoustic monitoring system with capacity of processing the data. This is an intelligent digital hydrophone that offers directly sound, or alerts about underwater species movements without sending the raw data that weights a lot and takes a big bandwidth. These hydrophones are being deployed these month, during the demonstrations phase of the project, both in underwater vehicles (glider) as SeaExplorer of Alsemar, buoys as the Estoc in the Atlantic Sea operated by Plocan or underwater observatories as OBSEA. In Figure 4 NeXOS underwater acoustic monitoring systemit can be seen 4 hydrophone units connected to the data concentrator (electronic box) that offers too an estimation of the arrival angle of the sound source.

Figure 4 NeXOS underwater acoustic monitoring system

During **FixO3** project, OBSEA has been used as a test service for different research project through TNA (Transnational Acces) calls. Different business or institutes have done some deployments at OBSEA under the coverage of FixO3 founding. SARTI team has participated in the integration of this equipment giving real data access and continued sensor monitoring. The seven FixO3 projects located at OBSEA platform are listed below:

- ELCOMEDES [6]. The main objective was to perform different studies of corrosion in a real environment using a new potentiostat device (Figure 5). This new potentiostat had been designed to be connected in underwater observatories and to be operated remotely. Moreover, it could perform different test such as noise measurements or cyclic voltammetry. Furthermore, in order to achieve the objective, some electrode cells with different characteristics had been designed to be used with the potentiostat.

Figure 5 Potentistat device. Three electrode cell with waterproof enclosure

- FishOut [7]. Dedicated to explore multispecies temporal variability, as a product of activity rhythms and environmental forcing and analyze prey-predator interactions. That would be done by deploying two

underwater cameras in a real scenario (OBSEA) with automated video imaging procedure to classify and count fishes.

Figure 6 FixO3 underwater acoustic monitoring system

➢ SmartSea [8]. Consisting of testing GB MARETS (Galway Bay Marine and Renewable Energies Test Site) equipment in a real scenario (OBSEA) before the deployment in Galway. The steps were: to test the equipment in a hyperbaric chamber at OBSEA, to train SmartBay personnel on operation procedures and to compare the data collected with several similar instruments (Figure 7).

➢ CISWE [8]. Nortek company wanted to try his equipment in a real scenario. The aim of the project was to study and made an intercomparison of data between two Nortek ADCP deployed during a long period of time at shallow water.

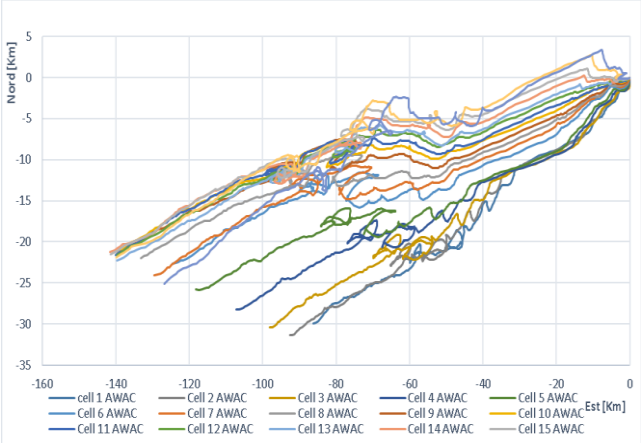

Figure 7 Comparing the progressive vector path between three ADCP; AWAC Nortek (Sarto-UPC), Signature Nortek (CISWE) and Sentinel RDI (SmartSea)

➢ UAMSync [9]. The aim of this study was to evaluate the performance of a communication system capable to trigger communication time stamps when frames access or exit the physical layer of the system. Frame time stamping was necessary to perform accurate time synchronization between sensors in an underwater sensor network

➢ upAUV. This project worked on validating the Autonomous Underwater Vehicles (AUVs) as current meters in different navigation modes. It took different moored ADCPs as reference. Also, it tried to see if AUVs provide new information about coastal upwelling processes.

➢ SWHAD. Over the FixO3 founding, SWHAD aimed to deploy a hydrophone (acoustic array) at OBSEA observatory, shallow water, set up the measurement parameters, verify its long term endurance and test its correct data on this environment.

B. H2020 calls

UPC – SARTI group participates at the **EmsoDev** project ((http://www.emsodev.eu/). The main objective of it is to catalyse the full operations of the EMSO distributed Research Infrastructure, through the development and deployment of the EMSO Generic Instrument Module (EGIM) [10], [11] EGIM will provide accurate, consistent, comparable, long-term measurements of ocean parameters, which are key to addressing urgent societal and scientific challenges. SARTI team leaded the test period of EGIM, which was deployed near OBSEA, at 20 meters' depth, from December 2016 to April 2017.

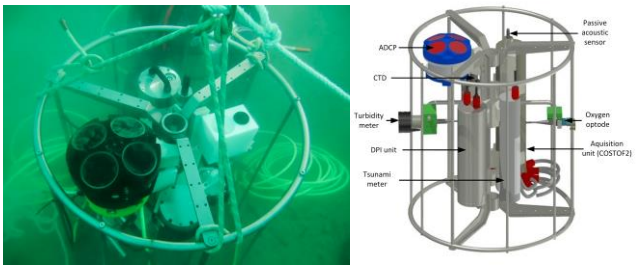

Figure 8 At left, EGIM system deployed at OBSEA surrondings and, at right, EGIM scheme

JericoNext (http://www.jerico-ri.eu/) is a H2020 project which objective consists in strengthening and enlarging a solid and transparent European network in providing operational services for the timely and continuous and sustainable delivery of high quality environmental data. UPC contributed to the harmonization and "best practices" report [12] about underwater cabled observatories and has offered its infrastructure to Transnational Access (TNA) calls, in which it has received three purposes to be evaluated:

➢ Evolul. Evologics, from Germany, brings different acoustic modems that will be deployed at seabed in order to characterize the error in the positioning study.

➢ FoulStop. In this project, Ifremer (France) and UPC (Spain) pretend to study the biofouling activity in the lens of underwater cameras.

➢ Advance. The ISMAR-CNR from Italy is interested in carry out a biologic monitoring study on Mediterranean shallow water.

Finally, **EmsoLink** kick off meeting took place on April 2017. SARTI group has the responsibility of apply different communication standards in order to facility the plug'n'play sensor operation in marine platforms, specifically at EGIM from EMSO. UPC has a large experience on this field and has a big background from

NeXOS project.

C. EMRP calls

In the framework of "ENV 58. Metrology for essential climate variables" the project **Meteomet2** has been developed. A new technique to perform traceable temperature measurements of the sea water profile and sea water surface is being studied, developed and applied to a real situation (OBSEA). This new thermometer consists on several Bragg gratings located at different points along an optical fiber, getting a thermometer based on distributed temperature sensor, that will be used to measure the sea water temperature profile (Figure 9 Scheme of the deployment of the Meteomet2 fibers). This technique will provide additional and valuable information about the evolution of the sea environment behavior [13].

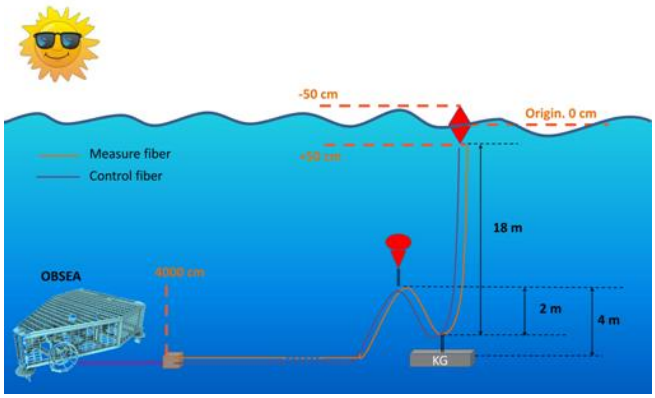

Figure 9 Scheme of the deployment of the Meteomet2 fibers

D. National Founding

SARTI group is involved too in some national projects. Motivated by the eruption of El Hierro (2011-2012) and the Earthquakes at the Alboran sea has born the **INTMARSIS** project [14], [15]. The main purpose of it is to design and deploy a near real-time Seismic Station. INTMARSIS sytem is composed by an Ocean Bottom Seismometer that transmits data to the surface through a mooring line (Figure 10). The communication is done thanks to an inductive link between the seafloor OBS and the surface buoy that sends packages each second. Then, from the surface, data is sent to the land with a GSM link. The advantages of this project is having near-real time data from a seafloor OBS but it's limited by it is battery pack which it is designed to last for at least 3 months.

IV. STUDIES AVALAIBLE

The variety of studies at OBSEA is large. From stability of the instrumentation, drift, biofouling action among others. Having data at real time and being operable easily by divers offers the possibility to evaluate the results and act accordingly in a short period. SARTI group is open to receive new challenges and offers their facilities to the scientific community.

ACKNOWLEDGMENT

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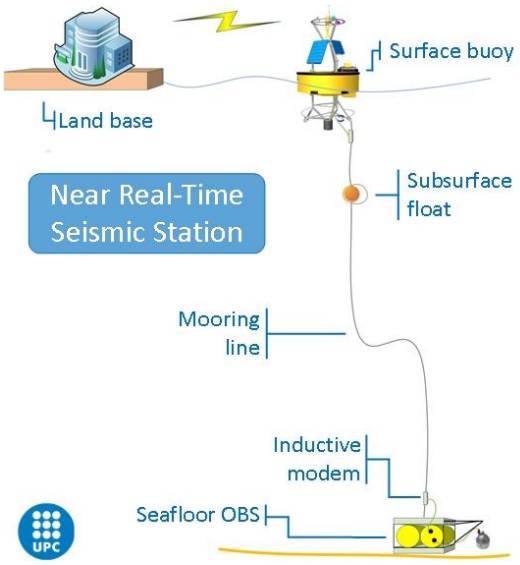

Figure 10 Near Real-Time Seismis Station scheme, INTMARSIS

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Figure 11 OBSEA underwater observatory