D9.3– Mediterranean Sea Demonstration Report:
Report on demonstration of sensor systems in the Mediterranean

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Deliverable 9.3 – Mediterranean Sea Demonstration Report:

Report on demonstration of sensor systems in the Mediterranean

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Abstract

This report is Deliverable D9.3 in the NeXOS project. It describes the efforts in demonstrating the Ecosystem Approach to Fisheries (EAF) sensor system and passive acoustic sensors in the Mediterranean Sea (Task 9.3).

There have been variations compared to the original program that has affected the demonstration activity in the Mediterranean Sea. First, the original plan to simultaneously equip a fishing vessel with EAF and A2 passive acoustics sensor systems turned out to be unworkable. Consequently, the two systems were demonstrated separately, with the EAF installed on a fishing vessel (MED3) and another version of passive acoustic sensor, the A1.hybrid (i.e., featuring Serial + Ethernet comms), installed on the TeleSenigallia fixed platform (MED1). A further demonstration mission was added, involving the installation of an A2 passive acoustic sensor system in the OBSEA cabled observatory (MED3). The latter replaces the demonstration originally planned in ESTOC (Task 9.1).

Demonstrations of the three missions are delivering real-time and near-real time data to the standard OGC Sensor Web Enablement (SWE) based Services, from which data streams are displayed on a SWE data visualization client. They will also be displayed on the screens of the PLOCAN operation room during the final stakeholders day during the last General Assembly. Data are encouraged to be made available through the Global Earth Observation System of Systems without any restrictions (on discovery, access or use).

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1. Common Background

This document describes the final Demonstration phase of the NeXOS project held in the Mediterranean Sea for the "Ecosystem Approach to Fisheries" (EAF) probes and the passive acoustic sensors developed within the project. This is the last important phase, aiming at demonstrating the value of the NeXOS approach and takes place on selected platforms after the integration and validation of the sensors. Reported in this document is the effectiveness of integrating such sensors into particular platforms for specific purposes or applications into realistic operational scenarios (developed in the Deliverable D1.2) under mission control services (SWE, SOS) allowing data handling and visualization (interoperability). The final purpose is to demonstrate the path from the sensor to the web-based dissemination tool via sensor platform to an end-to-end approach.

Demonstration missions were carried out following the plans developed in Deliverable D8.4; in particular, have regarded the following user scenarios:

- Characterising the underwater soundscape with a focus on areas where human activities take place (MED1 and MED2)
- Observations for sustainable fisheries (MED3).

Three platforms were selected in the Mediterranean Sea and paired with the NeXOS sensors as summarized in Table 1. Sensors and platforms are described in detail in Deliverables D8.1 and D8.4.

Table 1: Platforms and Sensors for each Demonstration Mission in the Mediterranean Sea.

Mission	Platform name and type	Partner owner	Sensor name and type	Sensor owner	Contacts
MED1	TeleSenigallia Stand-alone mooring (pylon)	CNR	A1.hybrid Passive acoustics	SMID	Platform: pierluigi.penna@an.ismar.cnr.it Sensor: a.figoli@smidtechnology.it
MED2	OBSEA Cabled observatory	UPC	A2 Passive acoustics	SMID	Platform: joaquin.del.rio@upc.edu Sensor: a.figoli@smidtechnology.it
MED3	Fishery and Oceanography Observing System (FOOS) installed on a commercial fishing vessels	CNR	EAF.4 DO & EAF.6 FLUO Ecosystem Approach to Fisheries sensors	NKE	Platform: michela.martinelli@an.ismar.cnr.it Sensor: dmalarde@nke.fr

2. Demonstration reports

This chapter provides the reports from the demonstration missions in the Mediterranen Sea. It is organized into compact forms to allow for an easy overview.

2.1 MED1: TeleSenigallia pylon and A1 hybrid sensor

***NeXOS* Demonstration report**	
Sensor(s) name: Passive Acoustic A1. hybrid	Sensor owner(s): SMID
Platform name: TeleSenigallia pylon	Platform owner: CNR
Mission leader(s): Pierluigi Penna	Involved partners: CNR, SMID, 52North, UPC

Mission motivation

Sound levels in the ocean are not constant but differ from location to location and change with time. Different sources of sound contribute to the overall noise level, including shipping, breaking waves, marine life, and other anthropogenic and natural sounds. At low frequencies (20–500 Hz), the background sound level is dominated by noise from distant ships in many places in the ocean, even when there is no ship nearby. When a large ship passes close to a receiver, the noise that is generated will temporarily increase the sound levels at that location substantially.

Noise from ships has the potential to mask or disturb the communication of acoustically active marine mammals and results in changes in their behaviour such as (i) reducing the communication distance between the animals, (ii) increasing the amplitude of vocalisations and (iii) reducing calling rates (Chen et al. 2017).

The mitigation of shipping noise pollution is therefore integral to marine spatial planning in the shelf seas. The International Maritime Organisation (IMO) recently released guidelines for the reduction of underwater shipping noise (IMO, 2014 MEPC.1/Circ.833). Anthropogenic underwater noise has also recently been recognised as a form of pollution, according to European legislation through the Marine Strategy Framework Directive (MSFD descriptor 11: 2010/477/EU). For low frequency noise, policy requires monitoring of trends in the ambient noise level within the 1/3 octave bands of 63 and 125 Hz (centre frequency). With chronic persistent noise, a comprehensive approach is required since both the source (ship) and the receiver (mobile marine species) are moving through space and time; this provides an additional challenge to assessing sound exposure.

This demonstration mission deals with assessing the effectiveness of integrating the A1.hybrid passive acoustics sensor into the TeleSenigallia fixed platform in the Adriatic sea with the purpose of monitoring the MSFD Indicator 11.2.1 continuous noise.

Sensor description

The A1.hybrid sensor is a compact, low power consumption digital hydrophone with embedded pre-processing of acoustic data, and with OGC PUCK and SWE interoperability standards implemented. The A1.hybrid enables acoustic measurements and characterization of underwater noise, detection of bio-acoustic or other soundscape sources. It is mainly designed to be used on mobile and fixed platforms with limited autonomy and/or limited communication capability. Ethernet capability also extends usability to arrays and synchronised sound streaming from more power and bandwidth capable platforms (A2). For more details, see Deliverable D8.1.

The transducer used in this A1.hybrid is J-S B100.

Figure 1: The A1.hybrid sensor installed on the TeleSenigallia platform.

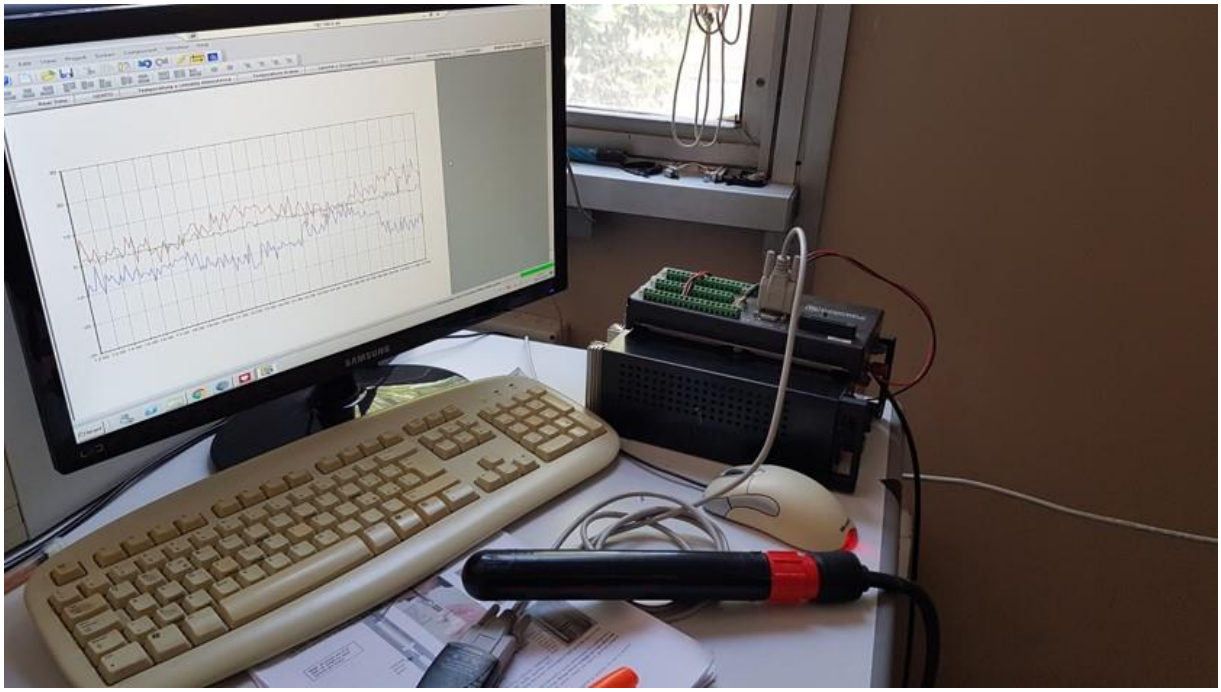


Figure 2: Laboratory test of A1.hybrid operation after shipment to CNR-ISMAR.

Platform description

CNR manages several multi-parameter observation systems, most of which are placed along the Italian coast and transmit real-time data to the receiving stations along the coast.

The platform TeleSenigallia pylon (water depth 12.5 m) is placed at 43°45.350'N, 13°12.540'E (Fig. 3), 1.2 nm offshore and 2.5 km from the town of Senigallia (AN).

It is equipped with meteorological (Wind Speed, Gust and Direction; Air Temperature; Relative

Humidity; Power monitoring) and marine sensors (Water Temperature, Water Salinity, Oxygen Concentration, Fluorescence, CDOM, Turbidity, Water current profile with ADCP current meter).

Data are collected every 10 minutes in a Campbell Scientific datalogger installed on board the pylon. A dedicated server placed in Ancona calls the remote datalogger every hour by using a GPRS modem. The collecting system onboard is powered by solar panels with 3 rechargeable batteries.

The TeleSenigallia pylon represents a good site for observation of the inter-annual variability of the physical, chemical and biological (phytoplankton communities) characters of water masses entering and leaving the northern Adriatic Sea. The study of the interannual variability of physical parameters, trophic conditions and phytoplankton communities, represents a powerful tool for assessing the magnitude of occurring climate change. Moreover, facing one of the high traffic areas of the North Adriatic Sea, the implementation of passive acoustics measurements in the site is an opportunity to monitor shipping activity and its impacts on marine animal populations for the purposes of marine spatial planning.

Platform website: http://rmm.an.ismar.cnr.it/index.php/meda-senigallia

Figure 3: Image of the emerging part of the TeleSenigallia pylon and the map of location.

Transversal innovations

A CR1000 datalogger (produced by Campbell Scientific) manages the data acquisition system of TeleSenigallia Pylon. A dedicated underwater connection cable between A1.hybrid sensor and datalogger was designed and implemented in order to install it on the selected platform. Both the datalogger and the CNR datacentre on land were updated in order to manage the new data produced by the A1.hybrid sensor. The data stream to the SOS was prepared and tested in the laboratory with the help of 52N and UPC.

CR1000 polls A1.hybrid each minute via serial link using the commands <MEASURE:TEMPERATURE?> (i.e. here processor temperature – not ambient), and <MEASURE:NOISE?>. With the last command, the sensor replies with a string of 6 floating point parameters as in the following:

147.331223,139.698120,151.252502,144.774811,136.427155,149.564545.

Thus representing the sound pressure level in water at frequencies of 63 and 125 Hz (the two frequencies whose monitoring of trends is required by the MFSD policy), and their respective L10 and L90 percentiles.

Every 10 minutes, CR1000 calculates averages for the 6 parameters and stores them in its internal memory.

Every hour, the remote station calls CR1000 via GPRS connection and a dedicated software stores all the collected data into a MySql database.

Each night during the demonstration phase, a dedicated bash script provided by UPC runs on the CNR server, thus ensuring a push mechanism in order to upload the data on the NeXOS SOS.

The sensor is feeding the SOS since 20th of July 2017, when it was installed on the platform at a depth of about 5 m.

Plots of recorded time series can be accessed via the NeXOS Sensor Web Visualization Server (http://www.nexosproject.eu/dissemination/sensor-web-visualization). The procedure for accessing data from TeleSenigallia pylon follows:

1) Selection of **NeXOS Test SOS Server** in the menu **Provider** (Fig. 4a) redirects to the **Map**.
2) Clicking on the station in the Map (Fig. b) opens a menu with parameters available (Fig. 4c)**.**
3) Selection of one or more **parameter** in the list and pressing the OK button at the end of the page redirects to the visualization of the respective **Timeseries** (Fig. 4d)**.**

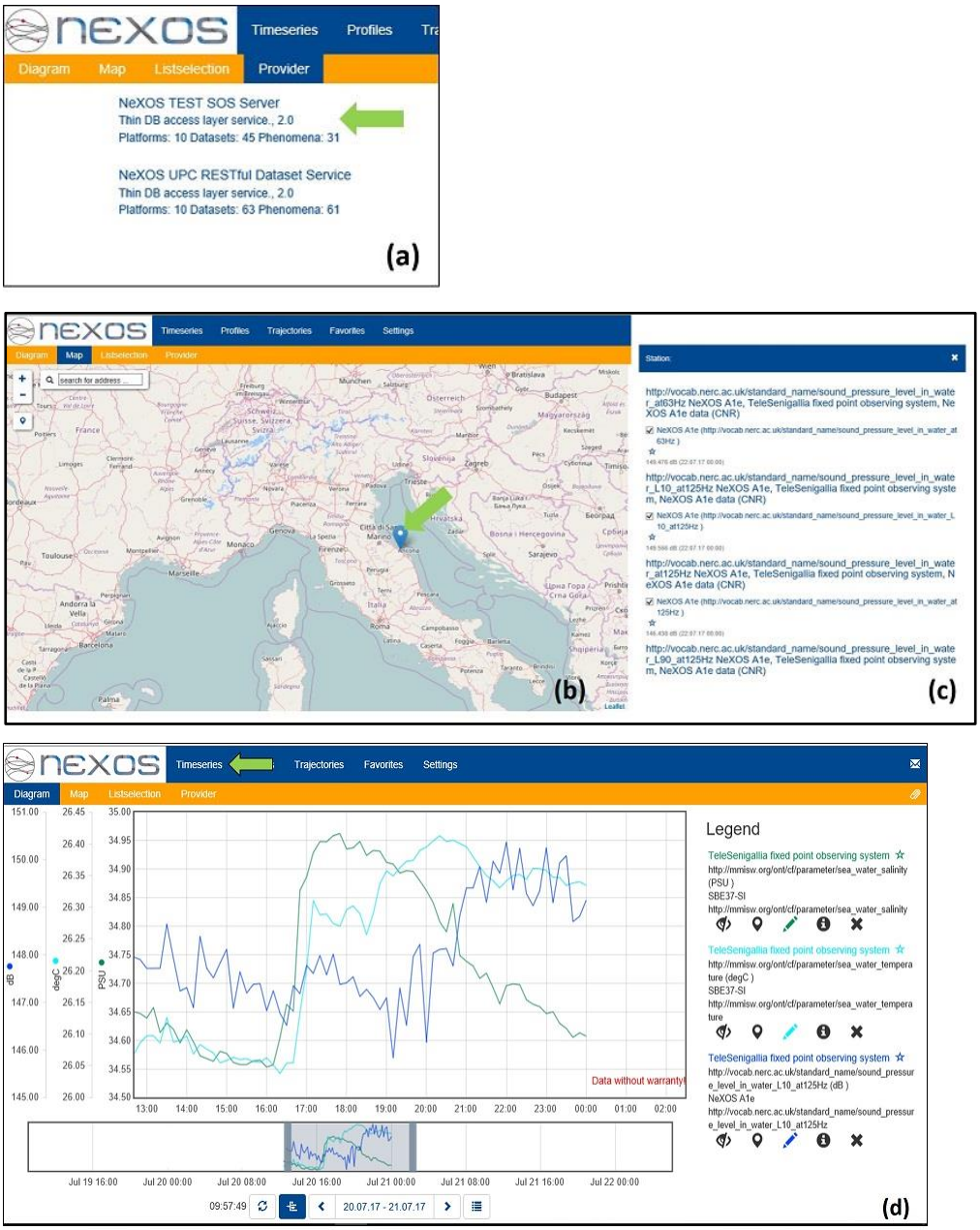


Figure 4: SOS server screens that illustrate the procedure for accessing time series data for the TeleSenigallia pylon.

Mission report

The Adriatic Sea is a continental basin and its circulation and water masses are strongly influenced by atmospheric conditions, mainly winds. The northernmost part is very shallow (about 50 m) and is highly influenced by the large amount of fresh water coming from the Po River, which spreads southward along the Italian coast.

It is also part of Corridor 6 (Trieste – Igoumenitsa – (Volos) – Limassol – Izmir – Tartous / Beirut), a great maritime artery that sets itself as a shortcut to Eastern trades (MEDA TEN-T, 2006). The trend of transport and maritime traffic follows the general one in the Mediterranean and sees the constant growth of varied freight traffic, passenger traffic and petroleum products traffic.

The TeleSenigallia pylon is positioned close to one of the high traffic areas of the North Adriatic Sea (Fig. 5).

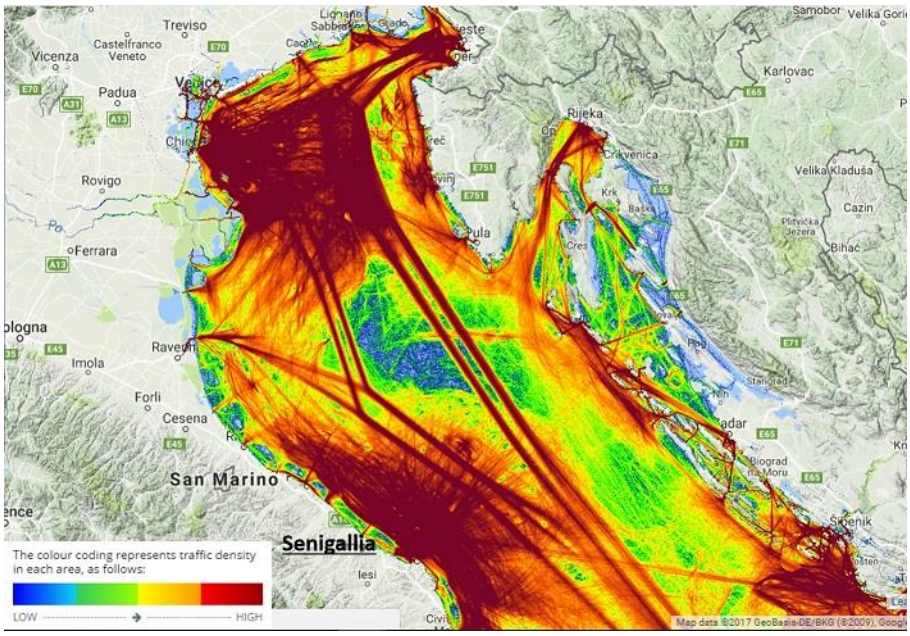


Figure 5: Shipping density in the North Adriatic as reported by Marine Traffic (https://www.marinetraffic.com) for the years 2015 and 2016. The color coding is based on a rather compound algorithm. It represents traffic on a daily basis and count positions per square km. Roughly, Blue = less than 30, Green = 30 to 70, Yellow = 70 to 140, Red = more than 140.

The A1.hybrid has been programmed to return measurements of the **sound pressure level in water** at frequencies of 63 and 125 Hz (the two frequencies whose monitoring of trends is required by the MFSD policy). By definition, sound pressure is the difference from the local ambient pressure caused by a sound wave at a particular location and time. Sound pressure level in water is expressed on a logarithmic scale with reference to a sound pressure of 10^{-6} Pa : Lp = 20 log10 (p/p0), where Lp is the pressure level in dB (decibels), p is the RMS sound pressure and p0 is the reference sound pressure.

Figure 6 shows the time series of RMS sound pressure levels obtained from the A1.hybrid sensor at frequencies of 63 and 125 Hz, as reported in the NeXOS Test SOS Server at the date of 24 July 00:00 hrs. The related basic statistics are summarized in Table 2.

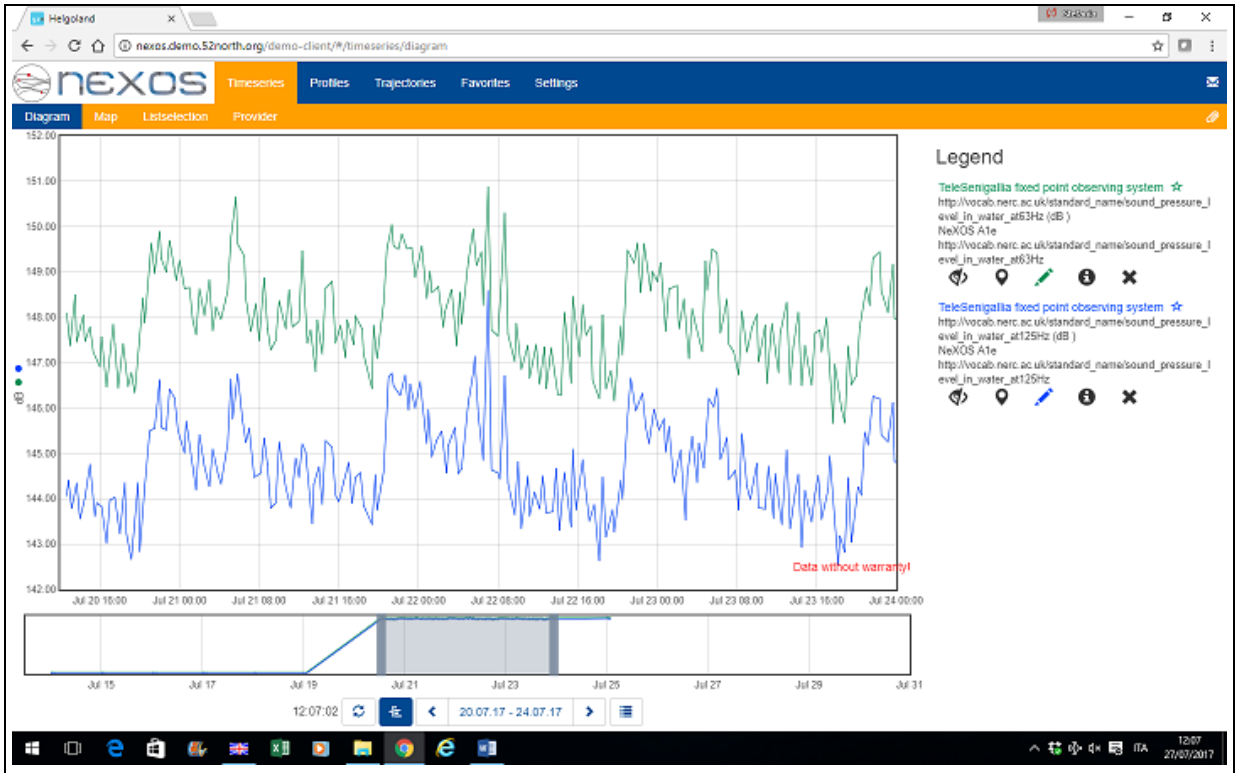


Figure 6: Time series of RMS sound pressure level in water at 63 Hz (green) and 125 Hz (blue), starting from the date of use of the sensor A1-hybrid in the TeleSenigallia site until July 23, 2017.

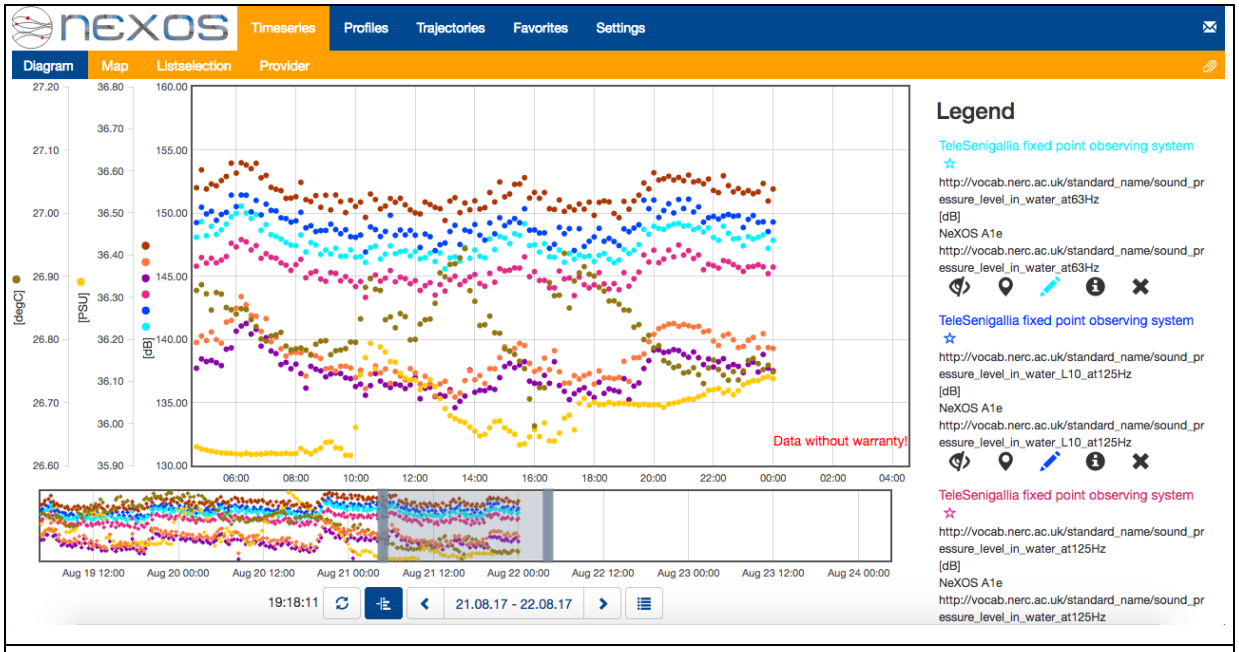
Table 2: Basic statistics calculated for the sound pressure levels at 63 Hz and 125 Hz recorded at the TeleSenigallia site from July 20 to July 23, 2017.

Frequency	Mean	St. deviation	Minimum value	Maximum value
63 Hz	148.0	0.9	145.5	150.9
125 Hz	144.7	1.0	142.5	148.6

The values of both the frequencies are higher than expected (90-100 dB is a reference for this area). After a discussion involving PLOCAN, UPC and CTN, it was determined, that the firmware of the sensor was not updated and the version used does not yet account for the actual sensitivity of JSB100 hydrid A1 hydrophones. Consequently, a change of the firmware is deemed. Due to planning access to the platform in order to perform such an upgrade in a short time, the adopted solution was to continue the mission without changes to the sensor and to perform a correction of the results, taking into account the hydrophone used in the mission as well as channel, gain and equalizers used. CTN will prepare the correction script to apply the correction to the present results.

Despite the problem found with the values calculated by the filter algorithms, this mission has demonstrated the chain from the A1.hybrid hydrophone/TeleSenigallia platform to the final visualization in the NeXOS Sensor Web client, allowing data handling and visualization.

Update on 22/08/2017



Author list:

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2.2 MED2: OBSEA and A2 sensor

***NeXOS* Demonstration report**	
Sensor(s) name: Passive Acoustic A2	Sensor owner(s): SMID
Platform name: OBSEA	Platform owner: UPC
Mission leader(s): Joaquin del Rio (UPC)	Involved partners: SMID, CTN, UPC, PLOCAN
Mission motivation	
The objective of the mission is the demonstration of the potential of the A2 system to estimate direction of arrival, based on precisely synchronised digital data streams. In essence, the scenario is to track in real time a specific sound source. A boat is used as the sound source, moving near the OBSEA area. The A2 system is expected to estimate the angle of arrival of the sound generated by the boat and display this information in real time on the NeXOS viewer using the SWE architecture. For practical reasons this scenario has therefore been limited in scope (e.g. no pre-processing of acoustic information occurs in the demo, nor are other acoustic sources considered). The demonstration only illustrates the additional potential of using WP6 developments in array configuration.	
Sensor description	
The A2 is a digital passive acoustic transducer array, the output of which (digital raw signal) is pre-	

processed by a master unit. A detailed description of A2 can be found in Deliverable D6.3. The following is a summary of the main features:

The A2 array is also equipped with position sensors (pan, tilt, compass).

A2 will also allow the integration of additional oceanographic sensors (to measure sound velocity, temperature, depth) for real-time propagation modeling.

All signals (acoustic, position, oceanographic) are digitized and made available on a serial output line for proper transmission and pre- and post- processing.

A2 array is composed of:

- Four digital new NeXOS hydrophones, so-called A2hyd, based on A1 development.
- One Master Unit.

Each A2hyd serves acoustic data to the Master Unit through a serial digital port with Ethernet protocol.

The Master Unit manages the time synchronization of the four A2hyds for near-simultaneous sampling.

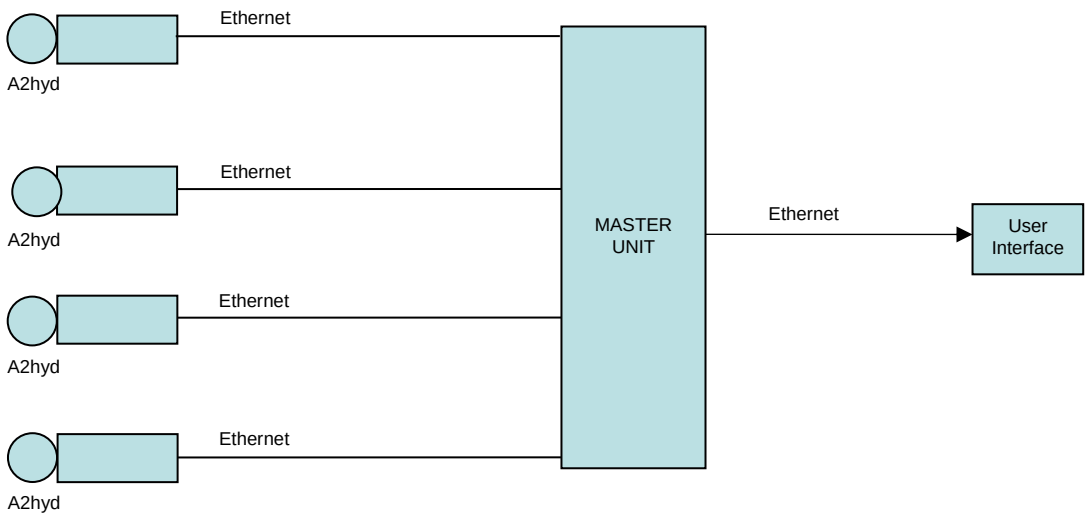


Figure 7: A2 architecture.

The hydrophone A2hyd is equipped with two amplifier stages with different gains in order to match the project requirement in terms of dynamic range, 130 dB.

Signals are sampled by two 16-bit SAR converters and controlled by the microcontroller (MCU).

Filters have been added in the chain to avoid aliasing problems.

JS-B100 transducers were chosen for future deployments at greater depths..

The Master Unit is based on the ODROID C2 from Hardkernel. The ODROID-C2 is a 64-bit quad-core single board computer (SBC) that is one of the most cost-effective 64-bit development boards available in the ARM world. The ARM processor's small size, reduced complexity and low power consumption, make it very suitable for miniaturized devices such as wearables and embedded controllers.

The main features of the Master Unit are:

- Amlogic ARM® Cortex®-A53(ARMv8) 2Ghz quad core CPUs
- Mali™-450 GPU (3 Pixel-processors + 2 Vertex shader processors)
- 2Gbyte DDR3 SDRAM
- Gigabit Ethernet
- HDMI 2.0 4K/60Hz display

- H.265 4K/60FPS and H.264 4K/30FPS capable VPU
- 40pin GPIOs + 7pin I2S
- eMMC5.0 HS400 Flash Storage slot / UHS-1 SDR50 MicroSD Card slot
- USB 2.0 Host x 4, USB OTG x 1 (power + data capable)
- Infrared(IR) Receiver
- Ubuntu 16.04 or Android 5.1 Lollipop based on Kernel 3.14LTS

The Master Unit is composed of:

- Processing Unit
- PTP Grandmaster Clock
- Auxiliary serial port for Positioning Unit (pan tilt compass & depth), optionally Sound Velocity Profiler and GPS.
- One Ethernet Switch.

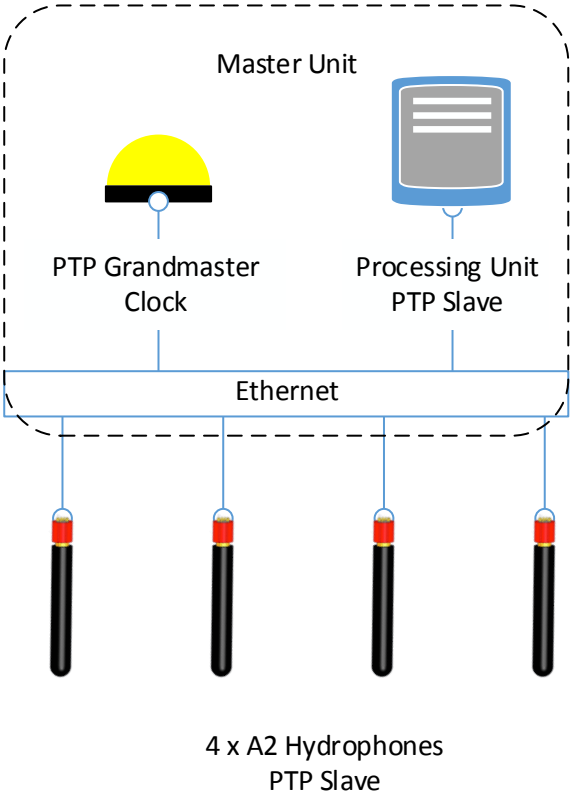


Figure 8: A2 architecture with Master Unit Components.

Platform description

The A2 system is deployed on the underwater-cabled observatory OBSEA.

OBSEA is a cabled seafloor observatory located 4 km off the Vilanova i la Geltru coast in a fishing protected area. It is connected to the coast by a power and communications cable.

The main objective of this site located in the Western Mediterranean is to be a test bed for the development of oceanographic instrumentation while being a shallow-water observatory providing real time data and a database with historical values.

OBSEA offers the possibility to deploy different types of measurement instruments, communication modules or scientific experiments, and allow real time communication with your deployment.

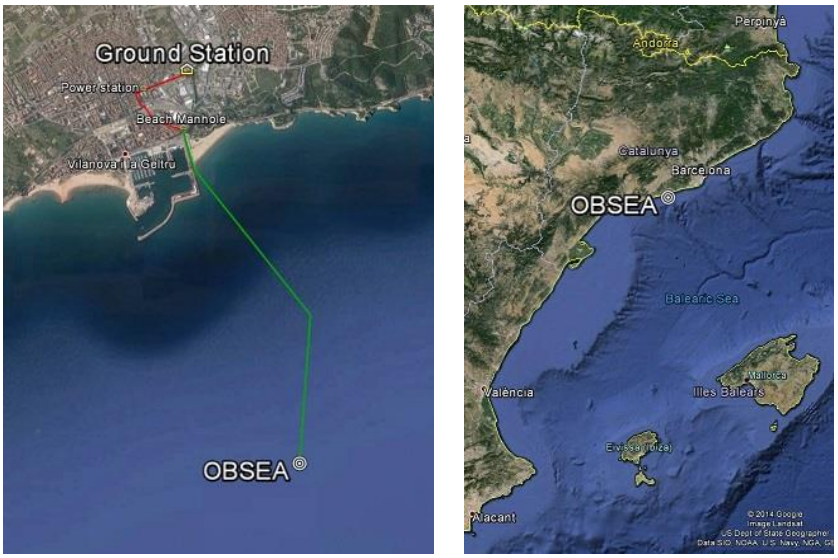
Devices can be deployed at 20m depth or at the surface buoy.

OBSEA offers power supply, Ethernet and serial communications, and synchronization over PTP IEEE Std 1588. Continuous real-time communication is provided, allowing real-time monitoring of the experiment for the full duration of the experiment.

A small boat and scuba divers are available in order to reach OBSEA, deploy the instrumentation and plug it to OBSEA.

An informatics team will support the communication with your instrument, the data quality control and several output formats for archiving.

Master CLK for IEEE std.1588 Precision Time protocol acts as a master clock on the network providing synchronization. It is connected to a GPS.



Ground Station: 41.2235ºN 1.7363ºE

Sea Station 41.1819°N 1.7524°E

Figure 9: Maps of location of OBSEA components.

Table 3: OBSEA fixed point observing system: components and equipment.

Measuring component	**Coordinates**	**Equipment**
Surface buoy: OBSEA buoy	41.1820°N 1.7527°E	Weather station (Temperature, pressure, wind, GPS, compass) and camera.
Coastal cabled system: OBSEA node 1	41.1819°N 1.7524°E	CTD, Hydrophone, Camera, AWAC waves and current meter, Seismometer
Meteorological Station: Meteo Land	41.2235ºN 1.7363ºE	Temperature, Humidity, Wind, Rain, Pressure, CO2.

Transversal innovations

The A2 system embeds several NeXOS transversal innovations:

Multifunctional: the same hardware is able to cover different applications. As a programmable Passive Acoustic Monitoring System (PAMS), the master unit can execute different algorithms processing data acquired by the digital hydrophones.

NeXOS Architecture: the digital hydrophones implement the OGC PUCK protocol.

SWE: Data will be visualised through the NeXOS SOS client. This implies many advantages as all the validation and demonstration missions within the Nexos project are visualized through the same interface following the SOS standard: To accomplish this requirement, on the one hand, a specific application has been developed to generate proper O&M files with time stamp and geographical information of the boat. These applications are executed by the computer on board the boat and inject data into the SOS database with the boat position. On the other hand, the Master Unit of the A2 system computes the angle of arrival of the sound source. This information is also formatted as O&M files and injected into the SOS database, where both boat position, and estimated angle of arrival are printed on the client.

The following figure shows the positions of the 4 A2 hydrophones and 3 positions of the boat:

Figure 10: Positions of the four A2 hydrophones and three positions of the boat during the demonstration mission.

Mission report

The A2 was deployed at OBSEA on June 7th, 2017. A spatial configuration mapping of the system is shown in the following figure.

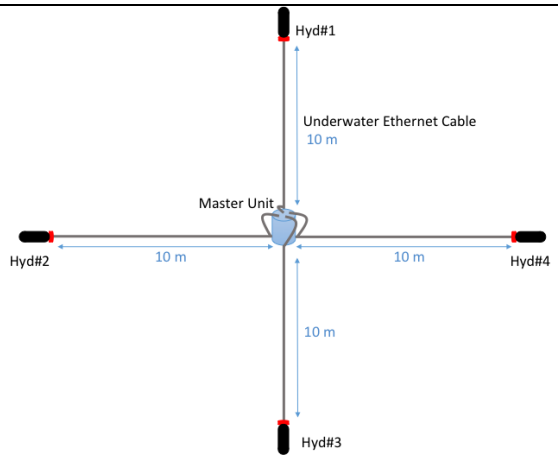


Figure 11: Plan drawing of the spatial configuration of the A2 system composed of 4 hydrophones connected to the Master Unit. The Master Unit is connected to OBSEA in order to have power and real-time communication to shore.

The deployment was executed with a small boat and scuba divers who deployed all the devices with its added weights on the sea floor. After the deployment, the real location of each component is shown in Fig. 12:

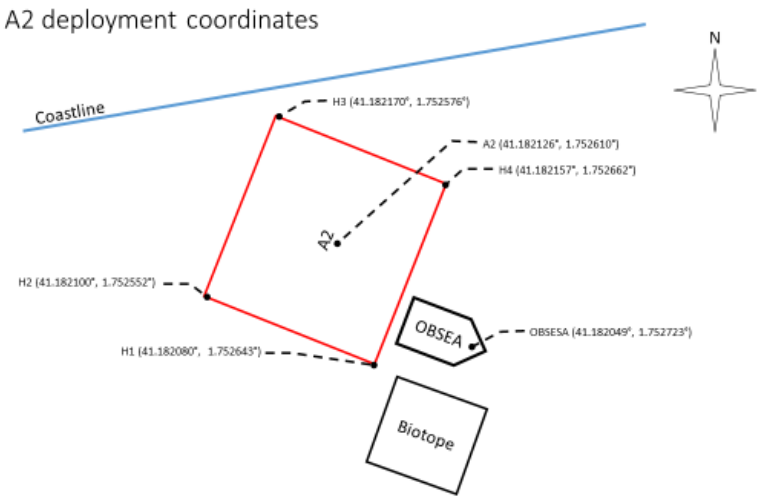


Figure 12: Present location of each component once connected to OBSEA. Hydrophones (H1,H2,H3,H4) and the Master Unit

After the first validation tests, time sync calibration was needed: different parameters of the algorithms have been improved. These are explained here:

1. **Correlation algorithm**

Some parts of the algorithm were not functioning properly due to a problem of a filter output, and a wrong array dimension interpretation. These problems have been solved, and now the correlation works.

2. **Time synchronization**

The 4 hydrophones were not synchronized during the first tests. Now the hydrophones are synchronized through IEEE 1588 protocol, all hydrophones are synchronized using a GPS master clock and its Ethernet connection.

The timestamp sent for each hydrophone is a nanoseconds counter between 0 ns and 10^9 ns (which is between 0 and 1 second). This timestamp is set to 0 every second.

The Master Unit (ODROID) uses four parallel processors to read and buffer each hydrophone data stream (timestamp, packet number, and signal value). In order to synchronize the 4 channels, the zero-cross of the received timestamp to start the buffering is used. This gives a first rude synchronization, with an accuracy of a few microseconds, as can be observed below.

Timestamp Hydrophones[0,1,2,3] in ms = [0.860, 4.430, 0.490, 2.790] ms

After this first synchronization a fixed quantity of UDP packets (digitized signals), for example 20, are stored, analysed and saved in an ASCII text file. That means that 102.4 ms is computed at each time, with a resolution of 10 microseconds, which is a resolution of 1.5 centimetres.

(UDP Packets) x (512 samples) / (100000 sampling frequency) = 102.4 ms

Then, a second synchronization step is executed for each of these intervals to obtain a more accurate result, as can be observed below. The initial value for all four timestamps are the same.

INIT: timestamp0=4.430, timestamp1=4.430, timestamp2=4.430, timestamp3=4.430

3. **Threshold detection**

The algorithm uses a threshold as event detector. Detection is followed by the positioning algorithm execution.

4. **Angle notification**

The result obtained with the positioning algorithm is sent using a UDP connection to a computer on the network, which is in charge of sending this information to the final user.

The following picture shows the A2 Master Unit deployed at OBSEA. The four cables and ropes from the A2 to the hydrophones are shown in this picture.

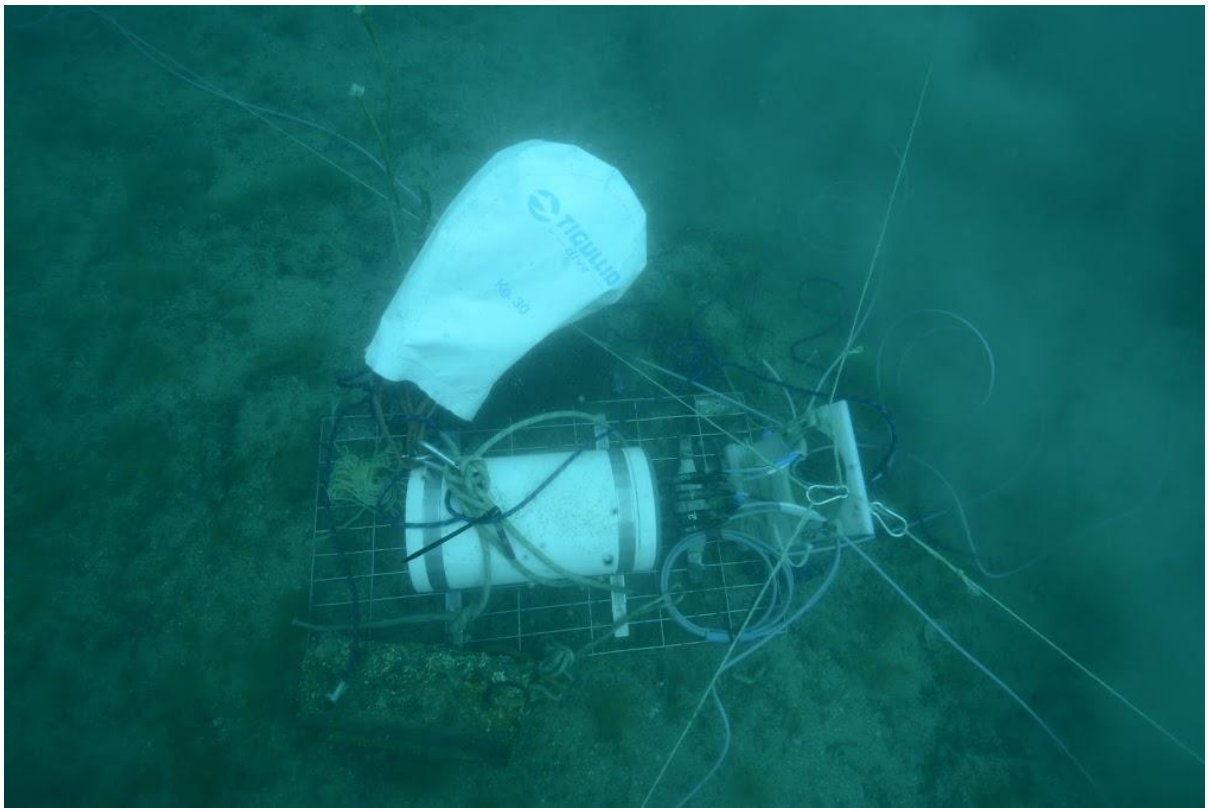


Figure 13: The A2 Master Unit deployed at OBSEA.

Following picture shows divers deploying one of the hydrophones (H3) and its support weight.

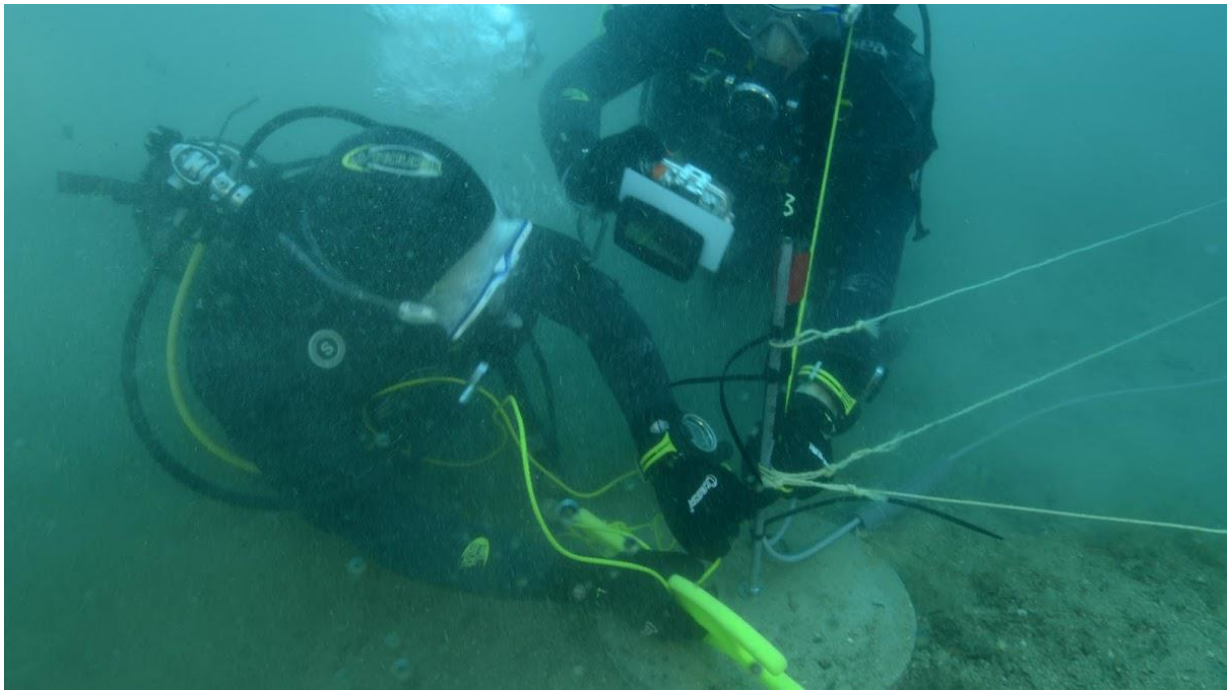


Figure 14: Divers deploying one of the Hydrophones (H3) and its support weight.

The following figures show the movement of the boat, heading from the A2 and distance to A2 through the NeXOS client.

The links to show the data are:

Distance A2-Boat: http://nexos.demo.52north.org/demo-client/#/trajectory/view?id=quantity_104&url=http://nexos.demo.52north.org/52n-sos-nexos-test/api/

Heading A2-Boat: http://nexos.demo.52north.org/demo-client/#/trajectory/view?id=quantity_103&url=http://nexos.demo.52north.org/52n-sos-nexos-test/api/

Or step by step following the configuration below:

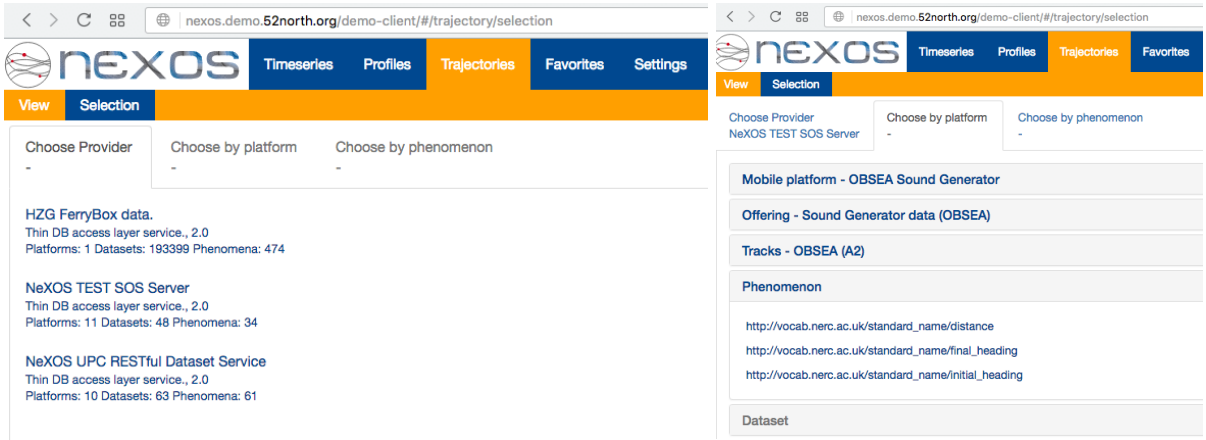


Figure 15: SOS server screens that illustrate the procedure for accessing track data for the OBSEA demonstration mission.

which produces the following maps and information:

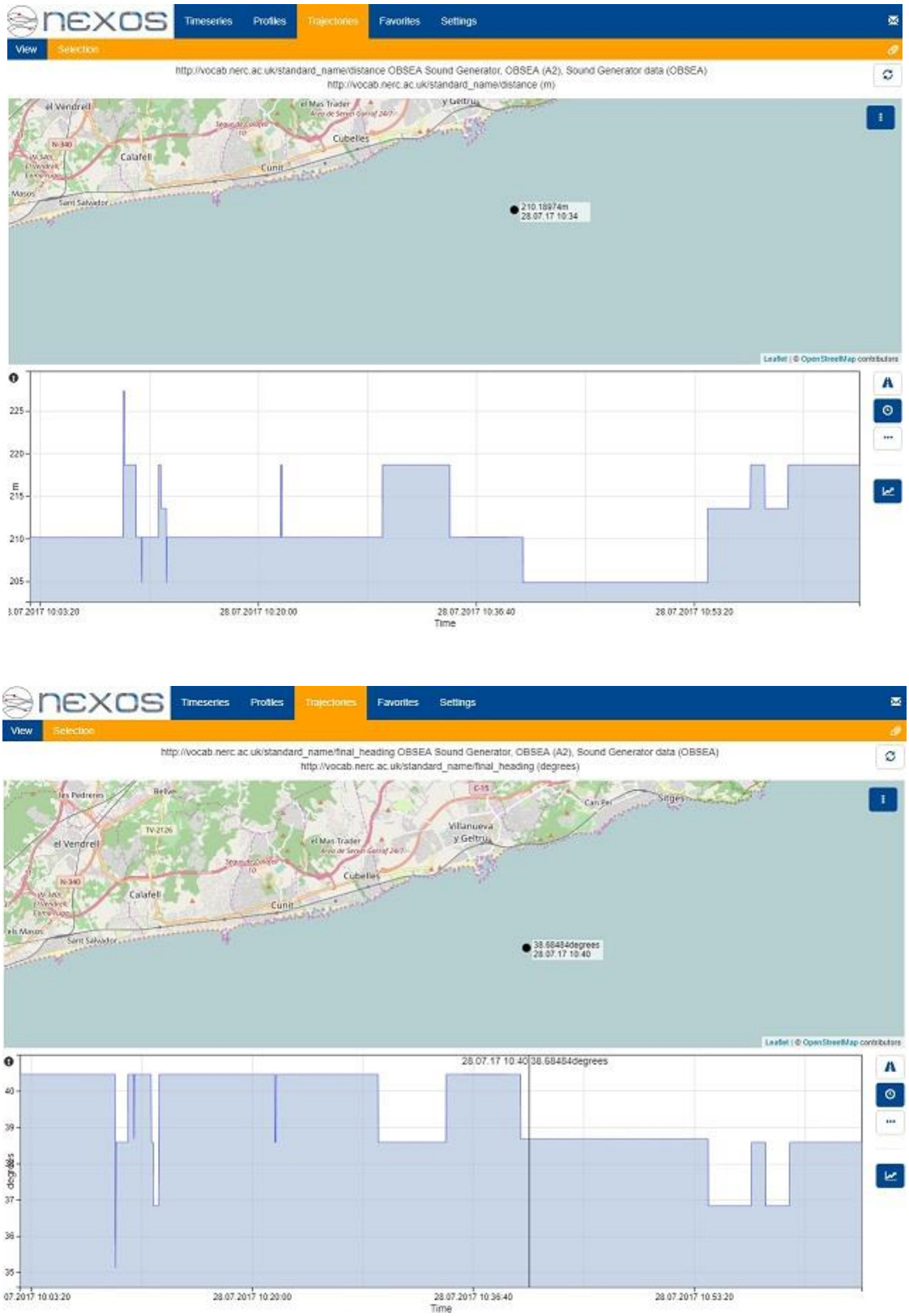


Figure 15: SOS server screens that illustrate the procedure for accessing track data for the OBSEA demonstration mission (continued).

More tests to characterize the error on the estimation of the angle of arrival will be executed during

August 2017 in order to be able to show a real time demonstration during the NeXOS General Assembly in September 2017.
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2.3 MED3: FOOS and EAF.4/EAF.6 sensors

NeXOS Demonstration report

Sensor(s) name: EAF.4 & EAF.6	Sensor owner(s): NKE
Platform name: FOOS on Fishing vessel	Platform owner: CNR
Mission leader(s): Michela Martinelli	Involved partners: CNR, NKE, 52North, UPC

Mission motivation

The aim of this mission was to demonstrate the possibility to collect environmental parameters during the fishing hauls in order to put them in relation with the catches. The collected information would be helpful both for scientific purposes (operational oceanography) and management options (ecosystem approach to fisheries management); allowing a better understanding of the whole ecosystem and the fish distribution patterns. Observing systems based on this approach were already available (e.g. FOOS in Italy and RECOPESCA in France) but the sensors developed through the NeXOS project were conceived to acquire two more environmental parameters, oxygen and chlorophyll-fluorescence, which are fundamental for a better comprehension of the environment dynamics.

Sensor description

The developed prototypes, EAF.4 and EAF.6, respectively allow the collection of depth/temperature/oxygen and depth/temperature/chlorophyll-fluorescence concentrations in the water column during the fishing operations. The sensors are compact and robust; designed specifically to be mounted on fishing gears and resistant to heavy stress. For more information, including the validation process, see Deliverable D7.3 and D8.2.

Figure 16: One of the EAF prototypes mounted on the fishing gear.

Platform description

The FOOS (Patti et al. 2016) is a modular observational system designed to be mounted on different types of fishing vessels. The FOOS already embeds the RECOPESCA system previously developed by NKE which allows the collection of some parameters in the water column during the fishing operations and sending them in near real time to a datacentre on-shore. The FOOS is installed on various fishing vessels operating in the Adriatic Sea, constituting the AdriFOOS observational network (http://www.ismar.cnr.it/infrastructures/observational-systems/adri-fishery-observing-system). In this mission, a bottom trawler belonging to the FOOS fleet has been selected for the demonstration of the new prototypes because oxygen and chlorophyll are two important parameters influencing the life history of the targeted demersal resources (e.g., hake, Norway lobster, prawns etc.).

Transversal innovations

The data collected by the sensors are transmitted on board via radio link to the NKE concentrator and then via serial link to the FOOS e-logbook, which then transmits them via GPRS to the CNR datacentre in Ancona. A routine developed through the project allows the direct transmission to the SOS and data visualization.

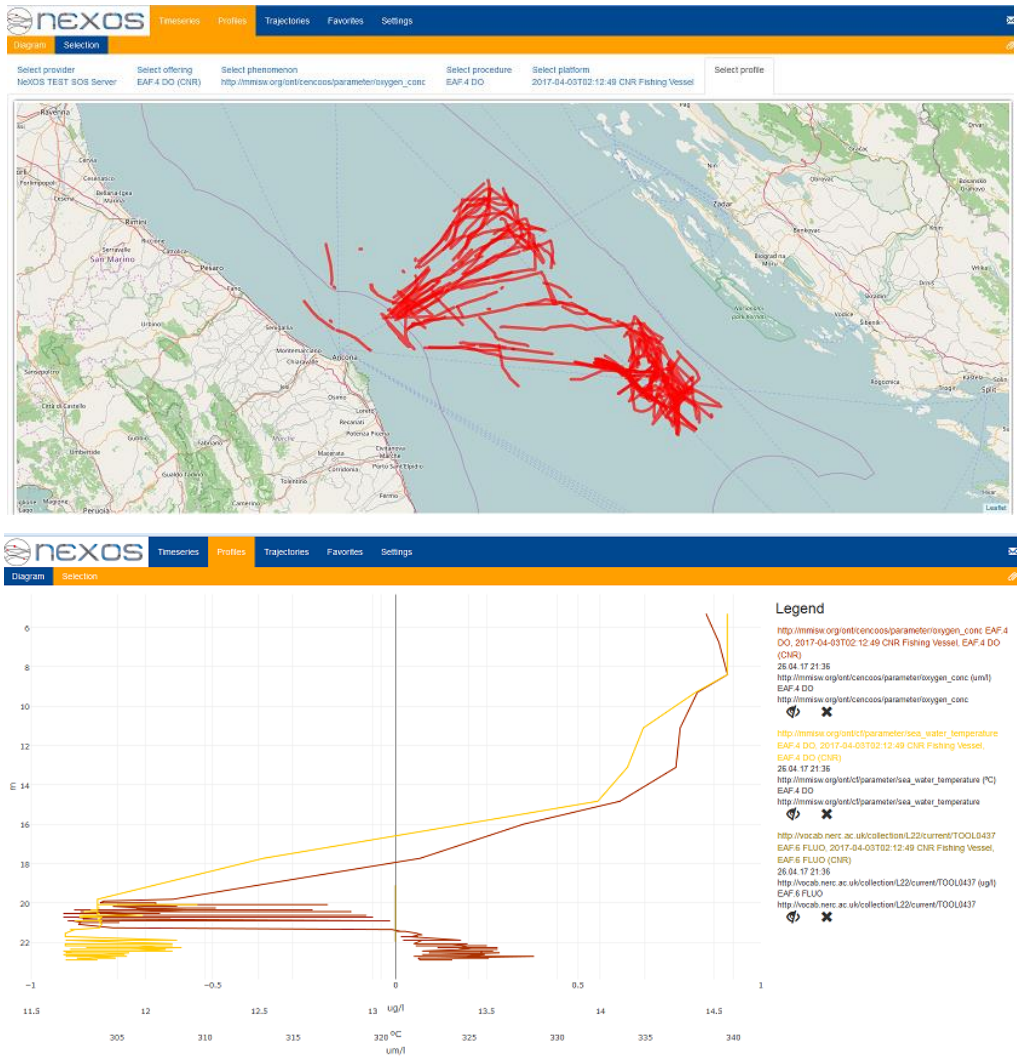

Figure 17: Map of the collected profiles and corresponding diagram showed in the NeXOS SOS repository.

Mission report

The Adriatic Sea is a continental basin of the Mediterranean Sea, located between the Italian peninsula and the Slovenian–Croatian–Montenegro–Albanian coasts with its major axis (about 800 km versus 200 km) in a NW–SE direction. The northern part is very shallow (about 50 m) and highly influenced by the large amount of fresh water coming from the Po River, which spreads southward along the Italian coast. The middle Adriatic is deeper reaching a depression of 270 m (Jabuka Pit), while the southern part has a maximum depth at 1250 m. The Adriatic Sea is one of the most productive regions in the Mediterranean because of numerous rivers and streams discharging their nutrient-rich freshwater into its shallow waters with limited external water exchange. The principal inflow occurs along the eastern coast (Eastern Adriatic Current—EAC) advecting warmer and high salinity modified Levantine Intermediate Water (LIW). However, the general circulation in the northern Adriatic is more complex due to wind stress and riverine inflows, producing both high spatial and temporal variabilities (Campanelli et al., 2011; Marini et al., 2014).

These particular oceanographic conditions strongly influence the spatial distribution of the resources, and this area represents one of the most intensively fished in Europe. Furthermore, shared stocks occur in this area and the fleets operating there include all segments, from small-scale fishery to large trawlers. The bottom-trawl fishery targeting demersal species takes place on the entire continental shelf and exploits a high number of species. Some environmental parameters may strongly influence the distribution of these species, thus a bottom trawler was selected to be equipped with the FOOS and become a demonstration platform for the new NeXOS EAF probes.

The sensors were first installed on the 3rd of April 2017, on the fishing gear (on an otter board, in order to be in a protected position and to allow collection of data through the water column and close to the bottom during the fishing operations; Fig. 18). After testing and validation (see Deliverable D8.2), trials on data transmission to SOS were carried out with the help of UPC and 52N.

In mid-May, the direct data transmission started and the environmental parameters collected by the two prototypes started streaming directly from the sensors to the concentrator on board, to the CNR data centre (via e-logbook and GPRS connection) and finally to the NeXOS SOS. The data arrive to the CNR data centre as soon as GPRS connection is available and are sent daily to the NeXOS SOS, which allows visualization of the collected datasets beginning on the 3rd of April 2017 to present (Fig. 17).

The prototypes demonstrated to be robust enough to resist the stress from the impact with the bottom of the fishing gear (helped by their positioning on the otter board). However, the EAF.6 went out of order on the 14th of June due to low battery levels (the possible occurrence of this problem was already reported in Deliverable D8.2: a continuous blinking of the Light Emitting Device (LED) of the fluorescence sensor). Nevertheless, the sensor was quickly recovered from the fishing vessels and sent to NKE for a battery change. On the 30th of June, it was reinstalled on-board and started to collect and send near-real time data again.

Problems needing to be solved: there is a LED that is always switched on consuming the battery too quickly; each time the battery needs to be changed, the sensor must be returned to NKE.

Discussion of results:

The environmental parameters collected via FOOS using the NKE probes for depth, temperature and salinity already demonstrated their value from the oceanographic and fishery biology point of view. These new probes represent an added benefit in the possibility of allowing a better comprehension of the environment.

The collected oxygen concentrations, post-processed using known values of salinity (see Deliverable D8.2) would be of great importance to be correlated with catches of different species (e.g. Norway lobsters burrowing into the sediment etc.).

The fluorescence sensors are, in general, known to be more difficult to calibrate and in this case showed a weakness in their battery endurance. However, they are still a good compromise and probably will be applied in other kinds of fisheries (e.g. small scale fishery in very coastal areas) with better results.

Regardless, both sensors used on this kind of platform and with near real time visualization options, have the potential to be effective tools for the rapid detection of environmental changes that may affect fish distributions.

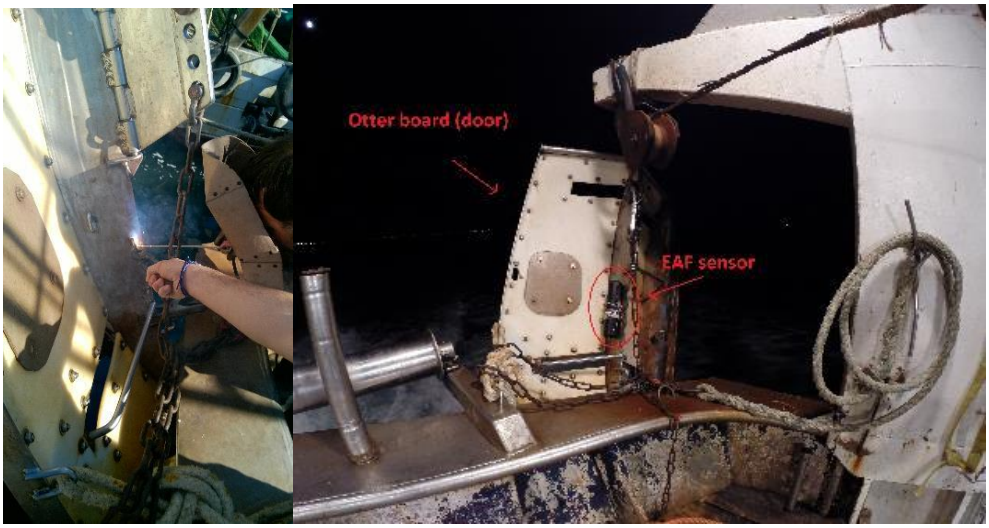

Figure 18: EAF sensor mounted on an otter board (door) which is part of the fishing equipment.

Figure 19: Stern of the bottom trawler fishing vessel during a fishing operation.

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3. Summary remarks

The original plan to simultaneously equip a fishing vessel with EAF and A2 passive acoustics sensor systems turned out to be unworkable. Consequently, the two systems were demonstrated separately, with the EAF installed on a fishing vessel (MED3 mission) and another version of passive acoustic sensor, the A1.hybrid, installed on the TeleSenigallia fixed platform (MED1). This is an extra sensor produced ad hoc by SMID for this mission and its integration in the platform was not planned and not accordingly scheduled in the Grant Agreement, as it was not the integration into a fishing vessel. As a consequence of this change of plans, the MED1 mission started delayed, since the production and integration of the sensor in the platform required extra time. Therefore, this entails the collection of a short time series of passive acoustics data (2-3 months from the installation until the end of the project) in the summer season only, that will limit the exploitation for scientific studies. Moreover, data collected during the first few days from deployment revealed the need of a firmware upgrade. Without the possibility to recover the sensor before the end of demonstration, the demonstration mission will continue without the update and the data will be corrected after collection. Despite this problem, this mission has demonstrated the chain from the A1 hydrophone/TeleSenigallia platform to the final visualization in the NeXOS Sensor Web client, allowing data handling and visualization.

The MED2 deployment was on time, beginning the 7th of June. The A2 hardware components were assembled on time: Hydrophones, waterproof cylinder for the master unit, the master unit, power supply, networking elements, etc. The tests at the hyperbaric chamber were OK and the A2 was properly deployed and connected to OBSEA cabled observatory. Scuba divers completed the A2 deployment. Each hydrophone is attached to a support weight to ensure a fixed position at the sea-bottom, additionally; The master unit is attached to a heavy weight. After deployment and with recognition for the real-time connection of A2 to the OBSEA network, the firmware development will continue for another few weeks . Fine tuning of the algorithm for the estimation of the angle of arrival was needed; additionally, some work to ensure proper synchronization between the acquisition of the four hydrophones was also needed. This work executed by UPC overlapped with the validation phase.

More demonstration activities will be carried out during the September 2017 NeXOS General Assembly in PLOCAN (Las Palmas, Spain), where a real time localization will be shown during the meeting.

The MED3 mission has started and is progressing approximately as planned, lasting about 5 months, thus allowing the collection of a good dataset to be put in relation with catches and to be used for environmental considerations. There were two major issues encountered during this mission; the impossibility to use EAF.4 together with the old RECOPESCA NKE STPS-R temperature, conductivity and depth probe, and the EAF.6 had to be recovered and redeployed due to a battery default. Most certainly for EAF.4 measuring oxygen concentration, especially in coastal areas where the salinity values at sea are often changing (e.g. fresh water inputs by rivers, floods), it would have been crucial to install the new sensor together with the conductivity probe. This would allow the direct collection of salinity values to use in the post processing formula to calculate the oxygen concentrations (ml/l) (Aminot & Kerouel 2004). Unfortunately this was impossible due to incompatibility of the old probes with the new configuration of the concentrator. For the concern of the EAF.6 measuring fluorescence, the major weak point is the short battery duration due to a continuous LED blinking. The sensors showed to be appropriate for the use on trawlers, by being positioned in protected portions of the fishing gears however, especially for EAF.6, use on small scale fishery vessels is suggested due to operational conditions.

4. References

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