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MARTECH 18

8TH INTERNATIONAL WORKSHOP ON MARINE TECHNOLOGY

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INFORMATION FOR AUTHORS

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EDITOR'S NOTE

Welcome to the 8th International Workshop on Marine Technology - MARTECH18.

MARTECH congregates a broad research community dedicated to developing innovative equipment in the fields of marine sciences and technology. In 2018, this diverse community will meet in Porto, Portugal, at the Faculty of Engineering from the University of Porto for MARTECH18. This edition is co-organized by the Laboratório de Sistemas e Tecnologia Subaquática – LSTS (Underwater Systems and Technologies Laboratory) of Porto University and the Universitat Politècnica de Catalunya. Porto, the second largest city in Portugal, was elected by the European citizens Best European Destination in 2014 and in 2017. The essence of Porto, the "Cidade Invicta" (unvanquished city) is a blend of history, architecture, culture, gastronomy, trade, encounters and discoveries.
The MARTECH workshop aims to bring together those working in MARine TECHnology for discussions and presentations of recent advances in the field and for cross-disciplinary knowledge exchange cutting across engineering and science. This knowledge exchange is fundamental for the development of systems and technologies that will enable us to explore and exploit the ocean in a sustainable manner and to monitor how key issues such as climate change, ocean acidification, unsustainable fishing, pollution, loss of habitats, shipping, security, and mining are affecting ocean sustainability and stewardship.

The MARTECH18 program includes one plenary talk, forty-eight presentations distributed over 8 technical sessions, one outreach session for high school students working in marine robotics, one open session for discussions, and technical exhibits.
Plenary talk:
Sub-mesoscale processes in the upper ocean: a satellite remote sensing perspective.
Prof. José da Silva, Faculdade de Ciências da Universidade do Porto.
The 8 technical sessions cover themes of great relevance to academia, industry and practitioners:
Session 1 – Exploring the Pacific Subtropical Front.
Session 2 – Image processing.
Session 3 – Ocean observation.
Session 4 - EMODnet.
Session 6 - Instrumentation, operations, and systems.
Session 7 – Biology.
Session 8 – Sensor systems.
Session 9 - Using robots in oceanography: a user perspective.
MARTECH18 is aligned with Europe 2020 strategy, on the one hand by relating to the Innovation Union, building the European Research Area as it promotes a truly free movement of knowledge, and on the other hand by fulfilling the Blue Growth objective of establishing marine technologies as one of the main technologies required to work offshore. MARTECH18 is also well aligned with the Atlantic International Research Centre (AIR Centre) initiative launched by the Portuguese government is an example of a Long-Term Multilateral Platform for Cooperation Along and Across the Atlantic with an Inclusive Perspective to S&T and Economic Development.
Thank you all for contributing to make MARTECH18 a success.

João Borges de Sousa
Chairman of the Organizing Committee

MARTECH 2018 TECHNICAL PROGRAM

TIME	MONDAY DEC 10TH 2018
8:30 - 9:00 h	Registration
9:00 - 9:15 h	Opening Session
9:15 - 10:00 h	Plenary
10:00 - 11:00 h	Session 1
11:00 - 11:30 h	Coffee Break
11:30 - 13:00 h	Session 2 / Session 3
13:00 - 14:00 h	Lunch Break
14:00 - 15:30 h	Session 4
15:30 - 16:00 h	Session 5 (Outreach)
16:00 - 16:30 h	Coffee Break
16:30 - 18:30 h	Session 6
20:00 - 22:00 h	Gala Dinner

TIME	TUESDAY DEC 11TH 2018
9:30 - 10:30 h	Session 7
10:30 - 11:00 h	Cofee Break
11:00 - 12:30 h	Session 8 / Session9
12:30 - 13:00 h	Discussion Session
13:00 - 14:00 h	Lunch and Closing Session

PLENARY

Submesoscale processes in the upper ocean: a satellite remote sensing perspective

SESSION 1

TOPIC	ID	ABSTRACT TITLE	PG
Exploring the subtropical front	33	Studying the Pacific Subtropical Front with Multiple Assets	**49**
	35	Ripples: A Tool for Supervision and Control of Remote Assets	**51**
		Understanding Ocean Fronts Together: Cross disciplinary approach to study genetic signatures of microplankton diversity across Pacific Subtropical Front	**--**
		Exploring the subtropical front: Oceonography	**--**

SESSION 2

TOPIC	ID	ABSTRACT TITLE	PG
Using robots in oceanography: an user perspective 11:30 – 13:00	17	Robotic applications in coastal environments: the Douro River plume case study	**--**
	36	REP18 Atlantic – A Large Scale Exercise Using Unmanned Systems	**52**
		Ocean colour and the monitoring of coastal waters in Portugal	**--**
		An autonomous biosampler to capture in situ aquatic microbiomes	**--**
		Estuarine Salinity Patterns Adaptation: Coastal Management and Climate Change Impacts	**--**
		Climate-driven oceanic deoxygenation leads to a top predator habitat compression more prone to overfishing	**--**

SESSION 3

TOPIC	ID	ABSTRACT TITLE	PG
Ocean observation	10	Hydrophone installation in the RAIA ocean-meteorological observatory net	**23**
	12	Expanding ocean-monitoring capabilities in the Macaronesia with unmanned mobile platforms	**25**
	14	EMSO-Antares (Western Ligurian Sea) A unique Observatory for Sea Science and particle astrophysics.	**30**
	23	The EMSO-Azores deep-sea observatory – 8 years of operation	**40**
	26	EuskOOS (Basque Operational Oceanography System): an integrated approach to providing coastal and oceanic information	**43**
	30	Autonomous acoustic surveillance system for nearshore soundscaping	**46**

SESSION 4

TOPIC	ID	ABSTRACT TITLE	PG
EMODNet	6	EMODnet: your gateway to marine data in Europe	**18**
	4	EMODnet Ingestion portal – Wake up your data! Set them free for Blue Society	**15**
	2	EMODnet Physics: towards a European Impulsive Noise Register	**12**
	15	Proof of Concept for Distributing Underwater Noise Mapping through EMODNet Physics Portal	**31**
	3	Dataflow of Underwater Noise Measurements: from Obsea to EMODnet	**14**
	5	River Runoff data management	**16**

SESSION 5

TOPIC	ID	ABSTRACT TITLE	PG
		Outreach	

SESSION 6

TOPIC	ID	ABSTRACT TITLE	PG
Instrumentation, operations, and systems	7	ANTEIA System: Cost-effective solution for extense wave monitoring	**20**
	11	Smart Sensing Interoperability Platforms in the scope of AtlantOS	**24**
	21	Operating around offshore infrastructure and safe manoeuvring by Autonaut USV	**38**
	22	The Sound of Waves in the Mutriku Wave Energy Plant	**39**
		Experimental Study of the Parametric Generation	**--**
	40	Design, manufacturing and set-up tests of a wave energy converter prototype in the context of the European project LIFE-Demowave	**58**
	41	Design, validation and manufacturing of an anthropomorphic manipulator for ROVs using titanium rapid prototyping	**60**
	43	Tools for Deep-Sea Navigation	**63**

SESSION 7

TOPIC	ID	ABSTRACT TITLE	PG
Biology	8	Unexpected interaction in biological cultures	**21**
	9	RAMICA owen: Performing automatic microbiological cultures	**22**
	13	Acoustic TAG tracking: First experiments	**28**
	18	Combined current profiling and biological echosounding results from a single ADCP	**34**
	20	Monitoring coastal water quality with a combined approach of marine autonomy and satellite remote sensing	**37**
	28	Harmonisation and Dissemination of TSG data from IEO research vessels	**45**

SESSION 8

TOPIC	ID	ABSTRACT TITLE	PG
Sensor systems	16	A Nonlinear Kinetic Energy Harvester for Light Surface Ocean Drifters	**32**
	19	Evaluation of Sigfox LPWAN technology for autonomous sensors in coastal applications	**35**
	27	WAVY Operation Software: An observation centric system for multi-sensor devices	**44**
	34	The new iteration of the WAVY drifter (MELOA)	**50**
	39	Feasibility analysis of energy harvesting with piezoelectric devices in oceanographic buoys	**57**
	32	Sensor Web Enablement Implementations in Marine Observation Platforms	**48**

SESSION 9

TOPIC	ID	ABSTRACT TITLE	PG
Image processing	24	Deep Sea Spy: a collaborative annotation tool	**41**
	31	Coastal bathymetry estimation using an ensemble of Synthetic Aperture Radar images from Sentinel-1	**47**
	37	Fast Underwater Color Correction using Integral Images	**53**
	38	LitterDrone: marine litter characterization using drones and image analysis	**55**
	42	A survey on automatic habitat mapping	**62**
	17	Automatic panoramic image creation system from Obsea PTZ underwater camera	**33**

GENERAL INFORMATION

BY METRO

FEUP is served by three Metro stations on line D (yellow) in zone C6.

<u>Estação de Metro do Pólo Universitário</u>
Line D (yellow) connects the University Campus station Polo Universitário to Gaia City Hall in about 15 minutes, via Trindade, where it connects to line A (blue), line B (red) and line C (green). Leaving the Polo Universitário station, you should turn left into Rua Dr. Manuel Pereira da Silva and then, after passing Paranhos cemetery, turn left into Rua Dr. Roberto Frias. Go straight on and you will find FEUP on your right.

<u>Estação do Metro do Instituto Português de Oncologia</u>
Leaving the IPO station, you should go on down to the end of Rua Dr. Plácido da Costa and cross Rua Dr. Roberto Frias. You will then be in front of FEUP.

<u>Estação do Metro do Hospital de São João</u>
Leaving the Hospital de São João station, follow the Circunvalação ring road until you come to the junction with Rua Dr. Roberto Frias. Go down that road until the junction with Rua Dr. Plácido da Costa. FEUP will now be on your left.

Tickets must be purchased in advance. The ticket is printed in a card called Andante, and you can purchase as many rides (or travels) as you want for the zone you are staying in (Porto and surrounding is Z2, Matosinhos Z3 and Airport Z4). One travel will take you anywhere in your zone, and you can travel as many times as you want during one hour. If you plan on using it again, Do not throw away the card! The card can be re-charged (the card itself costs €0.60).

You can also buy daily passes. Visit Porto and circulate without limits throughout the Andante transport network. Just choose the number of days during which you want to benefit from this tariff. The Andante Tour 1 costs €7.00 and it's valid for 24 consecutive hours after the first validation. The Andante Tour 3 has the price of €15,00 and it's valid for 72 consecutive hours.

An important note: your Andante must be validated in one yellow machine before you enter the metro or a bus.
For more information please check: http://www.metrodoporto.pt/

BY BUS

There are 4 bus lines in the Faculty's zone: 204, 300, 301 and 803.
There are other STCP bus lines from Hospital de S.João, as well as regular bus routes to other cities.
STCP has many lines and buses, which are modern and comfortable. If you do not have the Andante (see Metro above) you can purchase tickets once you board a bus.
For more information please check: http://www.stcp.pt/

BY TAXI

Porto's taxi services provide a good alternative to get rapidly to/from the city. There are taxis waiting in the stands outside the airport and in different spots all around the city (train stations, some metro stations, etc). Taxis are all equipped with a meter and the number of passengers will not affect the travel cost, though taxi fares also include surcharges depending on circumstances such as time of the day, moment of the week, public holidays and extra luggage. The cars can have two different colors: most of them will be light beige, but some blacks with a green rooftop can still be found.

For more information please check:
• http://www.raditaxis.pt/
• http://www.taxisinvicta.com/en/inicio

BY CAR

The best way to find the Faculty of Engineering is to follow signs to Hospital de São João. The following are the main routes to FEUP by road:

Coming from Ermesinde, Gondomar and Valongo via the Circunvalação ring road (EN12)
You should follow the EN12 until you find Hospital de São João on your left. Go straight on at the traffic lights with Rua Dr. Roberto Frias and keep left. At the next traffic lights, turn left into Rua António Bernardino Almeida (the IPO will be on your right) and go straight on across Rua Dr. Plácido da Costa. Keep left until the next junction, where you should turn left. Go down this road until you reach another junction where you should turn left. Go to the end of the road and at the junction at the end, turn left into Rua Dr. Roberto Frias. Keep right until the junction with Via Estruturante, where you should turn right.

Coming from Maia and Matosinhos via the Circunvalação ring road (EN12)
You should follow the EN12 until you find the IPO on your right. Enter the right lane at the traffic lights in order to turn right into Rua António Bernardino Almeida (skirting round the IPO). Go straight on through the junction with Rua Dr. Plácido da Costa. Keep left until the next junction, where you should turn left. Go down this street until you reach another junction where you should turn left. Go to the end of the road and at the junction at the end, turn left into Rua Dr. Roberto Frias. Keep right until the junction with Via Estruturante, where you should turn right.

Car park
FEUP has three car parks skirting its south perimeter, all of which are accessed from Via Estruturante (which runs at right angles to Rua Dr. Roberto Frias).

P1/2	Access to the car park for faculty and (permanent) staff members, as well as visitors;
P3	Access to the student car park;
P4	Access to the car park for non-permanent staff members.

BY PLANE

Sá Carneiro Airport, (IATA: OPO), Pedras Rubras, Maia (+351) 229 432 400. Also known as Aeroporto do Porto or Aeroporto Francisco Sá Carneiro, this is the second busiest airport (after Lisbon) in the country and is located at approximately just 15 km from the city centre, making it one of the easier airports to fly in and out of. It is rated as Europe's 3rd best airport under ACI-Airports Council International 2015 ranking, which is the ninth award in the past ten years. Porto airport was in the top three between 2006 and 2011 and was voted by passengers as the best European Airport in 2007. After an intermission of one year, it was again awarded 3rd place in the ranking in 2013 and 2014. The airport presents a large number of nonstop destinations over Europe, US and Brazil and some of the main airlines that travel to Porto include Iberia, Lufthansa, Luxair and Ryanair. It also serves the Galiza region

Just outside of the airport there is a bus stop for the AeroBus which takes you to Praça da Liberdade (city center) or will drop you off at the Pousada da Juventude (youth hotel, but with no age limit). A similar taxi trip will cost 25 Euro. The Metro line (E-Violet: Aeroporto – Estádio do Dragão) connects the Airport to the city centre, offering a fast ride into the heart of the city. This line operates daily from 06:00 - 01:00 and takes about 30 minutes to get to the city centre (either Trindade or Bolhão station). The Andante ticket needed for this journey can be purchased at any of the automatic ticket machines in the Metro station – occasional ticket (Z4). It costs 2€, is valid for 1 hour and 15 minutes and is also rechargeable.

For more information please check: https://www.ana.pt/pt/opo/home

EXHIBITOR LIST

The exhibition area will be close to the room's sessions.

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www.lsts.fe.up.pt

ID2- EMODNET PHYSICS: TOWARDS AN EUROPEAN IMPULSIVE NOISE REGISTER

ANTONIO NOVELLINO[55], MARCO ALBA[57]

Abstract
EMODnet Physics, one of the European Marine Observation and Data network thematic portals, which is is currently providing access physical parameters of the oceans, has recently started working on water noise with the aim of making available more operational data (in terms of parameters and format that are close to MSFD I.11 requirements), offer a single European entry point to impulsive noise registries (MSFD I.11.1) and work on (regional) sound maps

Keywords – under water noise, data management, climatology

I. INTRODUCTION

Underwater noise has been significantly raising in the past decades due to an increment of human-related activities in the oceans such as shipping, industrial activities, seismic explorations, etc. These activities may have adverse effects on fish and mammals, such as communications masking and modifying predator–prey interactions.

In order to assess and limit the impact of these, the European Commission approved the Marine Strategy Framework Directive (MSFD) that aims to achieve a good environmental status in European waters. Within this directive, different environmental challenges are addressed, including the long-term monitoring of underwater noise throughout European waters.

EMODnet Physics, one of the European Marine Observation and Data network thematic portals, which is is currently providing access physical parameters of the oceans, has recently started working on water noise with the aim of making available more operational data (in terms of parameters and format that are close to MSFD I.11 requirements), offer a single European entry point to impulsive noise registries (MSFD I.11.1) and work on (regional) sound maps.

II. EUROPEAN MARINE OBSERVATION AND DATA NETWORK

EMODnet[1] is a long-term marine data initiative from the EU Commission Directorate-General for Maritime Affairs and Fisheries (DG MARE) involving more than 150 organisations for assembling marine data, products, and metadata. It has been developed through a step-wise approach and is currently in its third and final development phase.

The organisations involved work together to observe the sea, process the data according to international standards andmake that information freely available as interoperable data layers and data products. Unfortunately, marine data collection, storage and access in Europe has been carried out in a fragmented way for many years.

Most data collection has focused on meeting the needs of a single purpose by a wide range of private and public organisations, often in isolation from each other. EMODnet provides access to European marine data across seven themes: bathymetry[2], geology[3], seabed habitats[4], chemistry[5], biology[6], physics[7], and human activities[8]. For each theme, EMODnet has created a gateway to a range of data archives managed by local, national, regional and international organisations.

Users have free access to standardised observations, data quality indicators and processed data products, such as basinscale maps.

III. EMODET PHYSICS

EMODnet Physics is a domain specific portal of portals aggregating data and metadata from several data portals. A combined array of services and functionalities are offered to internal and external users, such as facility for viewing and downloading, dashboard reporting and machine-to-machine communication services, to obtain free-of-charge data, metadata and data products on the physical conditions of the ocean from many different distributed data sets.

The acquisition of physical parameters is largely an automated process that allows the dissemination of near real time information. In particular, EMODnet Physics is a stock-share portal strongly federated to the Copernicus Marine Environment Monitoring Service In Situ Thematic Assembly Center. Historical validated datasets are organized in collaboration with SeaDataNet and its network of National Oceanographic Data Centers.

The EMODnet Physics portal is currently providing easy access to metadata, data and products of: wave height and period; temperature and salinity of the water column; wind speed and direction; horizontal velocity of the water column; light attenuation; sea ice coverage and sea level trends (relative and absolute). Lately, EMODnet Physics started working on river runoff data, total suspended matter and underwater noise (acoustic pollution).

EMODnet Physics is continuously increasing the number and type of platforms in the system by unlocking and providing high quality data from a growing network.

EMODnet Physics was able to make available circa 30.000 platforms and more than 400.000 datasets, and to publish more than 350 map layers1 derived from the data products.

For each connected platform, a dedicated platform page is available. These pages provide the user with metadata, plots, download features, platform products e.g. monthly averages or wind plots, more info and links, as well as statistics on the use of the data from that platform. Data quality information is available in connection to datasets.

EMODnet Physics data policy is open and free and, in agreement with its pillars and the providers network, the user can download in situ data without authentication in case of operational data for past 60 days, operational data from plat-

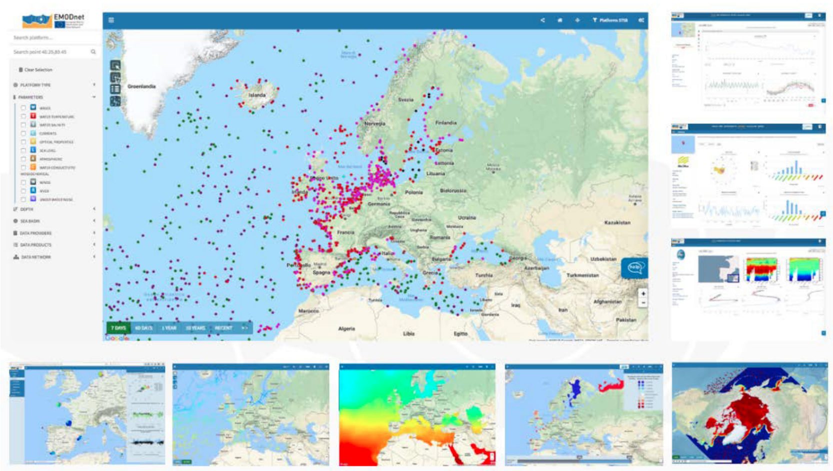

Fig 1. EMODnet Physics overview

http://geoserver.emodnet-physics.eu/geoserver/web/wicket/bookmarkable/org.geoserver.web.demo.MapPreviewPage?1

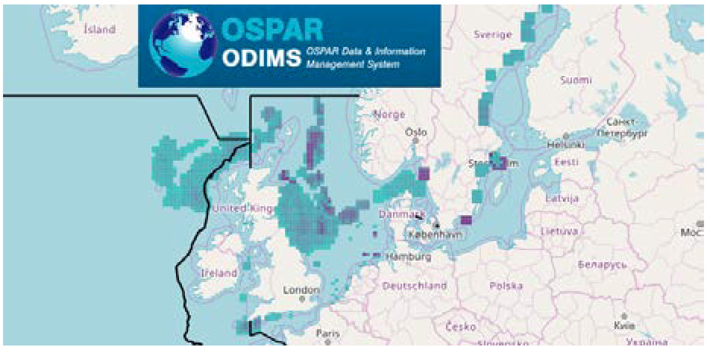

Fig 2. OSPAR registry https://odims.ospar.org/maps/524/view

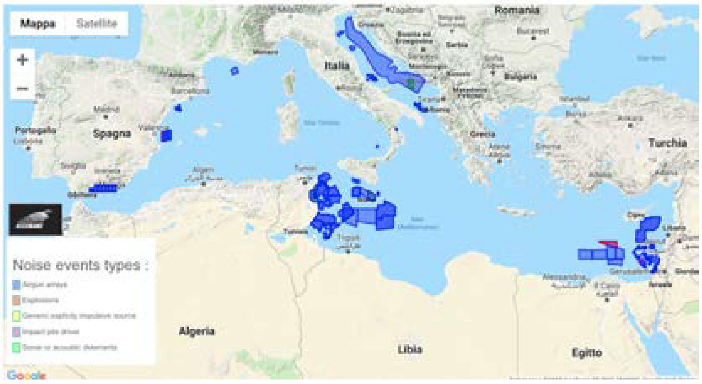

Fig 3. ACCOBAMS registry https://accobams.noiseregister.org/

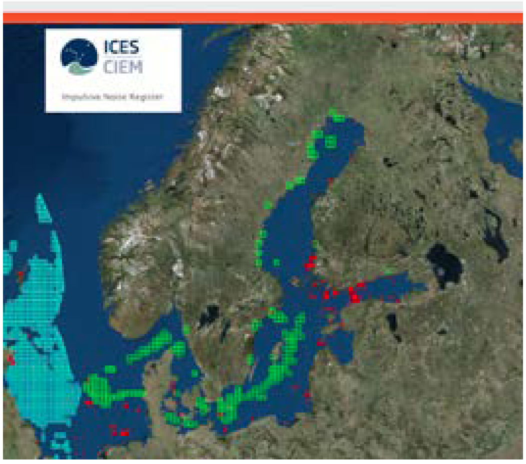

Fig 4 HELCOM registry http://underwaternoise.ices.dk/map.aspx

Fig 5 EMODnet Physics Impulsive Noise Registry

forms participating to international programs (e.g. ARGO) and data from providers that specifically requested it. User is asked to authenticate (CMEMS Service Level Agreement) for data older than 60 days and reprocessed/delay mode in situ data, and (SDN Service Level Agreement) for requesting CDI - historical data hosted by National Oceanographic.

IV. IMPULSIVE NOISE REGISTRY

The data are collated nationally from registers of licenced events such as pile driving, controlled explosions from naval operations and other activities that release energy. The registry is specifically purposed with supporting Regional Sea Conventions (Fig. 2, Fig.3, Fig.4) in providing information that will feed their regional assessments, and in reporting by its contracting parties to MSFD descriptor 11.1.1 (Low and mid frequency impulsive noise).

Data supplied by contracting parties to OSPAR (North East Atlantic), HELCOM (Baltic Sea), and Barcelona and ACCOBAMS (Mediterranean Sea, Black Sea). Starting from the already implemented regional registries of impulsive noise, EMODnet Physics harmonized and integrated the registry into one single discoverable interface (Fig. 5).

More specifically the ICES statistical subrectangles (10' lat*20' lon) was extended to cover the Mediterranean Sea, the noise event shape files were downloaded from the HELCOM, OSPAR and ACCOBAMS hosting repositories, finally the events falling into the block were counted to have the pulse event days per block.

V. CONCLUSIONS

EMOdnet Physics is providing a harmonized interface to discover and download impulsive noise event covering the European Regional Sea conventions. The same data is also exposed OGC compliant services[1] for easy integration and use.

REFERENCES

[1] EMODnet Homepage, http://www.emodnet.eu.
[2] EMODnet Bathymetry Homepage, http://www.emodnet-bathymetry.eu.
[3] EMODnet Geology Homepage, http://www.emodnet-geology.eu.
[4] EMODnet Seabed Habitats Homepage, http://www.emodnet-seabedhabitats.eu.
[5] EMODnet Chemistry Homepage, http://www.emodnet-chemistry.eu.
[6] EMODnet Biology Homepage, http://www.emodnet-biology.eu.

1 http://geoserver.emodnet-physics.eu/geoserver/emodnet/wms?service=WMS&version=1.1.0&request=GetMap&layers=emodnet:EP_UWN_INER&styles=&bb

ID3- DATAFLOW OF UNDERWATER NOISE MEASUREMENTS: FROM OBSEA TO EMODNET

JOAQUÍN DEL RIO FERNANDEZ[129], MICHEL ANDRE[103], THOMAS FOLEGOT[125], MIKE VAN DER SCHAAR[104], PATRICK GORRINGE[54], ANTONIO NOVELLINO[55], ALBERT GARCIA[144], ENOC MARTINEZ[145]

Abstract

Underwater noise has been significantly raising in the past decades due to an increment of human-related activities in the oceans such as shipping, industrial activities, seismic explorations, etc. These activities may have adverse effects on fish and mammals, such as communications masking and modifying predator–prey interactions.

In order to assess and limit the impact of these, the European Commission approved the Marine Strategy Framework Directive (MSFD) which aims to achieve a good environmental status in European waters. Within this directive different environmental challenges are addressed, including the long-term monitoring of underwater noise throughout European waters.

EMODnet Physics, one of the European Marine Observation and Data network thematic portals, which is is currently providing easy access to data and products of: wave height and period; temperature and salinity of the water column; wind speed and direction; horizontal velocity of the water column; light attenuation; sea ice coverage and sea level trends. EMODnet Physics is continuously increasing the number and type of platforms in the system by unlocking and providing high quality data from a growing network. EMODnet Physics has recently started working on water noise with the aim of making available more operational data (in terms of parameters and format that are close to MSFD I.11 requirements), offer a single European entry point to impulsive noise registries (MSFD I.11.1) and work on (regional) sound maps are three key identified activities for Physics. Furthermore the very first operational under water noise data (i.e. Sound Pressure Level – SPL), and HELCOM and OSPAR impulsive sounds registry were connected and are now available on the portal. Exploiting the LIDO (Listen to Deep Ocean) knowledge and the BIAS project (https://biasproject.wordpress.com/) experience EMODnet Physics will develop and make available monthly sound maps.

In this presentation, we give an overview of how EMODnet Physics is organized, with a particular focus on this new data flow and its perspectives.

Keywords - Underwater Noise, Emodnet, Obsea, MSFD, LIDO

ACKNOWLEDGMENTS

This work was supported by the project JERICO-NEXT from the European Commission's Horizon 2020 research and Innovation program under Grant Agreement No. 654410

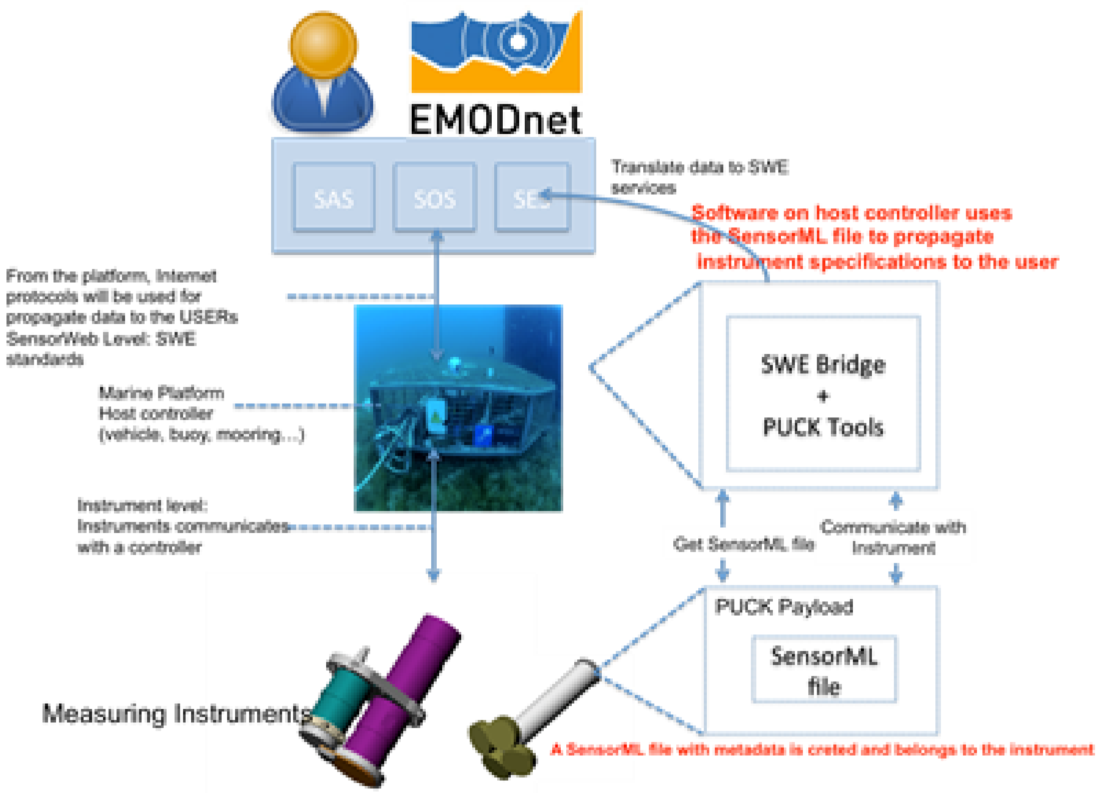

Figure 1: From sensor to user dataflow diagram and standards

ID4- EMODNET INGESTION PORTAL – WAKE UP YOUR DATA! SET THEM FREE FOR BLUE SOCIETY

DICK M.A. SCHAAP[109], PATRICK GORRINGE[54]

Keywords: data management, long term stewardship, mapping, geology, physics, chemistry, biology, seabed habitats, human activities

I. INTRODUCTION

The European Marine Observation and Data Network (EMODnet) consists of more than 160 organisations that together work on assembling, harmonising and making marine data, products and metadata more available to public and private users. This Data Ingestion portal facilitates additional data managers to ingest their marine datasets for further processing, publishing as open data and contributing to applications for society.

II. EMODnet INGESTION PORTAL

EU recognizes that seas and oceans are drivers for the European economy with great potential for innovation and growth. The 'blue' economy represents about 5.5 million jobs and a gross added value of just under €500 billion a year. The oceans and seas offer new opportunities for smart, sustainable and inclusive growth.

The current spread of new technologies and the emergence of the internet as a public network are carving out fresh opportunities to widen public knowledge and improve human life. In modern society, technologically-mediated information is constantly growing and permeates all aspects of civil society. Knowledge is at the base of improvements in society and the economy. Knowledge-sharing (including data, information, skills, expertise) makes a group, an organisation and society as a whole more competitive.

A series of documents of the European Commission has identified strategies for Blue Growth and bottlenecks for a more competitive EU economy, such as the lack of appropriate skills, access to capital – including risk capital, fragmented marine data, environmental challenges and difficult planning processes.

EMODnet[1] is a long-term marine data initiative of the EU DG MARE. It builds and provides a gateway to marine data in Europe across seven discipline-based themes: high resolution seabed and coastal mapping, geology, physics, chemistry, biology, seabed habitats, and human activities. For each theme there is a dedicated portal maintained and expanded in functionalities and data coverages. The portals provide users discovery, access and viewing services for measured data sets and generic data products, such as basin-scale maps.

The EMODnet development is a dynamic process that relies on the contributions of data providers and users. The EMODnet thematic portals are continuously improved to make the services and products more fit for purpose and with low threshold.

The EMODnet portals are developed and operated by a large network of data centres and data experts from major marine research institutes, geological surveys, hydrographic services, and other organisations. These data centres also work together in major European infrastructures for marine data management, such as SeaDataNet, EurOBIS, and EGDI. These infrastructures provide the backbones for the EMODnet portals and this way using the networks and protocols already large volumes of marine data are made discoverable and accessible, where possible in harmonised ways.

However there is still a lot of marine data often collected at great expense that does not reach those infrastructures and EMODnet portals. This can be data sets acquired by industry, but also at governmental departments, and research organisations. These data sets and their data holders need to be 'waked up' and guided to make their data sets also available so that the overall EMODnet data offer and quality of EMODnet products can be improved to the benefit of users, which come from science, government and industry. The EMODnet Data Ingestion portal aims at streamlining the data ingestion process by which 'awoken' data holders from public and private sectors can easily release their data for long term safekeeping, further validation and conversion to standard formats, and subsequent distribution through EMODnet portals.

The EMODnet Data Ingestion portal[2] aims at

- To identify and reach out to organisations from public, research and private sectors who are managing marine datasets for bathymetry, geology, physics, chemistry, biology and/or human activities and who are not yet connected and contributing to the existing marine data management infrastructures
- To motivate and support those potential data providers to release their datasets for safekeeping and subsequent freely distribution through EMODnet
- To facilitate the inclusion of those marine datasets by means of a data ingestion service and subsequent communication with expert data repositories to work up the metadata documentation for direct publishing and, in a second stage, for making the submitted datasets fit for inclusion in the EMODnet data services and products.
- Streamlining the data ingestion process by which 'awoken' data holders from public and private sectors can easily release their data for long term safekeeping, further validation and conversion to standard formats, and subsequent distribution through EMODnet portals.

EMODnet Data Ingestion also holds a Data Wanted Service that facilitates anyone seeking certain types of datasets to specify its needs and to post these. This might challenge potential owners of matching datasets to come forward and as follow-up to ingest their datasets. Also it gives direction to the operators of the Ingestion portal in their searches for additional datasets as they will try to match the posted data requests.

III. CONCLUSIONS

The EMODnet Data Ingestion portal aims at streamlining the data ingestion process so that data holders from public and private sectors that are not yet connected to the existing marine data management infrastructures can easily release their data for safekeeping and subsequent distribution through EMODnet. This will enrich the total offer for all types of users and conform to the EMODnet motto 'collect data once and use it many times'.

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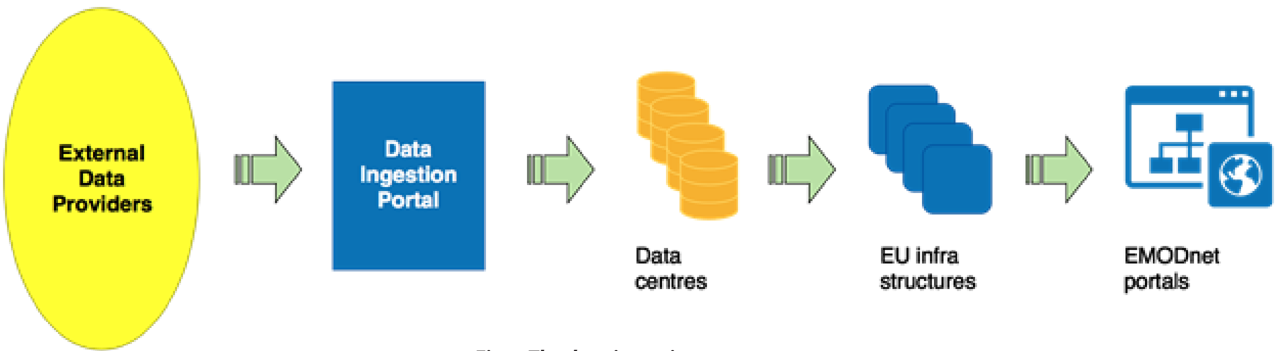

Fig 1. The data ingestion process

ID5- EMODNET PHYSICS AND RIVER RUNOFF DATA MANAGEMENT

FRANCISCO CAMPUZANO[105], GIUSEPPE MANZELLA[56], JORGE PALMA[106], RAMIRO NEVES[107], ANTONIO NOVELLINO[55]

Abstract
Rivers runoff exert a strong influence in their neighbouring coastal area in several ways, modifying the water stratification, introducing significant fluctuations in circulation patterns and modulating the impact of upwelling events. This paper presents data management methods and standards to make harmonised river data available and accessible.

Keywords – River Runoff, data management, climatology, MOHID Land model, forecast, near real time data

I INTRODUCTION

Rivers runoff exert a strong influence in their neighbouring coastal area in several ways, modifying the water stratification [1], introducing significant fluctuations in circulation patterns and modulating the impact of upwelling events [2,3]. In the current context of a global decline of the hydrometric networks [4], the uncertainties include the river runoff reaching the coast and most of the water properties as temperature, salinity, etc. For this reason, river climatologies are generally imposed in the land boundaries of coastal or regional ocean models, ignoring river variability in flow and other associated properties. Anyhow, the main weakness of river climatologies is its incapacity to include the interannual variability compared to watershed model applications that agree with the main river flow trends. On the other hand, watershed models tend to overestimate river flows, especially during dry seasons, as they are closer to the natural flows and thus disregarding fresh water human management [5]. This current approach for freshwater incorporation into regional models translates into a poor representation of the sea surface salinity due to the large uncertainties remain regarding the runoff and river discharges that force the models [6].
Near real time data near the coastal area is not easily accessible in many countries and information and, when available, data sources provide access to the data in webpages in the local language under many different data formats. Fresh water management differs greatly among countries, in some the water is managed by a national agency (i.e. Portugal and Ireland) while in others are the regions the specific bodies for large watersheds or regions can coexists (i.e. Spain and Italy). This organisation for collecting river data increases data fragmentation. Global databases (such as the Global Runoff Data Base) collect and distribute historic data however they fail to provide operational near real time data. In addition, there are rivers where monitoring is absent, or stations were data provided consist only in water levels that without a flow conversion curve and thus not useful for obtaining the river contributions at the coastal area.

II. EUROPEAN MARINE OBSERVATION AND RIVER DATA NETWORK

EMODnet [7] is a long-term marine data initiative from the EU Commission Directorate-General for Maritime Affairs and Fisheries (DG MARE) involving more than 150 organisations for assembling marine data, products and metadata. It has been developed through a step-wise approach and is currently in its third and final development phase. The organisations involved work together to observe the sea, process the data according to international standards and make that information freely available as interoperable data layers and data products. EMODnet provides access to European marine data across seven themes: bathymetry [8], geology [9], seabed habitats [10], chemistry [11], biology [12], physics [13] and human activities [14]. For each theme, EMODnet has created a gateway to a range of data archives managed by local, national, regional and international organisations. Users have free access to standardised observations, data quality indicators and processed data products.
The acquisition of physical parameters is largely an automated process that allows the dissemination of near real time information. In particular, EMODnet Physics is a stock-share portal strongly federated to the Copernicus Marine Environment Monitoring Service in situ Thematic Assembly Center (CMEMS In Situ TAC). Historical validated datasets are organized in collaboration with SeaDataNet and its network of National Oceanographic Data Centers.
The EMODnet Physics portal is currently providing easy access the following products: wave height and period; temperature and salinity of the water column; wind speed and direction; horizontal velocity of the water column; light attenuation; sea ice coverage and sea level trends. Lately, EMODnet Physics started working on river runoff data, total suspended matter and underwater noise.

III. RIVER DATA – A RECENT EMODNET PHYSICS PRODUCT

For the reasons described above, EMODnet Physics has started gathering, harmonizing and making available near real time river runoff and in situ river run off trends (monthly and annual means). EMODnet Physics developed a dedicated data infrastructure to manage river station, and both near real time (about 100 stations; Fig. 1) and historical trends (in situ trends are an EMODnet Physics product and are computed from the Global Runoff Data Base) are available.
The main objective is to provide river observations integrated and distributed in a single platform with a common format and including relevant metadata information able to help coastal managers and to acknowledge data providers (Fig.2). Current activities include to identify the institutions responsible for maintaining the hydrographic network at each region/country and to select the most convenient and reliable stations near the coastal area. For the later, EMODnet physics is collecting valuable information from coastal/ocean experts and operational observations will be increasingly made available to the public and

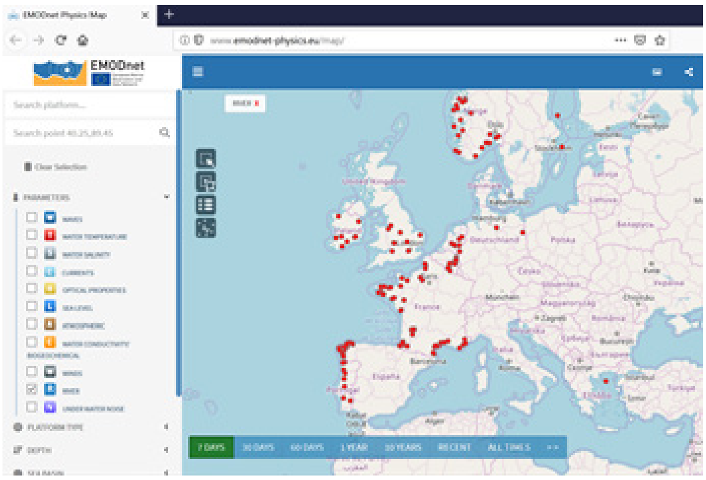

Fig 1. River Station EMODnet Physics

research community through the EMODnet physics webpage.
Key progress on the river data inclusion activities are:
• Ingestion of more and new operational systems: EMODnet Physics is now connecting platforms from Portugal, Spain, France, Germany, Belgium, Ireland, UK, and Italy. Data structure follows the already adopted for the management of data coming from the other networks: transport file is netcdf v3.6 (and v.4.0), data is be stored in a data server with three folders according the data age: latest, monthly and history. CF convention/SeaDataNet P09 are used for parameters.
• In situ river outflow trends, computed from the Global Runoff Database, with

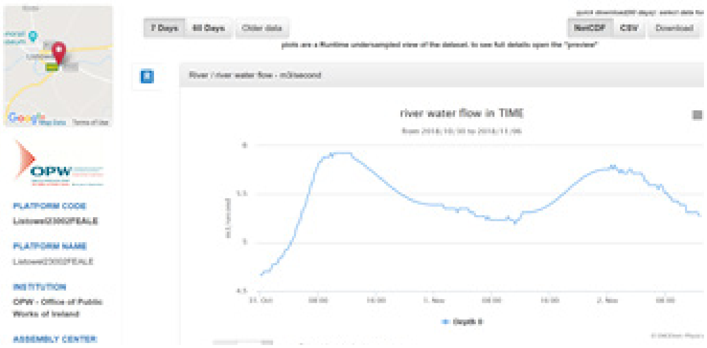

Fig 2. Example of an Irish river runoff station in EMODnet Physics

data coverage until 31/12/2016.

IV. CONCLUSIONS

The efforts to make available near real time river data is being welcomed by the community such as the EUROGOOS coastal working group and the CMEMS Monitoring Forecast Centres (MFCs) that are interested in improving their thermohaline circulation in coastal areas by a better characterisation of the land-marine boundary conditions.

However, many hydrographic networks mainly focus in river water levels and/or flows and other relevant variables such as temperature, which is important for the generation of thermal fronts near the coastal areas, is not measured operationally in many regions. Numerical models can provide unmonitored variables, fill network gaps and generate forecasts. Watershed applications, based on MOHID Land model [15], will be made available through the same platform in the next future in order to provide a consistent product for coastal managers.

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ID6- EMODNET: YOUR GATEWAY TO MARINE DATA IN EUROPE

PATRICK GORRINGE[54], JAN-BART CALEWAERT[58], ANTONIO NOVELLINO[55]

Keywords: data management, data portals, mapping, geology, physics, chemistry, biology, seabed habitats, human activities

I. INTRODUCTION

Marine data are needed for many purposes: for acquiring a better scientific understanding of the marine environment, but also, increasingly, for decision making as well as supporting economic growth. Data must be of sufficient quality to meet the specific users' needs. It must also be accessible in a timely manner.

And yet, despite being critical, this timely access to high-quality data proves challenging. Europe's marine data have traditionally been collected by a myriad of entities with the result that much of our data are scattered in unconnected databases and repositories. Even when data are available, often they are not compatible, making the sharing of the information and data-aggregation impossible. To tackle those problems in 2007 the European Commission through its Directorate General for Maritime Affairs and Fisheries (DG MARE) initiated the development of the European Marine Observation and Data network, EMODnet[1], in the framework of the EU's Integrated Maritime Policy and Marine Knowledge 2020 Strategy and in support of Blue Growth. Today EMODnet is comprised of more than 150 organisations which gather marine data, metadata and data products and make them more accessible for a wider range of users.

EMODnet Physics[2] is one of the specific EMODnet portals providing easy access to metadata, data and products of: wave height and period; temperature and salinity of the water column; wind speed and direction; horizontal velocity of the water column; light attenuation; river runoff; underwater noise; sea ice coverage and sea level trends (relative and absolute). A combined array of services and functionalities are offered to users, such as facility for viewing and downloading, dashboard reporting and machine-to-machine communication services, to obtain free-ofcharge data, metadata and data products on the physical conditions of the ocean from many different distributed data sets.

We will present how EMODnet has developed, currently consisting of seven subportals providing access to marine data from the following themes: bathymetry, geology, physics, chemistry, biology, seabed habitats and human activities. We give a closer look at one of the portals, EMODnet Physics.

II. EMODNET – THE CHALLENGE

Ocean and marine data collection in Europe is carried out by many hundreds of organisations, focusing on many disciplines, and using various heterogeneous observing methods and sensors installed on board of research vessels, submarines, fixed and drifting platforms, satellites etc.. Most data collection has focused on meeting the needs of a single purpose by private and public organisations, often in isolation from each other. Marine data can be generated as a result of marine environmental monitoring obligations, through the activities of maritime and offshore industries and by the research community. These data may have numerous applications beyond the purpose for which they were taken. Over the year's great progress has been made with developing standards, services, and infrastructures for providing long term storage and means for discovery and access to these valuble data resources. However, for a variety of reasons, a big part of these data still remained out of reach and thus inaccessible for other users, while the cooperation on European scales between these data management initiatives was limited. This changed considerably with the EMODnet initiative in 2009 which strived for an overarching European data and observation network.

III. EMODNET – The Solution

The European Marine Observation and Data Network (EMODnet), is the key implementing mechanism of the European Commission's Marine Knowledge 2020 strategy to unlock the potential of Europe's wealth of marine data. Based on the principle of collecting data once and using it many times for many purposes, EMODnet is a network of organisations (currently more than 150) supported by the EU's Integrated Maritime Policy who work together to aggregate and process marine data, according to international standards, and make these marine data, metadata and data products, derived from diverse sources, easily accessible via an integrated network of thematic data portals together with a central entry portal.

EMODnet's objectives are:

• Increase productivity in all tasks involving marine data by avoiding re-collection of data and saving costs involved in putting together marine data;
• Increase competition and innovation in established and emerging maritime sectors;
• Reduce uncertainty in our knowledge of the oceans and the seas and improve our ability to forecast the behaviour of the seas.

EMODnet currently provides access to marine data, metadata and data products spanning seven broad disciplinary themes: bathymetry, geology, seabed habitats, physics, chemistry, biology and human activities, the so-called thematic groups, with corresponding thematic portals.

IV. EMODNET DEVELOPMENT

EMODnet development is based on the following core principles that continue to guide and underpin the strategic expansion of its services:

• Collect data once and use them many times;
• Develop data standards across disciplines as well as within them;
• Process and validate data at different scales: regional, basin and pan-European;
• Build on existing efforts where data communities have already organised themselves;
• Put the user first when developing priorities and taking decisions;
• Provide statements on data ownership, accuracy and precision;
• Provide sustainable funding at a European level to maximise benefit from the efforts of individual Member States.

Established in 2009, EMODnet is a long-term initiative that has been built through a phased approach. During the first phase (2009-2013), six prototype data portals were developed, largely building on existing data repositories, infrastructures, initiatives and projects by specific and distinct communities of experts, these covered a limited selection of sea basins and parameters, and offered data-products at low resolution. The second phase saw the data portals expanded to provide full coverage of all European sea basins. A wider selection of parameters and medium resolution data products were also made available. The second phase also included the addition of a new portal on Human Activities and the creation of the cross-cutting EMODnet Central Portal, as well as the establishment of the six regional Seabasin Checkpoints and the Data Ingestion facility. To oversee and coordinate these growing and diverse activities, an EMODnet Secretariat was also established in this second phase. Currently in its third development phase, EMODnet has reached a mature and operational stage where efforts are now focused on maximising its use and achieving the goal of providing access to a multi-resolution digital map of the entire European seabed by 2020. Throughout the different phases, the number of institutions working together within EMODnet has grown from 59 in the first phase to currently more than 150.

V. EMODNET THEMATIC GROUPS

The EMODnet thematic groups provide the operational infrastructure of EMODnet and are each underpinned by a series of data systems, networks, projects, thematic and regional assembly groups. Each EMODnet thematic group has a portal, where users gain access to standardised observations, data quality indicators and processed data products, such as basin-scale maps for each of the themes (bathymetry, geology, physics, chemistry, biology, seafloor habitats and human activities). These data products are free to access and use..

VI. EMODNET PHYSICS

EMODnet Physics is a domain specific portal of portals aggregating data and metadata from several data portals. EMODnet Physics is developing a combined array of services and functionalities such as facility for viewing and downloading, dashboard reporting and machine-to-machine communication services, to obtain, free of charge data, meta-data and data products on the physical conditions of the ocean from many different distributed data sets.
The acquisition of physical parameters is largely an automated process that allows the dissemination of near real time information. In particular EMODnet Physics is a stock-share portal strongly federated to the Copernicus Marine Environment Monitoring Service In Situ Thematic Assembly Center. Historical validated datasets are organized in collaboration with SeaDataNet and its network of National Oceanographic Data Centers, NODCs.
The EMODnet Physics portal is currently providing easy access to data and products of: wave height and period; temperature and salinity of the water column; wind speed and direction; horizontal velocity of the water column; light attenuation; sea ice coverage and sea level trends (relative and absolute).
EMODnet Physics is continuously increasing the number and type of platforms in the system by unlocking and providing high quality data from a growing network. Recently EMODnet Physics started working on river runoff data, total suspended matter and underwater noise (acoustic pollution).

VII. CONCLUSIONS

Data from the marine environment are a valuable asset. Rapid access to reliable and accurate information is vital in addressing threats to the marine environment, in the development of policies and legislation to protect vulnerable areas of our coasts and oceans, in understanding trends and in forecasting future changes. Likewise, better quality and more easily accessible marine data is a prerequisite for further sustainable economic development, so-called 'blue growth'. The European Marine Observation and Data Network (EMODnet) is a network of organisations supported by the EU's integrated maritime policy. These organisations work together to observe the sea, process the data according to international standards and make that information freely available as interoperable data layers and data products. This "collect once and use many times" philosophy benefits all marine data users, including policy makers, scientists, private industry and the public.

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BATHYMETRY	GEOLOGY	SEABED HABITATS	PHYSICS	CHEMISTRY	BIOLOGY	HUMAN ACTIVITIES
-Digital Terrain Model -Survey tracks and bathymetric survey data -Source references -Depth contours	-Seabed substrate -Seabed accumulation rates -Seafloor lithology -Seafloor stratigraphy -Coastal migration -Geological events and probabilities -Mineral occurrences -Submerged landscapes* -Quaternary geology* -Geomorphology* -Boreholes locations* -Seismic tracks* -Backscatter outlines*	Collection of point data from surveys -Broad-scale seabed habitat map -Environmental variables influencing habitat type -Collection of individual seabed habitat maps from surveys -Modelled maps of specific habitats -Composite data products	-Wave height and duration -Sea temperature -Wind speed and direction Salinity -Horizontal speed of the water column -Water clarity -Changes in sea level -Inflow from rivers -Water conductivity / biochemical parameters -Atmospheric parameters -Underwater noise	-Acidity -Antifoulants -Chlorophyll -Dissolved gases -Fertilisers -Hydrocarbons -Marine litter* (micro, beach, seafloor) -Heavy metals -Organic matter -Polychlorinated biphenyls -Pesticides and biocides -Radionuclides -Silicates	-Phytoplankton -Zooplankton -Macro-algae -Seagrass -Fish -Reptile -Benthos -Bird -Sea mammals -Functional traits -Introduced species -Protected species -Indicator species	-Aggregate extraction -Aquaculture -Cables -Cultural heritage -Dredging -Environment -Fisheries -Hydrocarbon extraction -Main ports -Ocean energy facilities -Other forms of area management/ designation -Waste disposal -Wind farms -Vessel density*

◄ ***Fig 1. Thematic coverage provided by the data and products available through EMODnet thematic portals.***

Fig 2. Example of data during the past seven days accessible in EMODnet Physics

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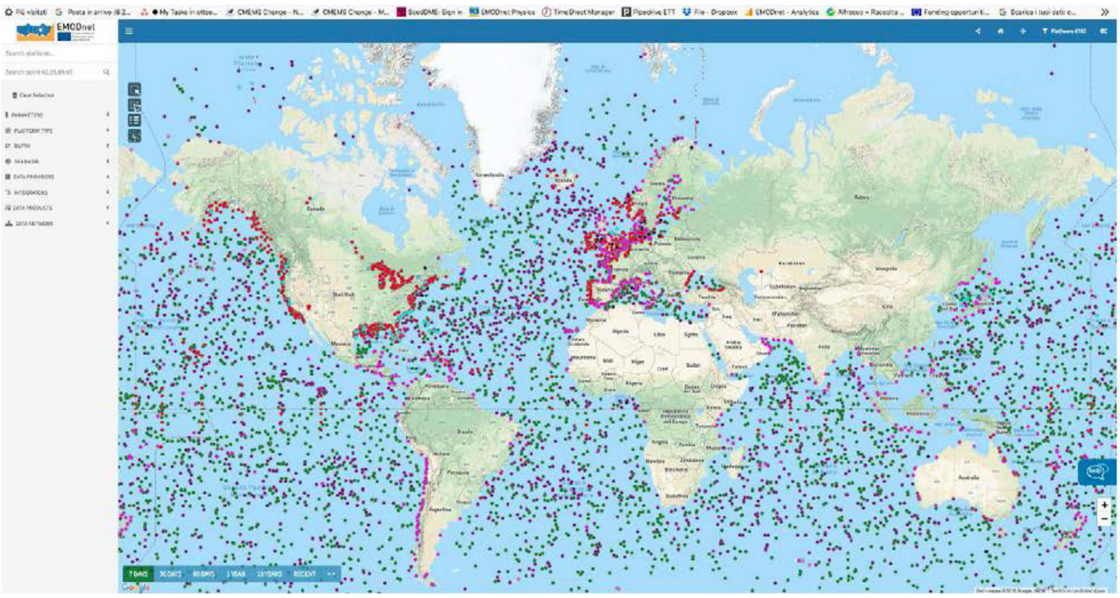

ID7- ANTEIA SYSTEM: COST-EFFECTIVE SOLUTION FOR EXTENSE WAVE MONITORING

IRATXE ARRAIBI-LANDA[127], ADOLFO GARCÍA-CORCUERA[128], JULIEN MADER[11], MANUEL GONZÁLEZ[12]

Abstract
Bearing in mind the growing importance of reliable temporal data series for scientific surveys and monitoring related to climate change and extreme events, among other things, the ANTEIA System was developed as a cost-effective solution and service to measure ocean surface waves, available to the scientific world.
In this sense, ANTEIA System has some specific advantages which include its light weight (26kg), its diameter (0.6m) and its solar powered rechargeable battery. It also offers real time data visualization via website and app, bespoke mooring design for each site and tried-and-tested reliability, which will be shown in the comparative section of this paper.

Keywords – wave buoy, array, oceanography, comparative, service.

I. INTRODUCTION
Marine meteorology and oceanography occupy a global role, serving a wide range of users, from international shipping, fishing and other met-ocean activities on the high seas, to the various activities which take place in coastal and offshore areas and on the coast itself.
The observational requirements for global and regional wave modelling depend on the applications for which the data are required and are based on the need to provide an accurate analysis of the sea state at regular intervals. The key model variables for which observations are needed are: 1) significant wave height; 2) dominant wave period; 3) wave 1-D energy frequency spectrum; 4) wave directional energy frequency spectrum, and 5) 2-D frequency-direction spectral wave energy density[1].
Although the technology for ocean observation has improved during the last few decades, the prices for these systems have remained more or less constant, and this is the main reason for a poor coverage of in situ wave data collection. ANTEIA addresses this gap by proposing a cost-effective solution to wave observation and long-term monitoring.

II. ANTEIA SYSTEM DESCRIPTION
ANTEIA System has been developed to fulfil the most recent market requirements and it is composed of the following elements:
1. ANTEIA Wave Buoy: A small and easy-to-deploy buoy weighing 26 kg and measuring 0.6 meters in diameter. The physical characteristics and the materials with which it is made provide many advantages. There is no need for heavy lifting equipment as it can be deployed and recovered using a small boat and it is much easier to deploy an array of buoys to cover as much area as possible. Its physical characteristics also open the way to reducing the operational costs linked to buoy maintenance.
2. Mooring system: This buoy has a bespoke mooring system, allowing free movement for optimum wave parameters detection. This mooring is specially designed for the buoy and can be fitted to different depths and current conditions.
3. Real-time data website: Zunibal has developed its own website for data visualization. By means of this website, Zunibal offers the following relevant information:
a. Display of the latest wave data;
b. Historical data download, both statistical and spectral wave data;
c. Data visualization through a set of dynamic graphics;
d. Wave-by-wave data display and download options.
4. 24x7 technical assistance policy: In this case, the assistance and monitoring of the state of the buoys is given by automatic warnings if any problem is detected, such as a low battery or mooring break.
In terms of technology involved in this innovative system, the wave parameters are obtained from GPS information, unlike traditional systems which use inertial technology. The advantages of this novel technology are the following:
· No need for calibration;
· Provide a time absolute reference (GPS time);
· Increased accuracy as a single integration is needed to obtain wave parameters, instead of a noisy double integration of accelerations.
The data obtained from this system is related to all wave parameters (i. e., wave heave, period and direction), both statistical and spectral data, every 30 minutes and includes the possibility of having wave-by-wave information in real time.

III. COMPARATIVE
In this section, we show the tried-and-tested reliability of this system compared to the most known commercial buoy on the market (Datawell's Waverider). These comparative tests are taking place in the Smartbay Test Site, Galway Bay (Ireland).

	Latitude	Longitude
Datawell Waverider	53° 13.649'	09° 16.087
ANTEIA Wave Buoy	53° 13.762'	09° 16.100'

Table 1. Buoys' locations at Smartbay Test Site

The following figures show the data from ANTEIA and Waverider buoys, located at a distance of 130 m from each other, over a ten-day period.

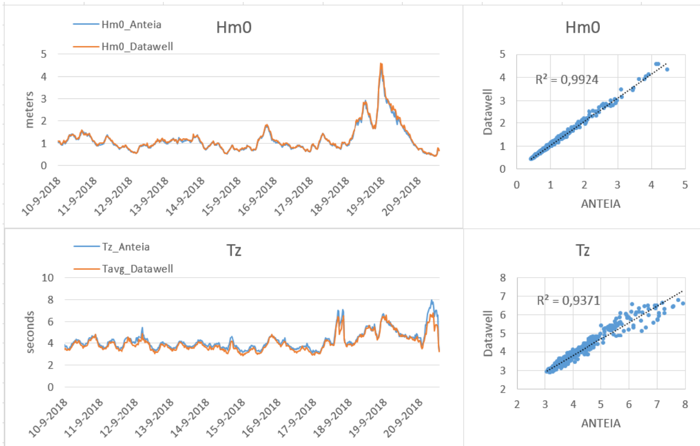

Fig 1. Data comparison between buoys

IV. CONCLUSIONS
As shown in the previous section, the correlation between ANTEIA and Datawell wave data is certainly high so it can be asserted that ANTEIA System can provide a long term solution for the current observational requirements in near shore operational surveys and coastal defence and management, as well as enable the validation of numerical models used for predictions.

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ID8- UNEXPECTED INTERACTION IN BIOLOGICAL CULTURES

XULIO FERNANDEZ HERMIDA[39], VICTOR ALONSO RORÍS[40]

Abstract
The aim of this article is to show how, in the development of the RAMICA sensor, we find an unexpected interaction between the IDDEX nutrient () and the flexible translucent catheters we need to implement the cells separation in the RAMICA sensor.

Keywords - RAMICA sensor, biological culture, TYGON flexible catheter, Silicon flexible catheter, IDDEX nutrient, IDDEX biological cultures.

I. INTRODUCTION

The RAMICA sensor (http://ramica.cetmar.org/) has been developed to implement the 'IDDEX culture protocol' () in a buoy and to be done completely automatic. The IDDEX protocol separates the culture in 51 independent cells and, depending on the number of 'positive cells' it gives a Most Probable Number of bacteria in the water under control.

To be able to implement the separation, and posterior cleaning, of the cells, Ramica sensor uses a flexible catheter that is smashed in 52 points along the catheter. A light and a very sensible color sensor has been implemented in each cell. It is able to read the color of the liquid inside the catheter with very good precision.

We, all of the researchers in the RAMICA project, assumed that the catheter will not interact with the culture; that is: -the catheter could be cleaned after a culture, -the color of the culture could be read by the color sensor, -the transparency of the catheter remains unaffected by the cultures and along of the days.

But things seem not to be that way. The first estrange interaction was when cells change to positive (they become yellow) and, after a time, they turn back to white. See Fig 1.

The color sensor reads the light 'going out of the catheter'. Somehow, in the first hours the light crosses the catheter wall and 'reads' the color of the liquid inside it. After several hours the color of the liquid is supposed to be the same but the reading have changed.

Then we recover the liquid of a very contaminated culture and we discover that the color of the culture in the RAMICA catheter is not the same of the one in the IDDEX blister. See Fig. 2.

Other estrange result appears when trying to clean the catheter after a culture have been done. We make a great amount of water to pass through the catheter and then we pass water with hydrochloric acid (Clh) several times. We are sure there is not bacteria in the catheter. The water plus Clh changes to yellow. We suppose it is due to 'something' that remains attached to the inner wall of the catheter. The very strange result is that the Clh plus water color changes to yellow and the amount of yellow varies along cleaning processes as shown in Fig 3.

HYPOTHESIS

After recognizing that we are broken with that results, one possible theory to explain the results is that:

-1.- The IDDEX nutrient includes a colorant that is liberated when the nutrient is metabolized by the bacteria.

-2.- That colorant is made with nano materials.

-3.- When liberated from the nutrient that nano materials, after a time, attach to the inner wall of the catheter.

-4.- That nano materials attached to the inner wall of the catheter affect the transparency of the catheter wall.

With the previous assumptions:

It would explain why the color read by the color sensor changes. It also would explain the different color of the culture in IDDEX blisters and in the RAMICA catheter.

And also the yellow color in the Clh plus water liquid when performing repeatedly cleanings.

CONCLUSIONS

We do not have conclusions, neither definitive nor provisional.

FUTURE LINES

With the Colloid Chemistry Group of the University of Vigo try to modify the inner surface of the catheter to avoid these estrange interactions with the culture and the IDDEX nutrient.

While this line does not have results, trying to use pieces of glass catheter in the cells attached by elastic catheter in the parts it must be smashed to separate the cells.

Fig. 1: Evolution of 'positive cells' along the 18 hours of a culture. Every cell that turns to yellow -positive- does not change its color. If the sensor reads white, it means that the light going out the catheter is white.

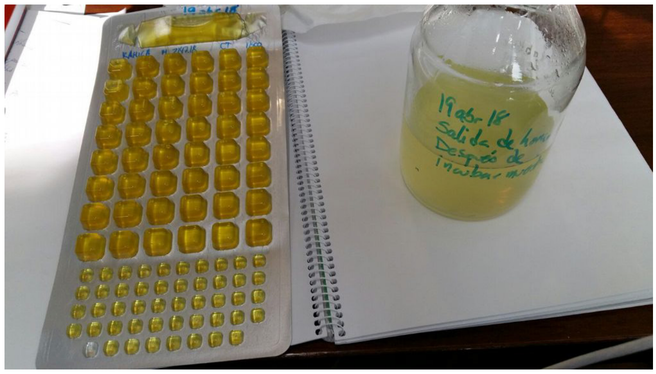


Fig. 2: The color in the cells of the IDDEX blister is clearly different to the color of the culture being done in a flexible catheter

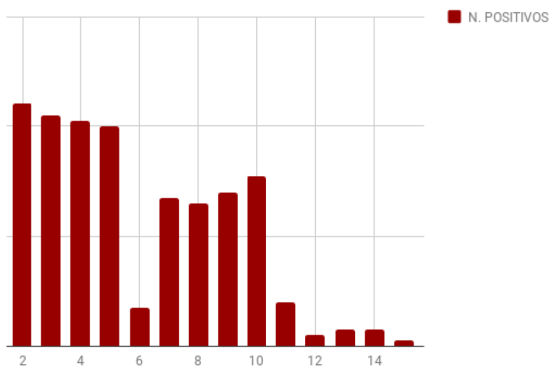


Fig. 3: Evolution of 'positive cells' while repeatedly cleaning the catheter. Positive cells only means that the color sensor reads yellow. We consider there are unless 3 different processes in the nutrient – catheter interaction

ID9- RAMICA OWEN: PERFORMING AUTOMATIC MICROBIOLOGICAL CULTURES

XULIO FERNANDEZ HERMIDA[39], VICTOR ALONSO RORÍS[40]. MANUEL VAZQUEZ ENRIQUEZ[41]

Abstract
This article presents the RAMICA owen. The whole RAMICA sensor is able to implement a complete culture of bacteria inside a buoy. It does a culture every day, for 3 months, and sends data in real time. This allows to monitor the evolution of bacteriological contamination and relate it with what it is happening in human doing.
RAMICA sensor is a certified laboratory. It implements the MPN (Most Probable Number) Standard Method using 51 separated cells. In each cell it uses different light illumination (white or ultra violet) and its oven can work at different temperatures. With the right combination of lightning and temperature, it can culture Total coliform, Enterococcus and Ecoli.

Keywords - RAMICA sensor, microbiological quality of waters, bacteriological contamination, coliform contamination.

I. INTRODUCTION
The RAMICA sensor has been developed in a 'Retos Colaboración' project in the University of Vigo (http://ramica.cetmar.org/). To implement the IDDEX protocol it is necessary to separate the culture in 51 independent cells. Depending on the number of 'positive cells' it gives a Most Probable Number of bacteria in the water under control.
To be able to split the culture in cells, and posterior cleaning, of the cells, in the Ramica owen we use a flexible catheter (culture catheter in Fig. 2) that is smashed in 52 points along the catheter. To read the color of the cells a very sensible color sensor has been implemented in each cell.
This color sensor consist of one white led (used to light in order to see the visual color of the culture), one ultraviolet led (used to light in order to see if the culture has fluorescence), and one PIN color sensor with 16 individual sensors: 4 in red, 4 in green, 4 in blue and 4 in white.
The color sensor of each cell pretends to be able to read the color of the liquid inside the catheter with very good precision. What it really reads is the light going out of the culture catheter when it is lighted with white or uv lightning from outside it and, in actual version, the diodes and the PIN color sensor are located in the same side.
The sampling of the water to analyze is done by means of a Hidroboya, which let us to pick the sample at any depth in the water column. In actual development there is an intermediate sample chamber that is difficult to disinfect and guarantee not any rest of biocide remains in it. If the depth of sample is not great (10 meters or less) the sample is took directly by the hydraulic part of the RAMICA owen which guarantees the disinfection process.
The hydraulic part of the RAMICA owen (we call it preowen) consist of several peristaltic pumps, valves and sensors and an electronic board responsible of the control of every sensor and active element.
The pre-owen performs the mixing processes to create the culture and moves it to the owen. That is, it mix 10 ml of sea water to analyze, with 90 ml of distilled water (in a deposit inside the RAMICA buoy) and with the IDDEX nutrient. The IDDEX nutrient has been previously dissolved in water (in order it to be easily moved by peristaltic pumps) and it is kept in the buoy at low temperature (in order it to remain active the 3 months that RAMICA buoy has been designed to work before it needs a maintenance process).
The owen is pre heated while the pre-owen performs the mixing in order the owen start to do the culture in the established temperature in a few minutes.
The pre-owen moves the mixing to the culture catheter in the owen. Then, an electric motor press the smash mechanical pieces against the catheter bed (Fig. 2) closing the owen. That crushes the culture catheter, splitting the culture in 51 separated cells. It also closes the first insolation box wrapping the owen.(Fig. 2) The control of the stove board adjust the temperature with a precision of 0,2 degrees. The culture process is running.
The definte MNP value is computed with the positive cells after 18 hours. Anyway, we read the cells every 3 or 6 hours. Then, the data is sent to the server in land.

CONCLUSIONS
The RAMICA sensor has been developed and with it, real time microbiological control can be performed. Many problems have been solved. The actual version is not ready to the market but it will be in a few months.

FUTURE LINES
Make the culture catheter as a connection of cylinders of glass (in the cells) with pieces of flexible catheter (in the smashed parts). This may solve the color sensor problem with the strange interaction between catheter and nutrient of the culture.

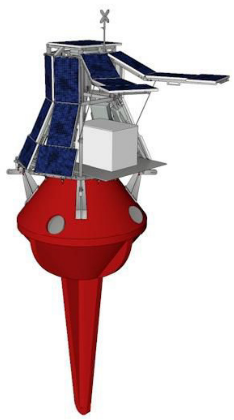


Fig. 1: Synthetic image of the whole buoy with solar panels and the box with the owen where the cultures are done.

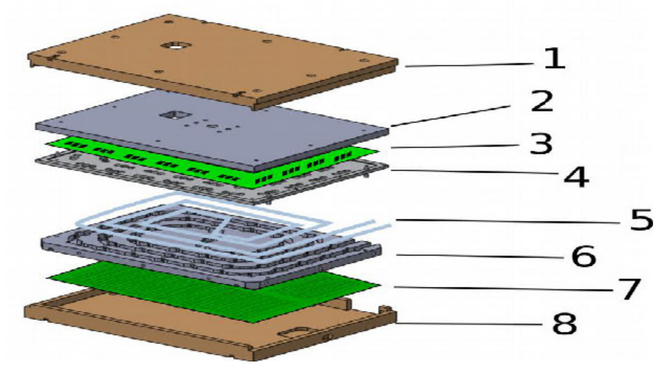


Fig. 2: Exploded view of the owen:
1, 8) first insulation box, 2, 4, 6) smash mechanical pieces and catheter bed (6), 3) colorimetry board, 5) culture catheter, 7) stove board,

ID10- HYDROPHONE INSTALLATION IN THE RAIA OCEAN-METEOROLOGICAL OBSERVATORY NET

PABLO ÁLVAREZ[139], ALBERT GARCÍA[144], CLARA ALMÉCIJA[140], IGNACIO GONZÁLEZ[141], CRISTIAN SIMOES[142], JOAQUÍN DEL RÍO[129], SILVIA TORRES[143]

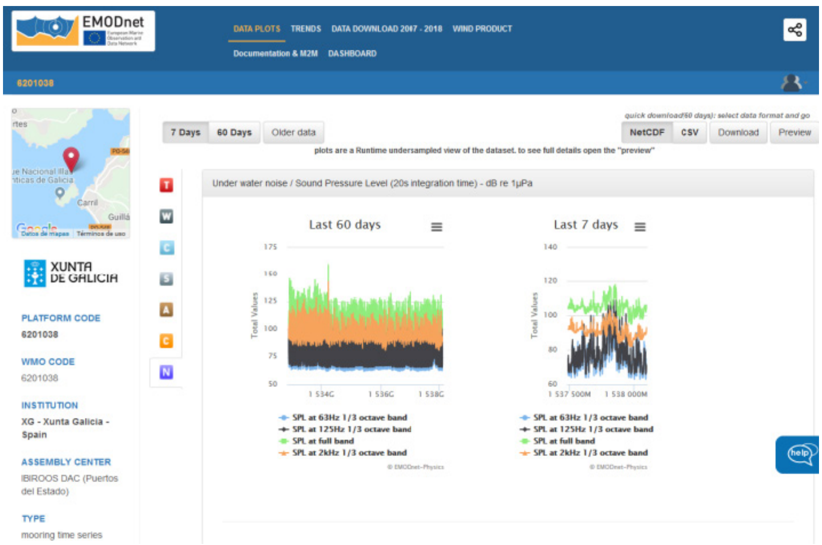
Abstract
An Iclisten hydrophone has been installed in a metocean platform of RAIA Obervatory, as part of the MarRisk project, and data are being uploaded to EMODnet web portal.

KEYWORDS - HYDROPHONE, AMBIENT NOISE, MSFD, EMODNET.

I. DESCRIPTION
The RAIA Observatory monitoring network provides reliable monitoring network provides reliable in-situ meteorological and oceanographic information. MarRisk project aims to improve resilience against climate change collecting and analysing metocean data. As part of this project, this year an ICListen hydrophone has been integrated in one station, new energy supply system and new storage system has been installed and ambient underwater noise is being recorded currently. Data is being processed in a raspberry pi 3 and the resulting SPL, SPL63, SPL125 and SPL2k are being uploaded to an EMODnet data center that checks and validate the calculated noise parameters.

II. CONCLUSIONS
Although the equipment has been installed recently, we can appreciate that the results are being good. It is still necessary to improve and optimize the energy generation system that now consists of 3 solar panels of 90w and a wind turbine of 90w. At the moment, raw data are stored in a 256GB memory that needs to be changed every month, which forces us to move to the station. In the future we may discard save these raw data and only save the processed that occupy much less volume.

Fig 1.Above, pictures of the station.
Image below is a chart captured at EMODnet website in 9/28/2018



ID11- SMART SENSING INTEROPERABILITY PLATFORMS IN THE SCOPE OF ATLANTOS

DANIEL A. REAL-ARCE[116], EHSAN ABDI[35], ENOC MARTÍNEZ[145], E. DELORY[117], C. BARRERA[118], J. HERNÁNDEZ[119] AND O. LLINÁS[120]

Abstract
This paper aims to demonstrate the capabilities of a Smart Cable which aims to convert any commercial non-PUCK-enabled sensor in a Smart PUCK-enabled device. Through this development, it can be easily integrated on a sensor web platform in order to access the data in real time, and so there is no need to rely on each sensor manufacturer to comply with Sensor Web Enablement standards. The results presented in this paper were acquired during some real field experiments performed between the 24th and 28th of September at PLOCAN facilities in Gran Canaria. During these days three Turner Designs Cyclops sensors were successfully integrated and tested in a mission using an observing surface vehicle such as the Wave Glider SV-2.

Key words: ASV, unmanned vehicle, sensors, communication, cable

INTRODUCTION
The presented work is done in the framework of H2020 AtlantOS EU- Project. Atlantos is a BG 8 (Developing in-situ Atlantic Ocean Observations for a better management and sustainable exploitation of the maritime resources) for the integration of ocean observing activities across all disciplines for the Atlantic, considering European partners as well as non-European participants.
The overall goal of this project is to improve ocean-observations capacity in the area of interest by using cutting-edge technologies in a cooperative and synergistic way between partners from different disciplines of the marine and maritime sector, by using new and existing resources provided by ongoing projects and initiatives at regional, national and international level, in order to cover the widest number of specific and common needs and requirements from each one of them, as well as additional potential stakeholders.
In this sense some demonstrative initiatives have taken place in PLOCAN facilities in the scope of AtlantOS. The one presented in this paper comprises the Cyprus Subsea company, creator of the Smart Cable used during the experiment, and coordinator of the H2020 project Bridges, and the UPC which was one of the partners of FP7 Nexos project involved in the creation of the web data viewer used – SOS viewer.

EXPERIMENT
The sensors integrated and demonstrated in this experiment are commercial optical sensors that measures turbidity, chlorophyll and refined fuels. Each of these three sensors are connected aboard the Wave Glider with a dedicated developed Smart Cable (Fig. 1) to a SensorML compatible device on board.

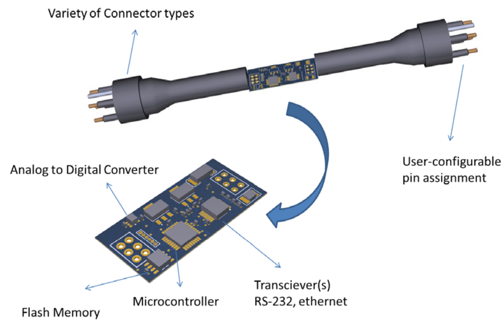


Fig. 1 Smart Cable from Cyprus Subsea

In this experiment the OGC PUCK protocol will be used to retrieve a SensorML file from the Smart Cable connected to a sensor. The SensorML is then parsed by the platform and a plug-and-work sensor integration shall be demonstrated. Additionally, the data from sensors shall be made available on a web client in real-time through a SOS server. Using this development any sensor can be turned into a plugand-work interoperable device as it stores and provides SensorML files.

RESULTS
The results of this experiment were retrieved during a 24h mission where the three sensors installed in the Wave Glider were acquiring data that could be seen through the AtlantOS SOS interface in real time (Fig. 2) via an Iridium link.

ACKNOWLEDGEMENT
The ATLANTOS Project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement 633211.

Fig. 2 Sensors installed in the Wave Glider / Data received in real time to the SOS interface

ID12- EXPANDING OCEAN-MONITORING CAPABILITIES IN THE MACARONESIA WITH UNMANNED MOBILE PLATFORMS

C. BARRERA[118], C.WALDMANN[27], R. CALDEIRA[115], MJ RUEDA[122], J. HERNÁNDEZ[119] AND O. LLINÁS[120]

Abstract

The Macaronesia is a vast area playing a key role in the East boundary of the Central North-Atlantic ocean-circulation system. Despite a significant research activity in ocean monitoring for decades using a wide range of observing systems and methodologies, the area is still under-sampled, mainly due access and coverage constrains, as well as the observation sustainability. Ocean gliders offer a new approach in terms of capacity and sustainability, allowing undertake ocean-monitoring in spatiotemporal scales hitherto unavailable. The present work shows preliminary results from the latest mission with buoyancy-driven and surface ocean gliders in the area, whose main goal focuses on to improve and expand ocean observation capabilities strengthening glider endurance lines between archipelagos, as part of the global ocean-observation strategy conducted by the Marine & Maritime Network (R3M), as regional contribution directly aligned with European and international initiatives and strategies in the North Atlantic basin.

Key words: Ocean, monitoring, glider, Macaronesia, robotics, marine, technology

INTRODUCTION

In-situ ocean monitoring is still difficult and costly for a large number of chief reasons, despite current advances on key marine technology fields. Oceans have a complex 3D-structure and their behavior is governed by a wide variety of processes. Long-term monitoring of them also poses substantial technical and logistic challenges. World oceans are constantly shifting in ways that impact on every face of our society. To keep open-ocean and coastal communities, economies, and ecosystems healthy requires to monitor key physical, chemical, and biological parameters to assess how these areas (offshore and coastal, from surface to seafloor) are changing in order to take the right decisions for them and the environment.

From a global and multidisciplinary perspective, currently is possible to link databases holding information from in-situ ocean observation with modelling tools and to use them for supporting forecasts ocean states according to end-users needs. Conflicts between commerce, leisure, research and development, environmental protection and the management of living resources are increasing. The social and economic costs of unsuitable informed decisions are growing accordingly. A global integrated system of ocean observations and analysis is still needed to provide the information (data products) required by the society to fill the existing key gaps in this context.

The Group on Earth Observations, GEO, is coordinating efforts to build a Global Earth Observation System of Systems, or GEOSS. GEO was launched in response to calls for action by the 2002 World Summit on Sustainable Development and by the G8 (Group of Eight) leading industrialized countries. These high-level meetings recognized that international collaboration is essential for exploiting the growing potential of Earth observations to support decision making in an increasingly complex and environmentally stressed world.

GEO has released GEOSS on the basis of a 10-Year Implementation Plan for the period 2005 to 2015 in order to define a vision statement for GEOSS, its purpose and scope, expected benefits, and the nine "Societal Benefit Areas" of disasters, health, energy, climate, water, weather, ecosystems, agriculture and biodiversity. GEO is coordinating efforts to build a Global Earth Observation System of Systems, or GEOSS. GOOS (Global Ocean Observing System) is the oceanographic component of GEOSS.

THE ATLANTOS PROJECT

AtlantOS is a project supported by the European Union's Horizon-2020 research and innovation programme, under the Call BG-8 Developing in-situ Atlantic Ocean Observations for a better management and sustainable exploitation of the maritime resources. It is a 4-year project, with a budget of 21 M€, involving 62 partners from 18 countries (13 EU and 5 non-EU), plus supporters. The overarching objective of AtlantOS is to achieve a transition from a loosely-coordinated set of existing ocean observing activities to a sustainable, efficient and fit-for-purpose Integrated Atlantic Ocean Observing System (IAOOS), by defining requirements and systems design, improving the readiness of observing networks and data systems, and engaging stakeholders around the Atlantic; and leaving a legacy and strengthened contribution to the Global Ocean Observing System (GOOS) and the Global Earth Observation System of Systems (GEOSS).

The project is organized along work packages on: i) observing system requirements and design studies, ii) enhancement of ship-based and autonomous observing networks, iii) interfaces with coastal ocean observing systems, iv) integration of regional observing systems, v) cross-cutting issues and emerging networks, vi) data flow and data integration, vii) societal benefits from observing /information systems, and viii) system evaluation and resource sustainability. Engagement with wider stakeholders including end-users of Atlantic Ocean observation products and services will also be key throughout the project. The AtlantOS initiative contributes to achieving the aims of the Galway Statement on Atlantic Ocean Cooperation signed in 2013 by the EU, Canada and the US, launching a Transatlantic Ocean Research Alliance to enhance collaboration to better understand the Atlantic Ocean and sustainably manage and use its resources.

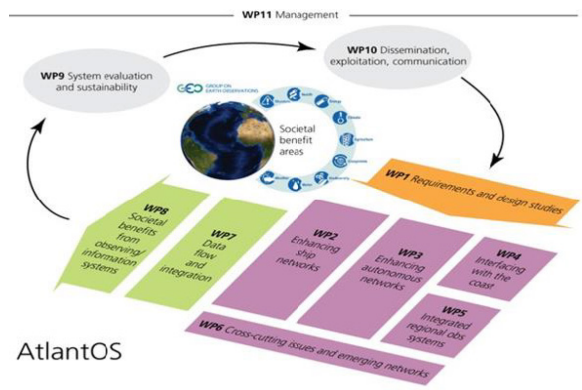


Fig. 1. AtlantOS project architecture and work flow.

The operational approach of AtlantOS includes a specific chapter (WP3 – Enhancing autonomous networks) related to ocean glider, as cutting-edge technology for a most sustainable and cost-effective ocean-observation capacity (Fig 1).

A. The role of PLOCAN in AtlantOS

PLOCAN, the Oceanic Platform of the Canary Islands is a Spanish multipurpose technical-scientific service infrastructure, suited by a set of large facilities that provide support to research, technological development and innovation in the ocean. The aim of PLOCAN is to build an infrastructure to promote marine science and technology of excellence and facilitate access to ocean areas while always safeguarding the environment. PLOCAN is a joint initiative of the Government of the Autonomous Region of the Canary Islands and the Spanish National Government (Ministry of Science and Innovation). PLOCAN's main role in AtlantOS refers to ocean-observation activities in the East-Central North-Atlantic area by the use of different autonomous and ship-based technologies, with special focus at ESTOC (European Station of Time-Series in the Ocean–Canary Islands). In order to accomplish the goals according to the task along the different work-packages, a wide range of ocean-platforms are used, being one of them ocean-gliders from the glider-fleet owned by PLOCAN.

B. Ocean-glider technology

Ocean-gliders technologyrepresents a new operational step in regards autonomous monitoring of physical and biochemical seawater parameters at surface and across the water column. Buoyancy-
driven (underwater) and surface-vehicles (ASV) are the two main families of ocean-gliders nowadays available and widely used by for different purposes. Underwater gliders (Fig 2) are autonomous vehicles that profile vertically by controlling buoyancy. By the other hand, ASV are platforms able to gather energy from the ocean (mainly wind of wave power) as motion-source. Gliders propel themselves by changing buoyancy and using wings to produce forward motion. Buoyancy is changed by varying the vehicle volume typically by O (100 cc) to create a buoyancy force of about 1 N. Wing lift balances the across-track buoyant force while the forward buoyant force balances drag. The ratio of horizontal speed O (25 cm/s) to vertical speed (glide slope) equals lift over drag and is typically 2 to 4, much less than for an aeronautical glider. Energy for gliding is supplied at the bottom of each dive cycle where work is performed to increase vehicle volume. On an O (1 km) deep-dive cycle lasting several hours, the O (10 kJ) energy used to change buoyancy implies a power usage for propulsion of about 0.5W. The saw-tooth flight-paths of gliders naturally sample the ocean both vertically and horizontally.
In both cases, profilers and surface technologies are open platforms able to carry on different sensor payload configurations, according to end-user needs, being the two main limitations: power and size/weight ratio. Water temperature, conductivity, dissolved oxygen, pigments, turbidity, nutrients, ocean-currents and meteorological are some examples of oceanographic parameters able to be monitored by these cutting-edge autonomous ocean-platforms.

Fig. 2. Buoyancy-driven glider technology example (Slocum G2. Teledyne Marine).

Buoyancy-driven and ASV gliders have become since some years ago part of the wide-range of ocean-platforms addressed to monitor the area of interest for PLOCAN and partners across the East-Central North Atlantic, as technical approach of the R3M -Maronesia Marine and Maritime Network- [6], the regional monitoring strategy in support to the main international ocean-observations programs and initiatives.

THE MACARONESIA AND R3M

The Macaronesia region is a wide ocean area with more than 5.5 million Km2 located in the East-Central North Atlantic that comprises four main archipelagos: Açores, Madeira, Canary Islands and Cape Verde (Fig. 3). All them clearly show a common volcanic (hotspot) origin which gives them similarities concerning biodiversity, although there is a climate variation due to their latitudinal distribution. The status of outermost region, the land fragmentation of each archipelago in islands as bounded units and the external dependence, are structural features that have conditioned and decisively influenced the development of human activities and the availability of resources. Despite this, Macaronesia has a clear and strategic international interest for all major socio-economic sectors within the marine maritime fields, which require information as derived product from the marine environment observations in a continuous and efficient way.
The R3M (Macaronesia Marine and Maritime Network) is a regional (linked globally) initiative aimed to increase the quantity and quality of marine environment observations across its four main archipelagos (Açores, Madeira, Canary Islands and Cape Verde), in order to understand and predict both the phenomena that take place on it and the related environmental and socioeconomic impact. The R3M is an integrative and synergic tool, making compatible and accessible to potential end-users (commercial and recreational navigation, harbors, safety & security, oil & gas, aquaculture, wastewater, tourism, marine research, water sports, ocean energies, protected areas, weather agencies, national and regional governments, etc.) all the marine environment observations [time series observations gathered by different "in-situ" and remote sensing platforms from cutting-edge and conventional methodologies], regardless of the institution or company that carry them out. The initiative includes technological developments for all types of required instruments and tools, aiming to make them more accessible both on a technical and economical point of view. The R3M has been built "from base to top", starting from the specific end-users towards general users, while keeping the goals and rules established by national and international agencies.

LATEST PERFORMED MISSIONS

A. MADEIRA-CANARIES TRANSECT -This glider mission was conducted and led by PLOCAN as part of its tasks committed within AtlantOS project work plan. The Instituto Hidrografico (IH) of Lisbon and the Madeira's Ocean Observatory (OOM) joined the mission as partners from the operational, scientific and strategic point of view in the Macaronesian context. The main goal of the mission was to evaluate cooperation capabilities between the abovementioned partners, looking for a permanent glider-endurance line between Madeira and Gran Canaria, as well as to identify new oceanographic features from water masses and associated processes from a high-frecuency sampling tool as it represents such type of autonomous platform, in comparison to the ship-based techniques used up to know as most common methodology for ocean observation in this area.

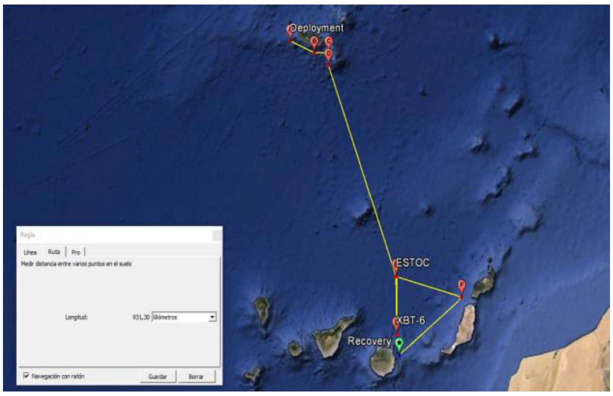


Fig. 3. Full glider path described across the mission.

A Slocum G2 glider owned by PLOCAN with a dedicated sensor-payload configuration (CTD, dissolved oxygen, turbidity and chlorophyll) was shipped to Madeira, place where the mission was started. After some last mission settings and verifications, the glider was deployed southwards Funchal from the Portuguese Navy's "NRP-Zaire" with the support of a Madeira's SAR rubber-boat. The nearly 1000 kilometers of glider-path between launching to recovery locations After 26 days of mission, the glider was successfully recovered northwards Gran Canaria from Spanish-Armada's "Meteoro" patrol-boat (Fig. 5). was divided in three areas (Fig. 3). An initial segment crossing the Island of Madeira, a second segment from Madeira to ESTOC site and the third and final one was conducted between Gran Canaria and Fuerteventura Islands. Piloting tasks were conducted from PLOCAN premises and data display was available along the mission through the glider portal web-tool. Additional data and modeling supporting piloting tasks were provided by OOM.

After 26 days of mission, the glider was successfully recovered northwards Gran Canaria from Spanish-Armada's "Meteoro" patrol-boat (Fig. 5).

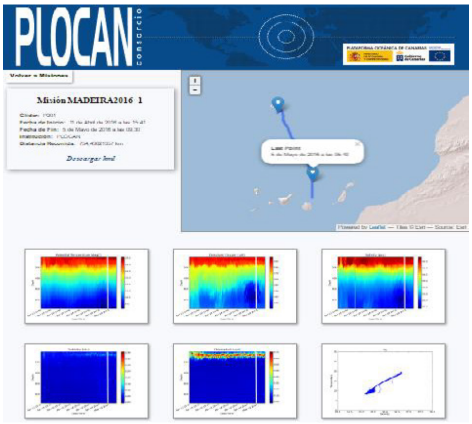


Fig. 4. PLOCAN glider portal tool.

Fig. 5. Glider recovery-maneuver from "Meteoro" patrol-boat.

Satellite derived observations including SSH and SLA from AVISO, SST from GHRSST, Ocean Surface Currents derived from satellite altimeter and Scatterometer data (OSCAR), monthly averages of Chlorophyll-a from MODIS-Aqua, NCEP wind and wave forecast using WAVEWATCH III, and forcing winds from GFS have been used as product-tool. MERCATOR-IBI36 hydrodynamic regional model forecast based on NEMO application updated daily to plot SSH, SST, SSS, ocean-current vectors over flow speed.

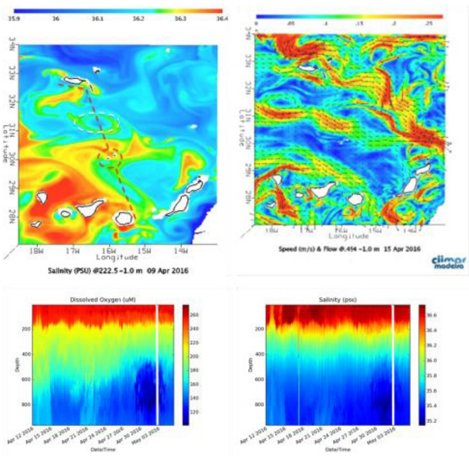


Fig.6 . Derived product-tools and preliminar derived results.

B. MSM61 – Oceanographic cruise MSM61 aboard the German research vessel RV/Maria S. Merian to study the physical and bio-geo-chemical characterization of the outstanding ecosystem of the Senghor Sea Mount located Northwards Cape Verde Archipelago, and to assess the operational response and capability of new, autonomous oceanic observation technologies in real operational scenarios. The study is part of AtlantOS and includes deploying and operating a range of autonomous observation equipment and platforms, such as multi-parameter modules anchored in the water column and on the seabed, autonomous surface marine vehicles (gliders) - SV2 and SV3 Wave Gliders - and profilers (Slocum G2-1000), all fitted with specific sensor equipment for taking samples and data in-situ, in response the scientific and technical needs and objectives set for the mission and the project.

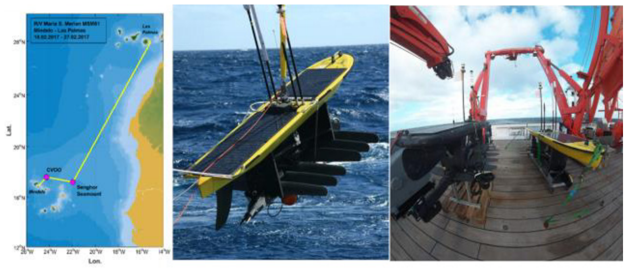


Fig. 7. Mission path, Wave Glider unit and MSM deck view.

C. CHALLENGER MISSION – The Challenger One is an international program initiative where PLOCAN cooperates with Teledyne Marine and Rutgers University in regards a Slocum G2 glider unit, under the name of Silbo, that attempts to circumnavigate the North Atlantic basin, for scientific and technological purposed. Deployed in Ireland in May 2017, after 178 days of navigation across the Macaronesia, Silbo reached Gran Canaria on November 2017, where is expected a maintenance and battery replacement before to be re-deployed. Glider data from the Challenger Mission is flowing to Global Telecom System and is being assimilated by European and American global ocean forecast models. The glider data has been used to assess the predictive skill between the American and European operational global ocean forecast models.

Fig.8 . Silbo after recovery and path described in this leg.

ACKNOWLEDGEMENT
The research leading to the presented results has been undertaken within the AtlantOS European project (Optimising and Enhancing the Integrated Atlantic Ocean Observing Systems), under Grant Agreement n. 633211 – European Union's Horizon 2020 Research and Innovation Program.

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ID13- ACOUSTIC TAG TRACKING: FIRST EXPERIMENTS

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Abstract
Nowadays, the use of autonomous vehicles for ocean research has increased, since these vehicles have a better cost/performance ratio than crewed vessels or oceanographic ships. For example, autonomous surface vehicles can be used to localize underwater targets. Whereas different research works are focused in target tracking using acoustic modems (or USBL), in this paper a new method called Area-Only target tracking is presented, which uses the signal generated by acoustic TAGs. This document, the first tests are presented and their results discussed, which were conducted in the Monterey Bay.
Keywords— underwater target localization, autonomous vehicle, acoustic, area-only, tagged animals

I. INTRODUCTION

One of the main challenges in oceanographic research is that of underwater positioning. Is well known that GPS signals suffer a large attenuation underwater. Therefore different methods and architectures have been developed using acoustic signals, which have better underwater performance.

This paper presents a novelty Area-Only target tracking method, using a Wave Glider autonomous surface vehicle [1] that detects a tagged underwater target while moving on the surface. Using the detection/no-detection information, it is able to compute target position and follow it. The main algorithm used is the Particle Filter (PF), which has been used successfully in range-only target tracking [2]. Whereas in our previous work [2] the information used to track the target was the slant range measured using acoustic modems, in this case the only information available is the presence/absence of TAG's detection, which yields in a more complex scenario.

The method presented in this paper can be used in a wide range of applications using the long-duration, autonomous navigation and computational characteristics of the Wave Glider, to locate stationary or slowly moving tagged targets on the seabed or in the water column. In this work we present the first tests conducted in order to characterize the performance of the Area-Only method.

II. AREA-ONLY METHOD

The information that can be obtained using acoustic TAGs is presence or absence of the TAG in the area of its influence. Therefore, we only can know if the TAG is inside the area of reception but we do not have any information about its direction neither how close or far it is from the receiver. At this point, we can say that the algorithm developed is area-only, where only the area formed by the maximum range achievable by the TAG is used as an input of the filter. Fig. 1 illustrates this performance.

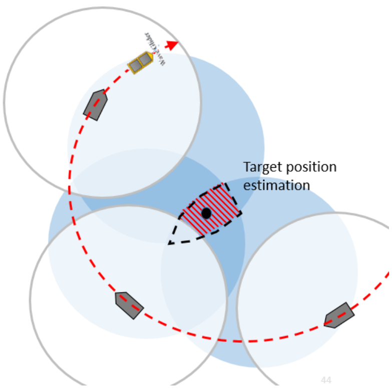

Figure 1. Area-Only target tracking problem representation.

Two kind of areas can be observed, one where the TAG is detected (blue circles), and a second area where the TAG is not detected (white circles). The target localization estimation can be computed overlapping all these areas, where the area with a main coincidence is where the target should be.

This method can be implemented using PF, where initially all the particles are drop in a specific area, and then for each new detection (or no-detection) the particles weight is updated until all of them converge in the target position estimation.

III. TEST CHARACTERISITICS

The following test was carried out on June 27-28, 2018. For this test, a Wave Glider (WG) and a Coastal Profiling Float (CPF) were used. The WG was equipped with a Vemco receiver, and two Vemco TAGs were installed on the CPF (Fig. 2).

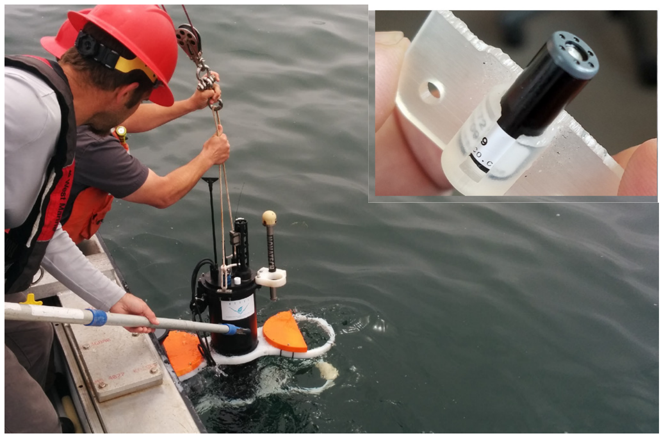

Figure 2. CPF's deployment during the test. Vemco TAG used (top).

This test was conducted as follows:

a) Test 6.1:
- Script: tracking.py with 50 meters of radius
- Start: 16:00 (PDT)
- Stop: 20:00 (PDT)
- File: *cpf_ivan-2.out

b) Test 6.2:
- Script: tracking.py with 150 meters of radius
- Start: 20:03 (PDT)
- Stop: 21:43 (PDT)
- File: *cpf_ivan-3.out

c) Test 6.3:
- Script: tracking.py NO STALKING
- Start: 22:17 (PDT)
- Stop: 08:39 (+1) (PDT)
- File: *cpf_ivan-6.out
- In parallel during the no stalking test (6.3) different watch circles were conducted manually with the WG as follows:

1. Radius: 50 m. Start: 21:53 (PDT)
2. Radius: 100 m. Start: 23:03 (PDT)
3. Radius: 150 m. Start: 02:11(+1) (PDT)
4. Radius: 200 m. Start: 05:17(+1) (PDT)

5. Radius: 250 m. Start: 07:35(+1) (PDT)
6. Stop: 08:40 (+1)(PDT)
d) Test 6.4:
• Script: tracking.py with ODSS improvements done by Brian
• Start: 08:40 (+1)(PDT)
• Stop: --:-- (PDT)
• File: *cpf_ivan-7.out

IV. RESULTS

The results and issues observed are addressed below.

a) Range differences

The first problem that can be pinpointed is the differences between the ranges measured using acoustic modems (DAT) and the range computed using the GPS positions of the Wave Glider (WG) and CPF. This error is highlighted using the red circle (Fig. 3). This issue is probably due a bad GPS measurement of the CPF, which only takes one or two positions while it is in the surface, and strong currents can move the CPF far away from its initial position.

a) Surface detections

Finally, another issue to take into consideration is the TAG's reception rate while the CPF was in the surface. We observed in previous tests that when both TAG and Receiver were placed too close to the sea surface the reception rate was not good. This behavior can be observed also in this case, as it is shown in the Fig. 4, where the TAG reception drops rapidly when the CPF reach the sea surface (green line in the middle plot).

V.CONCLUSIONS

This work describes a field test conducted to acoustically localize a benthic Rover deployed at 4000 m depth from an autonomous surface vehicle. For this purpose a new application using a Wave Glider as a single-beacon LBL has been developed. The work presented in this paper proves the good performance of this method.

ACKNOWLEDGMENT

This work was supported by the project JERICO-NEXTfrom the European Commission's Horizon 2020 research and Innovation program under Grant Agreement No. 654410. We are also grateful for the financial support from the Spanish Ministerio de Economia y Competitividad (contract TEC2017-87861-R project RESBIO). This work has been directed and carried out by members of the Tecnoterra-associated unit of the Scientific Research Council through the Universitat Politecnica de Catalunya, the Jaume Almera Earth Sciences Institute and the Marine Science Institute. We gratefully acknowledge the support of MBARI and the David and Lucile Packard foundation. The main author of this work has a scholarship (FPI-UPC) from UPC for his PhD research (agreement number 175/2015).

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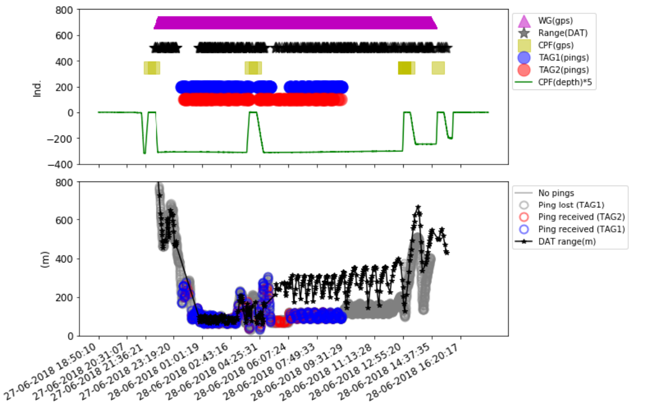

Figure 3. Data representation with their timestamp (top). Ping reception, range, and range error representation (bottom).

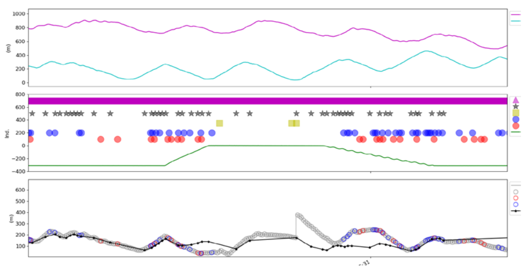

Figure 4. TAG reception (blue and red dots) is missing when the CPF is in the surface (green line), middle graph.

ID14- EMSO-ANTARES (WESTERN LIGURIAN SEA) A UNIQUE OBSERVATORY FOR SEA SCIENCE AND PARTICLE ASTROPHYSICS

D. LEFEVRE[8], C. TAMBURINI[9], C. GOJAK[50], K. MAHIOUZ[51], K. BERNARDET[52], Z. HAFIDI[53], P. COYLE[2], V. BERTIN[3], P. LAMARE[4], P. KELLER[3], J. BUSTO[6], V. CIAUSU[152], A. DESCHAMPS[66], Y. HELLO[67], R. BARBIER[81], H. GLOTIN[7]

Keywords: (Technology, Time Series, Neutrinos, Biogeochemistry, Hydrology, Mediterranean Sea)

EMSO-France is a distributed research infrastructure involving many sites of activity, one of which is the ANTARES (Astronomy with a Neutrino Telescope and Abyss environmental RESearch) site in the Western Ligurian Sea. The objective is to develop a scientific and technical observatory based on the mutualisation of effort with open access to international partners.

Based on the synergy between astroparticle physicists, focused on neutrino research, and oceanographers, geophysicists, biologists, which follow continuously the water column and the deep sea, the project aims to build a network of sensors connected in real-time to the underwater infrastructure via electro-optical cables. This multidisciplinary project, led by INSU and IN2P3, CNRS institutes, Universities of Aix-Marseille and Toulon-Var and IFREMER is also a node of the European projects KM3NeT and EMSO. This effort is supporting the science carried out within MISTRALS and the SNO MOOSE.

The ANTARES site is currently being upgraded to the next generation deep-sea neutrino telescope, named KM3NeT-ORCA (Oscillation Research with Cosmics in the Abyss). It will allow the measurement of neutrinos mass hierarchy, provide information on dark and a better knowledge of the earth deep core composition (neutrino tomography). This research infrastructure presents a unique opportunity to develop multidisciplinary projects across many different scientific fields (Fig. 1).

Building on the ANTARES experience, such as the instrumentation line and ongoing efforts aiming at instrumenting the water column for sustainable in situ a real time data acquisition, we are currently developing and diversifying our observing system (Fig.1). Furthermore, climatic changes will trigger change in temperature and other parameters that will impact on biogeochemical processes and biodiversity. It is therefore a strong necessity to setup the appropriate tools to monitor, understand our ecosystem evolution: study of the link between the surface to the deep ocean in relation with surface oceanic circulation (i.e. North current), events at the basin scale such as deep water formation, flux of organic matter and particles originating from diverse horizon, bioluminescence, nuclear radiation, seismology, monitoring deep sea fauna/flora using high-tech imaging cameras. Monitoring marine mammals through acoustic signals.

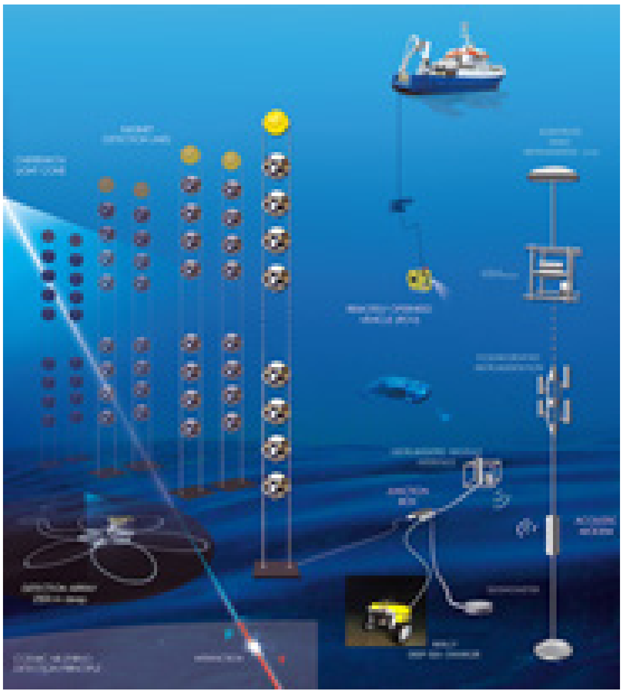

Figure 1: Artistic representation of the EMSO-KM3NeT deep-sea multidisciplinary observatory in the Western Ligurian Sea.

ID 15- PROOF OF CONCEPT FOR DISTRIBUTING UNDERWATER NOISE MAPPING THROUGH EMODNET PHYSICS PORTAL

THOMAS FOLEGOT[125], ARNAUD LEVAUFRE[126], MICHEL ANDRÉ[103], MIKE VAN DER SCHAAR[104], JOAQUIN DEL RIO FERNANDEZ[129], PATRICK GORRINGE[54] AND ANTONIO NOVELLINO[55]

Abstract

Underwater noise has been significantly raising in the past decades due to an increment of human-related activities in the oceans such as shipping, industrial activities, seismic explorations, coastal developments, etc. As recognized by the Marine Strategy Framework Directive (MSFD), these activities may have adverse effects on fish and mammals, such as communications masking and modifying predator–prey interactions, or, for the most intense noise sources, direct temporary or permanent physiological damage.

In order to assess and limit the impact of these, the European Commission approved the Marine Strategy Framework Directive which aims to achieve a good environmental status in European waters. Within this directive different environmental challenges are addressed, including the long-term monitoring of underwater noise throughout European waters.

EMODnet Physics is one of the European Marine Observation and Data network thematic portals, which is currently providing access physical parameters of the oceans. Quonops Online Services is an online and on-demand underwater noise prediction system (qos.quiet-oceans.com) that provides with global statistical maps of both natural and anthropogenic components of the underwater noise. Quonops has been successfully experimented to fulfil the requirements of the MSFD during the BIAS Life+ funded project to provide regional underwater noise mapping of the Baltic Sea.

The feasibility of the connection between Quonops and EMODNet platforms together with the LIDO (Listen to Deep Ocean) network of underwater sound monitoring network has been demonstrated through periodic and automatic delivery of monthly noise maps. This multi-platform technological innovation forms a major step forward towards an operational service dedicated to the operational survey of underwater noise at regional scales.

Keywords – Marine Strategy Framework Directive, Ocean Noise, Noise Map, Noise Modelling, Noise Monitoring

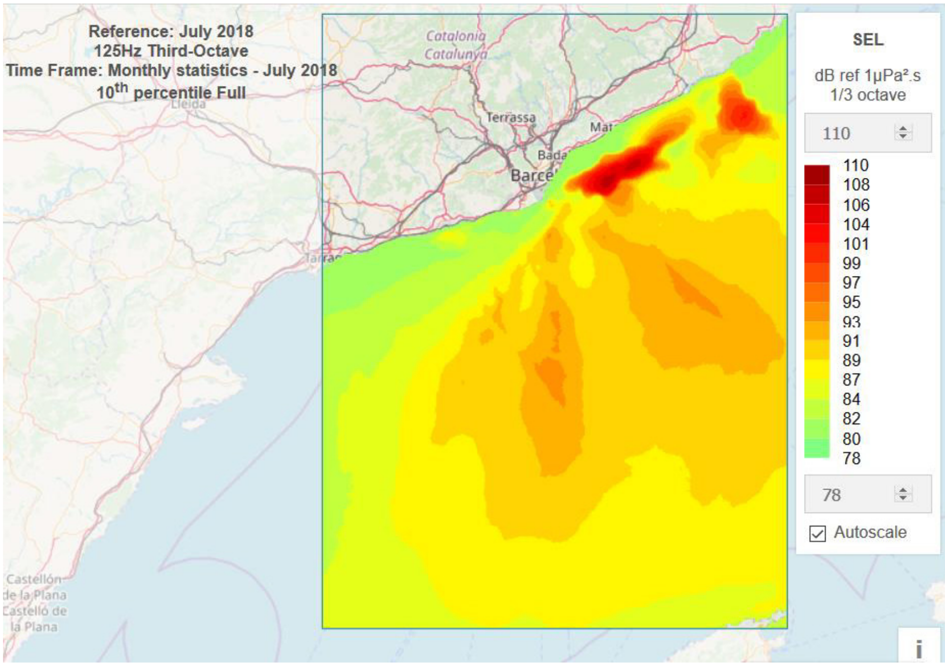

Fig. 1: Statistical noise map offshore Barcelona around the OBSEA monitoring station in July 2018. The map represent the 10th exceedance levels, indicating that the effective noise is equal or higher than the levels represented for 10% of the time, i.e. 3.1 days in July.

ID16- A NONLINEAR KINETIC ENERGY HARVESTER FOR LIGHT SURFACE OCEAN DRIFTERS

DANIEL M. TOMA[132], MATIAS CARANDELL[133], MONTSERRAT CARBONELL-VENTURA[134], LLUIS VALS[135], JOAQUIN DEL RIO[129]

Abstract
A nonlinear kinetic energy harvester for ocean drifter devices is presented. The design contains a gyroscopic wave energy harvesting system, capable of generating power from the wave-induced translational and rotational motions of a Wavy ocean drifter.

Keywords - energy harvesting; marine instruments.

The Wavy ocean drifters, as illustrated in Figure 1a., are basically small-size spheres with just enough room to accommodate power source, communications modules, antennae, sensors and data processor. The spherical shape of the proposed drifter allows it to re-float after stranding, while its optimized buoyancy reduces wind exposure to a minimum. However, the power supply of the Wavy drifters still relies on batteries, which exhibit several drawbacks such as low durability, difficulty of replacement, and most notably, inferior sustainability in terms of environmental impact. An alternative approach for replacing the battery in an ocean drifter involves harvesting kinetic energy from the ocean motion. Because of the very low and varying frequency, from 0.1Hz to 2Hz, harvesting this energy has an important hurdle. This study proposes a novel nonlinear energy harvester to supply low power oceanic drifters using an electromagnetic harvester. Therefore, this work presents a solution on how to generate power from low frequency driven electromagnetic energy harvester for an ocean drifter self-powered system. A prototype with a proposed electronic harvesting system is built and tested in a real medium

A general schematic of the device is shown in Figure 1b. The design is comprised of gyroscopic system, a gearing system to transform the oscillations to rotation, a flywheel, and a micro electromagnetic generator. As a result of the interaction with the waves, the float rotates with a pitching, roll and yaw motion. Moreover, the gyroscopic action provides a way to greatly enhance the ability of a mass to resist changes to its position which generates a torque along the axis that can be used to generate electrical power using the gearing system along with the flywheel and the micro electromagnetic generator. This structure has a proof mass oscillating in two orthogonal directions in-plane, one the sense direction and one the driven direction. Rotation about the out-of-plane axis couples these oscillations, allowing the sense rotation to be obtained.

ACKNOWLEDGMENTS
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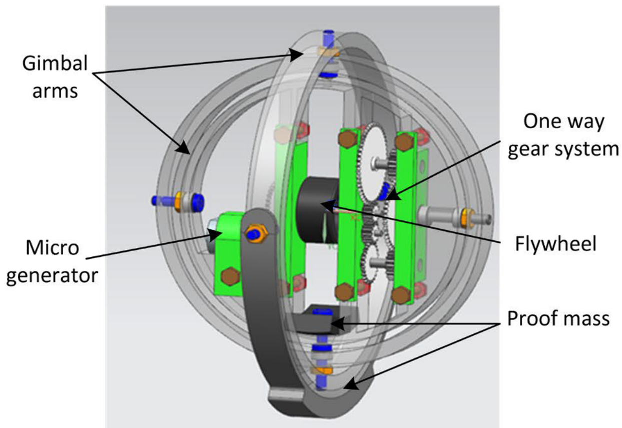

Figure 1 a) Wavy drifter b) Packaging view of the electromagnetic kinetic harvester

ID17- AUTOMATIC PANORAMIC IMAGE CREATION SYSTEM FROM OBSEA PTZ UNDERWATER CAMERA

MARC NOGUERAS CERVERA[136], JOAQUIN DEL RIO FERNANDEZ[129]

Abstract
This article is a description about how to take advantage of an underwater PTZ camera to obtain an immersive panoramic image of the seabed environment.

Keywords – OBSEA, panoramic image, LabVIEW, cabled coastal observatory.

I. INTRODUCTION
The OBSEA is a coastal cabled seabed observatory located at 4km from Vilanova i la Geltrú where an underwater PTZ camera is transmitting continuously real time images from the artificial reef to internet [1]. Since this camera was deployed, an image acquisition system has developed in order to generate panoramic images of the observatory environment.

II. DESCRIPTION
This acquisition system performs a sweep of the 340 x 120 degrees (maximum travel angle for the Sony SNC-RZ25N camera). In order to obtain a panoramic image with enough resolution in a reasonable time, this sweep has been divided in a matrix of 21 columns x 7 rows of VGA quality images. The images are taken with a focal length of 32.8mm that provides a horizontal angle of 21.3º. With this configuration every image has taken with a horizontal displacement of 17 degrees what produces a panoramic image with a minimum overlapping of 25%. The 147 images are captured with the maximum resolution of the camera 640 x 480 pixels for what the resulting panoramic image has a resolution of 10226 x 2596 pixels that is around 26 megapixels (Fig. 3). In order to obtain the panoramic image as much homogeneous as possible, all the 147 images are taken with the same adjust of white balance, exposure and focus. All the communication with the camera has been done with a short set of simple CGI commands executed and automatized by a LabVIEW application (Fig. 1), and takes less than 7 minutes. After the acquisition of the images, Hugin free software (Fig. 2) is used for the perspective manipulation and composition of the panorama. Because the configuration of the panoramic images is always the same for every acquisition the resulting images can be obtained manually with a few clicks.

III. CONCLUSIONS
Automatizing the panoramic image creation allows to monitor the evolution of the complete environment of the OBSEA observatory. With this tool, slow changes can be detected in the immediate vicinity of the observatory as well as differences in visibility and turbidity depending on the sea conditions

IV. ACKNOWLEDGMENTS
This work was supported by the project RESBIO with financial support from the Spanish Ministerio de Economia y Competitividad (contract TEC2017-87861-R). The work has been directed and carried out by members of the Tecnoterra-associated unit of the Scientific Research Council through the Universitat Politecnica de Catalunya, the Jaume Almera Earth Sciences Institute and the Marine Science Institute

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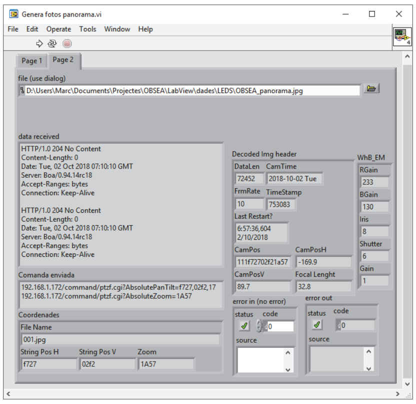

Fig 1. LabVIEW application controlling the camera to obtain the 147 images

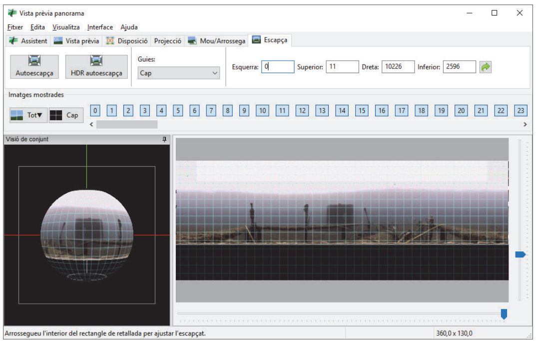

Fig 2. Hugin software interface

Fig 3. Resulting panoramic image

ID 18- COMBINED CURRENT PROFILING AND BIOLOGICAL ECHOSOUNDING RESULTS FROM A SINGLE ADCP

DAVID W VELASCO[112], SVEN NYLUND[113], CRISTOBAL MOLINA[114]

Abstract

The present work describes a newly-developed Acoustic Doppler Current Profiler (ADCP) that has a fully integrated single-beam wide-band biological echosounder, thus serving a dual purpose: current measurement and biomass assessment. The system comprises a traditional 4-beam Janus configuration head, which is responsible for profiling the currents, with a vertically oriented center beam for collecting high-resolution acoustic backscatter data for subsequent biomass analysis. The system belongs to the Signature Series family of ADCPs launched in 2013 by Norwegian scientific instrumentation company Nortek. Named Signature100, it is powered by the AD2CP electronics platform, described in United States Patent 7.911.880. The four slanted beams (current profiling beams) operate at a center frequency of 100 kHz and have a range of up to 400 m with 4 m spatial resolution and sampling rate up to 1 Hz. The center vertical beam (echosounding beam) has a wider frequency band of approximately 70-120 kHz with a high dynamic range (~130 dB), and presently operating in up to three discreet pulse characteristics from a single beam set: 1) 70 kHz monochromatic, 2) 120 kHz monochromatic, and 3) 91 kHz chirp with 50 percent bandwidth and pulse compression. Acoustic pulses from the echosounder beam are interweaved with pulses for the current profiling beam for synchronous data collection. In this work we describe the system's configuration, capabilities and results from initial trials.paper that is identical with the extended summaries format.

Keywords - echosounding, ADCP, currents, biomass.

I. INTRODUCTION

The continual global increase in human population is prompting governments to assess protein sources with greater detail. Global demand for animal-derived protein is expected to double between now and 2050 [1], driven by increasing urbanization (especially in emerging economies), improved recognition of protein's role in a healthy diet, and increased need for protein in the elderly community. Fish stocks are one source of animal-derived protein which is receiving considerable attention due to their potentially vast contribution to addressing global protein requirements. In fact, global fish production far surpass the production of all other animal protein in the world, and fish also contain many essential micronutrients, minerals and essential amino acids [2].

II. FIELD VALIDATION

Field trials have been done as part of the Signature100's development, and here we highlight one such deployment carried out in the Mediterranean Sea. The location was just south of Toulon, France, and the deployment lasted from the morning of 10/Nov/2017 until the afternoon of 15/Nov/2017. Water depth at the site was about 470 m and the instrument was mounted up-looking on a subsurface buoy at the top of a short mooring. Raw heading data from the Signature100 (not shown) indicates the buoy observed a strong spin moment on its 7 minute descent, rotating at about 3-4 revolutions per minute, which is not unreasonable during such deployments. For fixed installations (not this case), this spinning can be a source of raw magnetometer data allowing for compass calibration in post-processing. After about 3 hours on the bottom, the buoy stabilized and subsequent data shows the mooring was very stable throughout the rest of the deployment, with only a gentle rotation (less than one revolution every few hours) and a very minor variation in tilt (less than 1°).

A. Current Data

The ADCP portion of the instrument was configured to transmit 60 pings at 0.25 Hz, repeating the sequence every 5 minutes, with single ping data being recorded for quality control purposes. Current profiling was set for 60 depth cells of 10 m each (15 ms pulse) with a blanking distance of 1 m. Variable particle distribution in the water column caused the maximum usable range to oscillate from about 230 m to 420 m (beyond the instrument's specifications), especially during the first half of the deployment, as evidenced by the SNR data of the four slanted beams shown in Fig. 2. As expected, times of reduced SNR coincide with lower along-beam signal correlation values, indicating limit of usable data which is taken at 50% correlation. But despite the variations in particle distribution, over 68% of the data is above this 50% correlation threshold.

B. Echosounder Data

The echosounder portion of the Signature100 was configured to transmit all three pulse types supported, although only the 70 kHz monochromatic is presented here. Each pulse had a 1 ms transmit duration and were transmitted at 1 Hz. The echosounder pulses interweaved with the current profiling pulses at a ratio of 3:1 (i.e. every three echosounder pings to one current profiling ping). The echosounder pulses' return was recorded in 0.75 m depth cells.

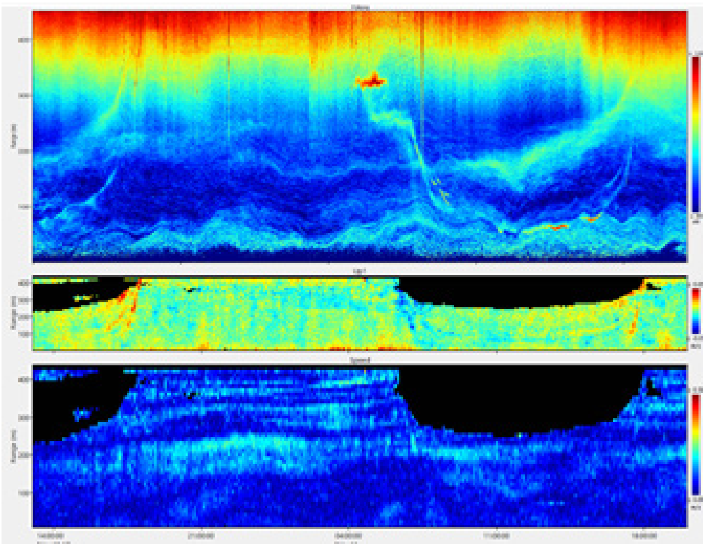

Fig 1. 70 kHz Echogram (top), vertical velocity (middle), and horizontal current speed (bottom) for the first two days of the deployment.

Four different features were selected from the echogram for presentation: plankton/krill diel migration, internal wave structures, passing surface vessels, and migration due to changes in current regime. The first type of feature is shown on Fig. 1. Although no trawling was conducted during the deployment to ground-truth the nature of the scatterers, it is reasonable to assume the features shown represent either plankton or krill (or both) migration, as the same patterns are widely observed in similar data [4]. The diel nature of the movement drives measurable vertical currents of approximately 5 cm/s upward during dusk hours, with the reverse pattern at dawn.

III. CONCLUSIONS

A newly-developed Acoustic Doppler Current Profiler (ADCP) with a fully integrated single-beam wide-band biological echosounder has been developed and presented. The system belongs to the Signature Series family of ADCPs launched in 2013 by Norwegian scientific instrumentation company Nortek and is powered by the AD2CP electronics platform (US Patent 7.911.880). Named Signature100, it performs two key functions simultaneously over a maximum nominal range of 400 m: current profiling and biological echosounding. Some of its key features include a novel transducer design, three distinct echosounder pulse types, data processing with pulse compression, and the capability of recording the complex demodulated return signal. Details from a field validation deployment in the Mediterranean Sea were presented, with a focus on the 70 kHz echogram created by the instrument. Four main features of the echograms were discussed: plankton/krill diel migration, internal wave structures, passing surface vessels, and migration due to changes in current regime. The current profiling data complemented the echosounder data, providing greater insights into the distribution, structure and behavior of the marine life at the test site during the deployment.

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ID19- EVALUATION OF SIGFOX LPWAN TECHNOLOGY FOR AUTONOMOUS SENSORS IN COASTAL APPLICATIONS

MATIAS CARANDELL[133], DANIEL MIHAI[132], JOAQUÍN DEL RÍO[129], KALOYAN GANCHEV[137], JULIEN PEUDENNIER[91]

Abstract

A low-power wide-area network (LPWAN) is a wireless communication network designed to send low bit rates in a long-range communication. SigFox is a LPWAN technology that uses Ultra Narrow Band to communicate packages of 12 bytes at a very low byte rate (<100 bits/s) and up to 140 messages/day per device. It is a payable service that includes the Base Stations and the Backend Services and works at 868 MHz (ISM band). These characteristics are attractive for IoT applications as it allows to send small packages at long distances at very low power range.

The TD1205P module features the SIGFOX Gateway and includes GNSS and Accelerometer sensors for tracking applications in 30x38x10.5 mm size. As a low power and compact solution that includes sensing, processing and transmitting units, it is suitable for Energy Harvesting Autonomous Sensor applications.

UPC is designing a drifter with a kinetic energy harvester, the electronics to adequate the power, the batteries to storage it and a TD1205P module as a tracker. It is going to be deployed at coastal areas to provide information of the surface currents for a long period hence, the power auntonomy has to be assured through the harvesting system. The aim of this study is to determinate the consumption of this module in his different modes of operation.

Two modules were set with different configuration and his power were compared, then in future studies, EH generation will be modelled in order to determine the autonomy of the buoy. The software is designed to minimize the consumption so it keeps the TD1205P sleeping during long periods, spending a few amount of energy. At some interval, the modules will wake up, fix the GPS position, take the measurements of battery voltage and temperature, send the

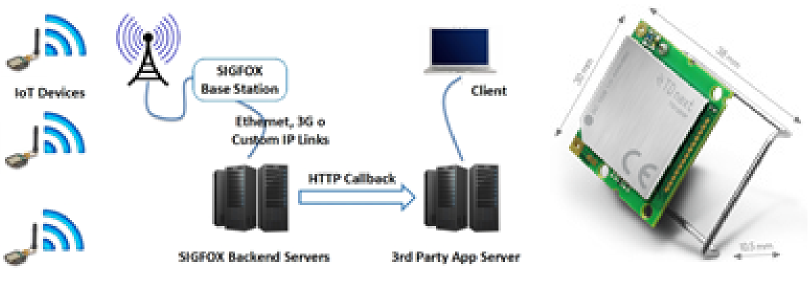


Fig 1. At left, Sigfox technology scheme and at right, TD1205P module

data thought Sigfox coverage and they will go back to sleep. Two modes were configured, called mode 0 and mode 1. The difference between them is that the first do not save any data of the satellite constellation and the second does, so differences were appreciated at fixing GPS time and at sleeping consumption.
At figure 2 consumption of both modes is plotted with a symbolic working interval of 120 seconds. Table 1 shows the data plotted, being mode 0 segments from 1 to 6 and mode 1 segments from a to f. In one cycle, the module gets up and starts fixing the GPS position a taking the sensor measurements (2 – b) and then it sends the data (3 – c). This is pretty much the same for both modes but, when the module goes to sleep (4 –d), mode 1 keeps some memory alive for saving GPS constellation information so consumption is 5 times higher. Nevertheless, when the cycle starts the GPS fixing time (5 – e) is strongly different, being 8 times more at mode 0 because it has to start from nothing.
In addition, in both modes, it is easy to appreciate how SigFox technology sends each package of 12 bytes 3 times, at 3 pseouranom frequencies on the UNB modulation of the ISM band (3, 6, c and f).
To sum up, substantial consumptions were appreciated at different modes of work, some in the range of mA for short intervals and some at uA level for long ones. To determine the best option, a long-term study was simulated with intervals of 2 hours each output package.

Reference	Current(_A)	Power(_W)	Time(s)	Energy(J)
1	12.94 u	42.96u	Indiferent	-
2	26.01m	86.35m	36.58	3.159
3	45.94m	152.52m	6.56	1.001
4	3.39u	11.25u	7150	0.081
5	24.01m	79.71m	36.39	2.901
6	46.11m	153.08m	6.57	1.006
a	13.04u	43.29u	0	-
b	24.94m	82.80m	35.52	2.941
c	45.62m	151.45m	6.61	1.001
d	16.31u	54.15u	7190	0.389
e	21.31m	70.74m	4.39	0.311
f	46.04m	152.85m	6.58	1.006

Table 1. Consumption of both modules. [1-6] mode 0. [a-f] mode 1.

Formulas below are used to calculate the energy consumption of one day. For 2 hours interval, 12 cycles will be performance. Notice that Duty Cycle change from one to the other because mode 1 is awake for shorter periods.

$$\overline{P_{cycle}} = P_{sleep} + D \cdot \overline{P_{active}}\,; E_{cycle} = \overline{P_{cycle}} \cdot T\,; E_{day} = E_{cycle} \cdot 12$$

In conclusion, mode 1 spend around 18 J in one day while mode 0 spend 48. Table 2 shows this conclusions and determines mode 1 as the best option for for Energy Harvesting Autonomous Sensor applications.

AKNOWLEDGEMENTS
This work was supported by the project MELOA from the European Commission's Horizon 2020 research and Innovation program under Grant Agreement No. 776280. The main author has a grant from the Secretary of Universities and Research of the Department of Companies and Knowledge of the Generalitat de Catalunya on the FI program (ref. BDNS 362582).

Keywords – Low Power Wide Area Network (LPWAN), Sigfox, Autonomous Sensor (AS), Energy Harvesting (EH).

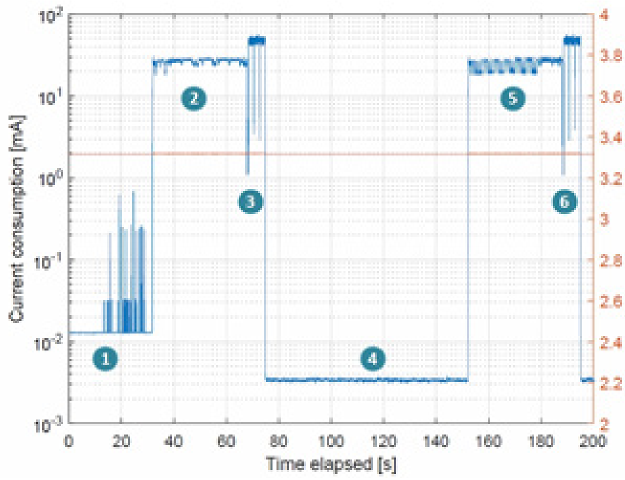
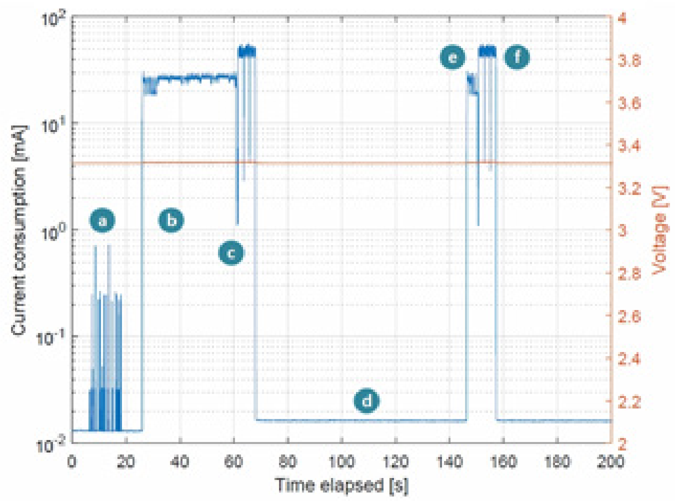


Fig 2. Above, mode 0 of TD1205P consumption, below mode 1



Mode	Duty Cycle (%)	P_{sleep} (_W)	P_{active} (_W)	P_{cycle}(_W)	E_{cycle} (J)	E_{day} (J)
0	0.60	11.25u	90.84m	0.56m	4.00	48.06
1	0.11	54.15u	137.12m	0.21	1.49	17.84

Table 2. Energy and Power comparison between mode 0 and mode 1 operation for one-day deployment with 2 hours interval.

ID20- MONITORING COASTAL WATER QUALITY WITH A COMBINED APPROACH OF MARINE AUTONOMY AND SATELLITE REMOTE SENSING

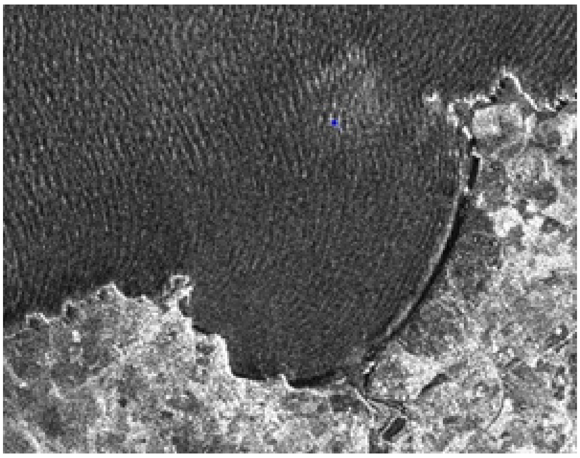
JOHNSTON, PHIL[10]

AutoNaut unmanned surface vessel (USV) completed a short water quality monitoring trial off the south-west coast of England in January 2017. A suite of sensors aboard the USV worked in conjunction with satellite data from synthetic aperture radar (SAR). The combination of a marine autonomous system and remote sensing successfully completed a task considered "dull, dirty and dangerous".

The challenge was to monitor the water quality by a sewage outfall within two miles of a rugged coastline. Conventional means of completing the task would involve small-boat work and/or seabed mounted sensors – but is rarely in fact conducted. A key aim of this concept trial was to demonstrate to the water utilities sector that autonomy and remote sensing offered a viable solution to a long-standing problem.

Proving capability and safety was crucial. Especially in the environment; for a USV, completion of a survey so close to land requires both the autonomous technology to be 100% reliable and the craft itself to have proven sea-worthiness. The AutoNaut "Islay" followed a track that passed over a sewage outflow diffuser and maintained a search pattern within approximately 0.25 nautical miles. Islay kept safely on track in high sea-states (up to 4) and in water depths as shallow as 40m. AutoNaut keep station within a safe monitoring area down tide of the diffuser in challenging conditions. Data was both recorded onboard and transmitted in real time over a Wifi link to a nearby headland. The AutoNaut was fitted with a YSI EX02 Sonde unit with sensor nodes for water chemistry, including: Conductivity, Temperature and pH. No outflow plume was detected by either the USV sensors or by the satellite SAR imagery.

The trial showed the potential for the innovative combined approach to be applied in the long term and at reasonable cost. If so, higher quality monitoring of coastal waters would have positive impacts on the environment and human health.



ID21- Operating around offshore infrastructure and safe manoeuvring by AutoNaut USV

Johnston, Phil[10]

In 2017, an AutoNaut wave-propelled unmanned surface vehicle (USV) conducted a “close pass” trial in proximity of an operating oil and gas platform. The 4-day mission required the vehicle to follow a series of pre-planned transect lines within a 4km sq area around the asset. Multiple close passes on all four sides of the asset were completed. At the closest point, a transit within 150 metres of the asset was achieved.

A strict 500metre “safety zone” is typically implemented around offshore oil and gas assets. Within which vessel traffic is restricted to essential operations. For this task, a marine autonomous system (MAS) offered two key advantages over other data collection methods close to platforms; such as conventional vessels or drifting devices:

1. A significantly reduced risk profile – no personnel, small size and propulsion characteristics of the Autonaut.

2. Movements following pre-planned transects in a controlled manner

Precise and consistent positioning of the AutoNaut USV was vital to mission success and for safety assurance. Throughout the mission the AutoNaut operated in sea states up to Beaufort 5-6 and surface currents of up to 1knot. Complete reliability was required of the command/control system and protocols: Offshore based remote operators on a supporting vessel (outside the safety-zone) utilised wireless comms, specifically for close-pass manoeuvres during day time periods. Shore based remote operators located in a different time zone oversaw USV operations during night time periods over iridium satellite link.

Challenges were posed by operating a USV in a busy working area, with other fixed assets and support vessels in the vicinity undertaking simultaneous operations. Robust planning and following established procedure were vital to meet stringent safety requirements and gain industry assurances for the operation of a USV near an oil and gas asset.

ID22 - THE SOUND OF WAVES IN THE MUTRIKU WAVE ENERGY PLANT

BALD, J.[13], URIARTE, A.[14], NOGUES, M.[15], MADER, J.[11], LIRIA, P.[16], AJURIA, O.[25], LEKUBE, J.[26]

The launch of the first acoustic observatory installed in the Wave Energy Plant of Mutriku took place on the 5th of June 2018. Located in the Bay of Biscay, this wave power plant was inaugurated in 2011 by the Basque Energy Agency, EVE (Fig 1.). The Mutriku Wave Energy Plant (https://www.bimep.com/pages/mutriku) is the only infrastructure related to the ocean energies in Gipuzkoa (northern Spain) (Fig.1). It´s the first commercial European wave energy plant based on the principle of oscillating water column (OWC) and the only one worldwide connected to the electricity grid. In fact, in June 2018, its 16 turbines reached a cumulative production of 1.6 GWh which was injected into the electricity grid. Since then, the wave energy plant of Mutriku also provides the opportunity to developers to test electric transformation turbines.

The acoustic observatory, managed by AZTI, will allow a continuous real time data monitoring of the underwater noise generated by the plant thanks to a hydrophone moored in front of the plant and connected to land by a submarine cable (Fig 2.). This observatory was funded by the Provincial Council of Gipuzkoa and the installation tasks were financed by Euskalmet, the Basque weather agency. The collaboration between different Basque public entities in this project is a sign of promoting clean and sustainable technologies.

Fig 1. Mutriku Wave Power Plant.

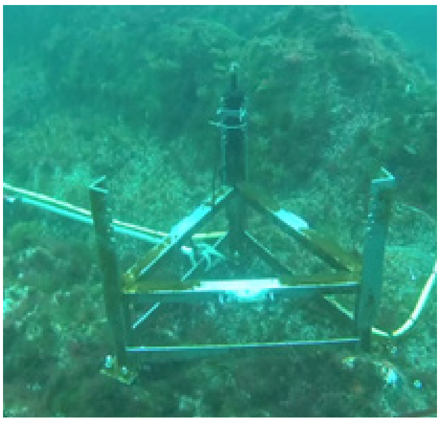


Fig.2. icListen Hydrophone of Ocean Sonics installed in the acoustic observatory of the Mutriku Wave Power Plant

The installed hydrophone, an icListen HF of Ocean Sonics, will allow to advance in the knowledge of the environmental impact related to underwater noise generated by the Mutriku Wave Energy Plant. For this purpose the underwater noise indicators linked to the Descriptor 11 (introduction of energy, including underwater noise, does not adversely affect the ecosystem) of the Marine Strategy Framework Directive (MSFD) (Directive 2008/56/CE) are being monitored: Indicator 11.1.2: Trends in the ambient noise level within the 1/3 octave bands 63 and 125 Hz (center frequency) (re 1µPa RMS; average noise level in these octave). All the data, the graphic outputs and the potential applications for scientific, technological and educational purposes obtained from the oceanographic observatory will be transferred to the data management portal of EMODnet Physics (http://www. emodnet-physics.eu/Portal).
In this way, the oceanographic observatory installed in the Wave Energy Plant of Mutriku will become the third observatory in Europe that contributes to the EMODnet Physics portal with data related to marine underwater noise.

Keywords – underwater sound, EMODnet Physics, Mutriku Wave Power Plant, Marine Strategy Framework Directive.

ID23 - THE EMSO-AZORES DEEP-SEA OBSERVATORY – 8 YEARS OF OPERATION

PIERRE- MARIE SARRADIN[63], MATHILDE CANNAT[80], JULIEN LEGRAND[64], AND THE EMSO AZORES REGIONAL TEAM[65]

Abstract

The EMSO-Azores deep sea observatory is a component of the EMSO ERIC. It focuses on two main questions: What are the feedbacks between volcanism, deformation, seismicity, and hydrothermalism at a slow spreading mid-ocean ridge and how does the hydrothermal ecosystem couple with these sub-seabed processes? The infrastructure comprises 2 sea monitoring nodes, autonomous instruments and a set of site studies experiments. It has been deployed in 2010 in the Lucky Strike vent field and acquires multidisciplinary data since then.

Keywords - hydrothermal, circulation, ecosystem, Lucky Strike

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The MoMAR "Monitoring the Mid-Atlantic Ridge" project was initiated by InterRidge in 1998 to study the environmental instability resulting from active mid-ocean-ridge processes at hydrothermal vent fields south of the Azores. It is a component of the EMSO (European Multidisciplinary Seafloor and water-column Observatory) European Research Infrastructure Consortium, which coordinates observatory regional facilities in European seas (http://emso.eu). The EMSO-Azores observatory focuses on two main questions: What are the feedbacks between volcanism, deformation, seismicity, and hydrothermalism at a slow spreading mid-ocean ridge and how does the hydrothermal ecosystem couple with these sub-seabed processes?

The uncabled observing system (Figure 1) was first deployed in 2010 in the Lucky Strike hydrothermal vent field (Mid Atlantic Ridge) at 1700 m depth. It comprises two Sea Monitoring Nodes (SeaMoN – Figure 2) providing the energy, controlling the sensors, archiving and transmitting the data. The first node is deployed on the Lucky Strike fossil lava lake and measures the seismic activity and the vertical deformation of the sea floor. The second one is deployed at the base of the Tour Eiffel active edifice. It allows the study of the variability of a mussel assemblage and its environment (HD camera and chemical sensors, thermistor string), the microbial colonization and the chlorinity of an active vents (Colonization module and BARS sensor) and the localized micro seismicity (seabed array of 4 hydrophones). The two nodes are acoustically linked to a surface relay instrumented buoy, ensuring satellite communication to a land base station in Brest -France.

The observing capacity of the marine infrastructure was upgraded in 2016 and 2017 thanks to the development of a new electronic core called COSTO2 based on Ethernet communication and implemented on the 2 monitoring nodes. This upgraded infrastructure was successfully redeployed and tested in situ using a WIFI link allowing communication at 50Mbits/sec between the ROV and the Sea monitoring station. Great improvement were done on the data management process. Data are archived, published with a doi and are available on the EMSO-Azores web page: http://www.emsofr.org/EMSO-Azores.

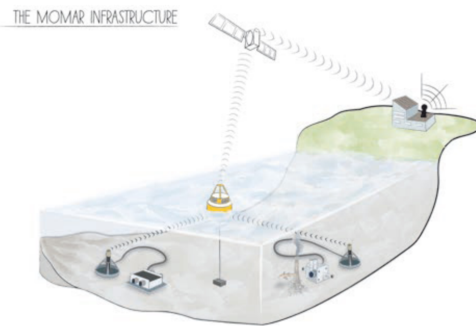
In addition, the observatory setup comprises several sets of autonomous instruments, whose data are collected during the yearly maintenance cruises. These data will also be made available on the web after quality and format validation by the EMSO-Azores team. The autonomous instruments deployed in the area comprises 4 OBS, 2 pressure gauges, a physical oceanography mooring near the vent field, an array of temperature probes distributed in hot and diffuse vents, 3 bottom currentmeters, and a prototype of sequential hot fluid sampler (DEAFS). In 2017, the EMSO Generic Instrumentation Module was also deployed in the vicinity of Tour Eiffel.

A complementary site studies program is implemented during the maintenance cruises and contributes to increase the set of accessible parameters (fluid sampling, ecological studies, survey of active and inactive areas, in situ experimentations…) and to extend the spatial coverage of the study.

The observatory is maintained every year during the Momarsat cruises (https://doi.org/10.18142/130). During these 2.5 week cruises, all the components of the system are recovered, serviced on board and redeployed using the ROV Victor 6000.

The studied area is part of a Marine Protected Area in the Portuguese EEZ.

This work has received funding from the European Union Seventh Framework Programme (FP7/2007-2013) under grant agreement n° [312463], the French ANR project Luckyscales ANR-14-CE02-0008.



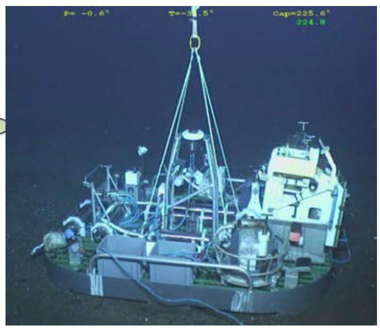


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Figure 1- The EMSO-Azores infrastructure

Figure 2: The Sea Monitoring node prior the deployment of the sensors

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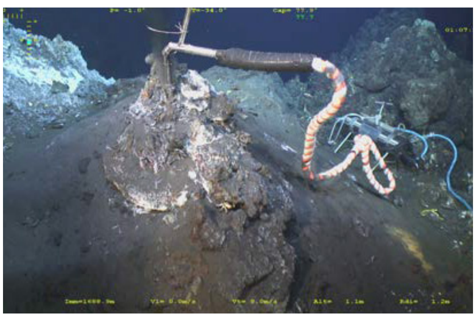
Figure 3 : BARS monitors the temperature and chlorinity of the hot hydrothermal fluid

Figure 4 : he EMSO Generic Instrumentation Module



ID24 - DEEP SEA SPY: A COLLABORATIVE ANNOTATION TOOL

MATABOS M.[68], BORREMANS C.[69], BOSSARD P.[72], TOUROLLE J.[70], SARRAZIN J.[71]

Abstract
Since 2010, remote hydrothermal ecosystems are continuously being monitored using video cameras deployed on instrumented platforms. The acquisition of high-frequency video data from deep-sea observatories like EMSO-Azores or Ocean Networks Canada provide information on species behaviour, feeding habits, growth, reproduction and organisms' response to changes in environmental conditions. Video cameras acquire hourly data representing thousands of hours and Tera Bytes of footage but their manual processing is time-consuming and highly labour-intensive, and cannot be comprehensively undertaken by individual researchers. In order to help preliminary manual assessment of this huge imagery archive, a free online annotation tool was developed to gather contributions from a wider community. The Deep Sea Spy system offers a fun and engaging web interface to members of the public to help perform initial footage annotations. The platform now hosts 623 active annotators who contributed 179,663 annotations to 19,541 images. Preliminary analyses highlight a high variability among participants but show promising results to detect trends in species abundance variation over time. Ultimately, the information gathered via this approach can help improving the algorithms necessary to produce accurate automated detection in imagery using a machine learning approach.
Keywords. Citizen science, Database, Deep-sea observatories, Image annotation, Underwater imagery

1. INTRODUCTION
Most of the current knowledge of deep-sea ecosystems is based on limited oceanographic cruises. As a result, little is known about the temporal dynamics of faunal communities inhabiting these environments [1]. This last decade, the development of deep-sea observatories enabled their long-term quasi-continuous monitoring [2]. Located on hydrothermal vents, the Ocean Networks Canada cabled network [3] (oceannetworks.ca) and the EMSO-Azores autonomous observatory [4] (www.emso-fr.org/fr/EMSO-Azores) host an ecological observation module, TEMPO, which monitors the animals colonizing these environments [5]. Since 2010, the cameras have recorded more than 5,000 hours of video sequences that represent a crucial source of information for assessing natural variability as well as ecosystem responses to increasing human activity in the deep sea. But the manual processing of these data is time-consuming and highly labour-intensive, and cannot be comprehensively undertaken by individual researchers. Previous attempts to develop algorithms for automated detection of species have failed in these environments characterized by a complex background and are still far from replacing the human eye in extracting scientific information [6,7]. Alternatively, engaging the public in initial data processing or annotation (i.e. adding caption and metadata to a digital image) has yielded useful results [8]. It's in this context that the Deep Sea Spy online annotation tool was developed.

2. THE ONLINE ANNOTATION INTERFACE
The Deep Sea Spy online annotation tool was developed to help the processing of images by members of the public. The interface is available online (www.deepseaspy.com) with an internet connection. It was built as a game, with a fun and engaging interface (Fig. 1). After following a tutorial, participants work through levels by annotating an increasing number of images. The task is simple and consists in annotating individual species, in order to allow its use by a wide audience. All annotations are stored in pixel values in a database located at Ifremer, along with their associated metadata.

3. COMMUNICATION STRATEGY
An associated project website provides background information on the scientific context and on how results will help increase scientific knowledge of deep-sea animal communities. Maintaining communication with the users during the lifetime of the project is essential to insure the success of the programme, but is extremely demanding and requires a dedicated person. A number of public actions were undertaken, including the development of school programs in collaboration with national education entities to bring the project in classrooms. To this end, educational booklets for kids between 3 and 11 were developed to support teachers in the project development.

4. PRELIMINARY RESULTS

4.1. General statistics
18 months after the project launch, 623 active annotators have contributed 179,663 annotations to 19,541 images. In the current mission, all 3,918 images have been annotated at least once, and most of them have been annotated 3 or 4 times. Rates of new registration highlight the importance of communication efforts to maintain existing members and engage new ones.
4.2. Annotation results
Preliminary results highlighted a high variability in species abundances among participants, but the use of geo-spatial information as recorded by the pixel values of the animal can help validate individual annotations (Fig. 3). These information can help set a threshold based on the number of times an annotation occurred at a given coordinate.

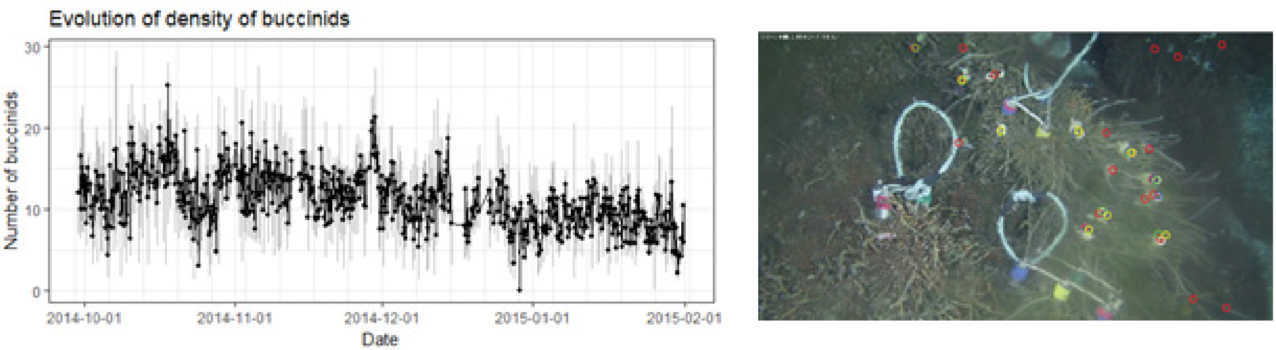


Fig. 3. Left panels: Evolution of the density of buccinid gastropods over 6 months showing the median value (black line) and variation range (grey bars). Right panel: Example of an image including the geospatial information of buccinid positions from the annotation, each colour represents a different participant.

5. CONCLUSION

The Deep Sea Spy online annotation platform now gathers hundreds of active annotators contributing to the analysis of images recorded by deep-sea cameras. Preliminary results highlight the potential of such an approach to not only facilitate the processing of the huge database acquired by deep-sea monitoring observatories, but also to engage the public in science, and thus increase ocean literacy. This approach is however still in its infancy, and validation procedures are still needed to optimize the use of the data gathered by a wide range of participants. Ultimately, the resulting database will help developing algorithms using machine learning approaches.

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ID26 - EUSKOOS (BASQUE OPERATIONAL OCEANOGRAPHY SYSTEM): AN INTEGRATED APPROACH TO PROVIDING COASTAL AND OCEANIC INFORMATION

MADER, J.[11], ASENSIO, J.L.[17], RUBIO, A[18], LIRIA, P.[16], EPELDE, I.[19], DEL CAMPO, A.[20], CABALLERO, A.[21], FERRER, L.[22], DE SANTIAGO, I.[23], GONZÁLEZ, M.[24], URIARTE, A.[14], ARANDA, J.A.[59]

EuskOOS is the Basque coastal operational oceanography system operated by Euskalmet (Basque Meteorological Agency) along with the expert advice of AZTI (a technology centre specialized in marine and food research). EuskOOS is designed to provide an accurate description of the current sea state conditions in the Basque coastal and oceanic area, offering ongoing forecasts of the near future sea conditions and supplying downstream services to both local and regional users. To address its objectives, EuskOOS is connected to other European initiatives in the oceanography field. EuskOOS is part of IBIROOS (Ireland-Biscay-Iberia Regional Operational Oceanographic System) and actively contributes to the EuroGOOS (European Global Ocean Observing System) strategy. EuskOOS also benefits from innovations and best practices coming from projects such as JERICO-NEXT (Joint European Research Infrastructure network for Coastal Observatory – Novel European eXpertise for coastal observaTories, Horizon 2020 Programme). EuskOOS is also collaborating with other eight coastal observatories along the Atlantic coast within the MyCOAST project (Coordinated Atlantic Coastal Operational Oceanographic Observatory, Interreg Atlantic Area Programme).
In terms of observing capacities, EuskOOS is fed with a wide network of coastal and oceanic platforms provided by Euskalmet: high-frequency radar, deep-water buoy, coastal stations and tidal gauges. Besides, the operational oceanography system is supported with video-monitoring stations developed by AZTI. These stations provide highly valuable information for the prevention and management of extreme events, and the acquisition of morphodynamic coastal data for long-term analysis (i.e. climate change).
The information produced is shared within European marine data structures, such as Emodnet and Copernicus Marine Service. At the same time, these facilities are used to optimize the downstream services. For the Basque local users, EuskOOS works as a walkway towards other sources of information distributed in such European marine structures.
Oceans are key climate regulators as well as sources of natural resources. Likewise, they are crucial for tourism, transport and commerce. Therefore, our future depends to a large extent on the good environmental status of the oceans. To take care of it, access to both high-quality and high-resolution information that can be continuously shared through different marine data services is needed (i.e. efficient operational oceanography systems). This is the main objective of EuskOOS, whose data will be integrated into different services for different applications (e.g. blue economy, sustainable management of natural resources, biodiversity conservation). EuskOOS will contribute to the outreach of applications and opportunities based on coastal and oceanic data.

Keywords – coastal observing system, coastal modelling, marine services.

ID27 - WAVY OPERATION SOFTWARE: AN OBSERVATION CENTRIC SYSTEM FOR MULTI-SENSOR DEVICES

CARLOS ALMEIDA[73], ARTUR ROCHA[74], LINO OLIVEIRA[75], JOÃO CORREIA LOPES[60]

Abstract

This communication focuses on the features of the WAVY Operation Software, addressing the needs of research teams in supporting the planning and operation of WAVY drifters in the scope of field research missions. The WAVY Operation Software is planned to be distributed alongside with the WAVY drifters to provide an interactive way of managing the campaign related data, as well as tools for exploratory visualization, cooperative annotation and sharing duly cleansed and curated datasets.

Keywords - MELOA, Observation and Measurements, Sensor Observation Service, SensorThings, WAVY drifters

I. INTRODUCTION

Field campaigns require on site organization and annotation of acquired measurements, such as the context in which they were acquired, device calibrations, user notes over measurements in the acquired datasets and exploratory visualization of the data collection in progress since it may provide important insight for possible observation procedure adjustments.

This communication describes how such tasks are accomplished in the scope of MELOA (Multi-purpose/Multi-Sensor Extra Light Oceanography Apparatus) project, particularly in the scope of littoral campaigns, in which WAVY drifter units are deployed near shore to the sea and again collected by multi-disciplinary research teams. Researchers from multiple institutions taking part in the campaign interact with the WAVY Operation Software (WOS) allowing users to collaborate in providing context and managing the measurements acquired by the devices.

II. METHODS

The WOS leverages on the conceptual model of the Observation & Measurements (O&M) standard [1], enhancing it with the necessary organizational, methodologic and contextual elements to support the planning, in-situ operation and post-processing phases of a multi-disciplinary research campaign. It follows a RESTful architectural style, building into a service ecosystem that incorporates other components such as catalogue systems and mobile applications for diverse application domains.

Features in the WOS include but are not limited to:

- Planning and management of a research campaign, including organizational aspects such as involved researchers and associated role-based access control (by user or participating institution), characterization of the desired area including map overlays, equipment to be used in a particular campaign and their characteristics, etc…
- Exploratory visualization of incoming data, allowing dynamic adjustment of campaign procedures and initial planning, as well as facilitating on-site recovery of WAVY drifter devices;
- Cooperative annotation of data streams, providing an interactive alternative to traditional log books for the record of relevant in-loco events and context information, that can provide additional input for post-processing;
- Support the creation of derived datasets, resulting from the post-processing of the original ones with the aid of data cleansing functionalities (possibly based on prior annotations), outliers identification, and other tools allowing the identification of inaccurate or meaningless data;
- Publishing data to DEIMOS catalogue and other external O&M compliant systems such as the SOS (Sensor Observation Service) [2], SensorThings API [3], or even different catalogues such as FIWARE.

III. RESULTS

The WAVY Operation Software is composed by three main components: Server, Web Client and Real Time Data Streamer.

The Server is the core component of the WOS, storing all the relevant information of the system, mapping the measurements received to the current context and providing a RESTful API service allowing technical users to develop custom applications.

The Web Client offers a responsive user-friendly interface with simple CRUD (CREATE, READ, UPDATE and DELETE) interfaces to manage all the research campaign related data. Additionally, it offers a map engine with the basic functions to navigate the georeferenced measurements in real-time, or load the georeferenced measurements from prior launches. The Real Time Data Streamer is a message broker that allows the WOS to subscribe and consume real-time messages sent by the WAVY drifters with virtually no data loss (assuming that data reaches the streamer), even in an unlikely event of server unavailability or maintenance, the Real Time Data Streamer will store the measurements until they are successfully transmitted to the WOS server component. The WAVY drifters send the measurements to the Real Time Data Streamer using the HTTPS (Hyper Text Transfer Protocol Secure) protocol, which then delivers them to the Server using the AMQP (Advanced Message Queuing Protocol) protocol.

IV. CONCLUSIONS

This communication introduces the WAVY Operation Software (WOS), a software system to be distributed alongside the WAVY drifters, which is under development in the scope of the EU project MELOA. Although this is a work in progress, given that MELOA is still in the first of its three year duration, a set of functionalities is in place, allowing WOS to be tested during the scheduled campaigns. User feedback and lessons learned in the scope of field campaigns will allow the refinement of existing features and the incorporation of new functionalities to enhance end-user experience.

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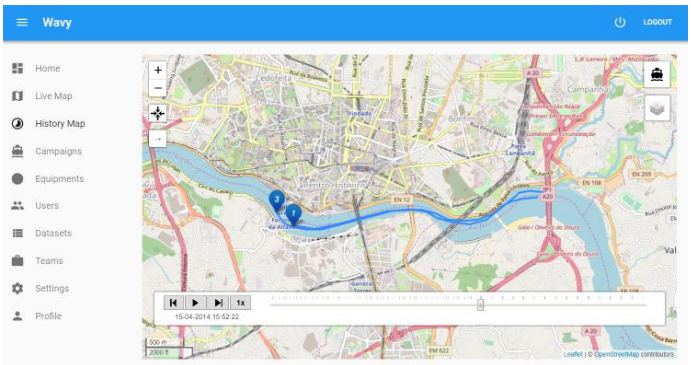

Fig 1. WAVY Operation Software - History Map

ID28 - HARMONISATION AND DISSEMINATION OF TSG DATA FROM IEO RESEARCH VESSELS

GONZALO GONZÁLEZ-NUEVO[82], MANUEL RUIZ-VILLARREAL[83], ÁGUEDA CABRERO[84], DAVID MARCOTE[85], ELENA TEL[86]

Abstract
Advances in the harmonisation and dissemination of underway data from research vessels in the Spanish Institute of Oceanography (IEO) fleets will be presented.

Keywords - TSG, research vessels

I. UNDERWAY MEASUREMENTS ON THE IEO FLEET
The Instituto Español de Oceanografía (IEO) has implemented a subsurface water sampling network on its RV fleet like part of its observing system: IEOOS (1). This ship-based network is composed of two local vessels (B/O Navaz, B/O Lura), three regional ones (B/O Ramon Margalef, B/O Angeles Alvariño and B/O Francisco de Paula Navarro) and an oceanic one (B/O Miguel Oliver), operated by Secretaría General de Pesca. Each of them has been instrumented with a SeaBird 21 thermosalinograph (TSG) and most of them with a Turner 10 Fluorometer. The vessels navigate all around the Spanish seawaters: the Iberian Peninsula, Balearic and Canary Islands. The TSG data are daily sent to a processing center, where an automatic data processing system has been developed to manage all the information generated in quasi-real time by this subsurface sampling network.

II. QUALITY CONTROL AND DISSEMINATION
The daily quality control is performed in order to detect geopositioning errors, spikes, etc. This quality control includes the assignment of quality flags based on international criteria established in the frame of SeaDataNet European projects (2) and adds information about the data reliability. Delayed mode quality control and permanent data archive at IEO datacenter, includes a monthly validation and their incorporation to the SeaDataNet infrastructure, from where they are also accessible under the agreed data policy in MEDAR/MEDATLAS + ODV + NetCDFpoint formats including a GEONETWORK Catalogue. Daily controlled data are disseminated. Some TSG data are stored in a Thematic Realtime Environmental Distributed Data Services server (THREDDS, http://centolo.co.ieo.es:8080/thredds/) for operational oceanography purposes. This infrastructure facilitates the data access by scientific community and its visualization by means of Open Geospatial Consortium (OGC) standard services. Nowadays an automatic data storage system based on Postgres/PostGIS database is being developed in order to make easier the implementation of a user-friendly web service to visualize them. The metadata generation is carried out following INSPIRE (2007/2/EC) directive, allowing the interoperability of the database and making easier the development of end-user services based on it. In the framework of Interreg projects POCTEP Marrisk (0262_MARRISK_1_E) and Atlantic Area Mycoast (EAPA_285/2016), further effort in TSG data harmonisation and dissemination is in progress.

III. APPLICATIONS
This effort in TSG data gathering and their efficient distribution is helping to use these TSG data for the evaluation of the ocean models that routinely run in the Atlantic area. As examples of the scientific interest of these routinely acquired data, the system has given information on the exchange of water between the Galician Rias Baixas (seawater inlets on the NW Spain) and the shelf [2], the variability in the position of river plume fronts or the spatial variability of chlorophyll concentration.

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ID30 - Autonomous Acoustic Surveillance System for Nearshore Soundscaping

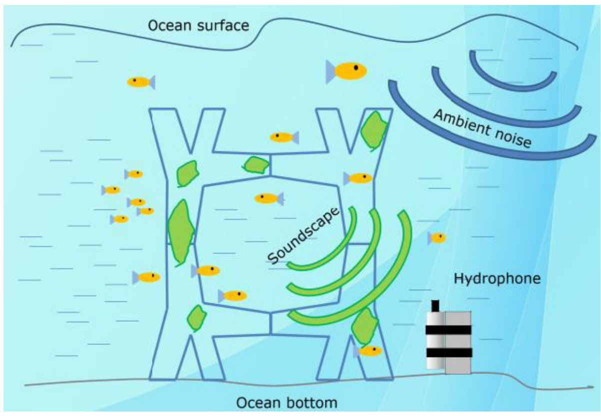
Dmytro Maslov[42], Eduardo Pereira[43], Tiago Miranda[44], Isabel Valente[45], Marisa Pinheiro[46], Fabio Cruz[47]

Abstract
In response to global climate change and growing industry capabilities, researchers are looking for robust and soft engineered solutions for nearshore ecosystems. A newly developed Multifunctional Artificial Reef is capable of performing several functions within one structure, among which is marine ecosystem restoration and the support for various sensors for structural and environmental monitoring. Combining such functionalities, implementation of passive acoustic shows great potential for biodiversity monitoring and colonization process observation of recently deployed artificial structure. Therefore, by integrating moored hydrophone within the artificial reef system and setting recording mode as well as post processing optimization, peculiar features of local marine habitat behaviour will be researched in order to provide better insight on the contribution of these structures for ecosystems preservation.

Keywords – Artificial reef, passive acoustics, ecosystem restoration.

Nowadays human population increase, associated with development of residential, industrial and recreational development, as well as severe weather conditions caused by global climate change, are inevitably becoming a key contributor to habitat loss and environmental degradation. Among numerous strategies aimed at preserving the existing biodiversity, one that is currently considered as very efficient consists on building underwater artificial reefs. The so-called Multifunctional Artificial Reef (MFAR) is currently seen as a tool with great potential for marine biodiversity restoration and rehabilitation, coastal protection and erosion prevention, and as a scientific platform supporting various sensors able to self-monitoring and sensing ambient environment, see Fig. 1. Modularity of the MFAR, parametrically designed reef parts, harsh and complex environmental loadings, remote positioning along with the growing complexity of the MFAR construction and instrumentation are joined in one underwater system.
One of the main system functionalities is serving as a platform to collect data for the better understanding of ecosystems using passive acoustic sensing of marine environment soundscape and biological monitoring. Due to the complexity deriving from reef positioning in remote areas, the only possible solution for observation of biological presence is the passive acoustic methods, which have been proven to be an effective tool and various applications were found on monitoring of soundscaping generated by local assemblage of soniferous species and ambient noise. It was found that short, daytime recordings from coral reefs, identified positive correlations between coral cover, fish density, and sound intensity. In addition, passive acoustic approach may be considered as relatively straightforward when applied to prospective reef structure from the hardware perspective, as it was shown that sole recording hydrophone on the study site is capable to record sufficient information for later analysis. The ongoing research has been dedicated to sensor integration, choosing the recording mode of the hydrophone and studying possibilities to apply postprocessing for better estimation of present biodiversity.

(a)



(b)

Fig 2. Typical hydrophone mooring for marine habitat acoustic monitoring: (a) moored setup for coral reef recordings, (b) in close proximity to the prospective MFAR.

ID31 - COASTAL BATHYMETRY ESTIMATION USING AN ENSEMBLE OF SYNTHETIC APERTURE RADAR IMAGES FROM SENTINEL-1

L. LAMAS[87], J. P. PINTO[88], P. VILAR[89], A. MOURA[90]

Abstract

In this study, coastal bathymetry is estimated with a wave ray-tracing algorithm using wave parameters retrieved from Synthetic Aperture Radar (SAR) images acquired by the Sentinel-1 satellites. The method relies on the long swell wave's detection by SAR imagery and the wave's properties adjustment to the underwater topography, which can be mathematically related using the linear dispersion relation. The ray-tracing algorithm tracks the shoaling waves until the wave breaking zone, using the wavelength and wave direction retrieved from the 2D directional spectra applied at consecutive sub-images. Then, by inverting the linear wave dispersion relationship, the depth is calculated based on the mean wavelength obtained for each sub-image and maintaining the wave period retrieved at the first offshore position, which is computed using a mean depth from an independent bathymetric source.

The output of the algorithm is a bathymetric model that results from the interpolation of the depth computed at each tracking position to a uniform grid and the results are compared with bathymetric information from the General Bathymetric Chart of the Ocean. The use of a monthly ensemble of SAR images, instead of individual ones, to reproduce the bathymetry near Aveiro, Portugal, resulted in a smoother topography with lower relative errors, suggesting that the final bathymetric model retrieved from SAR should result from a combination of SAR images.

The methodology presented here to infer the bathymetry using space-borne SAR imagery can be useful to retrieve the mean bottom topography (especially in remote areas where the traditional hydrographic surveying methods are not performed regularly) and to reproduce new underwater structures, such as banks, reefs or bars, which are important to detect for the safety of navigation.

Key words: Coastal Bathymetry, Synthetic Aperture Radar Data, Wavelength, Wave Direction, Earth Observation

I. INTRODUCTION

The knowledge of the water depth, specifically in coastal areas, is of crucial importance for a vast range of scientific, economic and societal fields. Accurate bathymetric information is imperative for the forecasting of the sea-state and coastal dynamics over shallow waters. Safety of navigation, fishing activities, offshore energy production, etc., all require precise information about underwater topography. The most accurate solution to retrieve bathymetric information is provided through traditional hydrographic surveying techniques, yet, these methods are time consuming, very costly and not regularly performed, especially in remote areas. The global bathymetry at 1 km resolution is already known and available through multiple different datasets (e.g. General Bathymetric Chart of the Ocean: GEBCO), however, those datasets also depend on in-situ data which can be out of date, especially in coastal areas where the hydrographic surveys are not performed often, or regions where the bottom floor changes rapidly due to, for example, the presence of energetic storms. The increasing advances in remote sensing technologies provided a natural solution for the development of methodologies that estimate the bottom depth ([1]; [2]; [3]; [4]; [5]; [6]; [7]; [8]; [9]; [10]). The use of SAR images acquired from satellites to derive the bathymetry can be particularly useful for many coastal applications, since satellites provide images globally, with high spatial and temporal resolution, and SAR sensors are independent of daylight and weather conditions.

A theory for bottom depth estimation using SAR imagery was first proposed by [1], which showed that the variation of strong currents detected by the SAR images could be related with the bottom topography. Other SAR-based methodologies have been proposed since, some of which use wave-current interactions [2], tidal currents [6] or directional changes of refracting waves [7]. In this study, the coastal bathymetry is derived with a ray-tracing algorithm (RTA) through wave parameters retrieved from SAR images from the Sentinel-1 satellites, following a similar methodology as proposed by [8] and [9]. The estimation of bathymetry through this method relies on the detection of long surface gravity waves and how the wavelength and direction are modified as the waves propagate towards the shore, which can be related to the bottom topography. The bottom depth estimated is compared against the bathymetry information provided by GEBCO. The methodology proposed here is tested for a region near Aveiro on the northwestern coast of Portugal and the results are discussed regarding the use of individual versus combined SAR images.

II. CONCLUSIONS

The bathymetry from SAR can be retrieved typically for depths between 10 to 100 m, depending on the long waves' length and breaking depth, which are specific to the sea state at the time of the sensing and the topography of the area of interest. In the case study presented here, the bottom depth estimated near Aveiro spanned between 20 and 100 m.

This study showed that using individual SAR images results in errors of the order of 10 to 20%, similar to previous studies ([8]; [9]) while using an ensemble of images can reduce this error to 5%. Fewer images in the ensemble resulted in higher relative error of the final bathymetric model. The topography near Aveiro at depths between 20 and 100 m are unlikely to change considerably in a monthly timescale, at least considering the spatial scales obtained by the SAR derived bathymetry. Apriori knowledge of the morphodynamics of the bottom floor for the area of interest is crucial in order to use the best timescale for the ensemble. For example, the time between images used in the ensemble should be reduced for places where the seabed changes often.

The bathymetric estimation using SAR might not be accurate enough to retrieve the absolute depth at a specific location, but can add useful information about the mean bottom topography (especially in remote areas where the traditional hydrographic surveying methods are not performed regularly) and can be used to detect new underwater structures, such as banks, reefs or bars, important to consider for the safety of navigation.

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ID32 - SENSOR WEB ENABLEMENT IMPLEMENTATIONS IN MARINE OBSERVATION PLATFORMS

ENOC MARTÍNEZ[145], DANIEL M. TOMA[132] AND JOAQUÍN DEL RÍO[129]

Abstract
The study of global phenomena requires the integration of scientific data coming from multiple sources. Data is usually acquired by a wide variety of observation platforms, managed by different institutions and often using non-standardized data and metadata formats. In order to address these issues a generic solution to integrate sensor data into spatial data infrastructures based on the Sensor Web Enablement framework is proposed.

Keywords – Sensor Web Enablement, Interoperability, SensorML, Sensor Observation Service, Plug and Play

I. INTRODUCTION
The study of global phenomena requires the analysis of scientific data acquired by different institutions and usually stored in different formats. A considerable amount of work is required in order to arrange this heterogeneous data into coherent data sets. Furthermore, integrating sensors into marine observation platforms is a time-consuming task that requires expertise in both sensors and acquisition platforms. Despite advances in recent years, interoperability and data harmonization still remains an open issue in the marine community.
The Sensor Web Enablement (SWE) framework aims to address these interoperability challenges by providing a set of protocols and standards to achieve data harmonization and data interoperability among Spatial Data Infrastructures (SDIs) [1]. Although these standards provide well defined interfaces for web services and applications, the integration of sensor data into SDIs still remains a challenge. Due to the wide variety of marine observation platforms, a generic SWE-based architecture is proposed in order to integrate sensor data into data infrastructures in different scenarios.

II. GENERIC SWE-BASED ARCHITECTURE
As a standard solution to integrate sensor data into existing SDIs a generic and flexible architecture is proposed, based on SWE standards. The architecture, suitable to be deployed in various scenarios, is depicted in Fig. 1

The SensorML is a standard metadata language that provides robust encoding for sensor and sensor-related procedures. It is very flexible and permits to describe sensor identifiers, communication protocols, sensor capabilities and configurable parameters among others [2]. Each sensor should have an associated SensorML file, were its metadata will be encoded. Combining a SensorML file describing a sensor with the OGC PUCK Protocol it is possible to embed the sensor metadata in the sensor itself [3]. Afterwards, this metadata can be automatically accessed without any a priori knowledge of the sensor by the observation platform's controller using the OGC PUCK protocol interface [4].

The SWE Bridge is a open source, cross-platform universal driver capable of decoding SensorML files and automatically operate a sensor [5]. It gathers sensor data and generates standard Observations and Measurements data files, compatible with the Sensor Observation Service (SOS) interface [6], [7]. The SWE Bridge also is compatible with the OGC PUCK Protocol, providing sensor auto-detection and auto-identification capabilities.
The SOS Server is a web service that provides a standardized interface to archive and retrieve sensor data and sensor metadata. Using its standard interface data visualization tools and other web services can access to query for sensor data.
The proposed solution to integrate sensor data into SDIs has been deployed and tested in different scenarios, including underwater cabled observatories, buoys, a underwater gliders (SeaExplorer) and Wavegliders.

III. CONCLUSIONS
Adopting the proposed flexible, standards-based architecture the interoperability between sensors and observation platforms is greatly improved. Moreover, sensor data can be integrated into SDIs with minimal human intervention. The flexible nature of the proposed architecture significantly reduce the use of custom software components, facilitating component re-usability and decreasing maintenance costs.

ACKNOWLEDGEMENTS
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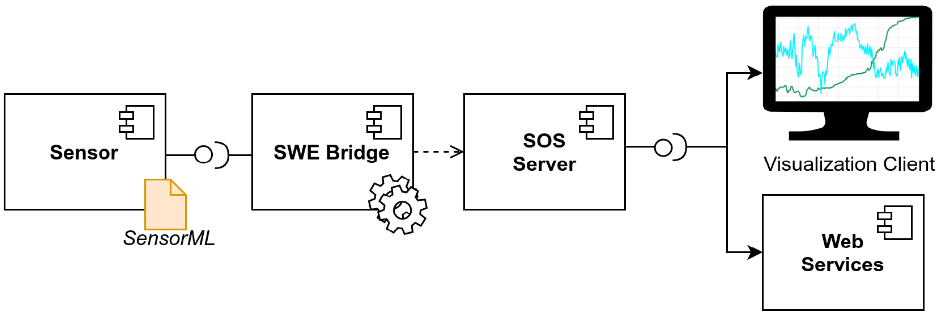

Fig 1. Generic Sensor Web Enablement architecture to integrate sensors

ID33 - STUDYING THE PACIFIC SUBTROPICAL FRONT WITH MULTIPLE ASSETS

JOSÉ PINTO[96], MARIA JOÃO COSTA[97], PAULO SOUSA DIAS[98], JOÃO BORGES DE SOUSA[99]

Abstract
We describe a novel approach to physical oceanography by coordinating remote sensing, multiple autonomous vehicles and ship borne sensors. In contrast with conventional oceanography where ships are the single point of sampling in the middle of a big ocean or are used simply as the base of operations from where autonomous vehicles are deployed, we propose a new approach where ship and autonomous vehicles are coordinated together via satellite communications. We conclude with results and lessons learned from a real-world deployment of the R/V Falkor oceanographic ship together with multiple autonomous vehicles to study the Pacific's Subtropical Front, 800 miles off the coast of San Diego.

Keywords – Physical Oceanography, Autonomous Vehicles, Remote Sensing.

I. INTRODUCTION

Our world is covered by a large, deep and mostly unknown ocean. A vast amount of physical oceanography uses scientific models together with remote sensing to grasp the complexity of its processes but this has several limitations. For instance, many properties of the water cannot be sensed remotely and satellites can only measure a few meters on the surface of the water. As such, in-situ sensing is still required to have a deeper understanding of processes and their manifestation under the water surface.

Oceanographic ships such as R/V Falkor from Schmidt Ocean Institute (SOI), have the capability to sample water down to hundreds of meters but only at one point at a time. Autonomous vehicles can acquire similar data at a fraction of the cost and do it at physically distributed locations simultaneously, contributing to a synoptic observation of the ocean.

Study of submesoscale ocean phenomena such as eddies, filaments and meanders requires high resolution in-situ sampling that can be addressed only with the coordinated movement and sampling of multiple assets over these regions. Our approach uses a proven software infrastructure to plan, command and monitor execution of all assets while keeping scientists in the loop either on site or remotely via the Internet.

II. FRONT MAPPING WITH MULTIPLE ASSETS

Our work builds upon the LSTS Toolchain [1], the Light Autonomous Underwater Vehicle (LAUV) [2] and Flightwave's Edge aerial platform. For the sake of this campaign, 3 new LAUV vehicles were developed from scratch for longer endurance and Iridium-only operation. Moreover, a dimethyl sulphite (DMS) sensor was mounted on the aerial platforms to detect this by-product of cyanobacteria, commonly found on ocean fronts. The LSTS Toolchain has been improved with new planning, communication, situation awareness and integrated data from multiple new sources.

Three long-range surface vehicles have been deployed prior to our departure to first scout the location of the STF. These robots transmitted data over Iridium which was received and plotted in real-time using Neptus (part of LSTS Toolchain). A WaveGlider departed from San Francisco on May 1st and was sent directly to the estimated position of the front (roughly 800 miles away). Two Saildrone ASVs that were in the area were also tasked to go to the area and, as a result, all 3 ASVs were able to cross the front before the departure of R/V falkor on May 28th, giving a precise target on where to go with the ship.

As soon as the ship arrived at the location, 4 days after departure from San Diego, 3 of the AUVs were deployed to map the front with unprecedented resolution (5 miles apart from each other), and were later replaced with other 3 to continue the survey for 5 days. Even though direct communication was not viable over the distance of 5 miles, the collected data was decimated and transmitted in near real-time to the internet over satellite communications.

The data from the AUVs and the ship's salt water system, allowed the scientists to perceive in real-time features from the front such as a filament which was targeted next.

In a later deployment, 2 of the AUVs did a coordinated survey together with the ship and an UAV, with the ship travelling at 2 knots for 5 miles. This approach resulted in a high-resolution map of the filament with sensors crossing the front from the air, at the surface and underwater.

III. CONCLUSIONS

The developed system was successfully used onboard R/V Falkor to detect the STF front and later map with unprecedented resolution a filament of this front. This was possible only by having the scientists on ship and in land driving the campaign with access to both real-time data coming from the vehicles overimposed with oceanographic models. The software developments were fundamental to be able to coordinate the vehicles over Iridium while maintaining good situational awareness. In the end, a very good map of the front was produced and our knowledge of the STF front has improved considerably.

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Fig 1. Fleet of autonomous vehicles deployed from R/V Falkor (left) and Scientists using real-time data from vehicles and oceanographic models to decide next surveys (right)

ID34 - THE NEW ITERATION OF THE WAVY DRIFTER (MELOA)

PEDRO GONÇALVES[100], TIAGO MARQUES[101], BRUNO LOUREIRO[102], JOÃO BORGES DE SOUSA[99]

Abstract

The MELOA (Multi-purpose/Multi-sensor Extra Light Oceanography Apparatus), H2020 project, proposes to develop a low-cost, easy-to-handle, wave resilient, multi-purpose, multi-sensor, extra light surface drifter for use in all water environments, ranging from deep-sea to inland waters, including coastal areas, river plumes and surf zones. The device will be developed as an upgrade to the WAVY drifter (Figure-1) conceived by the LSTS - Faculty of Engineering of the University of Porto, which was used to measure the surface circulation forced by wave breaking, including detailed structure of rifts and the littoral drift current.

The new iteration of the wavy drifter improves upon the older one by adding new functionality like wave spectrum computation from collected data, and adding sensors such as a Inertial Measurement Unit (IMU), Atmospheric Pressure Sensor (ATM), a new and improved GNSS modules with new positioning solutions, a new GSM supporting encrypted GPRS connections for real-time data transmission as well as more internal memory.

Furthermore a new MCU (Microcontroller Unit) was chosen to integrate all this sensors and data collection and a new firmware package.

To adapt to users' requests and different mission profiles there are five WAVY models available, all with different sensor packages and functionality: Basic and Litoral for coastal operations, Ocean, Ocean ATMO and Ocean Plus for open sea. For the later a Satellite transceiver is used for communication instead of the GSM module, to transmit the results of wave spectrum computation.

Figure-1: WAVY Drifter

ID35 - RIPPLES: A TOOL FOR SUPERVISION AND CONTROL OF REMOTE ASSETS

JOSÉ PINTO[96], PAULO SOUSA DIAS[98], JOÃO BORGES SOUSA[99]

Abstract
We describe the Ripples cloud-based software for coordination and control of multiple remote assets. Ripples can ingest and disseminate data coming from multiple sources such as physical models, drifting sensors, marine traffic (AIS) and unmanned vehicles deployed in remote areas. On top of data dissemination and awareness, Ripples can also be used for planning the autonomous assets using satellite communications, maintaining the operators in the loop.

Keywords – Autonomous Vehicles, Ocean Observation Systems, Remote Sensing

I. INTRODUCTION
There are many scientific applications that require synoptic observations over large remote areas, such as physical oceanography or marine biology.
In this paper, we present a new tool developed to help scientists have a better grasp of these large-scale phenomena using remote sensing data, autonomous vehicles, marine traffic and other in-situ sensors. Ripples, is a cloud-based software that can ingest data from multiple sources and control multiple distributed assets over low-bandwidth and high latency communications such as satellite.

II. IMPLEMENTATION
Ripples extends the existing LSTS Toolchain [1] as a centralized hub that concentrates and disseminates information between remote locations. Ripples provides multiple entry points to which data can be fed:

1. ARGO floats: receives data from thousands of drifters already deployed in the ocean [2];
2. FindMeSpot: receives real-time positions from SPOTTracker devic es which are associated with known assets such as ships or umanned vehicles;
3. AIS: can ingest data from different providers such as AISHub and Marine Traffic;
4. Neptus: can ingest real-time data pushed over the web (Web Sockets) from Neptus C4I software, part of LSTS Toolchain;
5. DeviceState: Device states (position and readings) can be pushed from any device connected to the web directly, or indirectly (e.g. using a web gateway);
6. Iridium: Ripples also supports data pushed over Iridium satellite communications. Namely it can listen to short burst data (SBD) from RockBlock.

The previous entry points all generate data points in a timeseries database of positions and measurements. These data can be queried also via several REST services using JSON and CSV formats. The JSON format is especially useful for web clients as it can be easily parsed in JavaScript and displayed visually with frameworks such as LeafletJS or OpenLayers.
Ripples is implemented in Java SE and is hosted in the Google Cloud Platform. This is an elastic platform that can grow linearly to the data size and number of users automatically. Google also provides several cached instances of the application which decreases load time across the world. The last state of all devices is also hosted on Google's Firebase, a real-time DB that pushes updates to clients automatically over the web.

III. SUPERVISION AND CONTROL OF AUTONOMOUS ASSETS
In order to control autonomous assets via Iridium, we consider part of its state the configuration and plan being executed by each autonomous asset. The configuration of each system is a list of key-value pairs which correspond to settings in the device that can be changed after it has been deployed. Examples of such configurations are the vehicle's active payloads, depth and speed to use for planning, etc.
In Ripples, a plan consists of a list of waypoints where the device will be sometime in the future. Each waypoint thus contain a geographical location together with estimated time of arrival. Even though the vehicles may not be travelling in straight lines between waypoints, Ripples assumes that the vehicles will arrive at the waypoints on time and can be contacted using Iridium at those locations. The assumption is possible if conservative speeds are used for planning and the vehicles actively pursue the desired ETAs (by controlling their speed).
Plans can be received from the operators (using Neptus) or they can also be generated onboard the vehicles (in reaction to dynamic phenomena or failures). In both cases these plans are communicated to Ripples and disseminated to all destinations so that the predicted state of every device can be calculated even while they remain disconnected.

IV. RESULTS AND CONCLUSIONS
Ripples has been used multiple times to supervise the execution of multiple autonomous vehicles. It is used to monitor the execution of surveys in Douro River while autonomously tracking river plumes and in recently it has been used to control a fleet of autonomous vehicles to map the Pacific's Subtropical Front, 800 miles offshore from San Diego.

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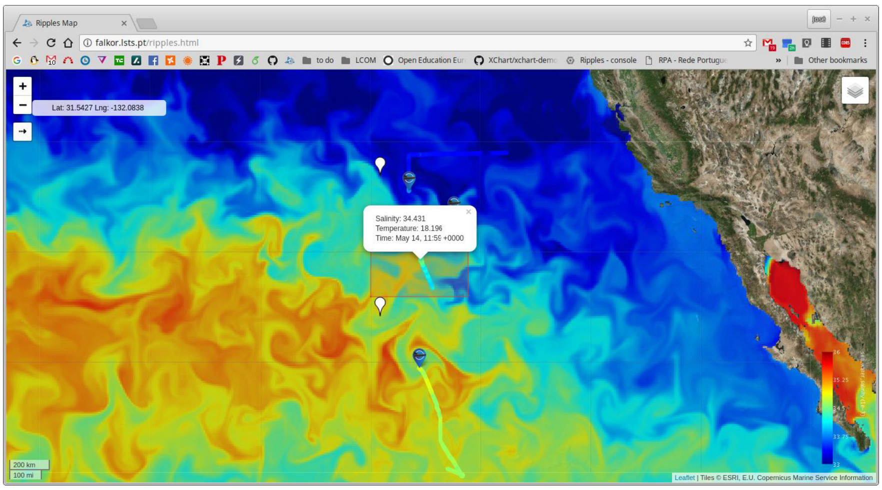

Fig 1. Snapshot of a Ripples web client showing real-time data from two autonomous vessels together with CMEMS salinity models

ID36 - REP18 ATLANTIC – A LARGE SCALE EXERCISE USING UNMANNED SYSTEMS

PAULO SOUSA DIAS[98], MARIA COSTA[97], JOÃO BORGES SOUSA[99]

Abstract
We present the REP18 exercise in which were operated heterogeneous unmanned underwater and aerial vehicles. This large scale exercise organized together with the PO Navy and with the participation of key players in the area, served to test the large scale use of unmanned vehicles in real-world operations both in defence and scientific areas. This work showcases how the LSTS Toolchain for Autonomous Systems enables all this.

Keywords – Autonomous Vehicles, Remote Sensing.

I. INTRODUCTION

REP18 Atlantic is a naval exercise with a share organization of LSTS (Underwater Systems and Technology Laboratory) from University of Porto – Faculty of Engineering, and Portuguese Navy. This yearly event focus on the use of autonomous systems to aid the execution of real-world operational needs in the areas of defence and science. For this purpose LSTS and PO Navy bring together world-class players to challenge and see in action both commercial and research products for unmanned systems. NATO CMRE from La Spezia, Italy, has been a long time participant in the exercise bringing their expertise on acoustics and also its research vessel. Additionally this year we operated with the Polish Navy, NUWC from the USA, and also the University of Hawaii.

We operated autonomous vehicles in the following scenarios:

· Acoustic communications for a manned submarine in a distress situation,
· Sidescan sonar and magnetometer in mine warfare surveys, and
· Scientific data collection for the study of a river estuary and the detection of nonlinear internal solitary waves.

Digital Acoustic Communications in Manned Submarine Distress was done jointly with NATO CMRE. We had a scenario where a manned submarine was in distress and underwater. We conducted the operation in two stages. First by using acoustic digital communication based on JANUS[1] protocol that allowed the communication of relevant distress information from on-board the submarine as text messages (done by the CMRE). In the second stage we processed those distress messages to trigger search and map behaviours on a AUV equipped with acoustic modem and sidescan sonar.

For the Mine Warfare scenario, we needed to survey several areas where mines and mine-like objects were disperse. The sensors used for these surveys were sidescan and magnetometer.

For the scientific data collection we had two exercises: SaVel – Sado Estuary Study, and SnOW – Study of Nonlinear Internal Solitary Waves. These operations have similar characteristics. Both were executed by launching several AUVs for periods that encompassed 13 to 30 hours in continuous operation. The areas where we operated are with heavy maritime traffic and with lengths of 2.5km (1.3 nautical miles), which makes Wi-Fi operations difficult. For this reason satellite communications was used. Also UAVs where deployed from ships in order to survey from the air with FLIR and visible light cameras in order to complement the data collected underwater. This UAV data served also to correlate the satellite data from the survey periods.

These scenarios contain several challenges due to their characteristics. Operating autonomous underwater vehicles (AUV) and unmanned aerial vehicles (UAV) have some differences in terms of operator awareness, data availability, and reaction to vehicle abnormal operation. Autonomous underwater vehicles stay longer periods of time disconnected from the operator due to the difficulty of underwater communications that are lower rate and unreliable. On the other hand, unmanned aerial vehicles keep, for the most time, connection with the operator. Another characteristic of UAVs is that they operate on much higher speeds than the AUVs and so the reaction to abnormal events needs to be quicker.

To operate on these challenge environments we use the LSTS Toolchain for Autonomous Systems [2]. It allows seamless operation of heterogeneous autonomous vehicles and contains tools to plan, simulate, execute and monitor, as well as review and analyse the collected data. We will show how the use of the LSTS toolchain helped to resolve the challenges posed by this rich operational environment with heterogeneous vehicles.

II. CONCLUSIONS

LSTS has been used to successfully operate with heterogeneous autonomous vehicles in the most diverse of operational challenge environments. It supports single vehicle operation, but also scales for multiple heterogeneous vehicle operations, either with or without coordination. The example is the REP18 naval exercise where multiple vehicles were operated from simple surveys to environmental triggered behaviours.

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Fig 1. AUV vehicles, UAV vehicles, and REP18 group photo

ID37 - FAST UNDERWATER COLOR CORRECTION USING INTEGRAL IMAGES

LÁSZLÓ NEUMANN[30], RAFAEL GARCIA[31], JÓZSEF JÁNOSIK[32], NUNO GRACIAS[33]

Abstract
Underwater image processing has to face the problem of loss of color and contrast that occurs when images are acquired at a certain depth and range. The longer wavelengths of sunlight such as red or orange are rapidly absorbed by the water body, while the shorter ones have a higher scattering. Thereby, at larger distance, the scene colors appear bluish-greenish, as well as blurry. The loss of color increases not only vertically through the water column, but also horizontally, so that the subjects further away from the camera appear colorless and indistinguishable, suffering from lack of visible details.

This paper presents a fast enhancement method for color correction of underwater images. The method is based on the gray-world assumption applied in the Ruderman-opponent color space and is able to cope with non-uniformly illuminated scenes. Integral images are exploited by the proposed method to perform fast color correction, taking into account locally changing luminance and chrominance. Due to the low-complexity cost this method is suitable for real-time applications ensuring realistic colors of the objects, more visible details and enhanced visual quality.

Keywords - Underwater imaging, Image enhancement, Color correction.

I. COLOR CORRECTION IN UNDERWATER IMAGING

As light propagates through water, it suffers from absorption and scattering, and these phenomena affect in a different way every wavelength of white light, shifting the color of objects as a function of their distance to the camera. This deterioration of underwater images is the result of the combination of multiplicative and additive processes, therefore underwater visibility enhancement is a challenging task [1].

Underwater enhancement techniques try to recover the original colors and bring back the lost image contrast. Enhancement often consists of three main steps [2]: (1) white balance estimation, (2) recovery of color hue and saturation and (3) enhancement of luminance contrast. Among the previous steps, white balance is the most challenging issue, and it is often addressed in the literature as the color constancy problem [3]. In fact, highly-variable illumination conditions due to the absorption and scattering effects are characteristic of underwater environments, along with the increasing bluish shift and color saturation loss with the depth and poor visible contrast. Automatic white balancing or chromatic adaption algorithms are not able to reflect the ability of the human visual system to locally adjust the perception of a complex-illuminated scene.

Several works on image restoration and haze removal have been proposed in the literature [4, 5, 6]. Dehazing methods propose complicated color correction solutions based on the estimation of the wavelength absorption with the depth. These methods correct the bluish effects on the light path between the camera and the imaged object, but cannot correct the depth-dependent bluish irradiance casted on the scene by the inherent absorption and scattering of the underwater medium.

[7, 8]. The automatic method proposed in [9] is composed by several successive independent processing steps, in which color is adjusted by equalization. However, results show that color cast in front of the objects cannot be removed completely. Computational color constancy approaches have also been proposed [10, 11], but assuming homogeneous illumination. In [11] the authors presented a method for fish recognition in underwater clear water, but their performance in general conditions is unknown.

In this paper, we deal with the color correction problem of underwater images by using a computational color constancy approach, which aims to correct the colors of a scene by mimicking the performance of the visual system [3]. In fact, the human visual system can perceive the true colors of objects even if not illuminated by a neutral light source, i.e. white. Imaging devices measure directly the incoming light radiance from the objects and they are not capable to distinguish between the color of the illuminant and the reflectivity of the objects. Digital cameras can balance color images under a wide variety of illumination conditions (i.e. neon light, sun light, cloudy sky) by internal processes but these settings often fall in underwater environments.

An underwater image can be regarded as a scene captured in the air, illuminated by a locally-colored light source. Often, correcting the white balance is performed using the gray-world assumption. It assumes that the average of each image channel (R, G and B) is the same, thus corresponding to a gray color. In other words, the average of the color distribution of the image should be gray (achromatic) under white illumination. In this work we propose to state the gray-world assumption in the Ruderman–lαβ space, a perceptual color space based on LMS cone responses of human retina. Ruderman–lαβ uses a non-linear opponent-color space composed by a luminance channel (l) and two opponent chromaticity coordinates (α and β) [12], where α is the red-green and β corresponds to the yellow-blue opponent channels.

Consider an underwater image expressed in RGB coordinates with a given white point chromaticity (D65, D50, E, etc.). We linearize the RGB coordinates for removing the gamma or camera response nonlinearities (from e.g. jpg or raw images), and then convert them to accurate colorimetric CIE-XYZ coordinates. The XYZ coordinates are then converted to the linear LMS space, with E equi-white point. The transformation matrices are described in [2] to calculate the lαβ coordinates in the Ruderman-lαβ opponent color space from the logarithms of LMS coordinates. In our work, the gray-world assumption is formulated in the lαβ space [13] as and , where and are the averages of the α and β channels, respectively, computed on a window w centered at pixel . Thus, and are the white balanced channels, shifting the chromatic distribution around the white point, while the luminance l remains unchanged. According to gray-world assumption and are an estimation of the illuminant color.

To efficiently calculate and we have to calculate first the LMS average values over window w centered at the current pixel . This can be very easily performed using integral images for L, M and S. For every window w , we can compute the L, M or S average values with 4+1 operations, independently of the size of the window w.

II. RESULTS AND CONCLUSIONS

Fig. 1 illustrates the results of the proposed method. Our color correction formula can be visualized as an image (see middle). In underwater photography, orangish, reddish or purple lens filters are often used in front of the camera. Our method can be seen as an adaptive image-dependent filter (middle) to obtain the desired corrected image (right). In the Ruderman space we perform a subtraction with the appropriate , and opponent chrominance values. We perform a global luminance (l) stretching in the Ruderman space to obtain an overall higher contrast image.

Fig 1. (left) Original UW image. (right) Corrected image using the proposed method. (middle) Image corresponding to $(-\overline{\alpha}_w(x,y), -\overline{\beta}_w(x,y))$ chrominance coordinates used for color correction. The blurriness of the image is due to the box filtering inherent of the integral imaging.

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ID38 - LitterDrone: Marine Litter Characterization Using Drones and Image Analysis

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Abstract
This communication is about "LitterDrone" project. LitterDrone is funded via the Blue-Labs program of the European commission and it aims to make a contribution to solve the problem of marine litter. Part of this problem is monitoring stranded marine litter on beaches (measuring number and type of litter elements). Monitoring results can be used to infer data on litter origin and on the influence of tides, currents and human activity. OSPAR convention [1] is a joint European initiative that tries to unify forces against marine pollution. Part of this convention implies that contracting parties (countries) must monitor periodically stranded marine litter on beaches. Spain has signed the convention in January 1994. Litter monitoring in Spain is nowadays implemented by human personnel counting (& picking) litter items in certain beaches at certain times (4 campaigns each year, one for each season). LitterDrone project aims to create a new and/or complementary methodology based on obtaining images from drone flights (creating orthomosaics of RGB and multiespectral images) and developing software to analyze such images to obtain results comparable to those of the manual sampling.

Keywords – marine litter, coastline, beach, drone, camera, remote sensing, computer vision.

I. THE PROJECT
LitterDrone project is being developed by a consortium constituted by the University of Vigo, project leader, the company Grafinta S.A. and the Spanish Association of Marine Litter (AEBAM). The project has the support of ECOEMBES and the collaboration of "Parque Nacional Marítimo-Terrestre de las Islas Atlánticas de Galicia" (PNIAG).

II. FLIGHTS & IMAGE ACQUISITION
Images are obtained with a UAV/RPA platform using auto-pilot over the section of interest. Different platformcamera combinations have been tried, being the most useful:
- Platform: multirotor at 10-20 m high. Above this height resolution becomes less than 1 cm per pixel and detection of small-sized debris is not possible. Fixed wing platforms were tested with less success because they must fly higher (can be useful to detect large debris in long stretches).
- RGB camera (conventional, visible light, camera).
- Multispectral camera: we used MicaSense, RedEdge model. It has 5 bands: R, G, B, NIR (near infrared) and RE (RedEdge: border between red and infrared).

The UAV platform will shoot images periodically (one image every t0 seconds), so that we will get plenty of images per flight. A photogrammetry application is used to integrate all of them in a single global image (ortho-mosaic). Commercial software Photomodeler [3] has been used, although there exist other options, including open-source.

II. IMAGE PROCESSING
Ortho-photos are then processed with a CV (computer vision) application. CV is mainly used because of the lack of most discriminant hyperspectral information [2] due to the reduced cost of the cameras we are using. Processing is done in two stages: first detection, then recognition of most common objects. A human operator must revise classification results.

IV. CONCLUSIONS
LitterDrone is a project that tries to improve the processes of monitoring and control of marine litter on European beaches. It is designed after the principles of the OSPAR protocol [1], which is followed by the EU countries, including Spain. The project consists of the development of new methodologies based on the capture of aerial images through unmanned platforms (drones) and different types of cameras.
Capture is made using state of the art technology based on standard cameras and photogrammetry software.
Analysis of the images is done through image processing software developed in MATLAB environment.
Methods are based on artificial vision techniques. However, the results are useful and original since there is no other software capable of a similar process.
LitterDrone is a two-year project that ends on January 31, 2019.
Main future lines are the following:
- Testing with other types of sensors, such as hyper-spectral and thermal cameras (thermal cameras tests are ongoing just now), searching for new discrimination possibilities.
- Improving image recognition, adding new patterns to the current system and/or testing other methods. The use of more advanced techniques such as convolutional neural networks is not discarded, although, currently, the existing database is not enough for this type of training.

V. ACKNOWLEDGEMENTS
The authors would like to thank the funding received from the European Commission through the action "EASME / EMFF / 2016 / 1.2.1.4". In addition, we appreciate the financial collaboration of Ecoembes and the help provided by the "Parque Nacional de las Islas Atlánticas de Galicia".

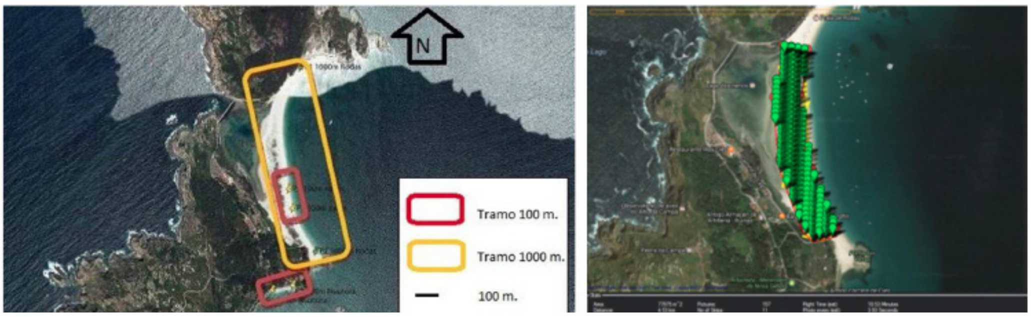

Fig 1. Left: interest areas in Rodas beach (coincide with the two sections of the official study: 100 & 1000 m). In "Nosa Señora" beach, we define another 100 m transect. Right: graphic report of a real flight where all the shooting points are represented

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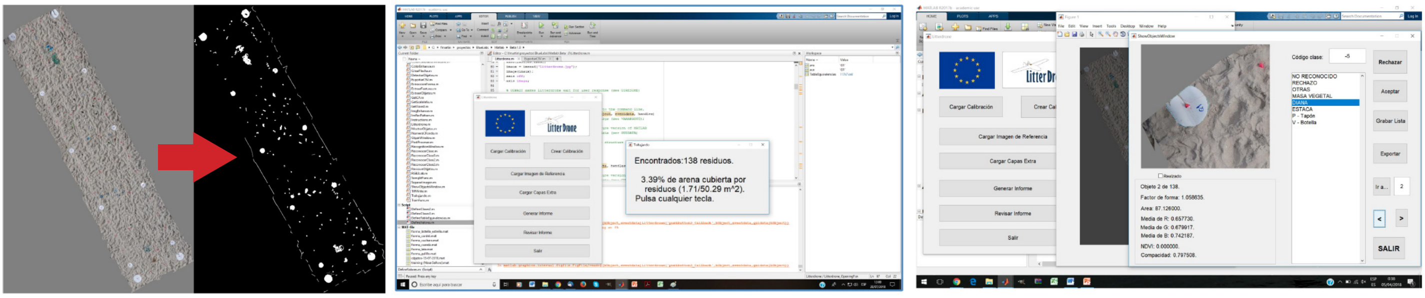

Fig 2. Left: debris location. Center: global automatic report. Right: recognition revision.

ID39 - FEASIBILITY ANALYSIS OF ENERGY HARVESTING WITH PIEZOELECTRIC DEVICES IN OCEANOGRAPHIC BUOYS

BEGOÑA POZO FERNÁNDEZ[36], CARMEN NÚÑEZ ESTÉVEZ[37], XULIO FERNÁNDEZ HERMIDA[39], JORGE MARCOS ACEVEDO[38]

Abstract

This document shows the study carried out to demonstrate the feasibility of using piezoelectric devices in oceanographic buoys, as generators of electric power for feeding the buoy system.

One of the basic problems in an application of this type is to supply electrical power to the systems of the buoy. But the realisation of prototypes and especially their test in real conditions, for their validation, are extremely expensive. Therefore, a good solution is to demonstrate, previously, the viability of the system. This requires real data on movements, accelerations, etc., but in this particular case, these data are available for carrying out previous R & D projects that have given rise to developments that are currently located on operational oceanographic buoys. . With all this we have been able to carry out a study that demonstrates the interest of this technology.

Keywords - energy harvesting, wave sensor, piezoelectric, oceanographic buoy.

I. INTRODUCTION

There are more and more needs to measure variables in remote locations. In these cases the electrical power of the systems in those locations is difficult, since the only solution would be with batteries that periodically need to be replaced, which complicates the efficient use of the system. These types of needs are, among others, those related to the measurement of environmental variables in the seas and oceans, which are carried out by means of oceanographic buoys. In this particular case, the buoy must be selfsufficient to feed the measurement systems, information storage and transmission of the same, via wireless, to a remote station located on land.

In the case of buoys, one can think of the generation of electric energy from thermal energy (Peltier cells), in the generation from piezoelectric devices, which could generate energy from the movement of the buoy due to its time, the movement of sea water, etc.

In this work, a theoretical analysis of the possible system to be used is made, based on piezoelectric devices, which is a form of generation that in principle seems adequate for this case.

Operation of the system

The buoy presents repetitive and oscillatory movements characterized by the amplitude and frequency of the waves to which the buoy is subjected. Specifically, these movements depend on the amplitude of the waves, the frequency of them and the combination of these movements. The result is a buoy that presents accelerations in the three axes, which means that in each of the three planes of the space appear different types of accelerations (Roll, Yaw and Pitch). By locating two piezoelectric devices in each of the planes, all the energy corresponding to all the movements of the buoy can be captured.

The movements of the buoy depend on the location of thesea in a specific location. In our case and due to previous work we know these movements for specific locations and based on this information we intend to make an assessment of the amount of energy that would be possible to obtain for a particular buoy located at a specific point.

Objectives

The general objective of the study is to evaluate the technical and economic feasibility of harvesting energy in a buoy from the movement of the own buoy. For this, the use of piezoelectric devices has been considered. To do this, all possible real movements of a buoy are analyzed and characterized for possible use to generate energy through commercial piezoelectric devices. An additional objective is the selection of the most suitable commercial devices for the design of a prototype that can be located in a concrete buoy.

Conclusions

The work done shows the interest of using this form of energy as a source of power for the electronic systems of an oceanographic buoy.

ACKNOWLEDGMENTS

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Data for the analysis have been provided by HCTech https://www.herculescontrol.com.

ID40 - DESIGN, MANUFACTURING AND SET-UP TESTS OF A WAVE ENERGY CONVERTER PROTOTYPE IN THE CONTEXT OF THE EUROPEAN PROJECT LIFE-DEMOWAVE

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Abstract
LifeDemoWave Project is a real case of development of a R&D project, from the initial idea to the final construction and installation of a prototype for testing in operational environment. This project was born from an idea of the main researcher of the CIMA Group that finally led to two patents of two wave generation systems. Based on these patents, CIMA sought different ways for funding with the aim of developing prototypes with a high TRL and being able to test the operating principle of the patented systems. Finally, funding was obtained through the Life Program of the European Union and in collaboration with five other partners. The main objective of the LifeDemoWave project (http://www.life-demowave.eu/en/) is the demonstration of the feasibility of the use of wave power for electric generation in order to reduce greenhouse gases' emissions. For demonstration purposes, prototypes of wave power generation, reproducible and scalable at high level, are installed in the Galician coast. LifeDemoWave project considers, as well as its design and implementation, the environmental impact in the installation areas and its effect on biodiversity.

Keywords - wave energy converter, prototype, LIFE-Demowave.

I. LIFEDEMOWAVE OBJECTIVES
The main objective of the project Life-Demowave (http://www.life-demowave.eu/en/) is demonstrate the viability of systems for wave energy conversion through design, construction and testing of a prototype installation operating under real conditions environment. In this way, the benefits of this renewable energy, in particular wave energy, will be prove. The final propose is to contribute to European policies for the promotion of renewable energies [1].

II. LIFEDEMOWAVE BEGINNING AND PARTNERS
This project starts with the development of two patents for the conversion of the wave energy into electrical energy, defined by the main researcher from CIMA Group at University of Vigo. The researches of this group, in collaboration with other groups of the Institution and different companies, leaded by Quantum Innovative: Cetmar, Hercules Control, ACSM and Grupo Josmar. All the entities of the consortium are located in Galicia, in the Northwest of Spain. This region is one of the European area with the highest density of wave energy.

III. LIFEDEMOWAVE WORKING PRINCIPLE, DESIGN AND SIMULATION PHASES
The LifeDemoWave prototypes take advantage of the differential movement between two bodies, one of flotation, and the other of reaction (see Fig. 1). Between both, a PTO (Power Take Off) device is included that converts the resultant energy of the differential movement between those two bodies into useful energy.
This mechanical design was structurally simulated and the electronic devices were integrated (see Fig. 2).
The prototype working principle was tested using a wave simulation FEM software (ANSYS Aqwa) and also using an scale prototype tested in a wave tank (see Fig. 3).

IV. LIFEDEMOWAVE MANUFACTURING PHASE
The first prototype was finished assembling at the end of June 2018 (Fig.4). The components of the flotation bodies were designed to be transported by road without the need for special transports (bear in mind that the complete system measures 4 meters in maximum diameter and 17 meters in height). For this reason, once installed the equipment on board, the final assembly of these components was made in port in the vicinity of the installation area (Experimental Site located in the Puerto Exterior de A Coruña – Punta Langosteira, managed by INEGA – Xunta de Galicia).

V. CONCLUSIONS
The prototype was recently installed for real conditions works for the final test phase of the project. The results expected are: obtain information about the energy production of the system and the installation 'survival' under the extreme wave conditions in the Experimental Site selected.

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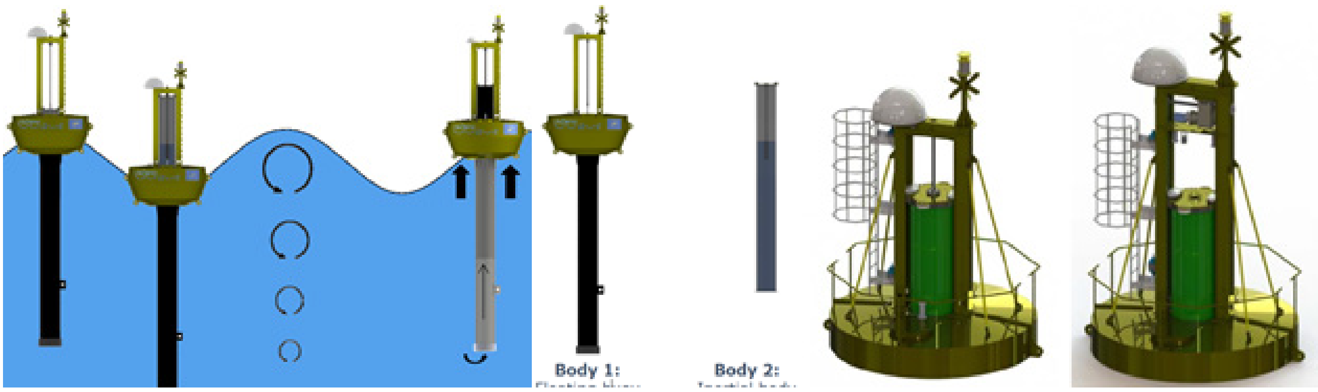

Fig 1. Prototype working principle and design

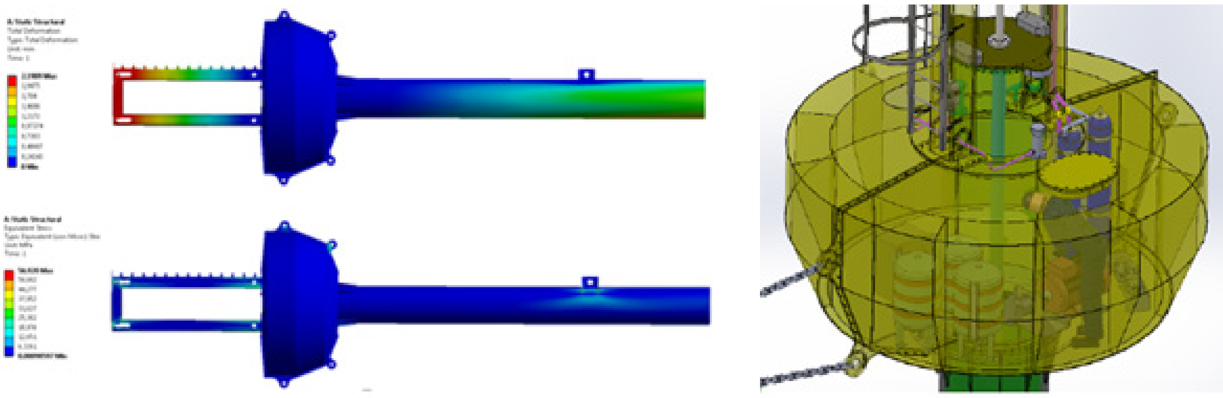

Fig 2. Mechanical validation FEM simulation and electronic design and integration Prototype working principle and design

Fig 3. FEM and scale test and simulations of the prototype

Fig 4. Manufacturing phase

ID41 - DESIGN, VALIDATION AND MANUFACTURING OF AN ANTHROPOMORPHIC MANIPULATOR FOR ROVS USING TITANIUM RAPID PROTOTYPING

P. IGLESIAS[124], P. IZQUIERDO[146], P. YAÑEZ[147], JA. VILÁN[148], A. ARIAS[123], A. SEGADE[149], E. CASAREJOS[150]

Abstract
It is at least two decades since the conventional robotic manipulators have become a common manufacturing tool for different industries, from automotive to pharmaceutical. The advances in manipulators and sensors have given robots the opportunity to become useful for more and more applications. Engineers have taken advantage of the extra mobility of the advanced robots to make them work in constrained environments, ranging from limited joint motions for redundant manipulators to obstacles in the way of mobile (ground, marine, and aerial) robots [1]. However, the incorporation some of these abilities and capacities that are already being used in land, have not made their way to the sea domain. This Abstract describes the project consisting in the design, development and manufacture of a prototype manipulator arm for ROVs introducing innovative fabrication technologies. The work has been done collaboratively among ACSM Maritime Agency SL, CIMA Group and the University of Vigo

Keywords - anthropomorphic manipulator, ROV, titanium rapid prototyping.

I. INTRODUCTION
The main objective of the project Titanrob (http://www.titanrob.com/) is the design of the prototype manipulator, using titanium rapid prototyping, for ROVs. In fact, different prototypes were development based on a titanium built hydraulic manipulator designed for heavy duty subsea applications in ROV (Remote Operated Vehicle) submarine operations.
In this paper is showed the successive phases of the development of those product: an original concept was developed in order to fulfil the gap between the big and heavy manipulators. Prototyped were fully designed and simulated (FEM) and the, manufacturing for the final tests.

II. CONCEPTUAL DESIGN OF THE TITANROB MANIPULATORS
This project starts with the development of a conceptual design of the prototypes taking into account an anthropomorphic shape and appearance (Fig. 1).

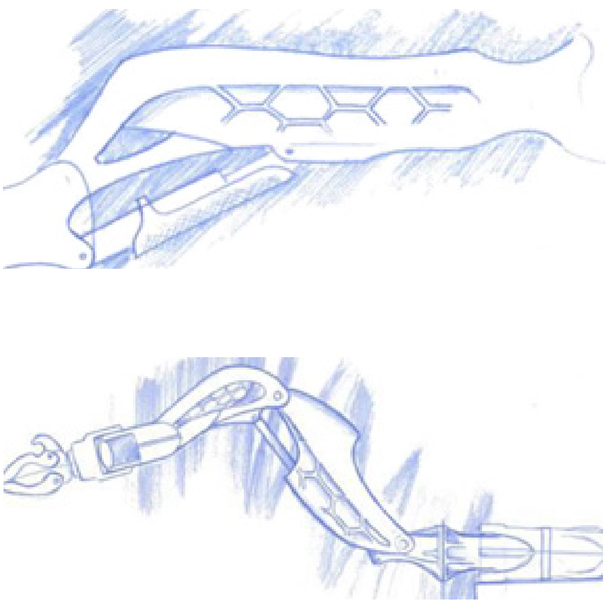

Fig 1. Prototype anthropomorphic shape and appearance

Based on those basic conceptual designs, a more detailed conceptual definitions were development (Fig. 2).

Fig 2. Conceptual definitions for the manipulators

III. TITANROB DESIGN AND SIMULATION PHASES
Titanrob prototypes were fully design in order to be manufacturing using titanium rapid prototyped. Before manufacturing phase, the design was validated structurally using FEM software. Next figure (Fig. 3) shows the mesh and simulation process and the results obtained.

IV. TITANROB MANUFACTURING PHASE
For the fabrication of the various components they were necessary different procedures such as milling, lathe works, metal fabrication, machining and surface treatments for parts. The fabrication of the arm itself, in order to minimize the weight and achieve the desired anthropomorphic forms, is held by implementing new manufacturing technologies. Finally, it was manufacturing with EBM (Electron Beam Melting) which allowed us to get any complex geometry and simplify some assemblies in a single piece. EBM manufactured parts were then treated by different processes to achieve their desired appearance (see Fig. 4). Once the different pieces of the manipulator were manufactured, the assembly of the various mechanical subassemblies machining operations (see Fig. 5).

V. FINAL INTEGRATION AND OPERATIONAL TEST
Finally, manipulator prototypes were integrated and tested using a ROV (see Fig. 6) to test the Titanrob arms under real operational conditions. As the results of this test, Titanrob arms designs were validated to their operation during sea trials were performed with excellent results.

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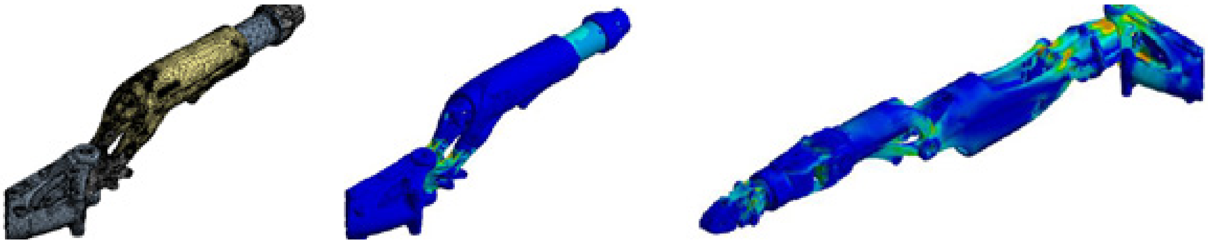

Fig 3. Mechanical validation FEM simulation

Fig 4. Manufacturing phase: parts manufacturing using EBM process

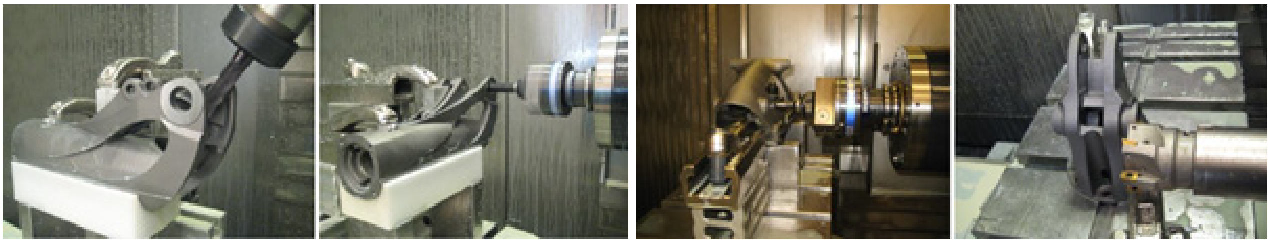

Fig 5. Manufacturing phase: post-machining phase

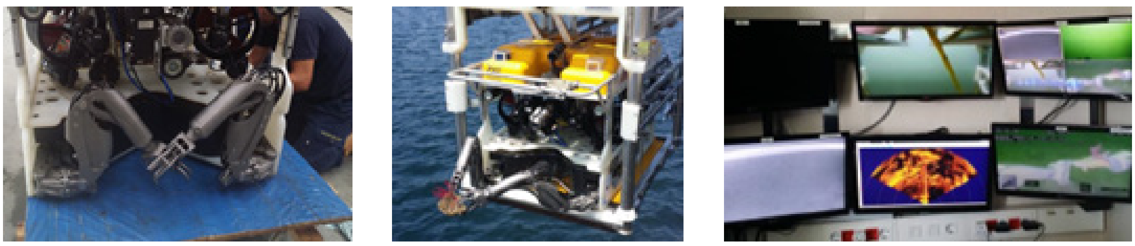

Fig 6. Integration and final operational tests

ID42 - A SURVEY ON AUTOMATIC HABITAT MAPPING

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Abstract
Habitat mapping can help assess the health of an ecosystem but the task is not always straightforward as, depending on the environment to be mapped, data types can be very different, such as marine and land habitats where in one case you can use sonar images and in the other satellite pictures. In this survey we explore works that used machine learning models when performing habitat mapping.

Keywords – Machine Learning, Habitat Mapping, European Nature Information System.

I. INTRODUCTION

Habitats and biological communities all over the world are being exposed to high risks of extinction because of climate changes, contamination, intrusive species or over-abuse [1]. Habitat mapping can, this way, give a superior comprehension of the outcomes of human activities and decisions to help overseeing biological communities with the end goal of safeguarding them [2].

Mapping habitats in big areas can be a time-consuming task as areas can span very wide throughout land or marine areas. The mapping should be done in accordance with a biological or geographical criterion, such as the European Nature Information System (EUNIS), to provide habitat information of the local area.

Marine habitats struggle with the fact that light does not travel through deep seabed floors. In that case, sonar images have better quality than optic images although they are difficult to analyse by humans. Location accuracy is also a concern when retrieving data from underwater environments.

In the following sections we describe habitat mapping applications using ML models.

II. MACHINE LEARNING MODELS FOR HABITAT MAPPING

Machine Learning (ML) is currently used for decisions simulation, image surveillance, forecast and diagnosis predictions, marketing and sales, manufacturing processes and so on [3]. All these applications have tremendous amount of data to analyse allowing for ML models to be a good option to automatize problem solving.

ML models such as Decision Trees (DTs), Support Vector Machines (SVMs), Random Forest (RF), Maximum Likelihood Classifiers (MLCs), Artificial Neural Networks (ANNs) or Convolutional Neural Networks (CNNs) have been used throughout the years to solve decision making problems.

Numerous works (see Table 1) pursued this objective by trying different ML models to perform habitat mapping, such as Kobler et al. [4] who used a DT model to classify forest habitats with EUNIS by using IKONOS satellite images. Ierodiaconou et al. [5] and Hasan et al. [6] used multibeam data to perform marine habitat using DT, SVM, RF and MLC. Petropoulos et al. [7] used Hyperion hyperspectral data to perform land habitat mapping and comparing the classifications of an SVM and an ANN. Mascaro et al. [8] and Diesing et al. [9] both use a RF model although for different habitat and data types whereas the first perform forest mapping with aerial images and the latter used multibeam data to perform marine habitat mapping. For last, the works of Berthold et al. [10], Gómez-Ríos et al. [11] and Diegues et al. [12] use a CNN model to perform marine habitat mapping. Berthold et al. [10] classified seabed sediment by retrieving sidescan sonar imagery. Gómez-Ríos et al. [11] performs coral classification. Diegues et al. [12] predicted EUNIS habitat types by using a pre-trained CNN and fine-tuning the model using data augmentation.

III. CONCLUSIONS

In this survey we tackled the problem that habitat mapping solves and described some challenges that the task may present. We also presented works that mapped either land, forest and marine habitats by using different data types, such as sonar, satellite or camera images and used different ML models.

Mapping big areas can be challenging but using an automatic approach with a ML model can help with the task. The approaches presented benefit from ML models since the 2000s where DTs were used. SVMs, RF or the most recent Deep Learning (DL) approaches (ANNs and CNNs) are still being used to solve this application with CNN models starting to become a tendency as it is a trending topic in image classification.

ACKNOWLEDGEMENT

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Author	Year	Habitat Type	Data Type	ML Model
Kobler et al. [4]	2006	Forest	Satellite	DT
Ierodiaconou et al. [5]	2007	Marine	Multibeam	DT
Hasan et al. [6]	2012	Marine	Multibeam	DT, SVM, RF and MLC
Petropoulos et al. [7]	2012	Land	Hyperion Hyperspectral	SVM and ANN
Mascaro et al. [8]	2014	Forest	Aerial	RF
Diesing et al. [9]	2014	Marine	Multibeam	RF
Berthold et al. [10]	2017	Marine	Sidescan Sonar	CNN
Gómez-Ríos et al. [11]	2018	Marine	Camera footage	CNN
Diegues et al. [12]	2018	Marine	Camera footage	CNN

Table 1. Examples of related work of habitat mapping using machine learning.

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ID43 - TOOLS FOR DEEP-SEA NAVIGATION

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Abstract

The SIDENAV and DEEPFLOAT innitiatives aims to develop a demonstrator that validates and apply technology that enables golds between the exploitation of mineral resources in deep-sea waters under Portuguese jurisdiction (for example the Mid-Atlantic Ridge).

The Portuguese Sea is characterized by a high depth, and many natural resources are at depths greater. This makes it difficult or even hinders its exploitation through either autonomous or even through tele-operated systems use. Sustainable industrial exploitation of these marine resources require the ability to have deep sea to surface transport systems with high accuracy navigation capabilities at sustainable costs.

Underwater operations are carried out by dedicated systems and for the most part with the use of ROVs (remotely operated vehicles) and AUV's (autonomous underwater vehicles) operated from a ship or a land base station. These systems are used in a wide variety of tasks, such as, installation of equipment and maintenance in the offshore industry O&G (Oil and Gas), in the inspection of pipelines, underwater data lines, underwater observatories, power generation systems, underwater mining, as well as, the collection of information for a wide range of activities with great economic value.

The movement in the water column, descent and ascent, are typically performed by buoyancy control or by conventional underwater thrusters (electric motors with propellers) using the localized movements/behaviours (such as hovering and faster manoeuvres) when necessary. The payload capacity requirements and task performance without the need for outside intervention, low power consumption and the high depth are very demanding. Based on the problem presented in the preceding paragraphs, the primary goal of the project is to develop hybrid variable ballast systems. In order to extend the range of possible operations to be held in high external pressure environments, reducing energy consumption by maximizing payload capacity and fine control in confined environments such as mining in mines with high groundwater levels (typically submerged operation). This type of system can be used in various types of underwater vehicles (AUV's, Landers or ROV's) or for the transport of materials or tools in the open sea or other freshwater environments. The proposed concept in this project consists of a flexible variable ballast system for deep underwater applications with advanced control capabilities. This system consists of a component that allows varying the buoyancy of a wide range of vehicles and systems for operation in the ocean environment, at different depths up to 1000m. Allows variation of buoyancy, for vehicles buoyancy trimming systems, or to change of direction of the vehicle with changes in buoyancy, and, more significantly to perform the ascend/descent motion control in the water column in an efficiently manner.

Figure 1 – TURTLE Hybrid Lander

ID44 - THE ROLE OF NETWORKED ROBOTIC SYSTEMS TO SURVEY COASTAL PHENOMENA: THE DOURO RIVER PLUME CASE STUDY

RENATO MENDES[29], JOÃO BORGES DE SOUSA[99], JOSÉ C.B. DA SILVA[49], JOÃO MIGUEL DIAS[29]

Propagation of river plumes along the coast strongly depends on several physical processes, which determine the plume fate over the shelf. The Douro is one of the largest rivers of the Iberian Peninsula, representing the most important freshwater input into the Atlantic Ocean on the northwestern Portuguese coast. Traditional methods of in situ measurements are often complicated and expensive due to the high spatial and temporal variability of its dominant drivers. By now, the general dispersion patterns of the Douro River Plume was mostly studied by numerical models and remote sensing imagery, considering the main drivers involved: river discharge, wind, and tide. From those results, the Douro River plume is classified as large-scale and surface-advected, presenting characteristics of a prototypical plume. The wind was found to play an essential role in the plume dispersion and fate. For example, southerly winds increase the velocity of the northward current, frequently merging the Douro plume with the northerly generated Minho plume. Both riverine water masses can propagate to the Rias Baixas (Spain), dramatically changing their normal circulation. By these reasons, the development of accurate and reliable plume monitoring systems is an important and challenging task.

This work reports the recent use of robotic systems (AUVs and UAVs) to detect, track and survey the Douro Plume front autonomously. These systems can survey this highly dynamic environment and characterize the frontal regions of the plume regarding salinity, water temperature, turbidity, and chlorophyll concentrations under summer conditions when the plume area is small and mainly tidally driven. Results from several frontal crossings, coincident with satellite imagery acquisitions (some of which were obtained in near real-time by the new Sentinel-2 mission), demonstrated the AUVs capability to fairly detect the front structure. Cross-frontal exchanges observed in the water column by AUVs along the front emphasize the importance of new technologies use on the monitoring and detection of high spatial and temporal dynamical phenomena such as river plumes.

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