MCEDD

DEEPWATER DEVELOPMENT

28 - 30 March 2023 | Millennium Gloucester Hotel | London, UK

ORGANIZED BY

GULF QUEST

Quest Offshore

World Oil®

Uncrewed Surface Vehicles (USV) Network Initiative in support to EOOS

marum

C.Waldmann

U.PORTO
FEUP FACULDADE DE ENGENHARIA UNIVERSIDADE DO PORTO

J. Tasso-Sousa

National Oceanography Centre
NATURAL ENVIRONMENT RESEARCH COUNCIL

J. Burris

PLOCAN
Plataforma Oceánica de Canarias

C. Barrera

NOAA

A. Chiodi

SCRIPPS INSTITUTION OF OCEANOGRAPHY
UC San Diego

L. Grare

EuroSea

oceanology international 2022
15-17 MARCH 2022
LONDON, EXCEL

29 companies exhibiting USV tech!!!

- Floats
- Moorings
- UW-gliders
- Research Vessels
- Sea-Level Gauges
- HF Radar
- FerryBox
- Animal-borne Instruments

FerryBox
EuroGOOS Task Team

Glider
EuroGOOS Task Team

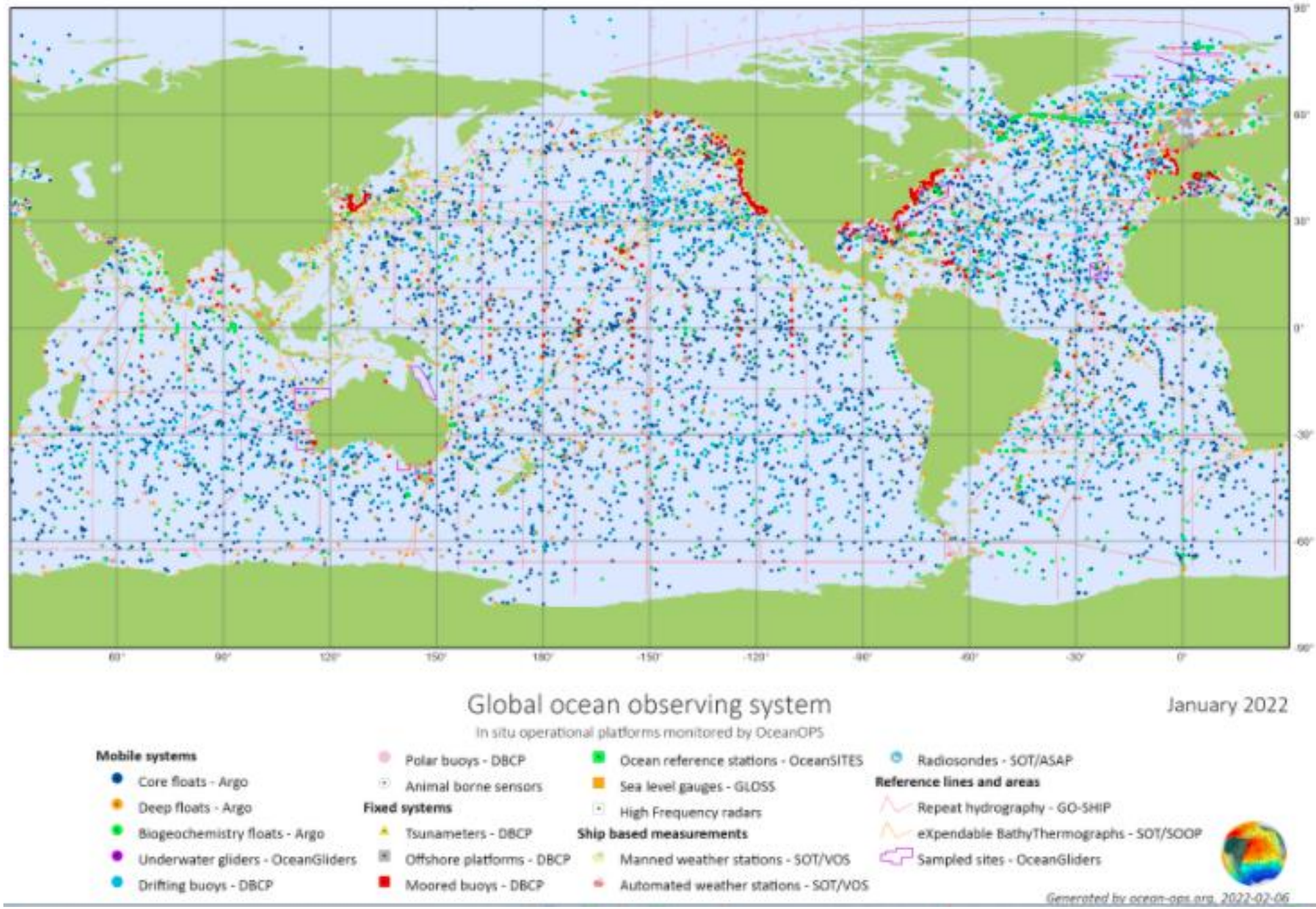
HFRadar
EuroGOOS Task Team

emso ERIC

OceanSITES
Taking the pulse of the global ocean

OCEAN TRACKING NETWORK

GLOSS



EMODnet
European Marine Observation and Data Network

SeaDataNet

OceanOPS

EOOS
European Ocean Observing System

- Floats
- Moorings
- UW-gliders
- Research Vessels
- Sea-Level Gauges
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GLOSS

- Floats
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- **Uncrewed Surface Vehicles -USV**

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OCEAN TRACKING NETWORK

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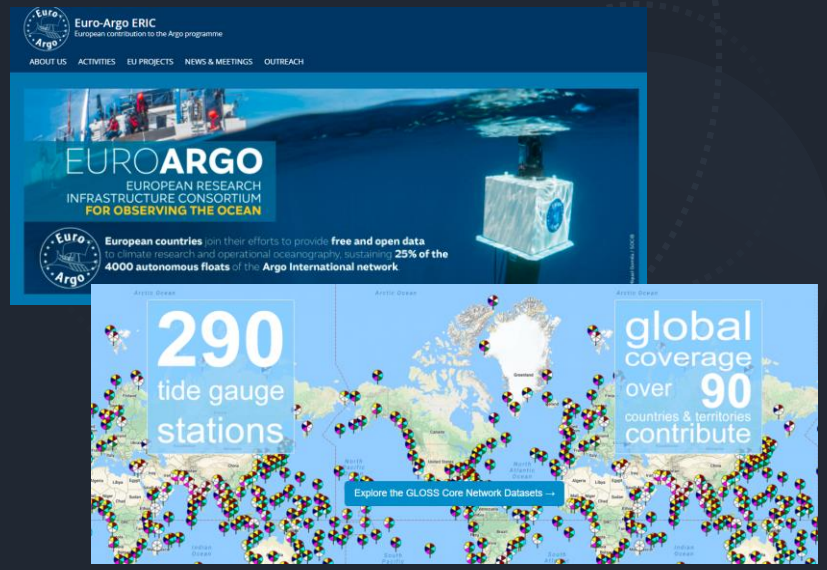
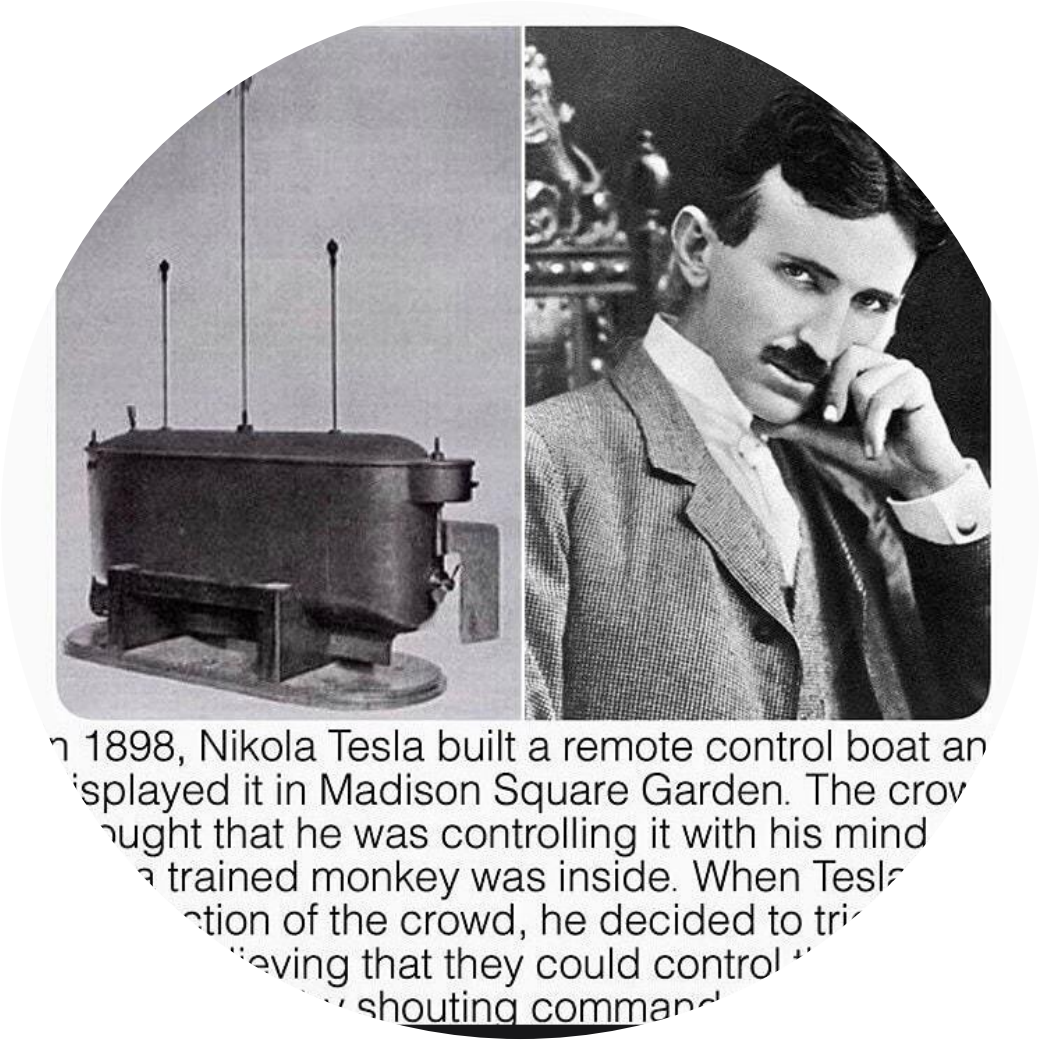


What exactly is an Uncrewed Surface Vehicle?

USV-tech SoA in brief…



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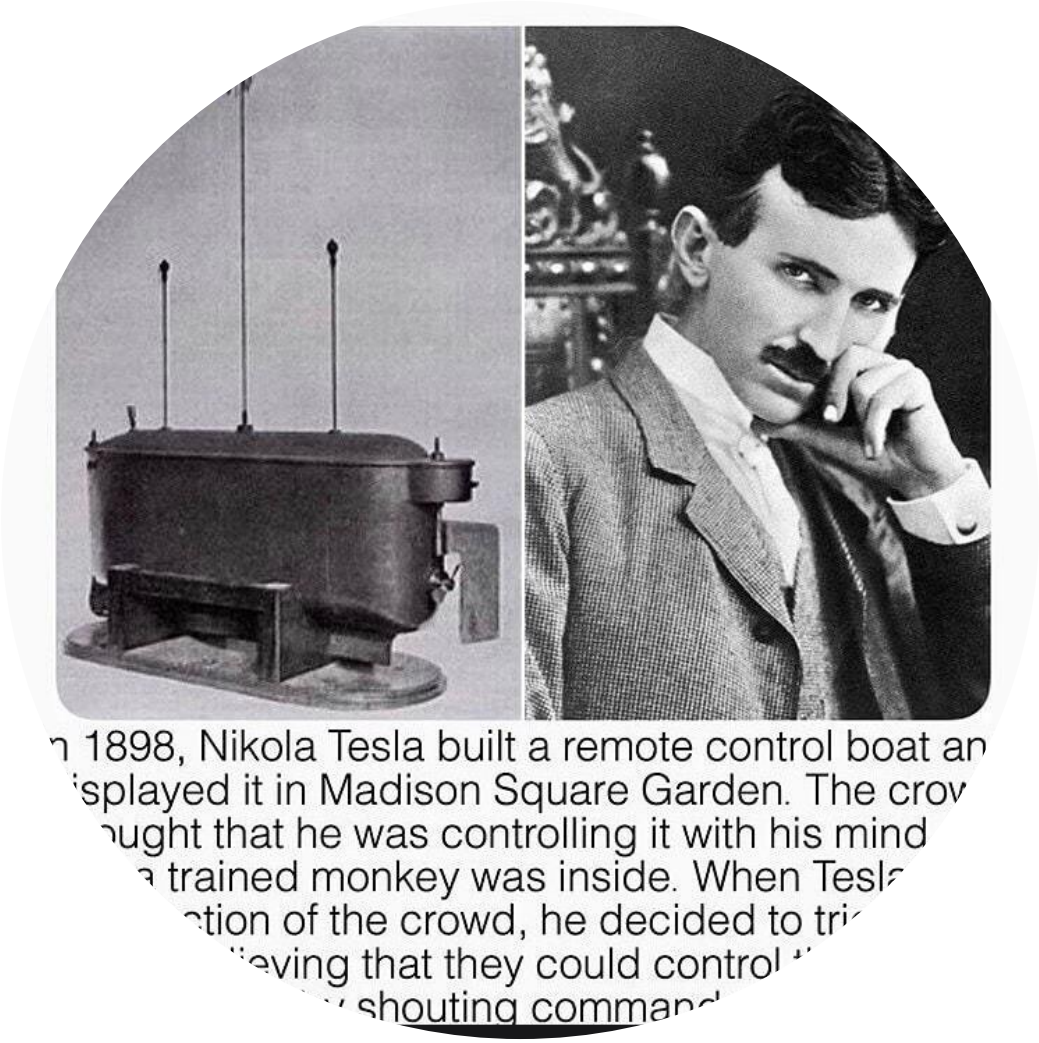
USV-tech SoA in brief…



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…

2021

Country	Year	USV Name	Research Purpose & Major Achievements
USA	1993	ARTEMIS (Vaneck et al., 1996)	1) Systems test; 2) Bathymetry sampling
	1996	ACES (Manley, 1997)	1) Oceanographic data collection
	1998	SCOUT (Goudey et al., 1998)	1) Cooperative control; 2) Testbed
	1990*s*	Roboski (Bremer et al., 2007)	1) Surveillance; 2) Target drones
	1990*s*	Owls USVs (Motwani, 2012)	1) Harbor and ship security
	2000	AutoCat (Manley et al., 2000)	1) Survey of shipwreck
	2001	Spartan Scout (Motwani, 2012)	1) Port surveillance; 2) Force protection
	2003	USSV-HTF (Motwani, 2012)	1) Towing various sensors and effectors
	2005	WASP (Mahacek, 2005)	1) Stability test; 2) Bathymetric mapping
	2005	Seadoo Challenger 2000 (Ebken et al., 2005)	1) Collision avoidance; 2) Autonomous recovery
	2005	HUSCy (Curcio et al., 2005)	1) Hydrographic survey
	2008	Wave Glider (Bingham et al., 2012)	1) Data collection
	2008	Nereus (Beck et al., 2009)	1) Stability test; 2) Bathymetric mapping
	2009	SeaWASP (Furfaro et al., 2009)	1) Environmental monitoring; 2) Testbed
	2010	Piranha (Yang et al., 2011)	1) Reconnaissance
	2011	MUSCL (Bertram, 2008)	1) Surveillance and reconnaissance
UK	1990*s*	MIMIR (Roberts & Sutton, 2006)	1) Shallow water search and survey
	2000*s*	C-series USVs (Anonymous, 2014a)	1) Assets security; 2) Environmental monitoring; 3) Mining
	2000*s*	FENRIR (Roberts & Sutton, 2006)	1) Relay between UUV and control center
	2000*s*	Sentry (Murray, 2008)	1) Harbor and shore survey and protection
	2003	SWIMS (Roberts & Sutton, 2006)	1) Mine sweeping
	2003	SeaFox (Yakimenko & Kragelund, 2011)	1) Maritime security operations
	2004	Springer (Naeem et al., 2008b)	1) Environment monitoring; 2) Test platform
	2008	Blackfish (Sonnenburg, 2012)	1) Harbor protection and patrol
Canada	1983	DOLPHIN (Curcio et al., 2005)	1) Bathymetric mapping
	2000*s*	Barracuda (Bertram, 2008)	1) As sea-surface target system
	2000*s*	Hammerhead (Bertram, 2008)	1) Simulating a multi-vehicle swarm threat
Italy	2004	SESAMO (Caccia et al., 2005)	1) Environmental sampling
	2005	Charlie (Caccia et al., 2007)	1) Environmental sampling and survey
	2007	ALANIS (Bibuli et al., 2012)	1) Environmental sampling and survey
	2008	U-Ranger (Motwani, 2012)	1) Mine sweeping; 2) Harbor protection
Portugal	2000	CARAVELA (Pascoal et al., 2006)	1) Oceanographic sampling; 2) Testbed
	2004	DELFIM (Alves et al., 2006) and DELFIMX (Gomes et al., 2006)	1) Oceanographic sampling; 2) Communication with UUVs
	2006	ROAZ I & II (Martins et al., 2007a)	1) Search and rescue
	2006	Swordfish (Ferreira et al., 2007)	1) Environmental survey
Norway	2008	Kaasbøll (Breivik et al., 2008)	1) Navigation and control systems test
	2008	Viknes (Breivik, 2010)	1) Multi-purpose system tests
	2000*s*	Mariner (Breivik, 2010)	1) Environmental surveillance and sampling
Israel	2003	Protector (Breivik et al., 2008)	1) Reconnaissance; 2) Counter-mine
	2005	Seastar (Yang et al., 2011)	1) Port, coastal survey; 2) Reconnaissance
	2005	Stingray (Bertram, 2008)	1) Homeland security and coastguard
	2007	Silver Marlin (Bertram, 2008)	1) Surveillance and reconnaissance
Germany	1998	MESSIN (Majohr & Buch, 2006)	1) Water ecological study
France	2005	Basil (Bertram, 2008)	1) Offshore pipelines survey
	2005	MiniVAMP (Bertram, 2008)	1) Remote survey of offshore pipelines
	2007	Inspector (Yang et al., 2011)	1) Surveillance and reconnaissance
Sweden	2002	Piraya (Yang et al., 2011)	1) Cooperative control
Singapore	2010	Venus (Bertram, 2008)	1) Multi-tasks test
China	2008	Tianxiang One (Yan et al., 2010)	1) Meteorological survey
	2010	USV-ZhengHe (Yang et al., 2011)	1) Inshore marine data collection
Japan	2000	Kan-Chan (Desa et al., 2007)	1) Study of global warming
	2004	UMV series (Bertram, 2008)	1) Ocean and atmosphere exploration
India	2006	ROSS (Desa et al., 2007)	1) Oceanographic sampling

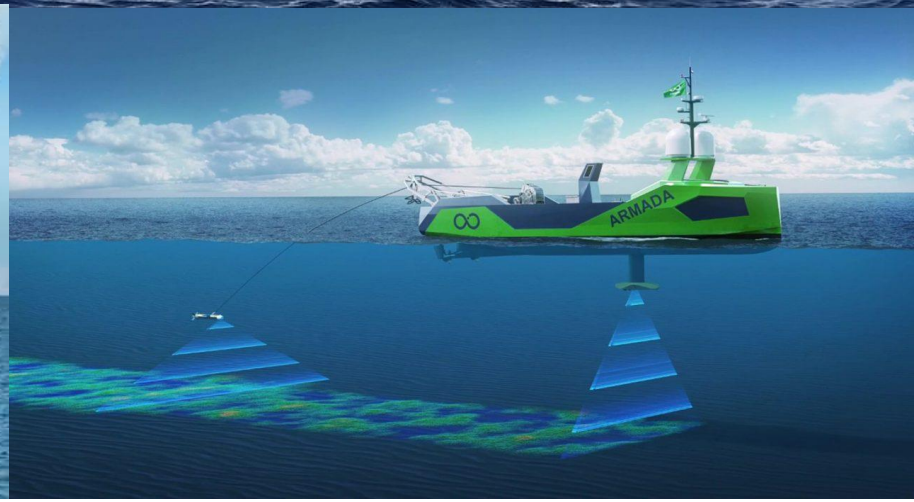
Liu et al. 2016








- Propulsion mainly based on electrical thrusters.
- Short-médium range endurance (hours/days) for missions near shore areas.



… USV development concept quite close to autonomous ships?

- Is USV technology paving the way somehow for Autonomous Maritime Navigation strategy?

- Should USV and Autonomous Ships development strategies work under a closer and synergetic manner in some fields in order to strength and promote MASS?

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25 May 2021

Autonomous ships: regulatory scoping exercise completed

E

IMO INTERNATIONAL MARITIME ORGANIZATION

4 ALBERT EMBANKMENT
LONDON SE1 7SR
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MSC.1/Circ.1638
3 June 2021

OUTCOME OF THE REGULATORY SCOPING EXERCISE FOR THE USE OF MARITIME AUTONOMOUS SURFACE SHIPS (MASS)

1 The Maritime Safety Committee, at its 103rd session (5 to 14 May 2021), approved the Outcome of the regulatory Scoping Exercise for the use of Maritime Autonomous Surface Ships (MASS), as set out in the annex, which provides the assessment of the degree to which the existing regulatory framework under purview of the Maritime Safety Committee (MSC) might be affected in order to address MASS operations. It further provides guidance to the MSC and interested parties to identify, select and decide on future work on MASS and, as such, facilitate the preparation of requests for, and consideration and approval of, new outputs.

2 Member States and international organizations are invited to take the annex into account when proposing future work on MASS for consideration by the MSC and bring it to the attention of shipowners, operators, academia and all other parties concerned.

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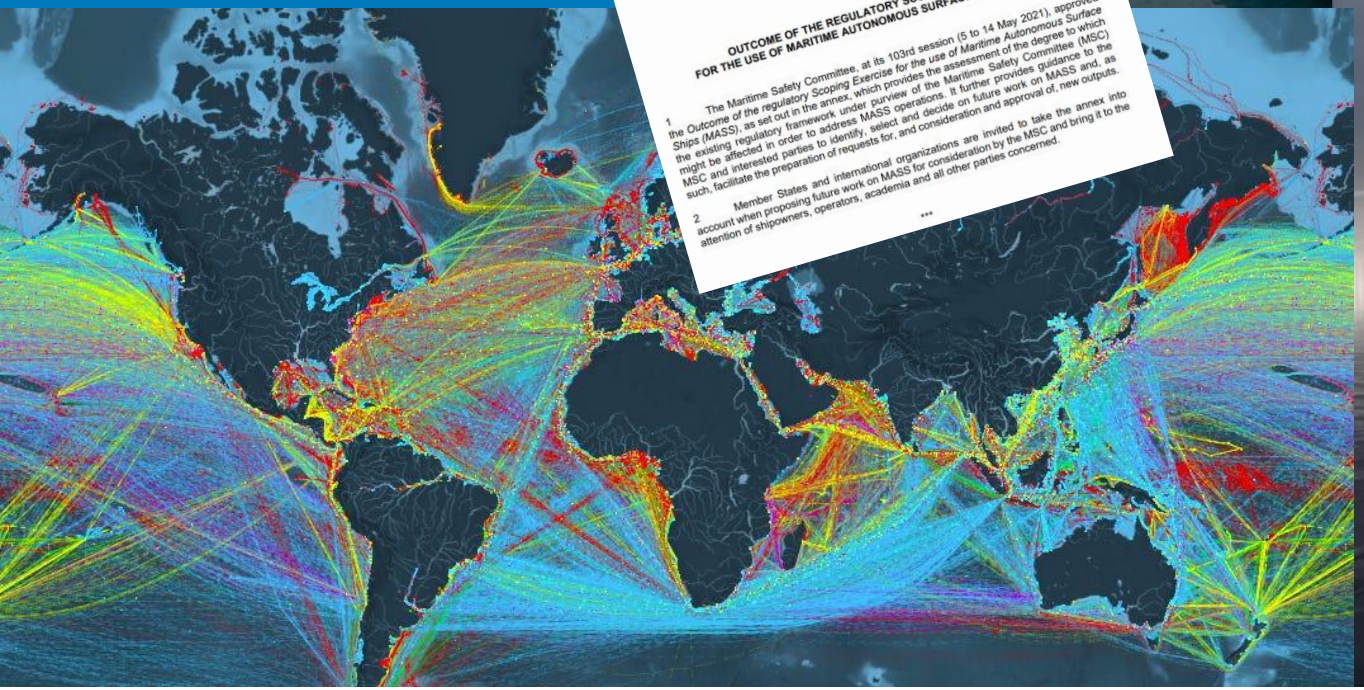
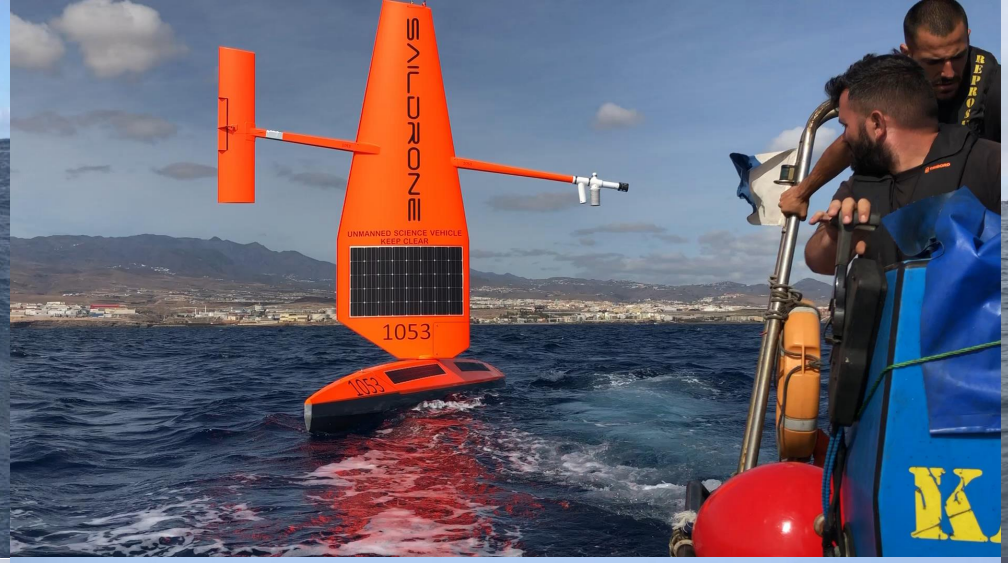


DIMECC One Sea

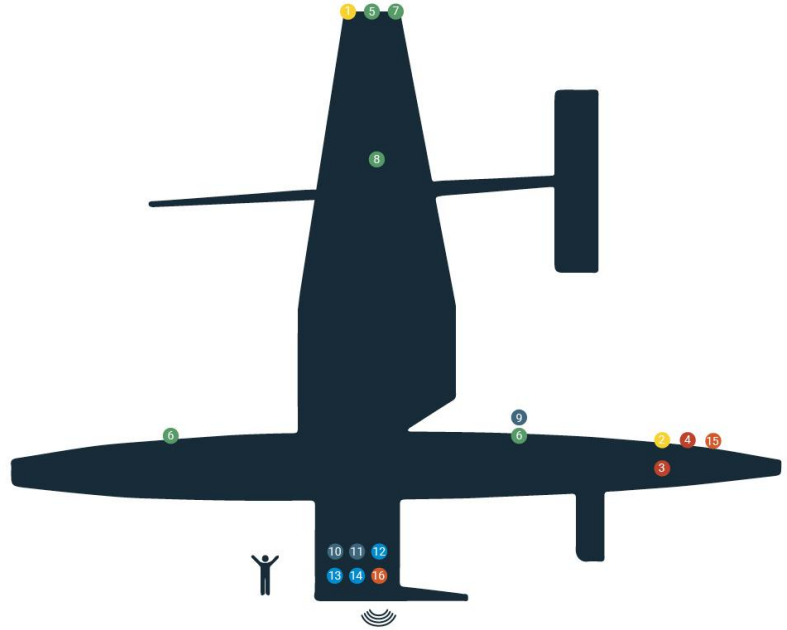
Timeline for autonomous ships

2017	2020	2023	2025
Remote monitoring	**Fully remote controlled vessel (manned) – unmanned with special approval**	**Gradual increase of autonomous control**	**Autonomous ship traffic commercial**
Test areas	National pilots	Several pilots globally	Full scale testing / validation
		Domestic authority approval / certificate	Class/IMO reg. in place
International collaboration	Design requirements for autonomous power and propulsion systems	Satellite becomes cheaper	Strongly decreased data communication
	Autonomous automobile commercial	Developed data transfer tech eg. 5G (limited to ferries/ports)	Mobility as a service
		"Industry standards in place"	Infrastructure
Ethical issues			
Development of cyber security			
Projects, IPR, competences, education			
National, IMO and global legislation development			

- Propulsion based on **ocean-energy sources (**waves, wind and sunlight). Highly capables to increase **persistent-presence** in the ocean in a more sustainable and efficient **routine-mode operation**.
- Long-range (weeks/months) missions in both coastal and open-ocean areas.

Why USV are key for Ocean-Observing?



ATMOSPHERIC MEASUREMENTS

1	WIND SPEED & DIRECTION	B&G anemometer
2	ATMOSPHERIC PRESSURE	Yacht Devices barometer

OCEAN MEASUREMENTS

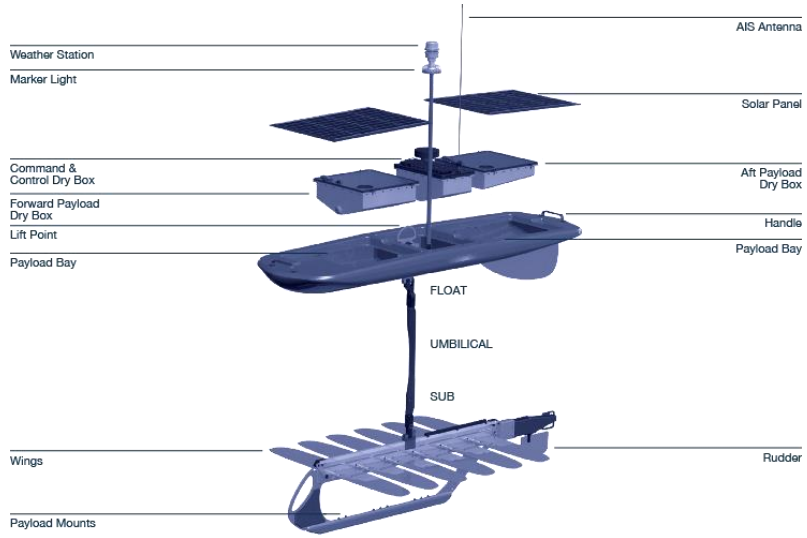
3	WAVE HEIGHT & PERIOD	VectorNav VN300 Dual GPS aided IMU
4	WATER SAMPLE COLLECTION	MBARI eDNA environmental sample processor

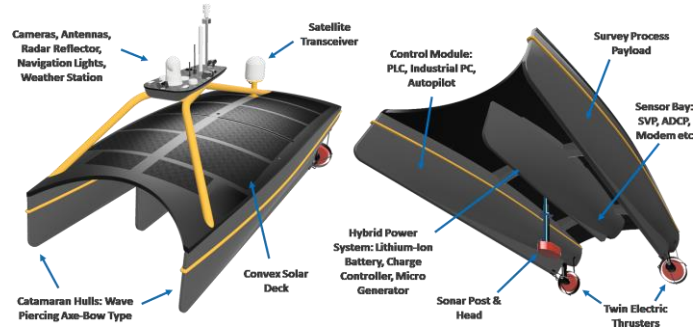
MARITIME DOMAIN AWARENESS

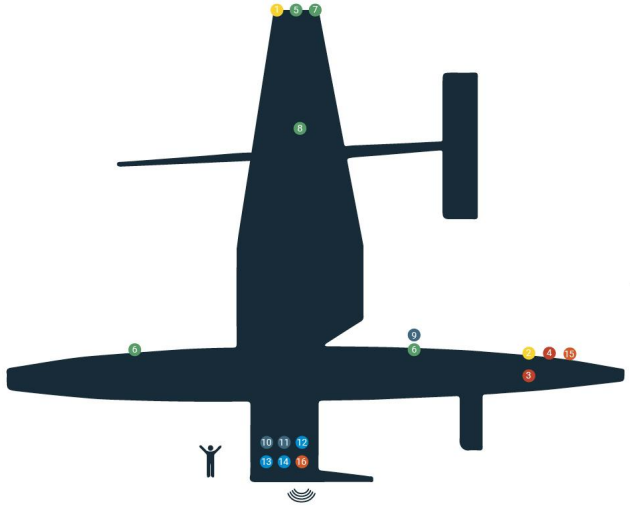
5	RADAR	Furuno Radar
6	SMART CAMERA ARRAY	360° High-resolution optical cameras with AI/ML target detection
7	SMART CAMERA ARRAY	2 x 220° High-resolution optical cameras with AI/ML target detection
8	AIS TRANSCEIVER	Class A AIS transceiver

ACOUSTIC MEASUREMENTS

9	BATHYMETRY	Seapath 380+ GNSS/INS system
10	BATHYMETRY	Kongsberg EM304 multibeam sonar
11	BATHYMETRY	Kongsberg EM2040 multibeam sonar
12	OCEAN CURRENTS	Simrad EC150 ADCP
13	OCEAN CURRENTS	Teledyne Pinnacle 45 ADCP
14	FISH BIOMASS	Simrad EK80 echo sounder
15	SOUND VELOCITY PROFILER	Valeport sound velocity probe (cast depth: 500 m)
16	SURFACE SOUND VELOCITY PROBE	Teledyne SVP-70 (fixed)







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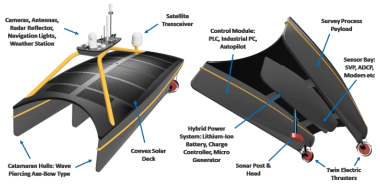
12 OCEAN CURRENTS — Simrad EC150 ADCP

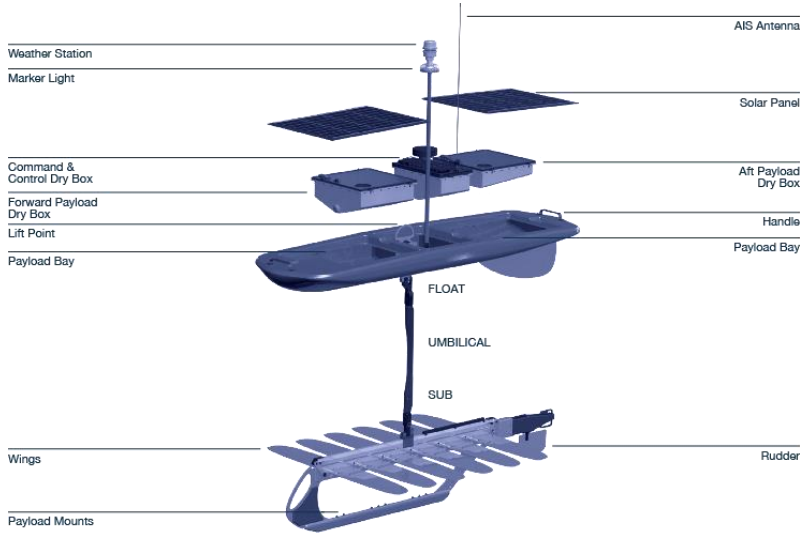
13 OCEAN CURRENTS — Teledyne Pinnacle 45 ADCP

14 FISH BIOMASS — Simrad EK80 echo sounder

15 SOUND VELOCITY PROFILER — Valeport sound velocity probe (cast depth: 500 m)

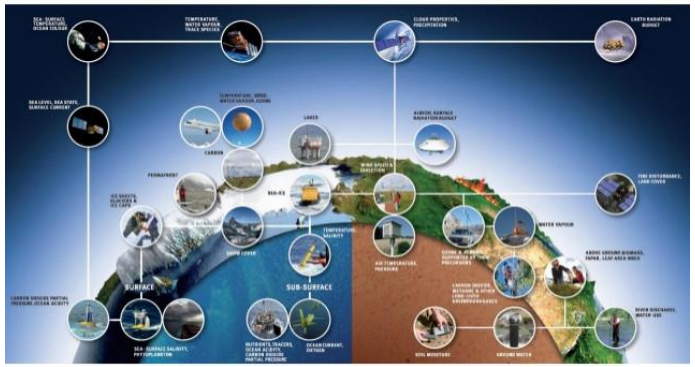
16 SURFACE SOUND VELOCITY PROBE — Teledyne SVP-70 (fixed)





WORLD METEOROLOGICAL ORGANIZATION

GCOS Essential Climate Variables

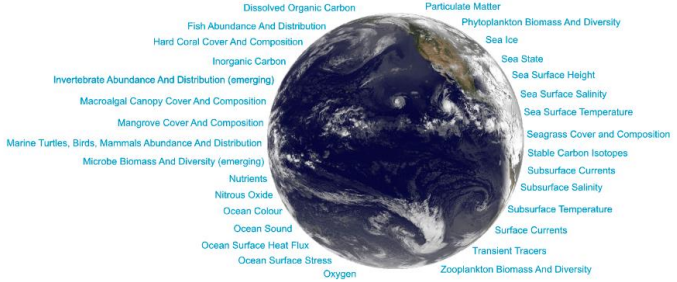


GCOS

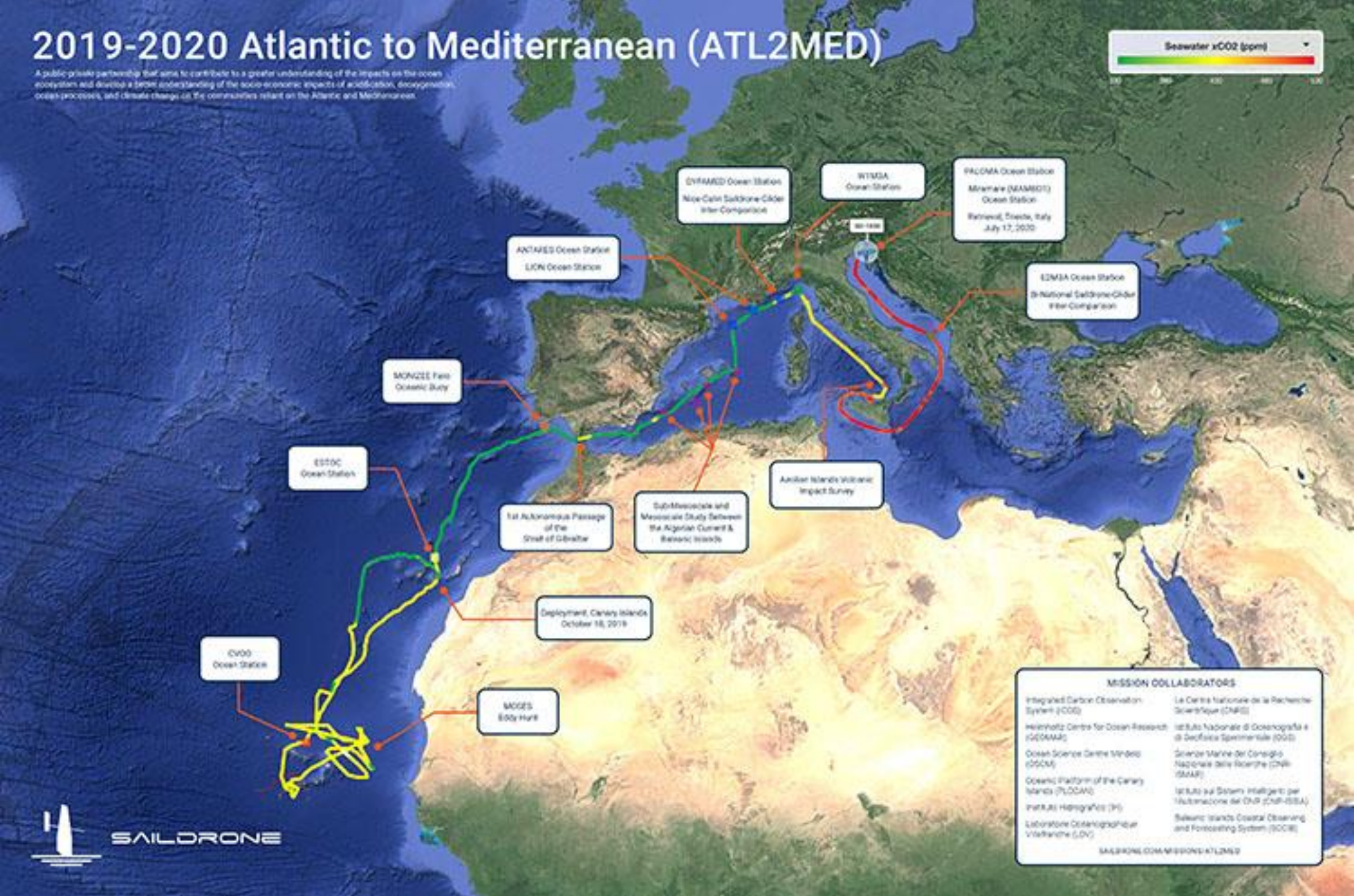
IOC UNEP ICSU

The Global Ocean Observing System

GOOS




SAILDRONE
UNMANNED SCIENCE VEHICLE
KEEP CLEAR
1053
1053



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SAILDRONE

EuroGOOS
European Global Ocean Observing System

ICOS
INTEGRATED CARBON OBSERVATION SYSTEM

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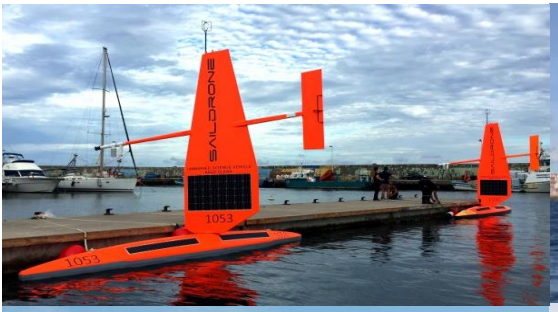
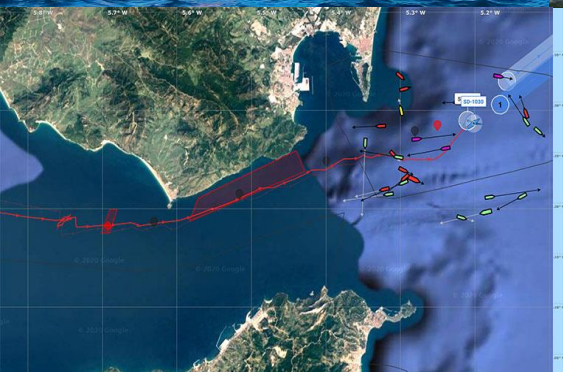
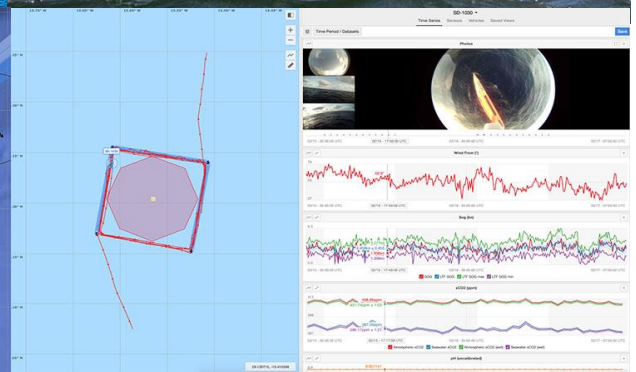
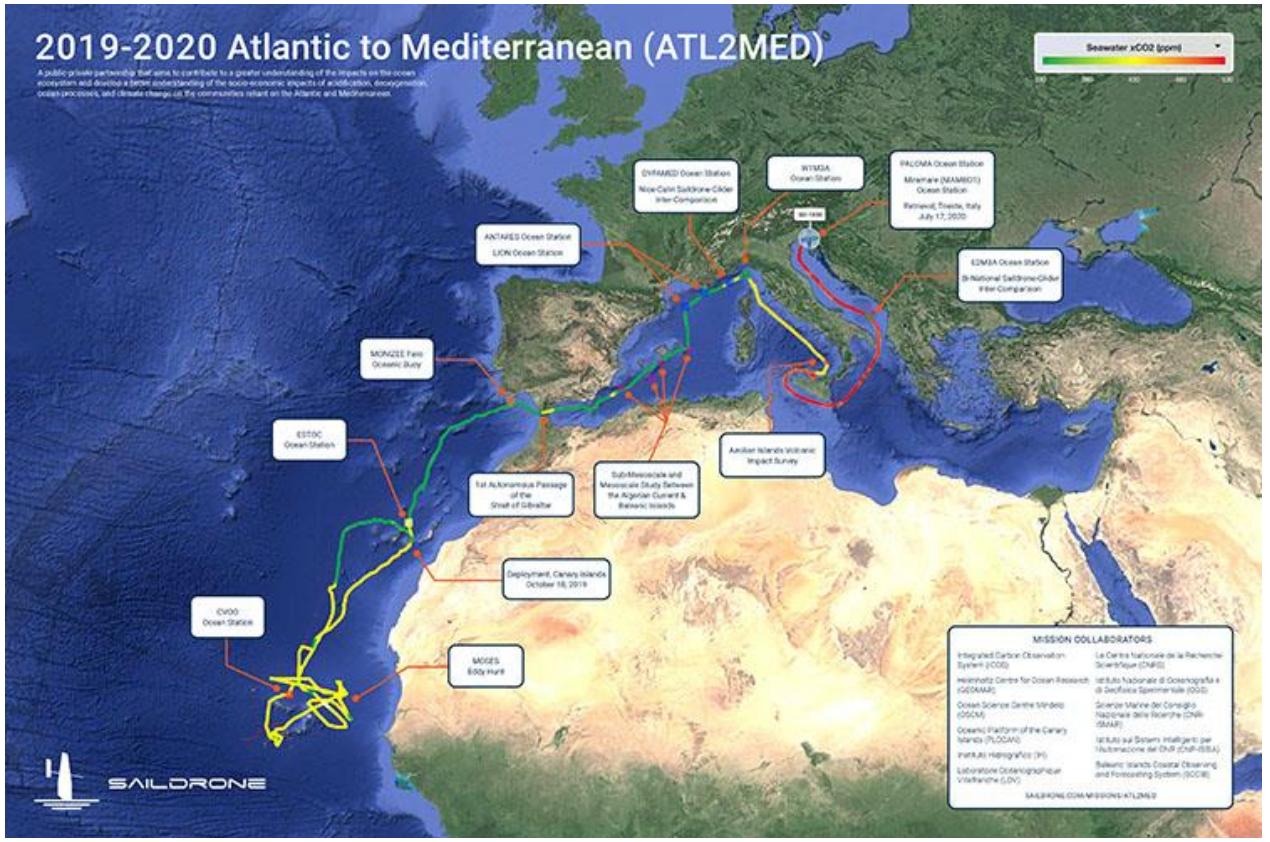








EuroSea · SAILDRONE · EuroGOOS European Global Ocean Observing System · ICOS Integrated Carbon Observation System · emso ERIC

2019-2020 ATL2MED Mission Stats

Mission duration	274 days (October 18, 2019 to July 17, 2020)
Distance sailed	15,015 nautical miles (27,810 kilometers or 17,280 miles) – both vehicles combined
Average vehicle speed	2–3 knots (average human walking pace)
Ocean stations visited	9
Data collected	Carbon, (pCO_2), acidity, current velocity & direction, wind speed & direction, relative humidity, barometric pressure, air & sea temperature, salinity, dissolved oxygen, chlorophyll, wave height & period, acoustic backscatter

- Technology level (TRL) already well developed and mature.
- Huge Tech&Operational capabilities /uses.
- Wide range of applications/services for key marine and maritime sectors on ocean observing, survey, intervention, etc. already underway.
- Clear lack at NETWORK level

Technical
Operations / Missions
Data/Metadata
Legal framework
Best Practices / Standards
…

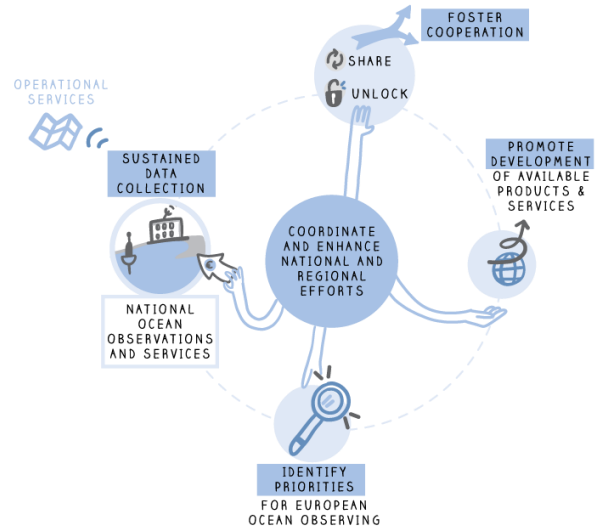

EuroGOOS
European Global Ocean Observing System
EuroGOOS Strategy 2030


EOOS
European Ocean Observing System
Towards an end-to-end, integrated and sustained ocean observing system for Europe
Consultation Document


EOOS
European Ocean Observing System
ALIGNING, INTEGRATING AND PROMOTING EUROPE'S OCEAN OBSERVING CAPACITY


EOOS
European Ocean Observing System
EOOS Strategy 2018-2022
OCTOBER 2010


HOW CAN WE ACHIEVE SUSTAINABLE OCEAN OBSERVING IN EUROPE?
A shared framework for a shared understanding
Communicate the value of ocean observing
Observations mapped out
EOOS
Share technology
Fit for purpose
Efficient use of resources
Share data
SHARED VISION & STRATEGY
FOR THE EUROPEAN OCEAN OBSERVING SYSTEM (EOOS)
CO-CREATION TO MEET USER NEEDS
EUROPEAN FRAMEWORK
Perfect place to COMMUNICATE NEEDS
Share KNOWLEDGE, EXPERTISE and scan horizon
WE ARE STRONGER TOGETHER
Engage in building EOOS
Contact us:
info@eoos-ocean.eu


FOSTER COOPERATION
SHARE
UNLOCK
OPERATIONAL SERVICES
SUSTAINED DATA COLLECTION
PROMOTE DEVELOPMENT OF AVAILABLE PRODUCTS & SERVICES
COORDINATE AND ENHANCE NATIONAL AND REGIONAL EFFORTS
NATIONAL OCEAN OBSERVATIONS AND SERVICES
IDENTIFY PRIORITIES
FOR EUROPEAN OCEAN OBSERVING

EuroSea

Improving and integrating the European Ocean Observing and Forecasting System

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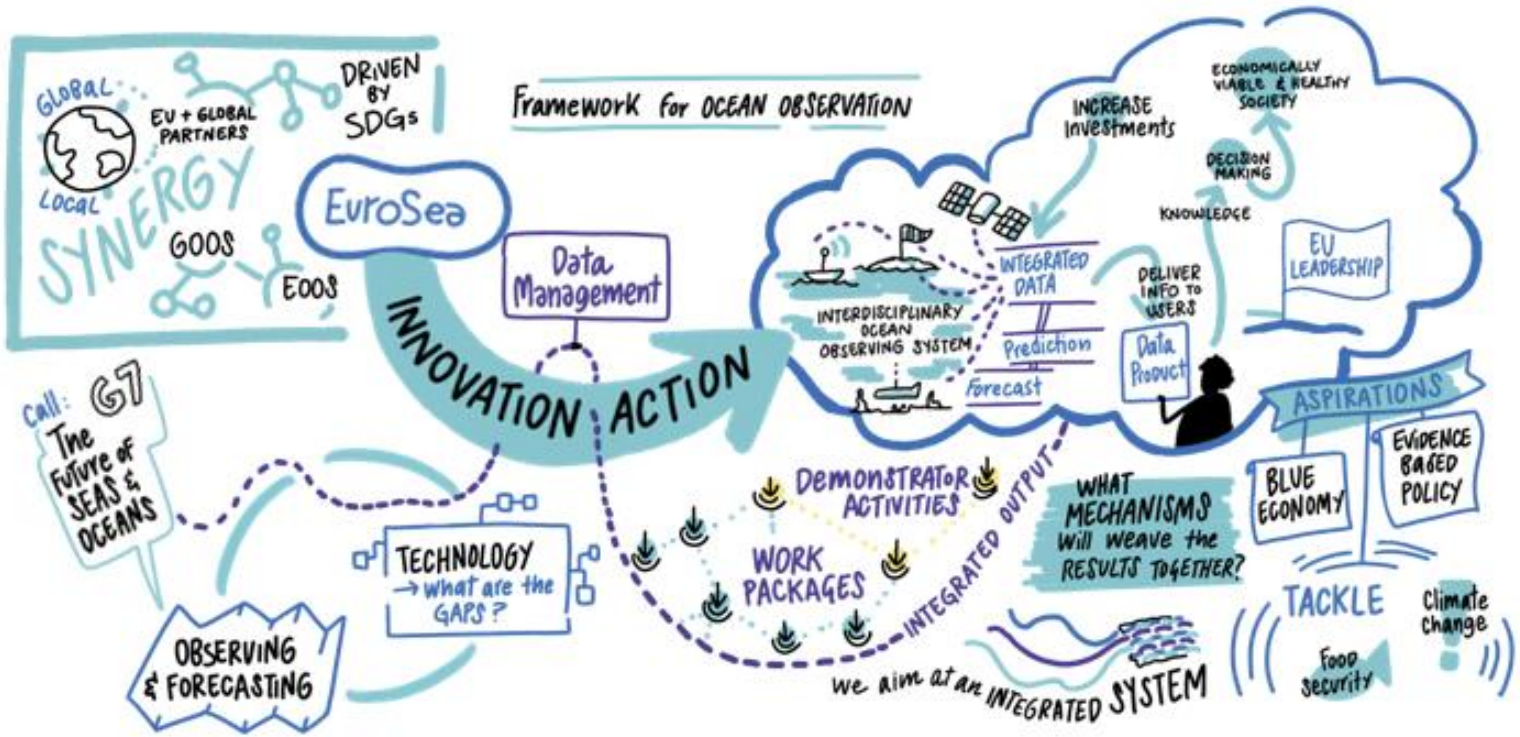
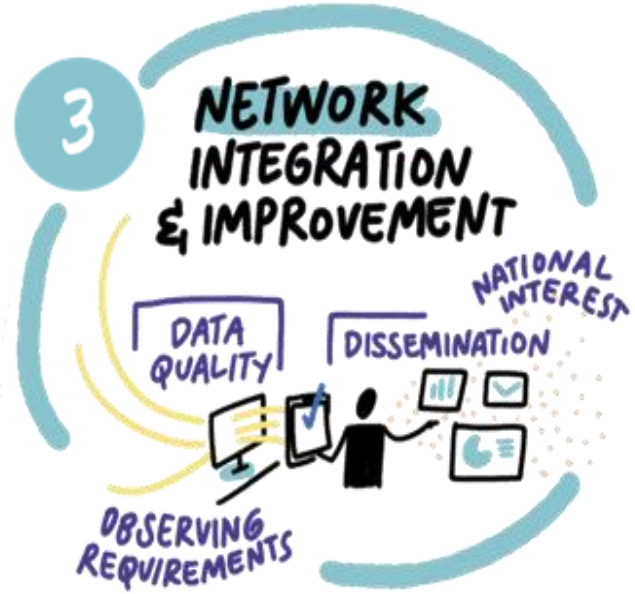
This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 862626

https://eurosea.eu/

GEOMAR
Helmholtz Centre for Ocean Research Kiel



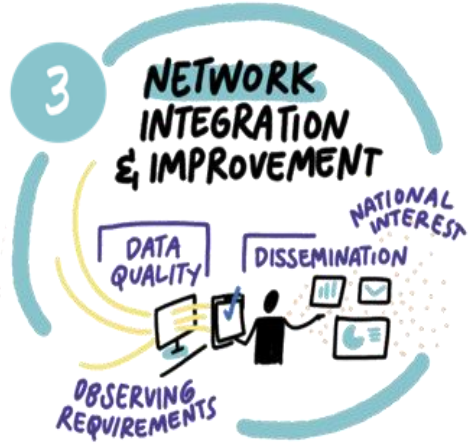


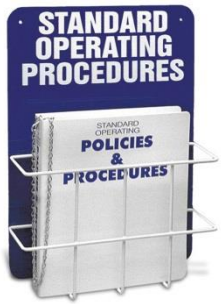
	European networks	Global networks
HF Radar	HFRadar	
Glider	Glider	Ocean Gliders
Fixed platforms	Fixed Platforms	OceanSITES
Surface vehicle	*in progress...*	
Profiling floats		Argo
Research ships	*in progress...*	
Commercial ships	FerryBox + ...	

EuroSea

WP3 – Task 3.7 Autonomous Surface Vehicles Network

1) ASV-Network definition and roadmap addressed to cover current and future user's needs, including access to infrastructures, community roadmap monitoring, promoting knowledge exchange, enhancement and partnership worldwide with the establishment of an ASV User Group.





2) Improvements on Standard Operating Procedures (SOP) for derived Best Practices (BP) implementation on operational protocols, data management, knowledge transfer, risk assessment, legislation, etc. in order to properly improve the ASV technology, contributing to the EOOS implementation plan.

3) Two workshops will be organized aiming at ASV technology - challenges, opportunities and user engagement, and ASV technology - BP implementation.

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NATURAL ENVIRONMENT RESEARCH COUNCIL

EuroSea

Gathering more Knowledge for a Sustainable Use of the Ocean through a Multiplatform-Network approach based on cutting-edge Observing Technologies

PLOCAN Plataforma Oceánica de Canarias

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National Oceanography Centre

WP3 – Network Integration and Improvement

Task 3.7

Autonomous Surface Vehicles (ASV) Network

1st Workshop (online)

October 5th – 6th, 2021







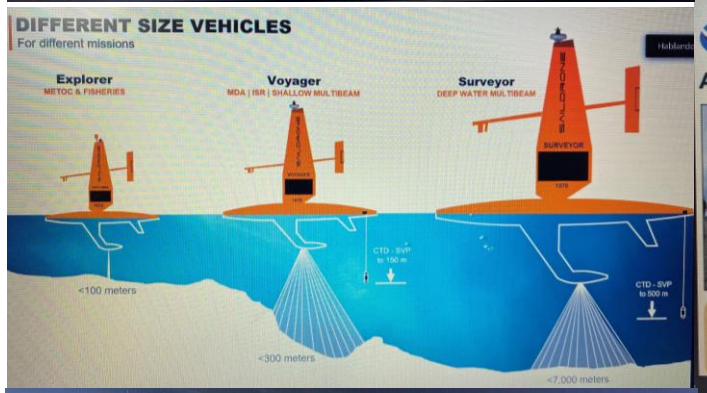
AGENDA

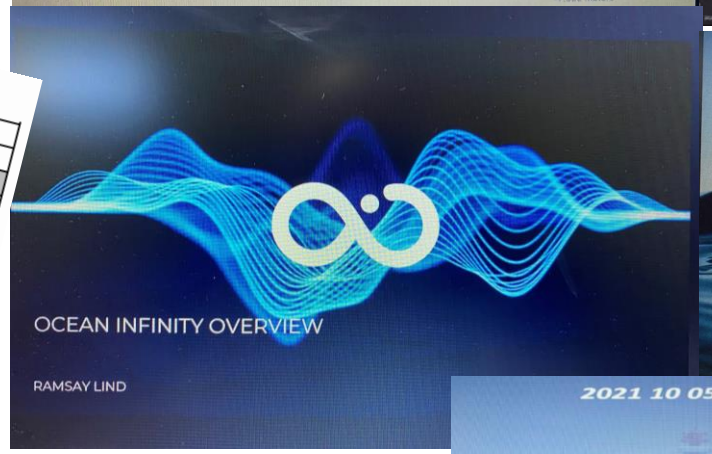
Oct 5th

2:00 PM	Welcome + Workshop goals	Carlos Barrera (PLOCAN)
2:10 PM	EuroSea Project Overview	George Petihakis (HCMR)
	Session 1 - ASV Technology	
2:20 PM	Offshore Sensing	David Peddie
2:30 PM	AutoNaut	Sarah Haesman
2:40 PM	GPASeabots	Pau Guasch/Adria Fradera/Daniel Sanchez
2:50 PM	iXblue	Guillaume Eudeline
3:00 PM	UTEK	Cesar Martinez
3:10 PM	SeaSats	Mike Flanigan / Declan Kerwin
3:20 PM	Saildrone	Andy Ziegwied
3:30 PM	Panel Discussion	All attendees
3:45 PM	Break	
	Session 2 - ASV Applications /Operations	
4:00 PM	UEA	Karen Heywood
4:10 PM	GEOMAR	Bjorn Fiedler
4:20 PM	XOCEAN Ltd.	Michael Huskilson
4:30 PM	Tidewise	Rafael Coelho / Sylvain Joyeux
4:40 PM	Ocean Infinity	Ramsay Lind
4:50 PM	Saildrone	Andy Ziegwied
5:00 PM	NOAA	Christian Meinig
5:10 PM	MARUM	Christoph Waldmann / Sebastian Meckel
5:20 PM	SEAPROVEN	[illegible] Thebaud
5:30 PM	Panel Discuss	
5:50 PM	Wrap up an	

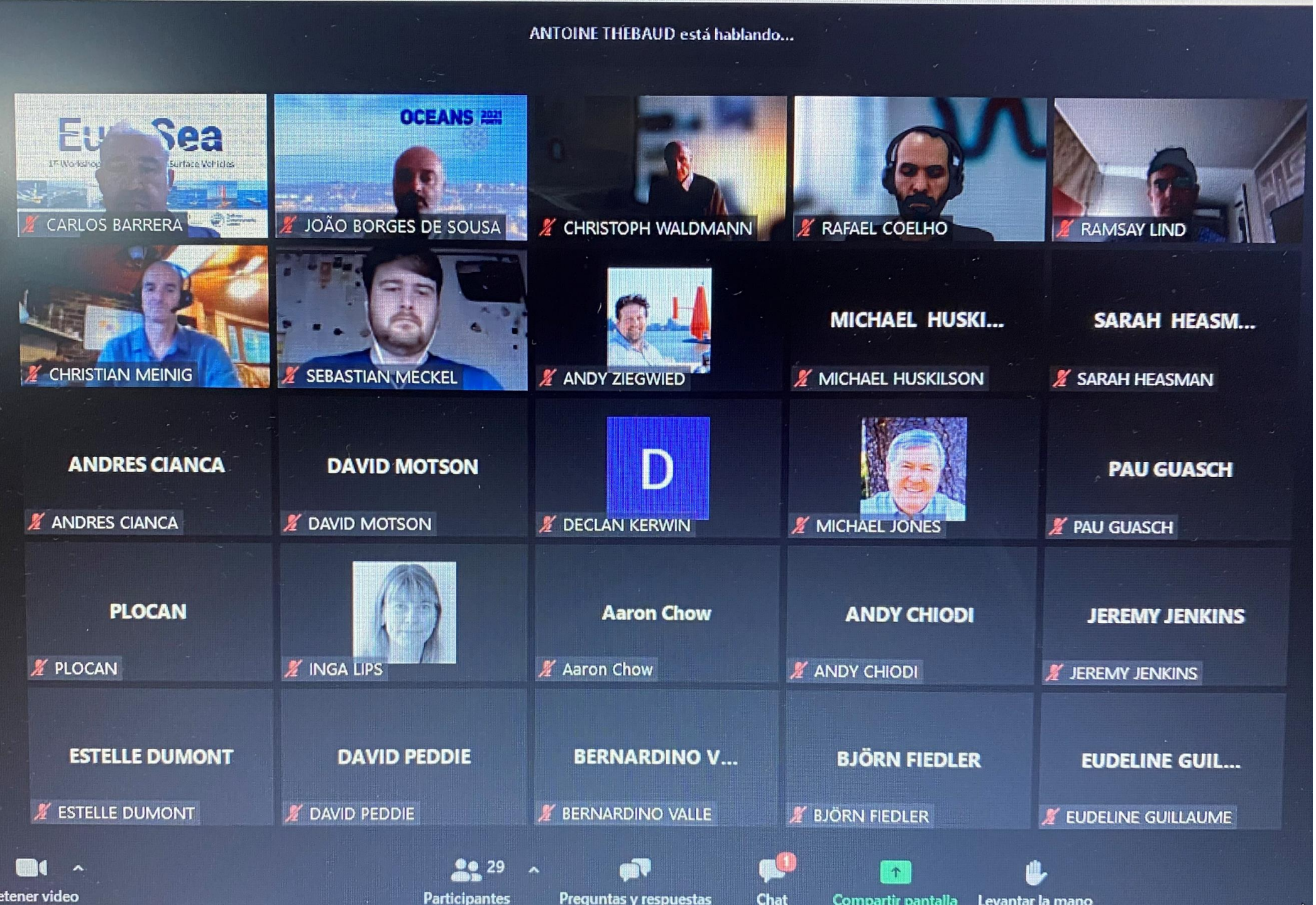
Oct, 6th

2:00 PM	Welcome + Session goals	Carlos Barrera (PLOCAN)
2:05 PM	EOOS Overview	Inga Lips (EuroGOOS)
	Session 3 - ASV Regulatory Framework	
2:20 PM	National Oceanography Center	Roland Rogers
2:40 PM	DGMM / MITMA	Hernan del Frade
3:00 PM	XOCEAN Ltd.	Michael Huskilson
3:15 PM	NOAA	Chris Meinig
3:30 PM	LSTS FEUP	Joao Tasso / Sergio Ferreira
3:40 PM	Panel Discussion	All attendees
3:50 PM	Break	
	Session 4 - Best Practices and ASV Network Roadmap Definition	
4:00 PM	Ocean Best Practices (OBPS)	Jay Pearlman /Johannes Karstensen
4:20 PM	EMODNet	Patrick Gorringe
4:40 PM	iXblue	Guillaume Eudeline (TBC)
4:50 PM	NOAA	Andy Chiodi
5:00 PM	MARUM	Christoph Waldmann
5:20 PM	Panel Discussion	All Attendees
5:40 PM	Next steps - AOB	Andres Cianca
5:50 PM	Wrap up and closure	Carlos Barrera





EuroSea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CARLOS BARRERA
JOÃO BORGES DE SOUSA
CHRISTOPH WALDMANN
RAFAEL COELHO
RAMSAY LIND
CHRISTIAN MEINIG
SEBASTIAN MECKEL
ANDY ZIEGWIED
MICHAEL HUSKI...
MICHAEL HUSKILSON
SARAH HEASM...
SARAH HEASMAN
ANDRES CIANCA
ANDRES CIANCA
DAVID MOTSON
DAVID MOTSON
D
DECLAN KERWIN
MICHAEL JONES
PAU GUASCH
PAU GUASCH
PLOCAN
PLOCAN
INGA LIPS
Aaron Chow
Aaron Chow
ANDY CHIODI
ANDY CHIODI
JEREMY JENKINS
JEREMY JENKINS
ESTELLE DUMONT
ESTELLE DUMONT
DAVID PEDDIE
DAVID PEDDIE
BERNARDINO V...
BERNARDINO VALLE
BJÖRN FIEDLER
BJÖRN FIEDLER
EUDELINE GUIL...
EUDELINE GUILLAUME
29
Participantes
Preguntas y respuestas
Chat
Compartir pantalla
Levantar la mano

1st USV WS - Main preliminary outcomes

- **Great level of interest, attendance and contribution** from current key USV-community members representing the “triple-helix” perspective (industry, academia/science and governance). Some other key members unable to attend but committed with future activities.
- The USV technology is already well developed and mature **(TRL 8-9)** in many cases.
- **Huge technological and operational capabilities** to cover in a synergistic way current ocean-observing gaps, being two of the main ones (1) to be able to monitor essential climate variables (ECV) and essential ocean variables (EOV) at the same time on an unprecedented space-time scale, and (2) act as gateway to link in real-time underwater observations with satellite platforms.
- Several helpful synergies already identified (and tested) with **other ocean-observing platforms** (fixed and mobile).
- **Wide range of applications/services for several Blue Growth sectors** on ocean-observing, survey, intervention, border security, etc. some of them already implemented in routine mode.
- Several technologies already as commercial product (important difference from other ocean-observing technologies).
- **Risk assessment and management system** is key.
- **Clear lack at network level** (main motivation to undertake this initiative under EuroSea project) from key aspects like technical -platforms and subsystems components-, coordinated operations/missions, data/metadata, legal framework (links with IMO/MASS strategy), best practices and standards, etc.

OT05 - Uncrewed Surface Vehicles (USVs) Technology Trends and Improvements on Observing Applications for the Ocean Decade

March 2nd 2022 – 3:00-4:00 PM CET (Room 9) // 4:00-5:00 PM CET (Room 28)

https://www.aslo.org/osm2022/scientific-sessions/#ot

EuroSea

LSTS

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National Oceanography Centre

PLOCAN
Plataforma Oceánica de Canarias

NOAA
National Oceanic and Atmospheric Administration
U.S. Department of Commerce

Scripps Institution of Oceanography






Integration and in-water testing of NOAA-PMEL's ASVCO2 (Autonomous Surface Vehicle Carbon Dioxide Sensor) into Wave Gliders and Saildrones

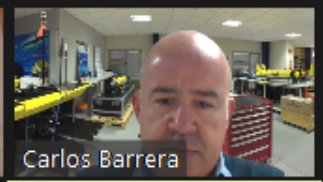
Christian Meinig, Noah Lawrence Slavas, Matt Casari, Adrienne Sutton, Stacy Maenner (NOAA-Pacific Marine Environmental Laboratory)
Alex Turpin, Sophie Chu (NOAA-PMEL & UW CICOES)
Kevin Rea (Jupiter Research Foundation)
Richard Jenkins (Saildrone)

NOAA

Ocean Sciences
March 2, 2022

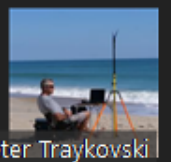
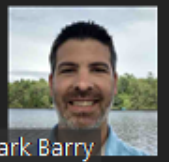
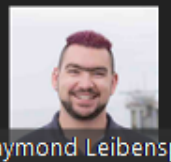
Sponsors:
NOAA-OA
NOAA-IOOS
NOAA-GOMO

PMEL Pacific Marine Environmental Laboratory
CICOES
Jupiter Research Foundation
SAILDRONE
CSIRO


Andrew Chiodi

Carlos Barrera

Raymond Young

Declan Kerwin

Christian Meinig
Christopher Wal...
Christopher Waldmann
Christian Engler
Christian Engler
Andre Amador
Andre Amador
Tianyu Jiang (St...
Tianyu Jiang (Student...
John Toole
John Toole
Richard Crout
Richard Crout

Peter Traykovski
Erin Hachey
Erin Hachey

Mark Barry

Raymond Leibensper...

USV Developments

15th March 2022

Andrew Tyrer

Industrial Strategy Challenge Director - Robotics, UKRI

Carlos Barrera

Head of the Ocean Vehicles Unit - Oceanic Platform of the Canary Islands (PLOCAN)

Michael King

Senior Business Development Manager - Ocean Infinity

Stephane Vannuffelen

Marine Autonomy Technical Director - IxBlue

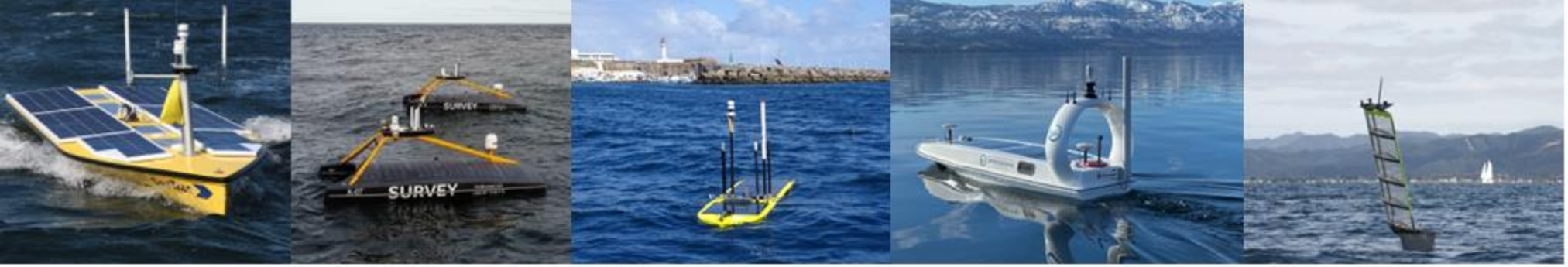
Stephen Thomson

Business Development Manager Renewables - Fugro

oceanology international 2022

15-17 MARCH 2022
LONDON, EXCEL

Sponsored by AUTONAUT



Autonomous Surface Vehicles (ASV) Network

2nd Workshop

In-person attendance event
(virtual access also available)

Travel grants available

EuroSea

April 13th and 14th, 2023
PLOCAN Headquarters
Gran Canaria, Spain

DISCUSSION TOPICS

- Standard Operational Procedures
- Data/Metadata Management
- Legal Framework
- Risk Assessment
- Best Practices
- Synergies and Services
- ASV Network Roadmap - User Group
- ...

Contact:
andres.cianca@plocan.eu

Organizers

marum

U.PORTO
FEUP FACULDADE DE ENGENHARIA UNIVERSIDADE DO PORTO

National Oceanography Centre

PLOCAN Plataforma Oceánica de Canarias

Collaborators

NOAA

PMEL

PLOCAN Plataforma Oceánica de Canarias

Any questions?

Thank you

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FEUP FACULDADE DE ENGENHARIA
UNIVERSIDADE DO PORTO

National Oceanography Centre
NATURAL ENVIRONMENT RESEARCH COUNCIL

NOAA

SCRIPPS INSTITUTION OF OCEANOGRAPHY
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DEEPWATER DEVELOPMENT

28 - 30 March 2023 | Millennium Gloucester Hotel | London, UK

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