
# Uncrewed Surface Vehicles (USV) Network Initiative in support to EOOS: The EuroSea Project

C.Waldmann

J. Tasso-Sousa

J. Burris

**C. Barrera**

A. Chiodi

L. Grare

IMO Seminar on Development of a Regulatory Framework for Maritime Autonomous Surface Ships (MASS)

Online – Sept 5th 2022

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

FerryBox
EuroGOOS Task Team

Glider
EuroGOOS Task Team

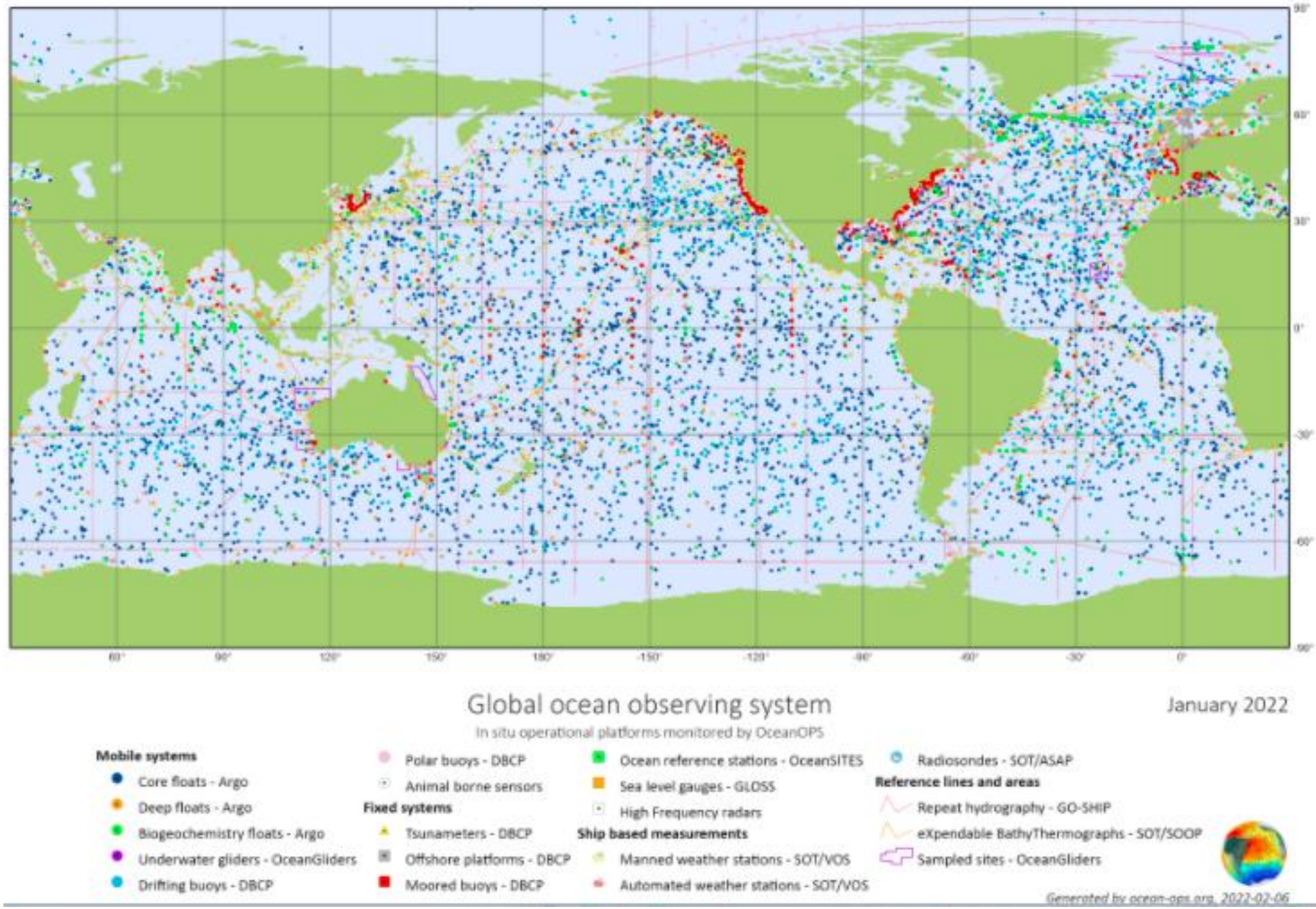
HFRadar
EuroGOOS Task Team

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
- 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



- Floats
- Moorings
- UW-gliders
- Research Vessels
- Sea-Level Gauges
- HF Radar
- FerryBox
- Animal-borne Instruments
- **Uncrewed Surface Vehicles -USV**

FerryBox
EuroGOOS Task Team

Glider
EuroGOOS Task Team

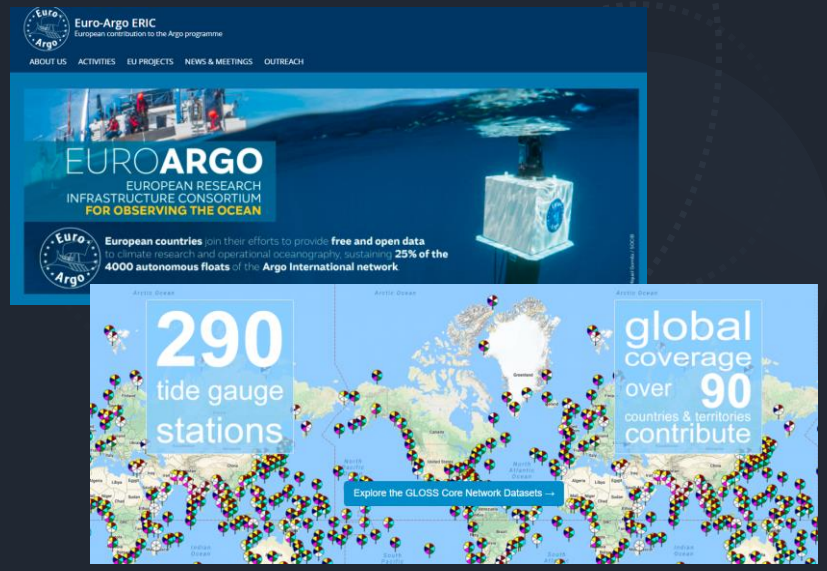
HFRadar
EuroGOOS Task Team

emso ERIC

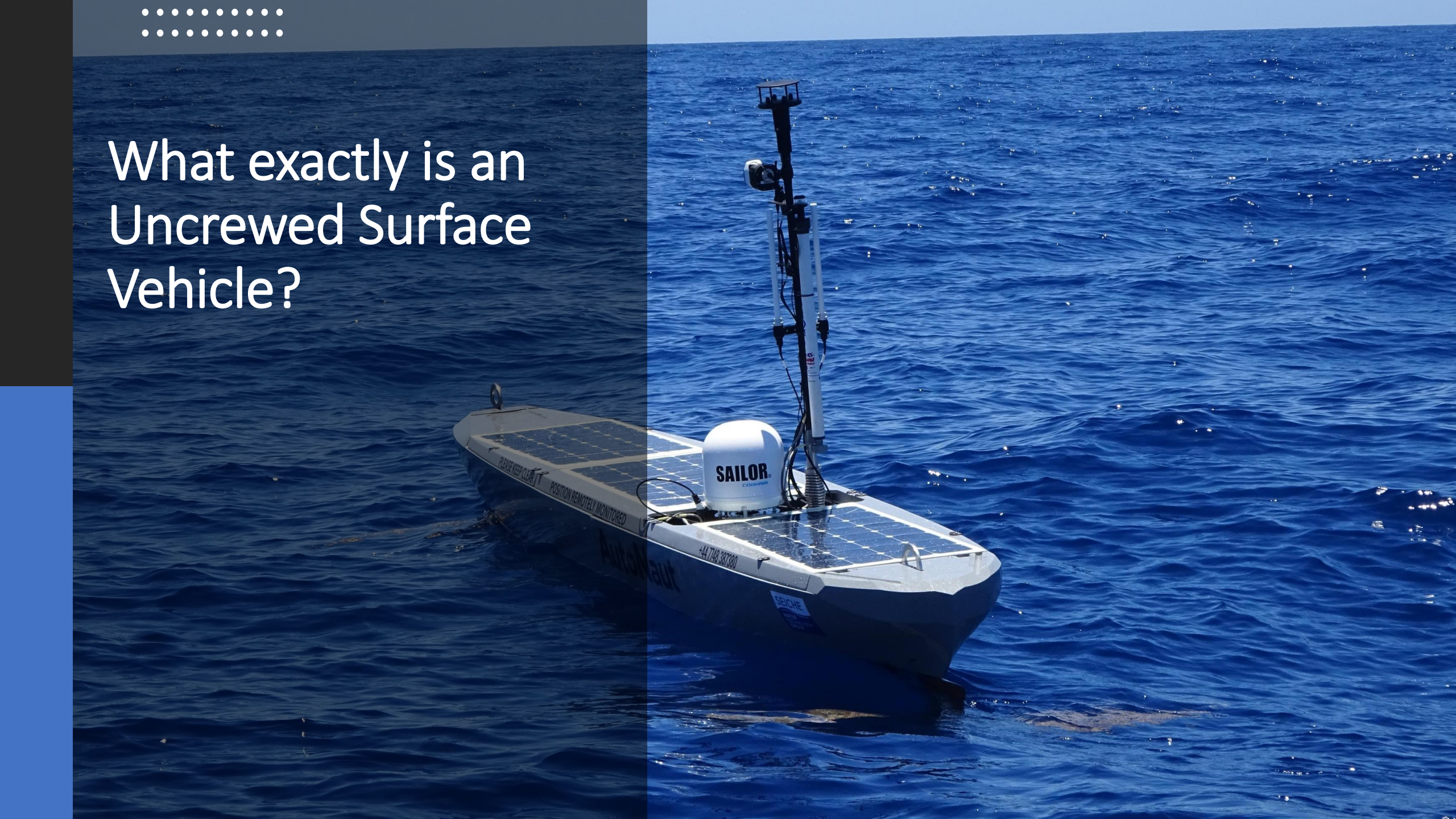
OceanSITES
Taking the pulse of the global ocean

OCEAN TRACKING NETWORK

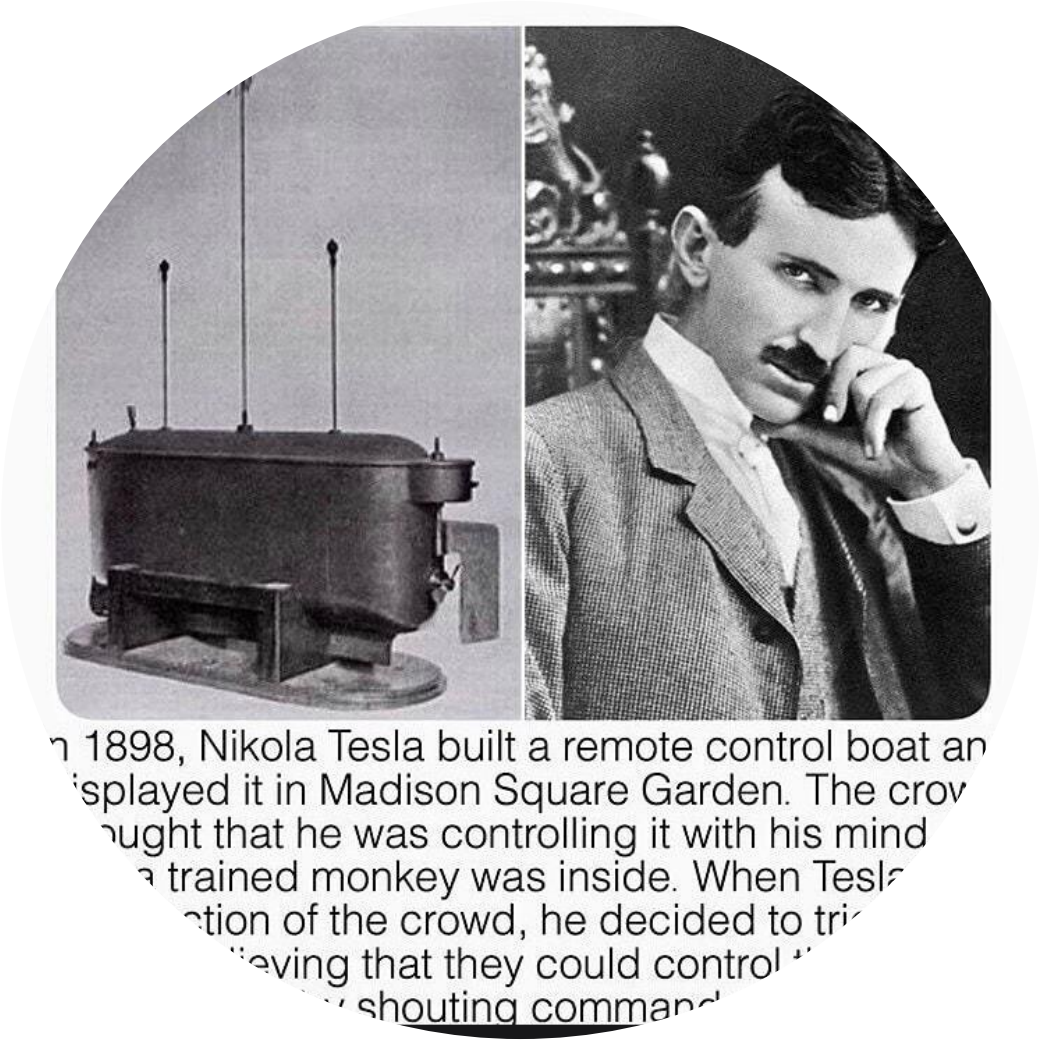
GLOSS



# What exactly is an Uncrewed Surface Vehicle?



# USV-tech SoA in brief…




1898

…


2022

| 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*





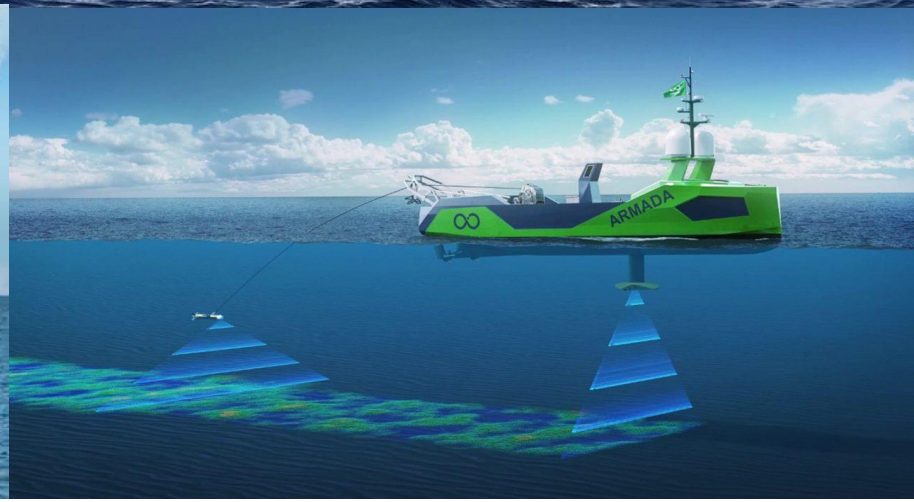




- Propulsion mainly based on electrical thrusters.
- Short-médium range endurance (hours/days) for missions near shore areas.







… USV development concept quite close to autonomous ships?

- Is USV technology also 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 MASS implementation?

INTERNATIONAL MARITIME ORGANIZATION

IMO INTERNATIONAL MARITIME ORGANIZATION

Contact us | Careers English | Français | Español

ABOUT IMO MEDIA CENTRE OUR WORK PUBLICATIONS KNOWLEDGE CENTRE

25 May 2021

# Autonomous ships: regulatory scoping exercise completed


E

IMO INTERNATIONAL MARITIME ORGANIZATION

4 ALBERT EMBANKMENT
LONDON SE1 7SR
Telephone: +44 (0)20 7735 7611 Fax: +44 (0)20 7587 3210

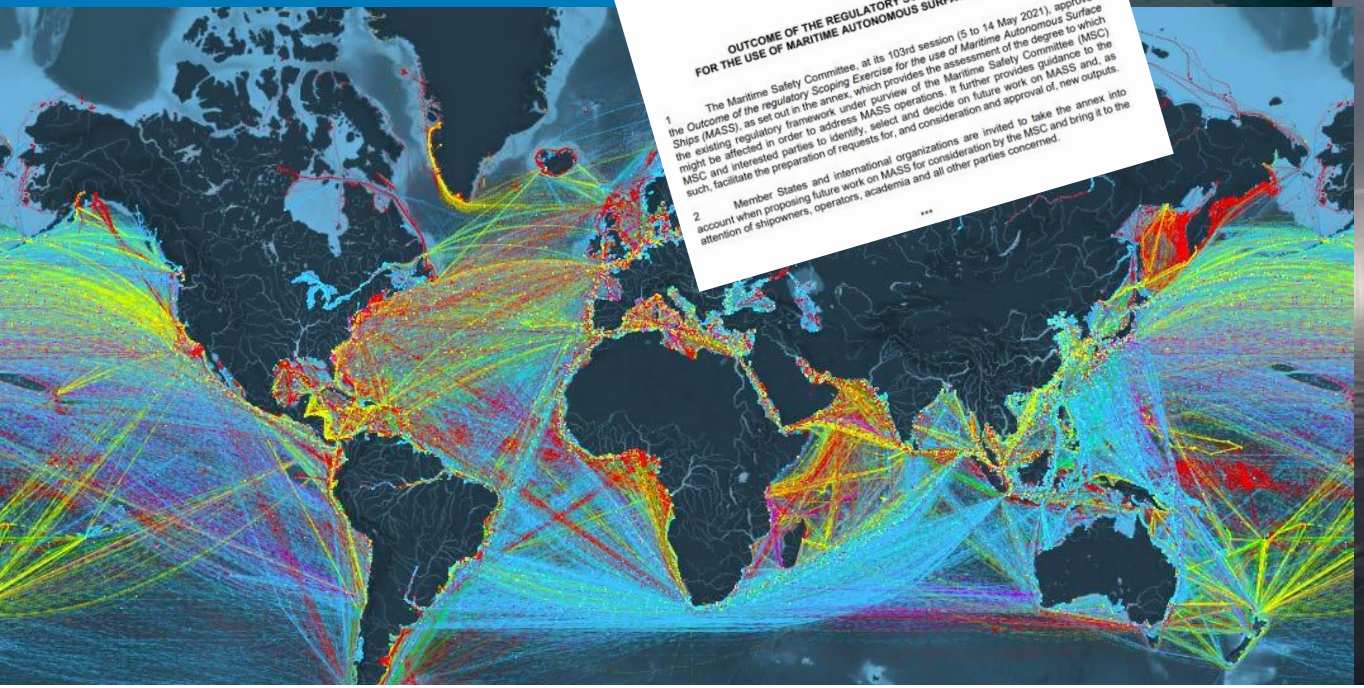
MSC.1/Circ.1638
3 June 2021

**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.

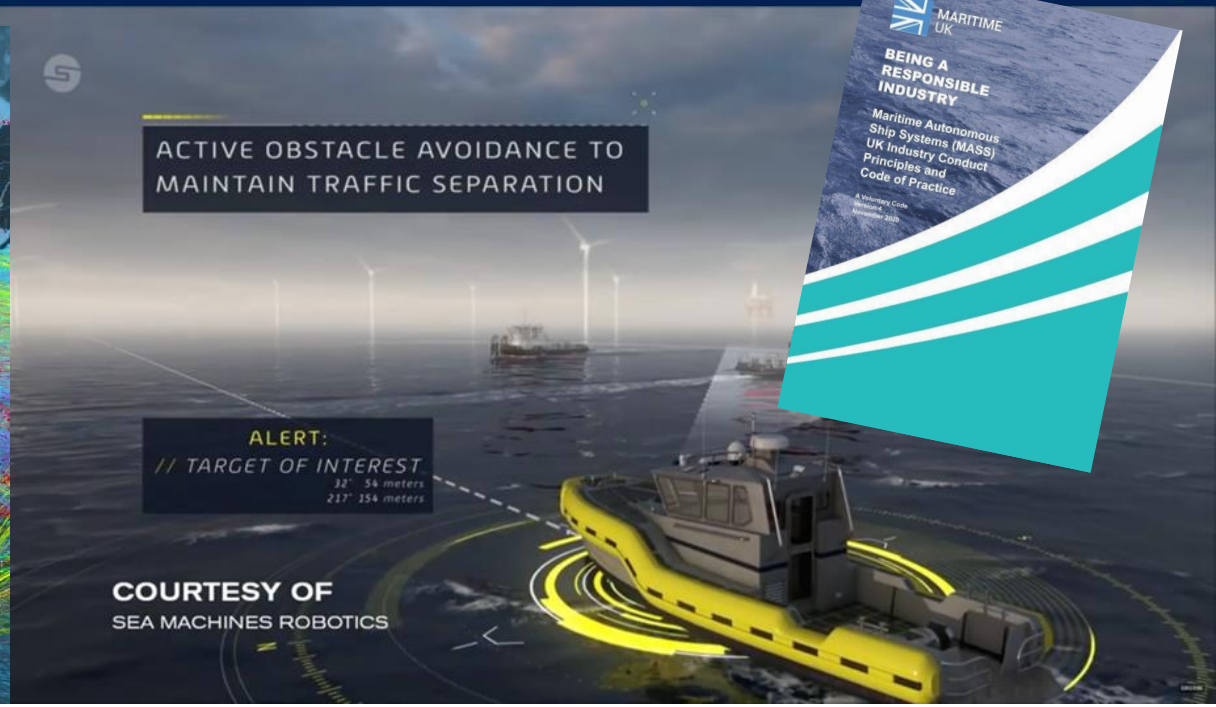
***

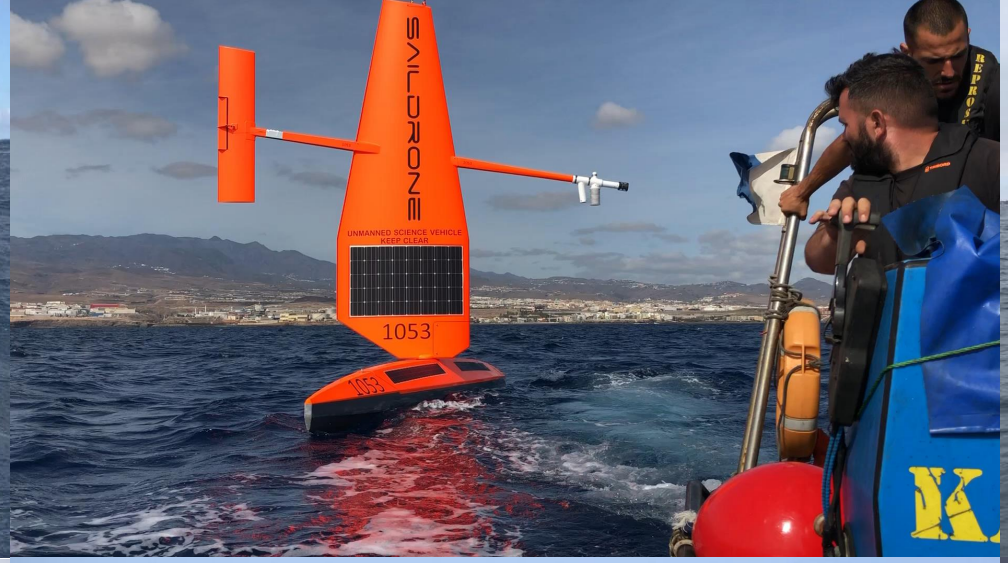


DIMECC One Sea

## 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 | | | |

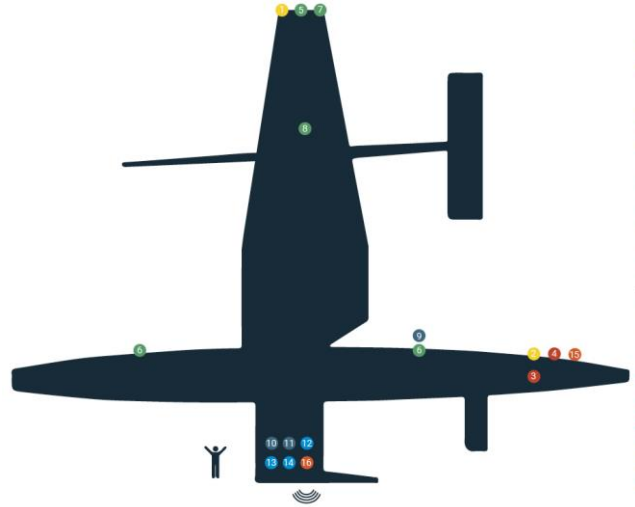








Propulsion based on **ocean-energy sources** (mainly waves, wind) and sunlight. Highly capables to increase **persistent-presence** in the ocean in a more sustainable and efficient **routine-mode operation**. Long-range (weeks/months) missions in both coastal and open-ocean areas.



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 — 360º High-resolution optical cameras with AI/ML target detection

7 SMART CAMERA ARRAY — 2 x 220º 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

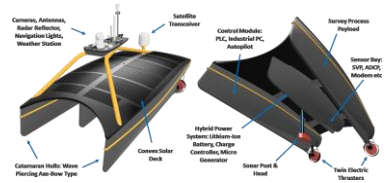
12 OCEAN CURRENTS — Simrad EC150 ADCP

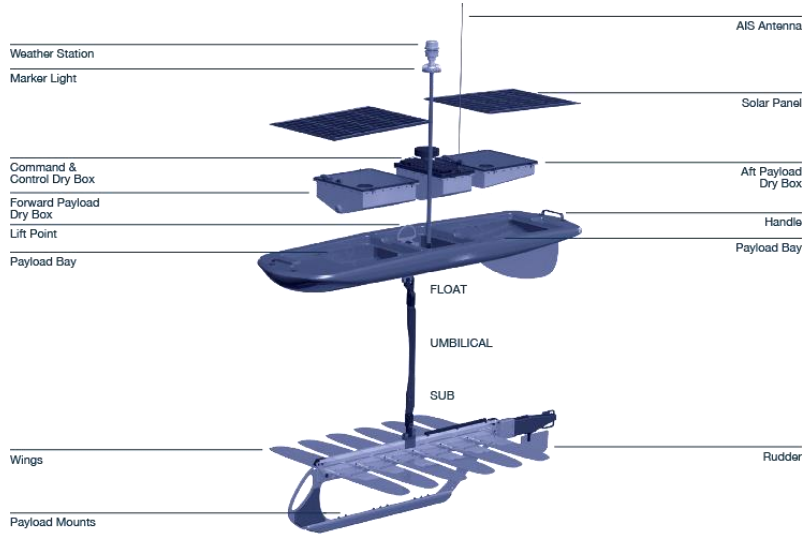
13 OCEAN CURRENTS — Teledyne Pinnacle 45 ADCP

14 FISH BIOMASS — Simrad EK80 echo sounder

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

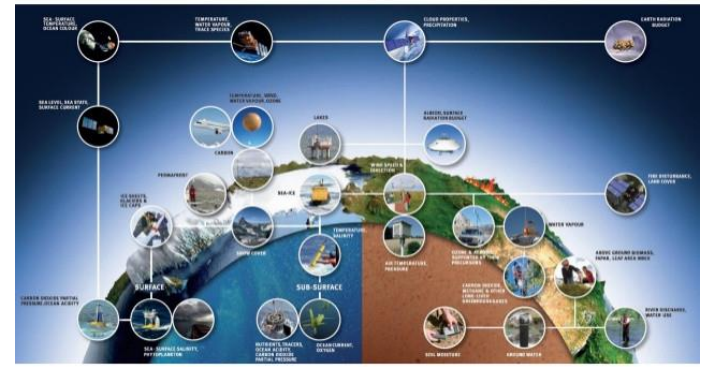
16 SURFACE SOUND VELOCITY PROBE — Teledyne SVP-70 (fixed)




WORLD METEOROLOGICAL ORGANIZATION

## GCOS Essential Climate Variables

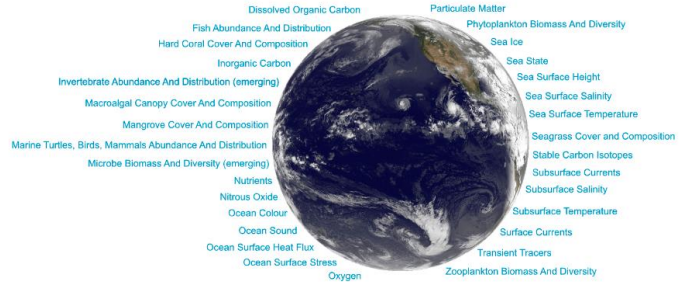



GCOS

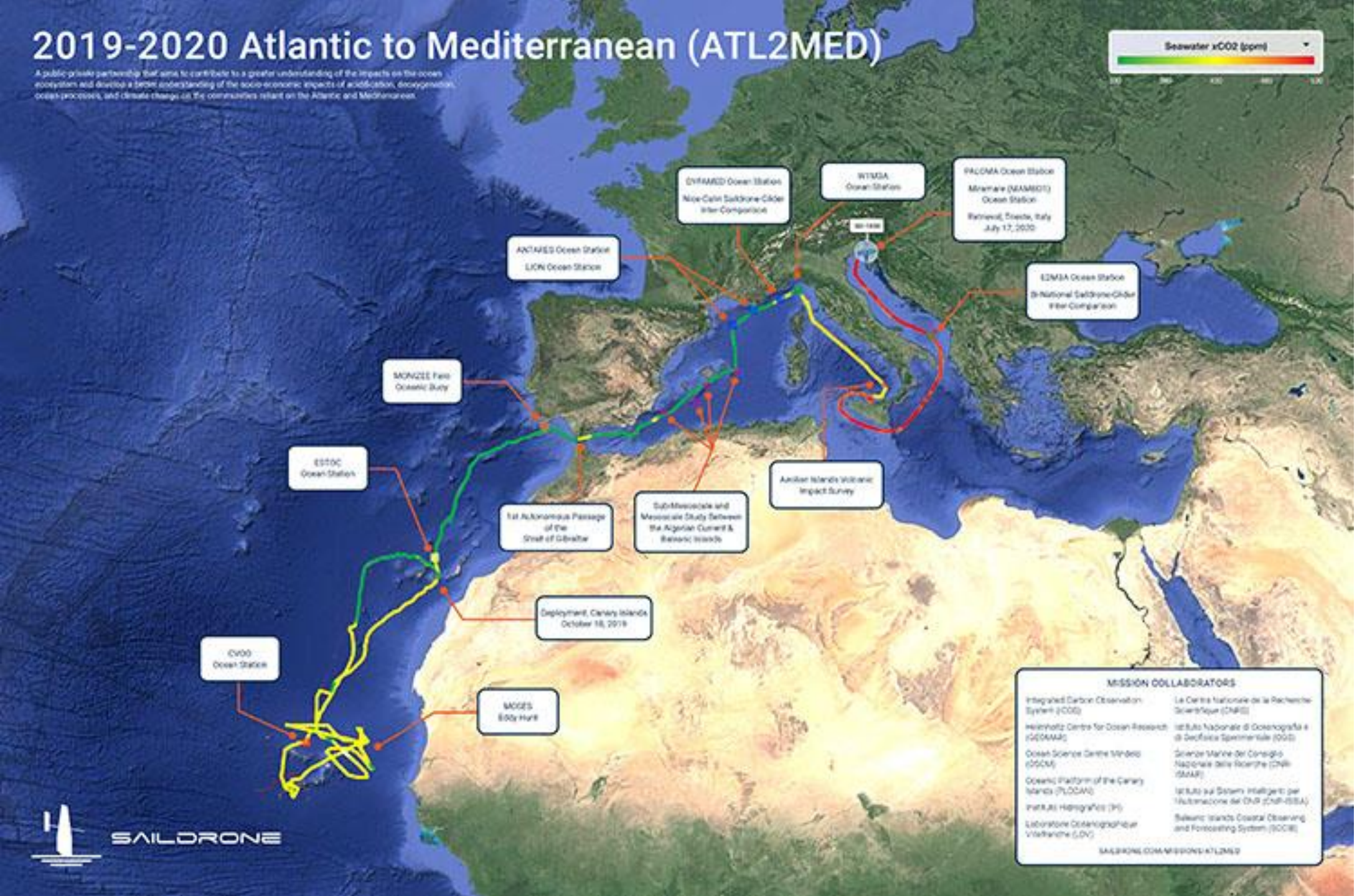
IOC UNEP ICSU

## The Global Ocean Observing System

GOOS




SAILDRONE
UNMANNED SCIENCE VEHICLE
KEEP CLEAR
1053
1053




EuroSea

SAILDRONE

EuroGOOS
European Global Ocean Observing System

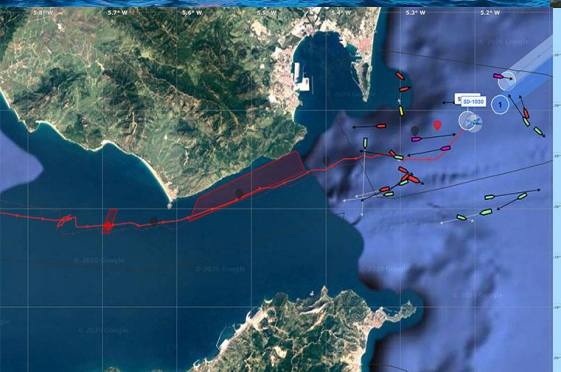
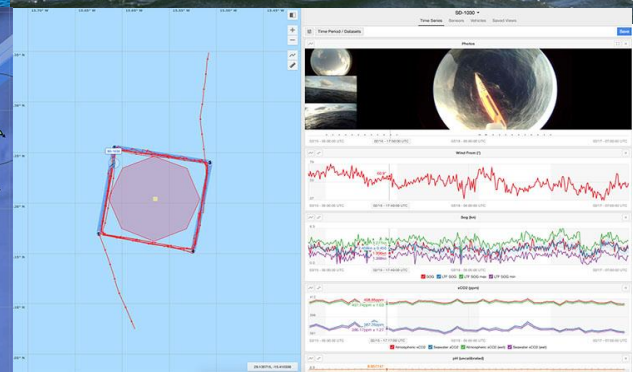
ICOS
INTEGRATED CARBON OBSERVATION SYSTEM

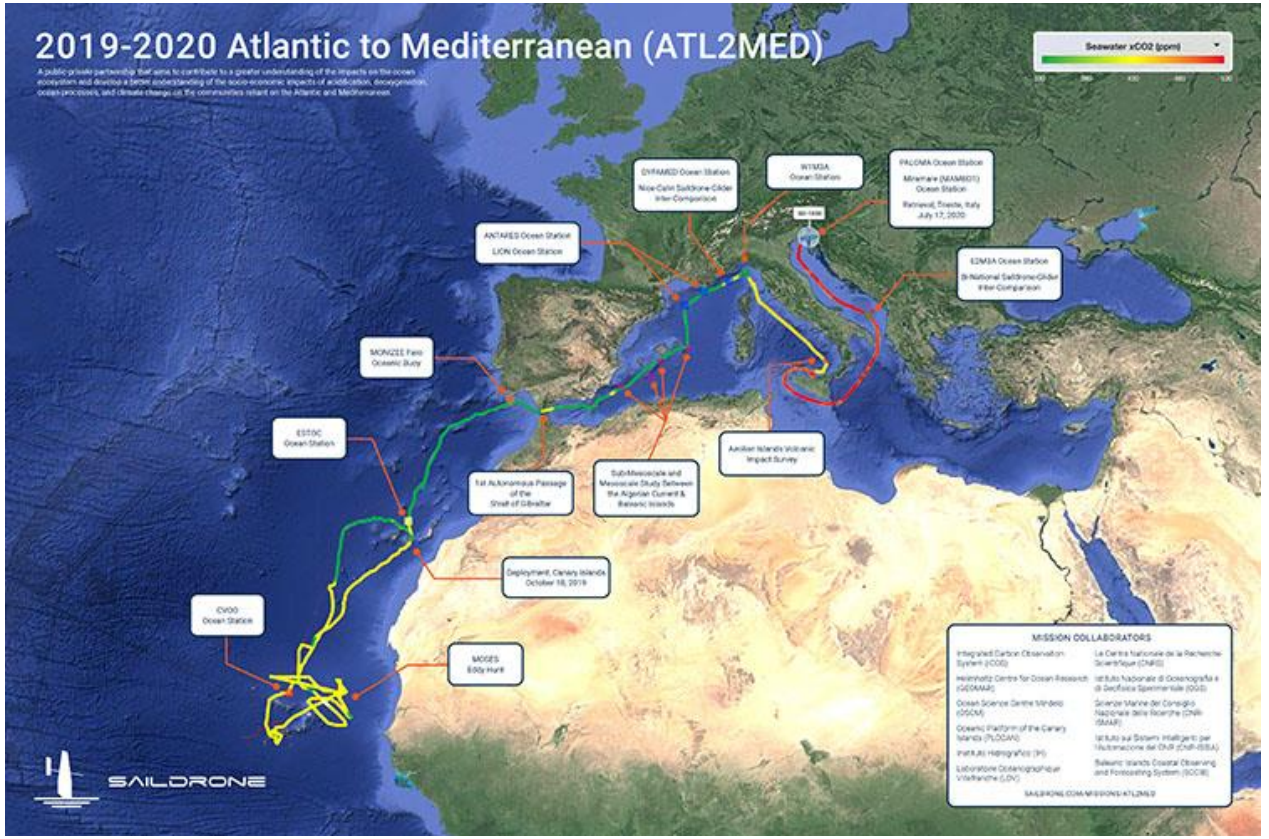
emso ERIC








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
# …

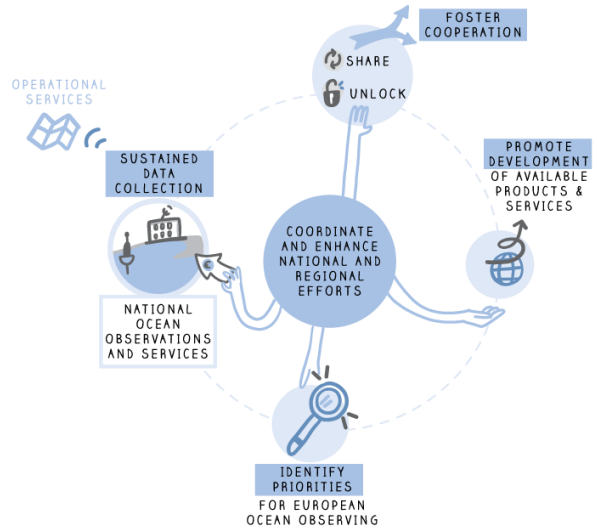

EuroGOOS
European Global Ocean Observing System
EuroGOOS Strategy 2030


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


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
WE ARE STRONGER TOGETHER
Engage in building EOOS
Contact us:
info@eoos-ocean.eu
Share KNOWLEDGE, EXPERTISE and scan horizon


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


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


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

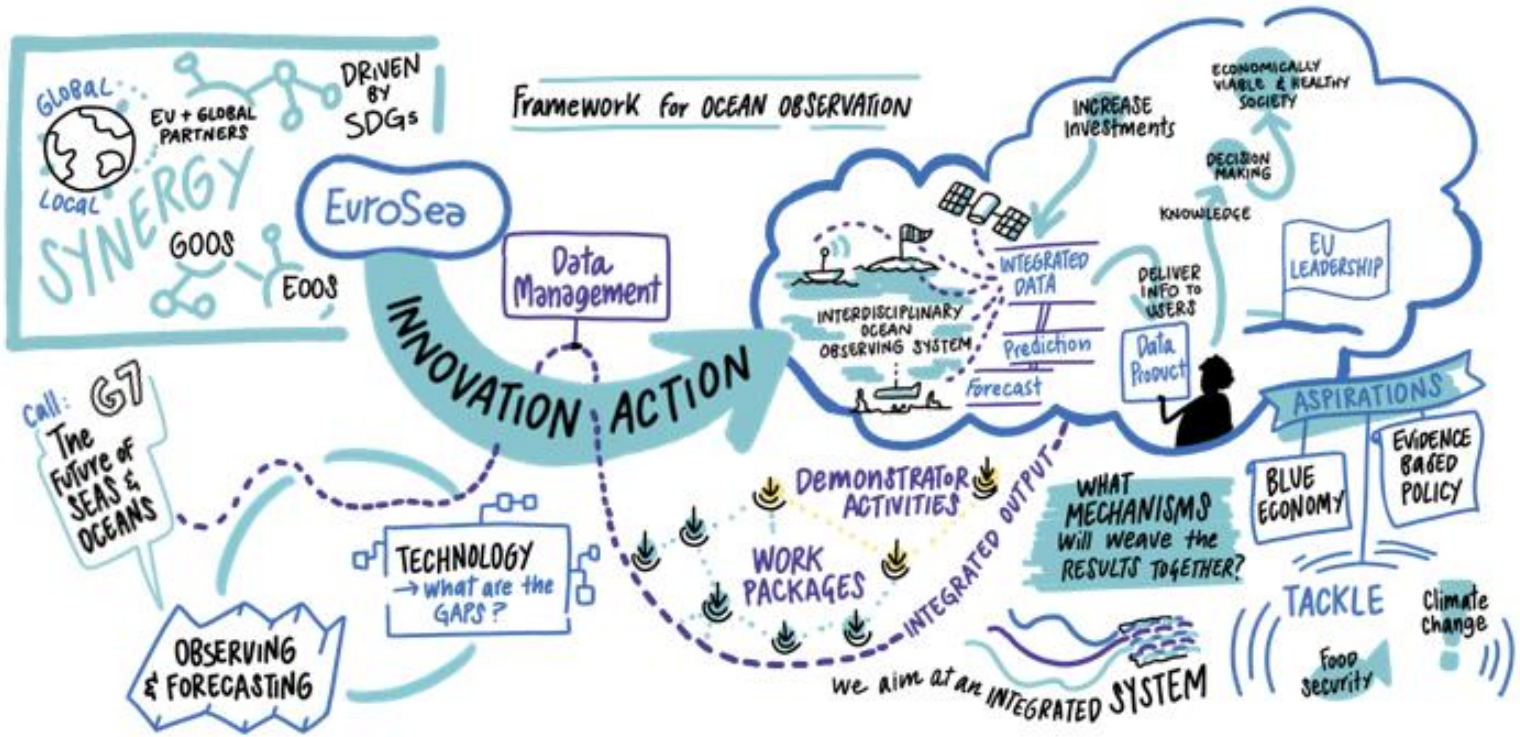
Improving and integrating the European Ocean Observing and Forecasting System

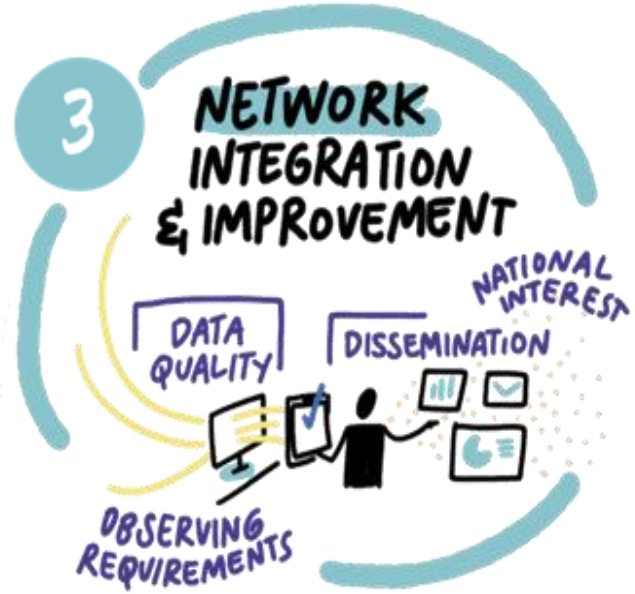
Project Info | Achievements | News & Events | Ocean Best Practices | Contact


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



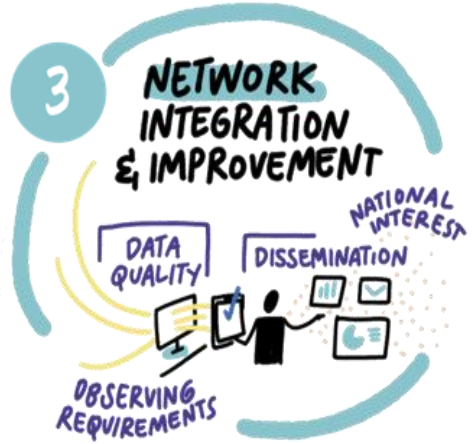



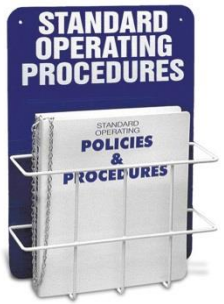

| | European networks | Global networks |
|---|---|---|
| HF Radar | HFRadar | |
| Glider | Glider | Ocean Gliders |
| Fixed platforms | Fixed Platforms | OceanSITES |
| Surface vehicle | *in progress...* | |
| Profiling floats | | Argo |
| Research ships | *in progress...* | |
| Commercial ships | FerryBox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

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.

PLOCAN
Plataforma Oceánica de Canarias

U.PORTO
FEUP FACULDADE DE ENGENHARIA UNIVERSIDADE DO PORTO

marum

National Oceanography Centre
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

marum

U.PORTO FEUP FACULDADE DE ENGENHARIA UNIVERSIDADE DO PORTO

National Oceanography Centre

# WP3 – Network Integration and Improvement

## Task 3.7

# Autonomous Surface Vehicles (ASV) Network

## 1st Workshop (online)

October 5th – 6th, 2021







# AGENDA

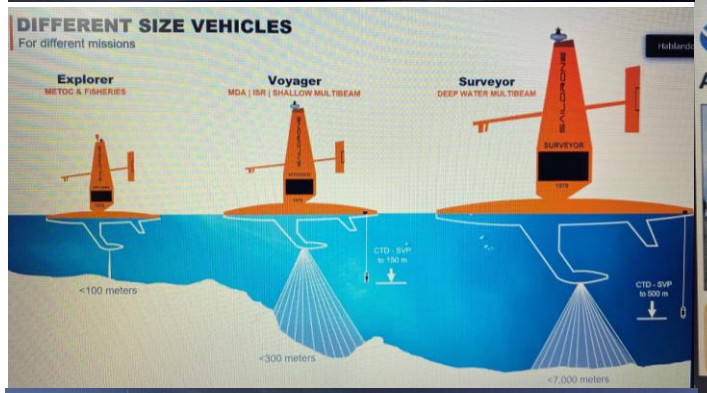
Oct 5th

| | | |
|---|---|---|
| 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 | |

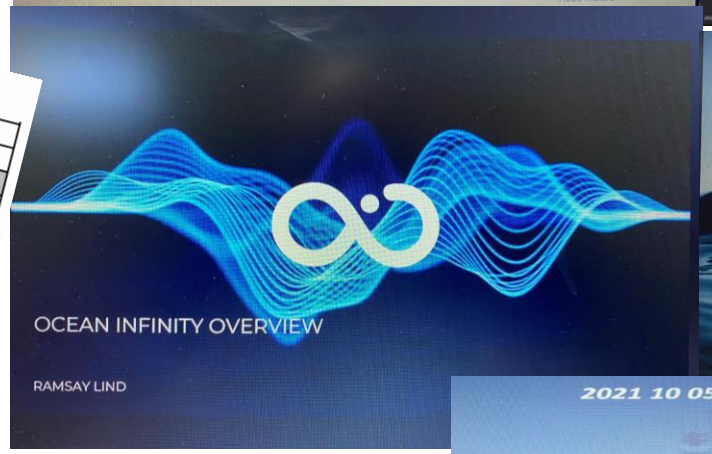
Oct, 6th

| | | |
|---|---|---|
| 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 |



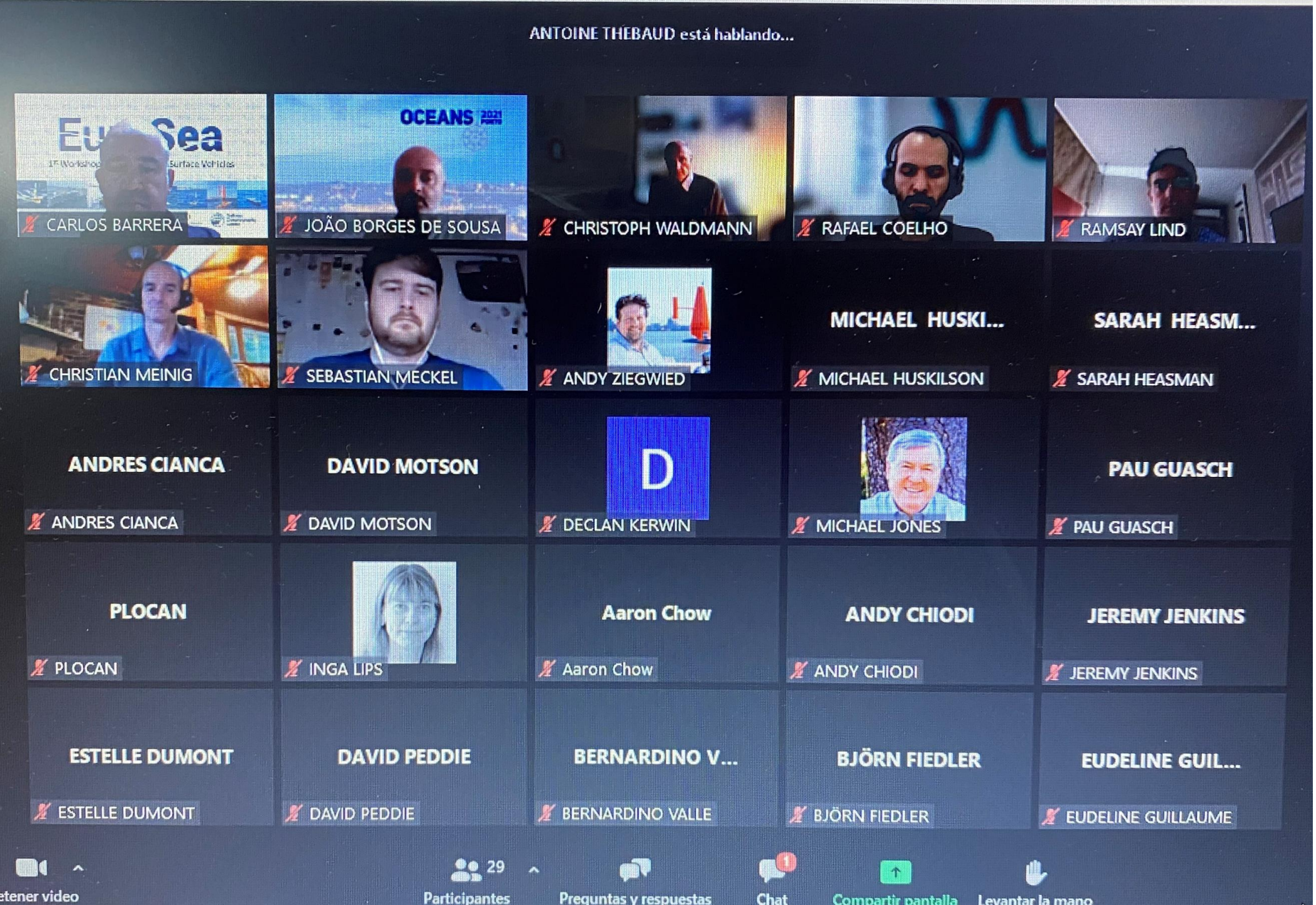









EuroSea


ANTOINE THEBAUD está hablando...
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

marum

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

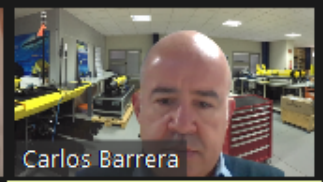
**Christian Meinig, Noah Lawrence Slavas, Matt Casari, Adrienne Sutton, Stacy Maenner** (NOAA-Pacific Marine Environmental Laboratory)
**Alex Turpin, Sophie Chu** (NOAA-PMEL & UW CICOES)
**Kevin Rea** (Jupiter Research Foundation)
**Richard Jenkins** (Saildrone)

NOAA

*Ocean Sciences*
*March 2, 2022*

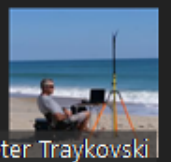
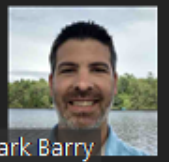
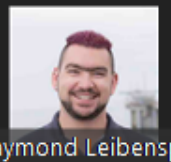
Sponsors:
NOAA-OA
NOAA-IOOS
NOAA-GOMO

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



29 companies exhibiting USV tech!!!

# Any questions?

Thank you