European Commission

# EC OCEAN OBSERVATION: SHARING RESPONSIBILITY

## Report & Community Recommendations from the virtual event on 18 June 2021

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*Maritime Affairs*

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EMODnet
European Marine Observation and Data Network

European MARINE BOARD
Advancing Seas & Ocean Science

EuroGOOS
European Global Ocean Observing System

Copernicus Marine Service

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Unit A1 — Maritime Innovation, marine knowledge and investment

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Directorate-General for Maritime Affairs and Fisheries
Integrated Maritime Policy

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# 1. INTRODUCTION

As Europe steps up to meet the ambitious targets of the EU Green Deal and related Climate Pact, the value of high quality, standardised marine data has never been clearer. This will continue to increase as Europe contributes marine knowledge to global efforts including the international United Nations (UN) 2030 Agenda for Sustainable Development, the COP21 Paris agreement and upcoming COP26, and the challenges and objectives of the UN Decade of Ocean Science for Sustainable Development (2021-2030). Ocean observations - and the resulting data - at the start of the marine knowledge value chain, the foundation upon which information and knowledge are created for society. Marine data and information underpins and enables Blue Economy[1] operations at sea, drives research and innovation to improve our understanding of ocean health, of geo-hazards, and of the oceans' role in climate regulation. Information on the status of the marine environment and human activities at sea also inform marine spatial planning and wider evidence-based decision-making concerning our environment, society and future wellbeing.

The ongoing success of existing long-term EU marine data services EMODnet[2] and the Copernicus Marine Service[3] are inherently linked – and completely dependent on – marine data collected through ocean observations and marine monitoring. However, the marine knowledge chain is only as strong as its weakest link. In particular, *in situ* ocean observation technology development, infrastructure operation and data collection are currently fragmented, under-resourced and largely un-sustained (EMB, 2021[4]). The European Ocean Observing System (EOOS) Conference Call to Action[5] recommended three specific actions for national, regional and European stakeholders to examine the existing capability in ocean observing and monitoring and the efforts that lie under their responsibility. Since then, the community has continued to develop EOOS as a coordination framework to connect stakeholders and initiatives and to further align and integrate Europe's ocean observing capacity.

In 2020 the European Commission (EC) Directorate-General for Maritime Affairs and Fisheries (DG MARE) commissioned an EC study on Marine Technology[6] on the state of the development of sensors and platforms in ocean observation. In addition, 2020 saw the launch of an EC Ocean Observation initiative titled EC Ocean Observation – sharing responsibility[7] with a public consultation which gathered feedback from over 150 stakeholders, including perspectives on the needs, requirements and opportunities for strengthened coordination at national level across marine and coastal data collection efforts. The consultation culminated in February 2021 with an online event hosted by the European Parliament Intergroup on Seas, Rivers, Islands and Coastal Areas (SEARICA)[8], in cooperation with the Directorate General for Maritime Affairs and Fisheries of the European Commission and the Conference of Peripheral Maritime Regions.

1/ All economic activities related to oceans, seas and coastal areas
2/ emodnet.ec.europa.eu/en
3/ https://marine.copernicus.eu/
4/ https://www.marineboard.eu/sustainable-funding-ocean-observations
5/ EOOS Call to Action 2018: https://www.emodnet.eu/conference/eoos2018/call-action.html
6/ State of the development of sensors and platforms in ocean observation (europa.eu)
7/ https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/12539-Ocean-observation-sharing-responsibility/public-consultation_en
8/ http://www.searica.eu/2020-2024/events-2019-2024/searica-event-on-ocean-observation

In the context of these EC and wider European community activities, the European Commission Directorate-General for Maritime Affairs and Fisheries (DG MARE), unit A1 Maritime Innovation, Marine Knowledge and Investment, convened an **EC Ocean Observation event** on 18 June 2021. The event was co-organised by the Secretariats of EMODnet, European Marine Board (EMB), EuroGOOS and Copernicus Marine Service.

The event brought together over 90 experts from the wider European and International community spanning ocean observing, marine monitoring and user communities. The event included showcase presentations, breakout discussions and a plenary panel dialogue, focusing on two key topics related to ocean observation, namely: (i) **Ocean Observing technology: optimising European capability** and (ii) **Ocean Observing gaps and requirements**.

In the first session on Ocean observing technology, showcase presentations were followed by breakout discussions on ocean observing technology, facilitated and rapporteured by representatives from the EMODnet, EMB and EuroGOOS Secretariats and Marine Research Infrastructures EMBRC-ERIC, EMSO-ERIC and LifeWatch-ERIC. Expert perspectives and recommendations were gathered in three key areas of marine technology with a focus on the EU market: (1) Technological Research and Innovation; (2) Market pull and; (3) Finance. The second session focused on ocean observing gaps and requirements. Showcase presentations were followed by a plenary panel consisting of experts from the European community. This session aimed to collectively assess the European capability and existing methodologies for assessing gaps and requirements in marine observation, and provided recommendations on how such efforts could evolve in the future, in the context of the EU Green Deal and global initiatives.

Community Recommendations were produced from the event presentations, stakeholder discussions and dialogues and are published in Section 2 of this report, and also as a stand-alone document. These Recommendations aim to inform policy makers and wider stakeholders of further ways to strengthen coordination across the marine knowledge value chain, particularly in terms of marine technology and ocean observation gaps and requirements, and in the context of the EC initiative on Ocean Observation: Sharing responsibility.

The EC Ocean Observation event was held back-to-back with the EMODnet Open Conference 2021 and the related EMODnet partnership Jamboree. This promoted further connection across stakeholder communities including academia/research, the Blue Economy, policy and civil society, involving key actors from the public and private sectors. It also promoted the alignment between the core EMODnet community (marine data managers, infrastructures, services and users) with data producers (ocean observation, monitoring data acquisition), and users. This in turn enabled discussions on connecting the marine knowledge value chain through feedback loops, reporting on data and information uptake, usage and adequacy, to inform on the value and impact of open marine data and priority gaps and requirements. Graphic recordings of the EC Ocean Observation event are available in this report and were also made available to the community on the EMODnet Open Conference 2021 virtual exhibition.

# 2. COMMUNITY RECOMMENDATIONS

Community recommendations taken from the EC Ocean Observation event on 18 June 2021 are presented below, with a focus on optimising European capability in the context of international efforts.

## Ocean Observing Technology

### Research and Innovation

- **Research, Development (R&D) and Innovation remain crucial for Europe** to evolve its world-leading capability role in ocean observing technology, platforms and infrastructure;
- **Future ocean observing technology user requirements should be identified across the marine knowledge value chain**, to include solutions for collecting high quality marine data related to the EU Green Deal and in the context of global needs e.g. of microplastics, wider pollutants, and biological parameters. These observations can connect to the wider environmental and human activities data to assess ocean biodiversity, ecosystem functioning and human impact. The observations offer information on the behaviour and migration of marine organisms to better populate ecosystem models through holistic assessment over space and time, technology fit for extreme environments and observation strategies for complex sea basins, such as the Arctic Ocean (environments across borders);
- **Build on existing mechanisms to further connect ocean observing and marine monitoring technology developers, ocean observation operators and user communities across the public and private sectors and – where appropriate – across domains**, to:
  a. Foster dialogue, exchange and innovation between technology developers, suppliers and users (e.g., the EOOS Technology Forum in Europe) and international initiatives (e.g., NOAAs U.S. Ocean Observing Enterprise, Global Ocean Observing System (GOOS), etc.);
  b. Promote new technology and innovation by ocean observing technology manufacturers (within Europe) across public and private sectors, to expand the range of existing variables, and to develop capability for sensors to monitor emerging parameters e.g. for biological variables;
  c. Connect to a broader range of users to ensure marine technology is developed for multiple applications, “design (marine technology) once, apply many times”;
- **Promote scalable ocean observing technology solutions (whilst preserving data quality), with direct involvement of the user community**, through:
  a. Promoting cost-effective solutions where sensors can be produced cheaply, and for larger-scale production and use;
  b. Supporting miniaturisation of technology, towards micro-sensors e.g. ‘lab-on-a-chip’ –omics and e-DNA sensors, and/or cost effective sensors, samplers and platforms that are fit for the transition from open ocean to coastal environments, and technology that can more easily adapt to ‘plug in’ new emerging sensors and data transmission requirements. This requires working with users for sensor testing and co-maintenance etc.;

- **Connect and operationalise marine data integration towards a more streamlined pipeline and 'data ecosystem', spanning all ocean observing and marine monitoring technology and data collection with interoperable data services and users**. Future sensors should be enabled with the capability for minimum and standardised metadata setting – in addition to near real-time data quality control and standardisation. This would move beyond the current capability where met-ocean data from a few limited parameters are streamed in near real-time for operational services, and could revolutionise the timely availability of marine data for use in web-based open science, ocean (and wider environmental) digital services (e.g., digital twins), high-performance modelling with predictive capability, to inform future scenarios, and in Machine Learning and wider Artificial Intelligence applications;
- **Incentivise international dialogue and best practice in marine technology development, including for scalability and for capacity development** to ensure ocean observation operators have the know-how and tools for marine technology, infrastructure and platform deployment, maintenance and operation, following international best practice to maximise the high quality, standardisation and interoperability of the resulting marine data, for all. This could be done through existing mechanisms e.g., EOOS Technology Forum and wider ocean observing fora.

## Market Pull

- **Increase market demand by developing lasting partnerships across the marine knowledge value chain e.g. from supplier to user, and between public and private stakeholders,** through:
  a. Strengthening coordination of ocean observation technology development at national (e.g., national authorities), regional (e.g. Regional Sea Conventions), pan-European (e.g. Marine Research Infrastructures), and global (e.g. Global Ocean Observing System (GOOS)) scales by working as a collective with an 'enterprise' mind-set to enhance a user-driven approach and to provide a reliable framework for companies to invest in new technology development, driving market demand after the initial development phase;
  b. Operationalising dialogue and feedback connecting the science 'push' and commercial 'pull';
  c. Identifying and communicating the societal and economic benefits and value of ocean observing activities and technologies to policymakers, industry, and broader society.
- **Create a European facilities pool for ocean observation technologies**, similar to International examples (e.g. NOAA in the U.S.), to widen the market pull for existing 'niche' applications and thereby extending the reach and diversity of users of ocean observing technology in terms of geographical, platform and domain demand;
- **Promote cooperation across the ocean observing technology community to increase the purchasing power for operators to buy ocean observing technologies "in bulk", thus increasing the market demand.** This could be done in cooperation with Marine Research infrastructures and wider EOOS;
- **Strengthen international cooperation in ocean observation technology development** to ensure EU ocean observation technology is useable beyond the EU market, to diversify and expand the market beyond Europe.

## Finance

- **Extend and innovate funding cycles towards less volatile, longer-term planning and sustainable financing of ocean observing technology**, through:
  a. Simplifying EU funding mechanisms for technology development and purchasing, adding incentives for the private sector – in particular Small-Medium Enterprises (SMEs) – to reduce geographical or sector-specific silos, and to promote public-private investment;
  b. Assessing and implementing a more optimal time-span for ocean observing technology R&D project funding, to provide the necessary support to turn R&D prototypes into significant European market capabilities, with a high Technology Readiness Level (TRL);
  c. Enabling mechanisms to make new sensors in test/pilot phases accessible for intermediate and/or end-users to deploy, test and feedback to manufactures, to fast-track the route to market, whilst minimising investment and/or risks;
  d. End-to-end financing of marine technology to include sensor hardware and software, data collection, technology maintenance, data and metadata standardisation, transmission and integration, including timely delivery of data into EMODnet and Copernicus Marine Service;
  e. Considering a funding feedback loop whereby profits from mature technologies can be used to further invest in new emerging technologies.
- **Connect accelerator programmes with ocean experts, finance and business experts, and wider mentors,** to help scale-up new ventures in the growing market for ocean observing technology, driven by - and meeting the needs of - the users;
- **Diversify financial mechanisms to promote co-funding for ocean observing technology across domains and disciplines**, to transform 'niche' marine technology designed for a specific marine/maritime use, to meet more diverse applications and thereby broaden the user base, encouraging venture capital for wider technology market applications.

## Ocean Observing Gaps and Requirements

- **Create mechanisms – building on existing methodologies - to regularly conduct community efforts evaluating ocean observing gaps and requirements and to synthesise across sectors, repeating these activities at regular intervals.** The EU has high capability but these are currently spread over multiple communities and lags behind the coordinated knowledge of gaps in remote (satellite-derived) observations;
- **Comprehensively assess data adequacy, data accessibility and data gaps** to fully identify if a gap may be a result of inadequacy or inaccessibility of the available data available, or if true gaps remain in the current ocean observing system, through:
  a. **Promoting the benefits and mechanisms for data sharing (e.g. with EMODnet and Copernicus Marine Service), to ocean observing coordination efforts of Member States, associated countries and regions (e.g. through Regional Sea Conventions) and at EU level** to further reduce duplication of effort, integrate existing data and reduce costs of future data collection;
  b. Strengthening **cooperation for ocean observation and marine data collection and sharing**

**within the EU and with non-EU countries** (e.g. through EOOS Operations Committee and GOOS National Focal Points) to increase the availability of national and regional *in situ* marine data through EU marine data services EMODnet and Copernicus Marine Service;

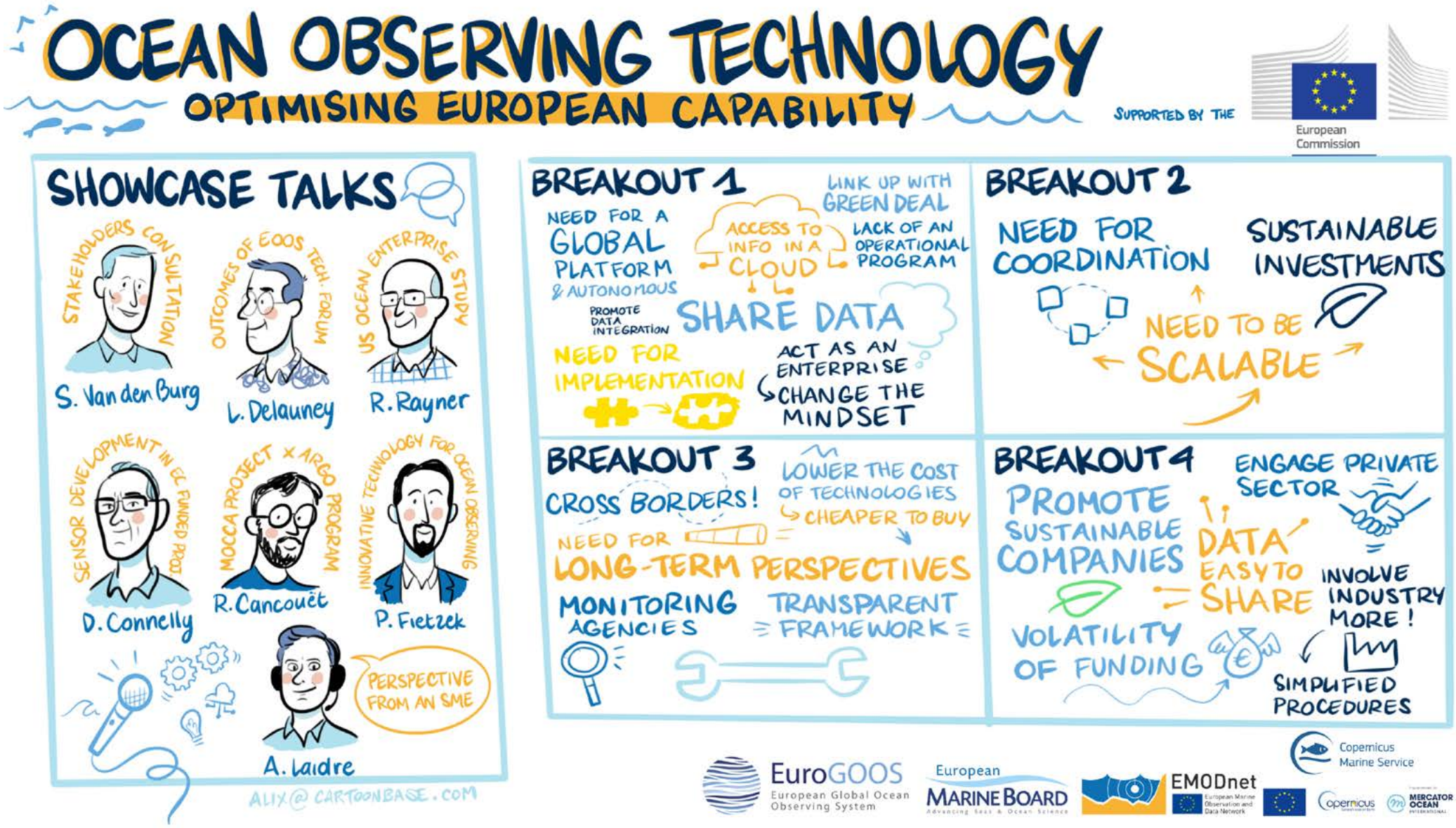
c. **Improving the integration and data sharing across ocean observing and marine monitoring assessments for legislative purposes (e.g. the EU Birds and Habitats and EU Marine Strategy Framework Directives);**
d. **When funding future contracts – both public and private – ensure that contracts include a requirement that explicitly mention EMODnet and Copernicus Marine Service as the EU services where data producers should submit marine data for long-term integration,** thereby expanding the data provision in these integrated, standardised and harmonised data sets, to further enable assessments of ocean observing gaps and requirements;
e. **Strengthening partnerships between *in situ*, satellite (remote sensing) and modelling communities to enable more holistic ocean observation and marine data integration, leading to easier identification of real gaps, and the opportunity to fill these gaps;**
f. **Actively promoting cooperation, co-design and data sharing from the private sector, civil society and wider citizens**, to fully bring in the diversity of user needs and requirements, and to further integrate data from diverse sources e.g. citizen science, in existing open data sharing platforms for re-use, including in data adequacy assessments;
g. **Expanding data adequacy assessments beyond European seas to include full Ocean basin scale assessments** (e.g., for the Atlantic Ocean and Arctic Ocean).

→ **Build on, integrate and innovate existing methodologies to assess ocean observation gaps and requirements (e.g., the EMODnet Sea-basin Checkpoints, Copernicus Marine Service, EuroGOOS, European Environment Agency (EEA)) to**:

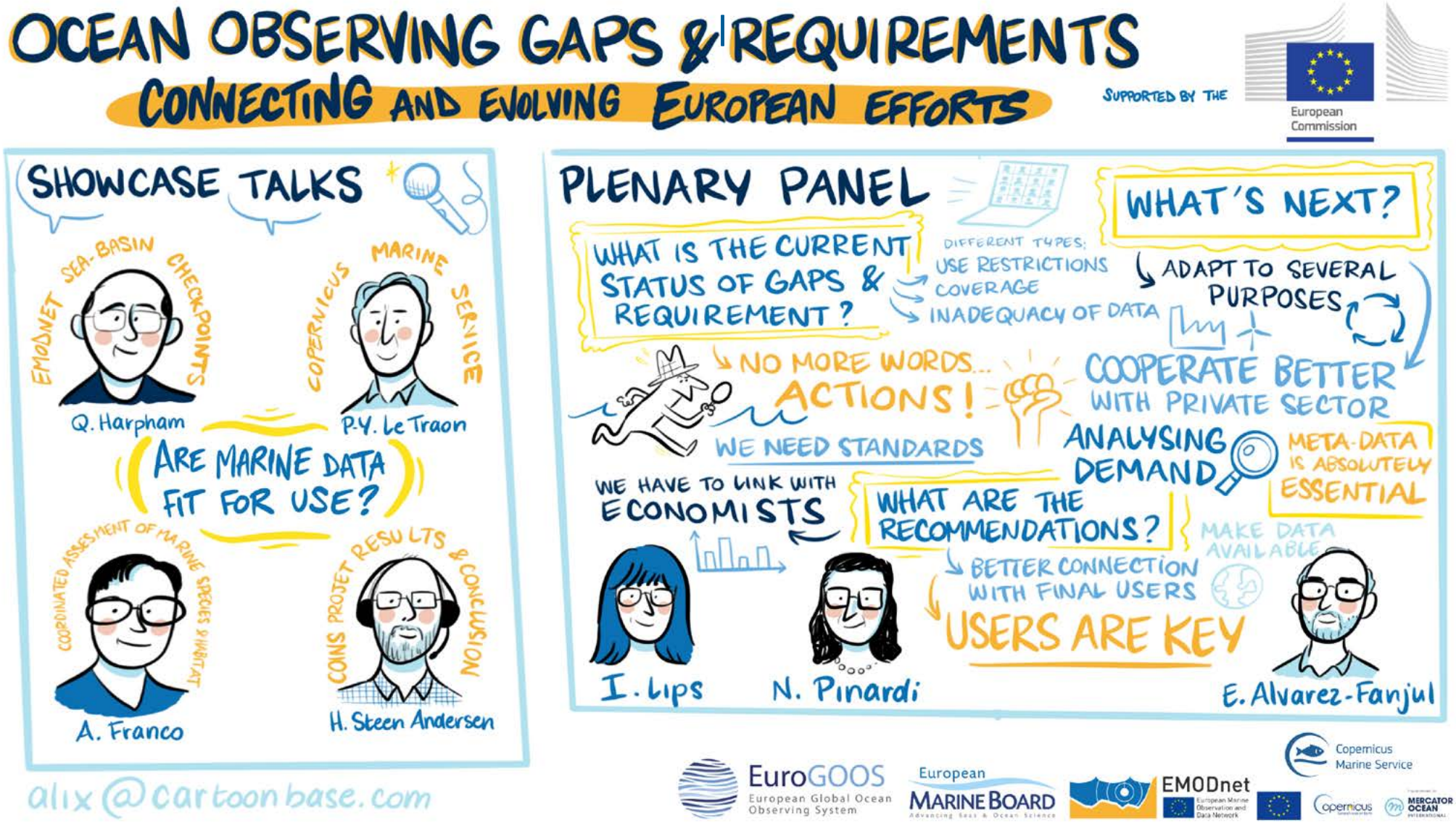
a. Shift from science-driven to user-driven approaches to identify ocean observation gaps and requirements and to move towards fully integrated, holistic assessments across data analysis and modelling communities, and to connect *in situ* with satellite-derived data;
b. Move from single user requirements to multiple, inter-connected, cross-border requirement identification, including cross-sectoral needs;
c. Facilitate active and operational feedback loops to connect the marine knowledge value chain as a "data ecosystem" with regular feedback on user requirements to inform future ocean observing technology and system design;
d. Design future ocean observing gaps and requirements assessments to evaluate current monitoring systems and data collection frameworks around user requirements;

→ **Further identify the different kinds of user requirements** (e.g. data quality, coverage, resolution, sustainability, integration) and the (multiple and evolving) purpose(s) for the use of the data, in order to identify gaps and requirements relevant for the user;

- **Enhance current capability and community application of metadata standards, and current exchanges on best practice** (e.g., EMODnet, Copernicus Marine Service, the International Oceanographic Data and Information Exchange (IODE) of the Intergovernmental Oceanographic Commission (IOC) of UNESCO Ocean Best Practices System (OBPS) initiative), to have simplified, user-friendly standards that will be a game-changer for data interoperability and re-use, and to aid the private and public sector in working together in a more coherent way towards "Create good metadata once, and be thanked many times.";
- **Promote collaboration across the marine knowledge value chain between marine data services, users, ocean observing and marine monitoring operators and implementers,** ensure more exchange on societal value and benefits of ocean observing and user gaps and requirements to inform ocean observing system design;
- **Diversify and expand the expertise involved in ocean observing gaps and requirements setting and design to enable cost-benefit analyses to be integrated into existing assessments,** e.g. through collaboration with economists, socio-economists, human activities at sea, etc.;
- **Incentivise observing of Essential Ocean Variables (EOVs) and Essential Biodiversity Variables (EBVs)**, towards more systematic approach to address major gaps in ocean variables - particularly biogeochemical and biological;
- **Encourage Member States to take a proactive approach to further connect existing national assets in ocean observation, coordinating with marine data and information services to optimise the assessment of ocean observational gaps, efforts and data availability.** Additional coordination is also recommended at EU level, to ensure interoperability. These actions will further enable the principles of measure once and using many times, to promote efficient and integrated assessments and sharing monitoring best practice across EU Member States;
- **Encourage the private sector to collect and share more data,** e.g. from Blue Economy operations including windfarms, aquaculture, etc. The win-win benefits (e.g., offered by EMODnet and Copernicus Marine Service) for providing access to free, integrated data, data products and services, could be further communicated by these marine data services to show the value of cooperation;
- **Coordinate EU contribution to global initiatives**: The UN Decade of Ocean Science for Sustainable Development provides an opportunity to collectively contribute EU expertise, capability and results on ocean observing gaps and requirements and ocean observing system design to international efforts, such as GOOS and the G7 and the UN 2030 Agenda, enabled through GOOS National Focal Points and EU initiatives e.g. EOOS, EMODnet, Copernicus Marine Service, GEO Blue Planet EU office and the EU4OceanObs project.




*Graphic recordings of the EC Ocean Observation: Sharing Responsibility event, 18 June 2021, Session 2: Ocean Observing Technology. Credit: Alix Garin (CartoonBase)*




*Graphic recordings of the EC Ocean Observation: Sharing Responsibility event, 18 June 2021, Session 2: Ocean Observing Gaps and Requirements. Credit: Alix Garin (CartoonBase)*

# 3. EVENT AGENDA

## EC OCEAN OBSERVATION EVENT (ONLINE)

### 18 June 2021, 13:30-17:00 CEST

| | |
|---|---|
| 13:30-13:40 | **Introduction**<br>**Andreea Strachinescu,** EC DG MARE<br>**Zoi Konstantinou,** EC DG MARE (Meeting Chair) |
| | **SESSION 1: OCEAN OBSERVING TECHNOLOGY: OPTIMISING EUROPEAN CAPABILITY** |
| 13:40-14:20 | **Short showcase talks**<br>⇢ **Sander van den Burg, WUR:** Improving market uptake of European technologies: lessons from stakeholder consultation<br>⇢ **Laurent Delauney, Ifremer:** Outcomes of the EOOS Technology Forum<br>⇢ **Ralph Rayner, NOAA IOOS**: The US Ocean Enterprise Study as an example of stakeholder engagement<br>⇢ **Doug Connelly, National Oceanography Centre:** Sensor development in EC funded projects: FP6 to Horizon Europe<br>⇢ **Romain Cancouët, Euro-Argo ERIC:** How MOCCA project contributed to strengthen European manufacturers position in Argo program<br>⇢ **Peer Fietzek, Kongsberg Maritime:** Innovative technology for ocean observing<br>⇢ **Andri Laidre, Flydog Marine:** Perspective from an SME |
| 14:20-15:00 | **Breakout discussions:** 4 break-out groups all discussing the same 3 topics.<br>***Facilitators:*** *Christos Arvanitidis (LifeWatch ERIC), Sheila Heymans (EMB Secretariat), Henning Wehde (EuroGOOS), Juanjo Dañobeitia (EMSO ERIC).*<br>***Rapporteurs:*** *Ana Lara-Lopez & Vincente Fernández (EuroGOOS Secretariat), Nicolas Pade & Ioulia Santi (EMBRC ERIC), Ángel Muñiz Piniella & Britt Alexander (EMB Secretariat), Kate Larkin and Nathalie Tonné (EMODnet Secretariat).*<br>1. **Technological Research and Innovation** - What are the priorities for developing new marine observing technology, considering the future requirements e.g. EU Green Deal, UN 2030 Agenda, etc.?<br>2. **Market pull** – How can we create the conditions for European technology to be more attractive to the market (end users) and encourage private companies (manufacturers) to scale up?<br>3. **Finance** – Are there any incentives that could be put in place to attract investment in mid-high Technology Readiness Levels (TRLs) of European marine technology from private companies (manufacturers) to make them accessible to the market (end-users)? |
| 15:00-15:10 | *Virtual Coffee Break* |
| 15:10-15:30 | **Report to plenary on Session 1**: key recommendations from 4 break-out discussions |

| | SESSION 2: OCEAN OBSERVING GAPS AND REQUIREMENTS |
|---|---|
| 15:30-16:00 | **Introduction to session: Kate Larkin**, EMODnet Secretariat (Meeting co-Chair)<br>**Short showcase talks** on key methodologies for Ocean observing gaps and requirements in Europe<br>⇢ **Quillon Harpham,** HR Wallingford: EMODnet Sea-basin Checkpoints: Results and challenges – are marine data fit for use?<br>⇢ **Pierre-Yves Le Traon,** Copernicus Marine Service / MOi: CMEMS Ocean Observing Gaps and requirements<br>⇢ **Anita Franco,** Estuarine & Marine Ecological Consultant: Coordinated Assessment of Marine Species and Habitats under the BHD and MSFD: Actions for Improvement<br>⇢ **Henrik Steen Andersen,** European Environment Agency (EEA): COINS project results and conclusions |
| 16:00-16:50 | **Plenary Panel: Evolving ocean observing gaps and requirement setting**<br>*Structured discussion, in plenary, with audience Q&A*<br>***Panel Chair:*** **Nadia Pinardi,** UNIBO / EMODnet Mediterranean Sea-basin Checkpoint Coordinator<br>***Panelists:***<br>⇢ **Inga Lips**, EuroGOOS / EOOS Operations Committee<br>⇢ **Enrique Alvarez Fanjul**, Puertos del Estado / EuroGOOS<br>⇢ **Quillon Harpham**, HR Wallingford / EC Marine Knowledge expert group / EMODnet North Sea-basin Checkpoint Coordinator / EMODnet Associated Partner<br>⇢ **Pierre-Yves Le Traon**, CMEMS / MOi<br>⇢ **Henrik Steen Andersen,** EEA<br>⇢ **Anita Franco**, Estuarine & Marine Ecological Consultant |
| 16:50-17:00 | Closing |

# 4. EVENT REPORT

## 4.1. WELCOME & INTRODUCTION

**Zoi Konstantinou** (European Commission Directorate-General for Maritime Affairs and Fisheries - EC DG MARE) opened the event and welcomed the participants. She highlighted that the discussions would focus on how to optimize European Ocean observing technology, and on ocean observation gaps and requirements. She noted that the 130 registered participants (of which 90 attended) were from 16 European Union (EU) Member States, and from six non-EU countries. Participants represented several key organizations and networks from the European and global Ocean observation communities (see box 1).

**Andreea Strachinescu** (EC DG MARE) welcomed and thanked the participants, as their input was strongly needed. She mentioned that Ocean observations are often taken for granted, but European Union (EU) services such as EMODnet and Copernicus rely on these observations. She stated that this is the rationale for the EU initiative on "Ocean observation – sharing responsibility"[9], which aims to achieve a common EU approach for measuring once and using the data for many purposes. She highlighted that the consultation on this initiative yielded 159 responses, and the proposal for this initiative has now been sent to the Regulatory Scrutiny Board. She concluded by reiterating the need for better communicating the importance of Ocean observations at all levels.

*"The EC public consultation on Ocean observation showed universal agreement on the need for better coordination at national, sea-basin and European levels, between the different communities involved in ocean observation."* Andreea Strachinescu

### Box 1: Participants' poll results

**How do you identify/consider yourself and your professional activities?**

- (29%) Ocean observations / marine data collector and/or provider
- (25%) Ocean observation infrastructure manager (manager, other)
- (5%) Data manager
- (29%) Government / policy (national authority, regional, EU, other)
- (15%) Service provider e.g. data service, web service
- (3%) Manufacturer of ocean observation sensors, platforms, infrastructure
- (29%) User of ocean observation / marine data or data product
- (0%) Funder of ocean observation / marine monitoring
- (15%) Other

*A total of 51 responses were received (selecting multiple options was possible).*

9/ https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/12539-Ocean-observation-sharing-responsibility_en

## 4.2. SESSION 1: OCEAN OBSERVING TECHNOLOGY: OPTIMISING EUROPEAN CAPABILITY

### Showcase talks

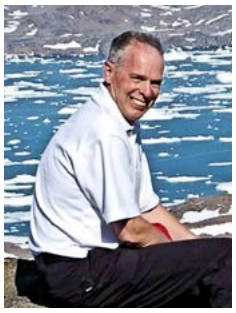
**Zoi Konstantinou** (EC DG MARE) introduced the first session of the event consisting of seven short showcase talks, presenting different perspectives on Ocean observing technology, followed by breakout discussion groups.

**Sander van den Burg** (Wageningen University & Research – WUR) presented the main outcomes from the report on "Uptake of new technology for Ocean observation" (see box 2), presenting the main stakeholder feedback on improving market uptake of European technologies from a stakeholder consultation. He explained that the purpose of this study was to understand the European market for Ocean observing technologies. The study compared the European and United States (U.S.) markets, and highlighted that both sides of the Atlantic Ocean admire each other and have their merits. He added that the demand was for reliable technology, and buyers did not consider the country of origin important. He listed some challenges related to technology development, finance and international cooperation, including that not much of the funding for technology went into the personnel needed for their operation and maintenance, or the analysis and sharing of data generated. Looking ahead, he highlighted that there should be a shift from national thinking towards thinking as a global community, and he re-iterated the importance of data governance.

*"It's important that future Ocean observation sensors and platforms have the technological capacity to both stream data and – in some cases – use 'smart sensor systems' to analyse the data collected. This capacity is lagging behind, but developments in artificial intelligence, machine learning and big data could help."* Sander van den Burg

**Laurent Delauney** (Ifremer, Chair of the European Ocean Observing System (EOOS) Operations Committee) presented the outcomes from the first EOOS Technology Forum (see box 2), which took place in October 2020 and was part of the EOOS Implementation Plan. The objectives of the Forum included the need to break down barriers between the technical and scientific community and the manufacturers of Ocean technologies. The event was hosted by EuroGOOS at the Sea Tech Week virtual event, and 39 companies participated world-wide. He highlighted that the main outcome was the need to establish a permanent platform in Europe to overcome fragmentation and enhance the visibility and accessibility of marine technology to the diverse ocean observing community creating a win-win situation. He finalized by listing other key points on how the EOOS Technology Forum could help with the identification of current and future trends in technology, and fostering continuous dialogue between different stakeholders in the public and private sectors in Europe.

*"The EOOS Technology Forum aims to bring together and break down the barriers between marine instrument manufacturers, technicians, technologists and scientists in and between the public and private sectors in Europe."* Laurent Delauney



**Ralph Rayner** (United States (U.S.) National Oceanic and Atmospheric Administration – NOAA, US Integrated Ocean Observing System – IOOS) presented the U.S. Ocean Enterprise Study from 2020 (see box 2) as an example of stakeholder engagement. Ocean Enterprise is a NOAA initiative to support Ocean technology, and the purpose of the study was to understand the scale and scope of the business activity in Ocean observation and forecasting, and make a comparison with the situation in 2015. He highlighted that the number of companies, export value, revenue and employees had increased during these five years. He also introduced the Benefit for Ocean Observation Catalogue (BOOC), a catalogue of use cases that demonstrate the added value of Ocean observation for end users. For the future support to the US Ocean observing capability, he listed the need to create greater awareness of the benefits; to raise the profile of business activity; to better connect NOAA with the users of the data and information; and to target the Department of Commerce (responsible for NOAA) to support the further development of the Ocean technology market.

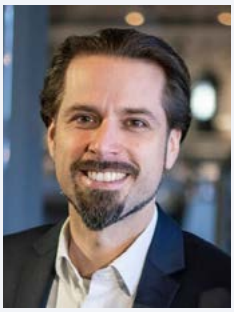
*"The NOAA IOOS Open Enterprise Study focuses on understanding and quantifying US business activity in two of the main elements of the Ocean observation value chain. In addition, the 'Benefit for Ocean Observation Catalogue' assesses the end-user benefits of Ocean observations by collecting, collating and reporting all available public and private Ocean observation use cases."* Ralph Rayner

**Douglas Connelly** (National Oceanography Centre – NOC) presented his experience in sensor development within EC funded projects, from Framework Programme 6 to Horizon Europe. He highlighted that one of the benefits of EU funding is the ability to build communities and partnerships that outlive the projects. He foresaw that in the future this will continue under Horizon Europe, and new initiatives such the European Marine Board report on sustaining *in situ* Ocean observations (see box 2) and the UN Decade of Ocean Science for Sustainable Development would influence how technology developments would be funded. He closed by sharing some lessons, such as the need for research projects to have a science push (e.g. to study pollution) and commercial pull to be able to bring a product to market. This can be achieved by involving large and small companies from the outset in order to build long-term relationships.

*"One of the greatest strengths of European funding for technology is the ability to build a community of researchers that outlives a single project and itself can effect real change over longer periods of time."* Douglas Connelly

**Romain Cancouët** (Euro-Argo ERIC) gave a presentation on how the Monitoring the Oceans and Climate Change with Argo (MOCCA) project (see box 2) contributed to strengthening the position of European float manufacturers in the Argo programme. He began by introducing the Argo programme, which is an international initiative with strong support from European countries. He said that the MOCCA project, supported by the European Maritime and Fisheries Fund (EMFF), enabled network upgrades in response to specific European research interests. He mentioned that the manufacturing of Argo float components is mainly dominated by U.S. companies, but thanks to the MOCCA project, a French manufacturer increased its reach in 2018 and 2019. This also informed the Euro-Argo-ERIC strategy. He finished by highlighting that research and development projects and sustained funding mechanisms to maintain the operations of these technologies are vital to develop market capabilities in Europe.

*"The MOCCA project contributed to strengthening the European manufacturers' position in the Argo program; of the 800 autonomous platforms deployed yearly, around 25% are from European countries."* Romain Cancouët



**Peer Fietzek** (Kongsberg Maritime) presented on innovative technology for Ocean observing, highlighting that active acoustics has had many innovative applications since its origins. He emphasized the need for a mature market for Ocean observing and listed some benefits for technology users, providers and society at large, including market clarity and transparency, cost savings and greater efficiency. He recognized that there were some promising changes in the landscape, such as the promotion of standards in science and academia, the development of the new Blue Economy, and the increase in environmental awareness of society. He recommended enhancing collaboration between academia and industry to mature the market by developing ambitious projects and initiatives to improve the communication between users and developers, noting that one example of an emerging initiative is the Ocean Observing Agora.

*"A mature Ocean observing market has many benefits for all stakeholders involved. The ongoing Ocean observing industry maturation is driven by both changes in the academic/science and industry sectors."* Peer Fietzek

**Andri Laidre** (Flydog Marine) shared his experience on the difficulties of being a start-up Small-to-Medium Sized Enterprise (SME) without funding or business track record in a market where the sales cycle is very long. He highlighted the problem of tenders to develop technology prototypes. This is a huge risk for companies, as product maturation is only done after the funding is finished. He presented the three questions that SMEs need to know: What are the new products that the market needs? Can they be sold at a bigger scale? Can they be sold on a longer scale? He finished by recommending to involve private companies and end users when developing monitoring technologies.

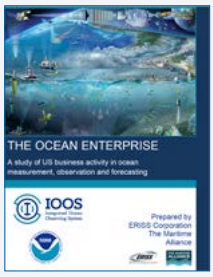
*"Entry barriers for a new company to enter the Ocean technology market are quite high, but Flydog Marine succeeded by asking three questions: What are the new products that the market needs? Can they be sold at a bigger scale? Can they be sold on a longer scale?"* Andri Laidre

# Box 2: Community outputs on ocean observation technology

**European Commission study on uptake of new technology for ocean observation.**
This study investigates the current state of the development of sensors and platforms to gain a better understanding of the uptake of new technology in ocean observation in Europe and outside Europe. The final report was published in April 2021. https://cinea.ec.europa.eu/news/state-development-sensors-and-platforms-ocean-observation-2021-07-02_en



**First EOOS Technology Forum.**
The 1st EOOS Technology Forum was organized in October 2020 by EuroGOOS through its Technology Plan Working Group, and the wider community, hosted at SeaTechWeek as a virtual event. The event was divided into two 2-hour sessions which included key presentations and two interactive workshops. Participants discussed the technological and operational aspects of ocean observing, exchanged knowledge and best practices, and explored new opportunities for collaboration. https://www.eoos-ocean.eu/download/EOOS-Technology-Forum_13-October_2020_Full-Report.pdf




**The Ocean Enterprise: A study of US business activity in ocean measurement, observation and forecasting.**
The Ocean Enterprise Study 2020 aims to understand the present scale and scope of U.S. business activity in the provision of products and services enabling ocean observations, measurements and forecasts and the commercial use of ocean information to support the needs of a growing ocean economy. The study is based on a detailed survey of nearly 900 U.S. companies engaged in the ocean enterprise space. The 2020 Ocean Enterprise Study delivers an update to earlier work conducted in 2015. https://ioos.noaa.gov/project/ocean-enterprise-study/


**Sustaining *in situ* Ocean Observations in the Age of the Digital Ocean. EMB Policy Brief 9.**
This document focuses on *in situ* Ocean observations and highlights their benefits, funding and governance challenges, and the investment needed for their transformation and sustainability. This Policy Brief propose the recognition of *in situ* Ocean observations as enabling infrastructure generating public-good data, which would deliver fit-for-purpose data and information supporting sustainable development, the 'Green Deal' and sustainable Blue Economy. https://www.marineboard.eu/publications/sustaining-situ-ocean-observations-age-digital-ocean


**Monitoring the Oceans and Climate Change with Argo (MOCCA): 5-year achievements.**
This document summarizes the results of the MOCCA project. This project, supported by the European Climate, Infrastructure and Environment Executive Agency (CINEA), allowed Euro-Argo to procure and deploy 150 new floats measuring temperature and salinity. MOCCA made available more than 20 000 quality-controlled data points to the oceanographic and scientific communities. https://www.euro-argo.eu/EU-Projects/Completed-projects/MOCCA-2015-2020

## Breakout discussions

**Zoi Konstantinou** (EC DG MARE) explained that the participants would split into four breakout discussion groups, each moderated by a facilitator and supported by two rapporteurs. She presented the questions to be answered, noting that all groups would discuss the same three questions (see yellow box below), and explained that lead rapporteurs would present the key findings from each session after reconvening in plenary at the end of the session.

**Facilitators:**

- **Christos Arvanitidis** (LifeWatch ERIC)
- **Sheila Heymans** (EMB Secretariat)
- **Henning Wehde** (EuroGOOS)
- **Juanjo Dañobeitia** (EMSO ERIC)

**Rapporteurs:**

- **Ana Lara-Lopez** & **Vicente Fernández** (EuroGOOS Secretariat)
- **Nicolas Pade** & **Ioulia Santi** (EMBRC ERIC)
- **Ángel Muñiz Piniella** & **Britt Alexander** (EMB Secretariat)
- **Kate Larkin** & **Nathalie Tonné** (EMODnet Secretariat)

**Questions (each breakout group covered all 3)**

- **Technological Research and Innovation** – What are the priorities for developing new marine observing technology, considering the future requirements e.g. EU Green Deal, UN 2030 Agenda, etc.?
- **Market pull** – How can we create the conditions for European technology to be more attractive to the market (end users) and encourage private companies (manufacturers) to scale up?
- **Finance** – Are there any incentives that could be put in place to attract investment from private companies (manufacturers) in mid-high Technology Readiness Levels (TRLs) of European marine technology to make them accessible to the market (end-users)?

The participants were randomly split in four breakout groups, where they discussed three key questions related to ocean observation technology, building on the short showcase talks given before. All groups started by listing what would be the priorities for developing future marine observing technologies, considering the needs and requirements for fundamental policies such as the EU Green Deal and the UN 2030 Agenda. Discussion groups recognized: the need to develop sensors on biogeochemical and biological (biodiversity and ecosystem functioning) variables; to increase the amount of data we gather today from the Ocean with autonomously operated instruments measuring several parameters, microsensors, technology fit for extreme environments; and the need for observation strategies for complex sea basins, such as the Arctic Ocean. However, technology development should consider cost-effective technologies that could be scaled up, for application in both open Ocean and coastal environments. Data quality, management and integration should be ensured, considering the technological capacity needed to analyse all the data collected in the future as well as the support funding, especially at the operational stage. Cross-disciplinary collaboration when developing platforms and sensors was also highlighted. This would enable the measurement of several parameters in one platform, and enable platforms to integrate future sensors more easily. The need for sound, long-term funding and capacity development (training) for observation and monitoring (in terms of sustainability aspects: maintenance, data integration, re-usability and analysis) was also advocated. While discussing which conditions could make European technology more attractive to end-users and encourage manufacturers to scale up, the discussion groups agreed on the need to stablish a mechanism to foster dialogue/ exchange/ interaction/ visibility between technology suppliers (private companies) and technology users (stakeholders from the

public sector). This is important for new companies trying to establish themselves in this niche market, and would facilitate the scoping of a market for a new technology (specially beyond prototype) and clarify the Technology Readiness Levels (TRLs) of technologies for investments. Special attention is needed to avoid the dominion of larger companies. This mechanism could also enable the set-up of Ocean observing priorities (also for research) and ambitious challenges (e.g. Seabed 2030) that could be discussed and co-designed. Finally, the discussion groups explored if any incentives could attract investment from manufacturers in mid-high TRLs of European marine technology to make them accessible to end users. As national-level funding plays an important role in stimulating Ocean observation technology development, call for tenders for new technologies could be done at European scale, facilitating the implementation of the new tools by the monitoring agencies (with appropriate benchmarking). This would reduce the national silos, promote other markets which could use marine technologies for other purposes and link up and create an environment that can encourage venture capital. Participants also highlighted that the current R&D funding model for marine technologies may not be the right model to facilitate investments, and implementation projects or sustained funding mechanisms need to be in place to turn these R&D innovations into significant European market capabilities. New sensors in test/pilot phases after proof of concept in projects could be freely accessible, to test without any investment or risks; and research infrastructures could be used as platforms for buying technologies "in bulk" and deploying and calibrating new sensors.

## Key messages

**To meet the requirements for ocean knowledge from future policies (e.g. EU Green Deal, UN 2030 Agenda, etc.), we need:**

- New marine observing technology, capable of gathering further biogeochemical and biological (biodiversity and ecosystem functioning) variables and also capable of measuring in areas where we don't observe so extensively (coastal and extreme environments), while developing more autonomy at less expense. Technology development should go hand in hand with a supporting capacity (data, training and operational funding) to ensure the use of the data gathered would inform these policies;
- To facilitate the establishment of a mechanism to bring together technology suppliers and users, such as the EOOS Technology Forum in Europe or the Ocean Observing Agora proposal by Ocean Observing Enterprise, GOOS and the Marine Technology Society at global level; to pool resources and boost the market pull;
- To rethink how Ocean observing technologies are developed in Europe and recognizse how funding models can catch up with technological innovation (and facilitate benchmarking). R&D projects are crucial to support technology innovation and testing in Europe, but may not be the right model to facilitate investments.

**Kate Larkin** (EMODnet Secretariat) took over the role of meeting chair and thanked the facilitators, rapporteurs and participants for the active discussions and interesting outcomes. She closed session 1.

## Box 3: Participants' poll

**Which of the three topics on Ocean observing technology do you think is a priority for the EU to focus efforts on?**

- (60%) Technological Research and Innovation
- (40%) Market pull
- (49%) Finance
- (4%) No opinion
- (9%) Other (neither of above)

*A total of 55 responses were received (selecting multiple options was possible).*

# 4.3. SESSION 2: OCEAN OBSERVING GAPS AND REQUIREMENTS

**Kate Larkin** (EMODnet Secretariat) opened the session by highlighting that Europe already has a strong capability for assessing gaps and requirements in Ocean observation throughout the value chain using a diverse range of methods. She noted that the expected outputs from this session included the assessment by the community on current key methodologies and initiatives, ideas on how to evolve these to meet future needs and among others EU Green Deal targets, and recommendations on where to concentrate efforts. She explained that four speakers would present examples of existing European activities in the area of Ocean observing gaps and requirements, and a panel discussion would follow.

## Showcase talks

**Quillon Harpham** (HR Wallingford/ member of EC Marine Knowledge expert group/ coordinator of EMODnet North Sea-basin Checkpoint Coordinator/ EMODnet Associated Partner) presented the results and challenges from the EMODnet Sea-basin Checkpoints methodology. He explained that these studies took place in 2013-2018 in all European sea-basins as a way to understand if current Ocean observation and monitoring systems were fit to address different real-life challenges, such as wind-farm siting or oil-spills. He highlighted that this innovative methodology focused on the users and how they were using the data. Detailed reports per sea-basin are available on the EMODnet website (see box 4), highlighting the common messages including that sampling gaps could be filled through better partnerships with satellite and modelling communities; Essential Ocean Variables (EOV) could be used and many biological variables would benefit from more standardization and a more systematic approach to monitoring; and collaboration with non-EU countries. He finished by emphasizing the importance of understanding the data usage, the opportunities that the synergies with satellite observations can offer, and the need to create a simple framework to evaluate the use of data.

*"EMODnet Sea-basin Checkpoints are an innovative method, evaluating how well the current monitoring systems and data collection frameworks provide data to meet the needs of users. Rather than doing a desk study, real-life activities and issues are simulated querying users for what purpose they need marine data."* Quillon Harpham

**Pierre-Yves Le Traon** (Copernicus Marine Service - CMEMS / Mercator Ocean international – MOi) presented the CMEMS studies on Ocean observing gaps and requirements and their main findings. He began by introducing CMEMS as a user and policy driven operational service and by highlighting the dependency of their services on both satellite (sentinels) and *in situ* components. He then explained that several present and future requirements for *in situ* and satellite observations have been defined and outlined in a series of reports (see box 4), based on impact assessments and expert analyses, with feedback loops across the value chain. He finished by listing some requirements for satellite and *in situ* observations, such as the need to develop new capabilities for satellite observations and address major gaps for biogeochemical *in situ* observations.

*"The specific role of the Copernicus Marine Service for agencies in charge of the observing system is to work on requirements, design, impact assessments, and, of course, to advocate for the long-term sustainability of the observing system. That's the start of the value chain that goes from observation to the end-user. Without observations, we cannot provide services."* Pierre-Yves Le Traon

**Anita Franco** (Estuarine & Marine Ecological Consultant) presented some results and actions for improvement from the Coordinated Assessment of Marine Species and Habitats under the EU Birds and Habitats Directive (BHD) and the EU Marine Strategy Framework Directive (MSFD) (see box 4). She began by introducing the objective, scope and methods of the study, which was commissioned by the Directorate General for Environment from the EC. She mentioned that they focused on marine species and habitats covered by both Directives, as there was a need to have better coordination, alignment and efficiency of the monitoring, assessment and reporting processes between the BHD and MSFD. She then listed the main recommendations formulated at European level, such as changes in policy and reporting requirements and guidance to Member States; and at Member State level, such as the need for improved biodiversity monitoring and efficiencies in data collection and flow, and build Member State capacity and internal cooperation.

*"The Coordinated Assessment of Marine Species and Habitats recommended the feasibility of non-traditional monitoring methods, such as telemetry and tracking methods, as well as participatory and citizen science, alongside the work undertaken by international working groups and existing monitoring networks."* Anita Franco

**Henrik Steen Andersen** (European Environment Agency – EEA) presented results and conclusions from the Copernicus Observations *In Situ* Networking and Sustainability (COINS) project. He briefly introduced the Copernicus *In Situ* Component and reiterated that Copernicus could not deliver services without *in situ* data. He then presented the COINS consortium and mentioned that the aim of the project was to create a picture of common gaps and requirements and common data by looking across the Copernicus services, including the Copernicus Marine Service. Finally, he listed some results from a detailed coastal data needs study with a focus on Spain, highlighting

the need to measure biogeochemical variables in coastal areas and to improve the operational reliability of the monitoring. These reports are available online (see box 4).

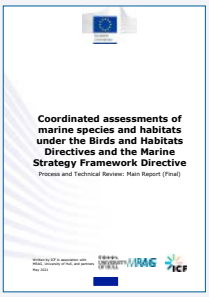
*"Copernicus cannot deliver according to end-user requirements without access to in situ data. As such, the operational and long-term nature of Copernicus underlines the need for sustainable and reliable essential observing systems."* Henrik Steen Andersen

## Box 4: Community documents on European Ocean observing gaps and requirements

**EMODnet Sea-basin Checkpoints.**
Between 2013 and 2018, a series of EMODnet Sea-basin Checkpoints assessed the quality of the current observation monitoring data at the level of the regional sea basins. This innovative methodology assessed data adequacy and ocean observing gaps and requirements from the user-perspective, by 'stress' testing the data availability and fitness-for-use against specific end-user challenges. Through this, the Sea-basin Checkpoints evaluated how well the monitoring systems and data collection frameworks provided data to meet the needs of users. In doing so, data gaps and duplications as well as significant bottlenecks were highlighted. Visit the EMODnet Sea-basin Checkpoints at https://emodnet.ec.europa.eu/en/checkpoints

Final Report (November 2018): https://emodnet.ec.europa.eu/sites/emodnet.ec.europa.eu/files/public/sea-basin_checkpoints_data_stress_tests_synthesis_2017.pdf


**Copernicus Marine Service requirements for the evolution of the Copernicus In Situ Component.**
Earth observation data from *in situ* components provide crucial and unique global ocean information along the water column. The provision of these data, used by CMEMS to derive more elaborated products, strongly depends on the proper specification of requirements, which have to be updated regularly to ensure the evolution of the service in response to user needs. This report by Mercator Ocean International, EuroGOOS and CMEMS partners assesses the CMEMS requirements for *in situ* observations, with a focus on European seas, following previous requirements gathering in the framework of the Global *In situ* Coordination (GISC) project led by the European Environment Agency (EEA). https://marine.copernicus.eu/sites/default/files/inline-files/CMEMS-requirements-In_Situ_03_2021_VF.pdf




**Coordinated assessments of marine species and habitats under the Birds and Habitats Directives and the Marine Strategy Framework Directive Process and Technical Review.**
The overall objective of the study was to establish an evidence-based understanding of the current level of coordination, alignment and efficiency of the BHD and MSFD monitoring, assessment and reporting on marine species and habitats. The study provides conclusions on the gaps and inconsistencies in processes, methods and assessments, and on Member State capacity and capabilities, and makes recommendations for action at a European and Member State level. https://ec.europa.eu/environment/marine/publications/pdf/BHD-MFSD_coordination%20study_Main_Final.pdf

**Kate Larkin** (EMODnet Secretariat) thanked the speakers, and passed the floor to Nadia Pinardi (University of Bologna - UNIBO/ EMODnet Mediterranean Sea-basin Checkpoint Coordinator), who introduced and moderated the panel discussion.

## Plenary panel discussion

**Nadia Pinardi** (University of Bologna - UNIBO/ EMODnet Mediterranean Sea-basin Checkpoint Coordinator) introduced the panelists. She highlighted that the identification of gaps and requirements for Ocean observation should continue and that Ocean observation should transition from a science-driven service to a user-driven service. She asked the panelists their views on the status of existing methodologies for assessing ocean observing gaps and requirements, and how to evolve and innovate existing methodologies in the future, and what would be their recommendations for the future.

**Panel Chair:**

- **Nadia Pinardi**, UNIBO / EMODnet Mediterranean Sea-basin Checkpoint Coordinator

**Panelists:**

- **Inga Lips**, EuroGOOS / EOOS Operations Committee Co-Chair
- **Enrique Alvarez Fanjul**, Puertos del Estado / EuroGOOS
- **Quillon Harpham**, HR Wallingford / member of EC Marine Knowledge expert group / EMODnet North Sea-basin Checkpoint Coordinator / EMODnet Associated Partner
- **Pierre-Yves Le Traon**, CMEMS / MOi
- **Henrik Steen Andersen,** EEA
- **Anita Franco**, Estuarine & Marine Ecological Consultant

The panelists highlighted that Ocean observation gaps and requirements analysis should focus on user requirements and the real-life challenges they face. Different users may have different requirements (e.g. quality, coverage, sustainability), so different gaps for the same observing system could be identified. Feedback loops across the value chain and simple evaluation indicators will also be necessary. The panelists agreed on the importance of addressing data adequacy and accessibility, which does not necessarily correspond to a lack of observations. Suggestions on how to increase data availability included to: concentrate on observing Essential Ocean Variables (EOVs), as a way to standardize and address in a more systematic approach major gaps in biogeochemical and biological variables; elaborate cooperation arrangements with non-EU countries, to make available, for instance, national *in situ* data in exchange of access to satellite data and services; explore the feasibility of adding non-traditional monitoring methods (e.g. citizen science) as source of data; strengthen partnerships with satellite and modelling communities to fill sampling gaps; and promote the use of simplified and standardized metadata records, as this is an essential component of data re-usability. Coordination and cooperation in data flow within and between Member States by using national centralized information systems to store and share data gathered for monitoring purposes was recommended, as well as to better coordinate, align and increase efficiency of the monitoring, assessment and reporting processes between relevant EU Directives. Further coordination at EU level beyond business-as-usual was also noted to be crucial, to connect the diverse - yet fragmented European capability. Finally, all panelists agreed on the need to act now at the occasion of the UN Ocean Decade and start addressing the gaps and requirements we already have, and to complement these with a cost-benefit analysis with the help from specialized economists.

## Panel take-home messages

- Shift from science-driven to user-driven marine services, and assess gaps and requirements from the user perspective;
- Recognize that insufficient data could be related not only to lack of observations, but equally well to inadequacy or inaccessibility of the data available, and that this has an enormous impact on the delivery to the requirements of end-users;
- Further EU action is needed (in addition to national efforts) to coordinate Europe's diverse - yet fragmented - ocean observation and marine monitoring community. This will reduce duplication, save costs and enable ocean observation capacity and data availability to be mapped against user requirements, informing future ocean observation design;
- Improve coordination in identifying gaps in data availability and accessibility, leading to increased efficiency of data use, which in turn can reduce costs;
- Complement gap and requirement assessments with cost-benefit analysis, to see if any changes are needed or whether gaps need to be assessed holistically;
- Metadata are essential. "Create a good metadata record once and be thanked many times";
- Act. We have good knowledge of gaps already, and the UN Ocean Decade provides an opportunity to fill these gaps and demonstrate that it can be done at European level.

## Box 5: Participants' poll results

**What could the EU do in the future to fill gaps in ocean observations and requirements?**

- (72%) Integrating existing methods e.g. sea-basin checkpoints, modelling analyses, etc.
- (42%) Co-design with Blue Economy from the start
- (51%) Trans-disciplinary including marine and socio-economic
- (24%) Basin-scale e.g. Atlantic Ocean
- (2%) Continue the current status
- (0%) No opinion

*Out of 54 responses (selecting multiple options were possible).*

## 4.4. CLOSING

**Kate Larkin** (EMODnet Secretariat) thanked all the participants, speakers, panelists, facilitators and rapporteurs for their valuable contributions. She acknowledged the work of Alix Garin (Cartoonbase), for summarizing the discussions in each session in a graphic recording and noted these had been made available on the EMODnet Open Conference virtual exhibition.

**Iain Shepherd** (EC DG MARE) added that this event had identified the need to increase European industry's participation in Ocean observation technology development, and the need to identify and fill the gaps – both at the national, sea-basin and European scale, building on the need to measure once and use many times. He noted that further communication from the EC about the next steps in the EC Ocean observation initiative were likely to be made available in 2022.

**Jan-Bart Calewaert** (EMODnet Secretariat) closed the meeting noting that what was discussed at the event critically underpins the Ocean knowledge value chain. He finished by saying that Ocean observation was a common concern and collective responsibility, which needs the input and continuous support from the stakeholders and experts, such as those invited to take part in this event. He closed the event by thanking the co-organizers for their support in preparing, implementing and reporting on the event, and to the EC DG MARE for convening and supporting the event.

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