

EVOLVING EUROPEAN OCEAN OBSERVING: CONNECTING COMMUNITIES FOR END-TO-END SOLUTIONS

CONFERENCE

21-23 NOVEMBER 2018

THE EGG, BRUSSELS

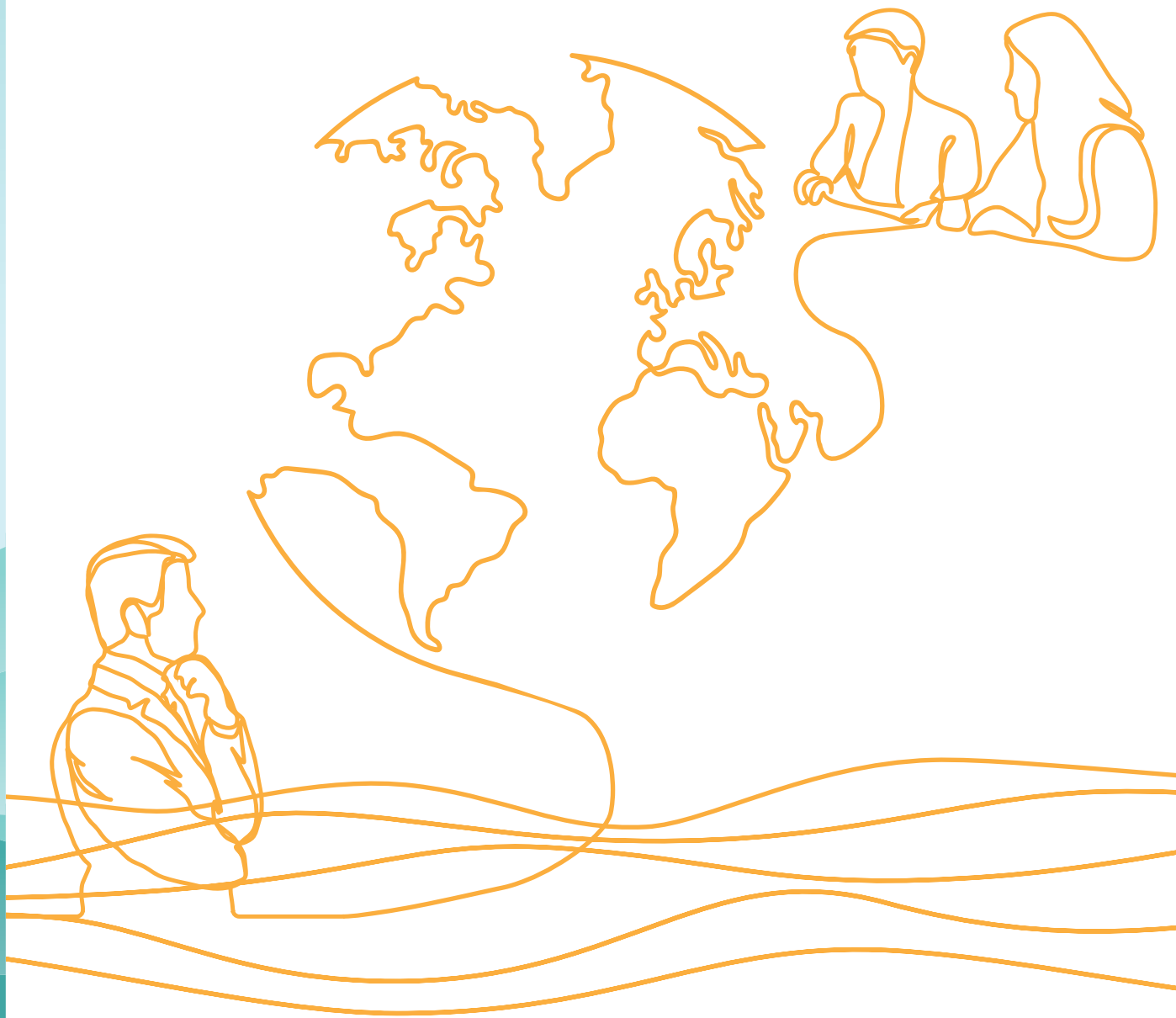


Conference Report and Call to Action

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The EOOS Conference 2018 was co-organised by the Secretariats of



EMODnet

European Marine
Observation and
Data Network



EuroGOOS

European Global Ocean
Observing System



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The organisers would like to thank all the participants for their engaging and invaluable contributions at the Conference. All of the >300 participants played a valuable role, ranging from speakers, chairs and panelists to poster and exhibit presenters, and the many moderators, rapporteurs and participants of the breakout discussion sessions. We wish to acknowledge the support of the European Commission, sponsors of the Conference, without whom this event would not have been possible.

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Foreword

We are at an important cross road for European ocean observation and monitoring. It is more than a decade since the launch of Europe's Integrated Maritime Policy in 2007 that provided a coherent framework to coordinate across sea-related policies. At a political level, there is growing recognition that ocean data are an enabler for the blue economy, crucial for assessing and achieving good environmental status of our seas and oceans, and indispensable for understanding and tackling major global issues such as climate change, marine litter, illegal fishing or marine protection. As a result, Europe's marine data collection has become much stronger and more diverse, with efforts shared across many different actors and stakeholder groups. There has been substantial progress in the infrastructures used to routinely monitor the seas and oceans, as well as in the ones used to deliver and assemble marine data and create knowledge in a way that is findable, accessible, interoperable and reusable (FAIR). However, whilst there has been momentum to coordinate within specific communities or regions, Europe's data collection effort still lacks coordination, sustained funding and a common vision.

In November 2018, over 300 European ocean observing and monitoring data collectors, data assemblers and users gathered in Brussels for the EOOS Conference 2018, to take stock of existing capacity, identify future priorities and co-design solutions for how to get there. This built upon a number of community activities over the past few years to develop a framework, strategy and common vision to strengthen Europe's coordination across existing ocean observing, monitoring and data collection initiatives. The 2018 Conference was pivotal in bringing so many people and diverse communities together. It recognised we already have many of the ocean observing and monitoring infrastructures, know-how, networks, mechanisms and instruments in place. The challenge now is to bring people, networks and systems closer together and to connect the existing fragmented landscape to make ocean observing even more relevant, cost-efficient and valuable to society. Whilst the value of ocean data is clear, we now need to go further, so that society sees ocean data and information as public utility and an additional source of wealth from the ocean in addition to its natural resources (minerals, fish etc.). With society moving towards decarbonisation and climate action, ocean data are essential for increasing sustainable clean energy generation from the sea can deliver crucial knowledge to understand ocean and wider earth system changes and inform the design of adaptation initiatives.

The demand for high quality, openly available marine data accompanied by user-oriented data products is growing. As a result, user communities are increasing and diversifying with many maritime industries now relying on national, regional and European open access data portals such as EMODnet and Copernicus for marine data, products and services. More data are also used in marine policy assessments than ever before, largely thanks to increasing efforts to improve data traceability and provenance. In short, the users are there and the expectations on ocean observing and monitoring are high. We now need to establish light but effective mechanisms for engaging actors across the full marine knowledge value chain to make

it more efficient and fit for use. European expertise has driven forward techniques to assess gaps and requirements for ocean observing and monitoring, with user-driven stress tests (e.g. EMODnet Sea-basin Checkpoints challenges) and observing system simulation experiments (OSSEs) just two promising methods to define the fitness-for-purpose of the existing systems. The extensive national and regional environmental status assessments for marine policies also serve to identify gaps and future ocean data needs. Future ocean observing system design should also capitalize on new scientific and technological developments to meet evolving societal needs, in the wider context of digitalisation and the move towards cloud computing.

The bottom line is that ocean data collection remains expensive. Cost-benefit analyses are crucial to demonstrate the value of marine data and derived products and services for society and to identify priority observations and key gaps to fill. Consolidating international best practices and developing realistic business cases for ocean observing and monitoring programmes will help to secure public and private investment and longer-term sustainability.

However, until we transform the way we communicate, coordinate, finance and use Europe's ocean observing and monitoring capability, including the people central to delivering it, the system will remain fragile and predominantly based on short-term national public funding. This is why the EOOS Conference was not just about connecting communities but also delivered a Call to Action. It calls on national and European organisations, and wider stakeholders, to step up and find concrete solutions and actions to consolidate national and European existing capacity. It also invites them to develop Roadmaps for the future evolution of these efforts is integrated, transparent and coordinated, to deliver marine data, data products and knowledge for the benefit of all society.

EMODnet Secretariat

Executive Summary

The first E00S Conference took place in Brussels from 21 to 23 November 2018, building on three years of community action to strengthen coordination of Europe’s capability in ocean observation, monitoring and data collection. More than 300 stakeholders gathered for 2.5 days to connect diverse observing and monitoring communities and those who rely upon their outputs and services.

The Conference followed a three-step programme to present insights from current capability, gather perspectives on the state-of-the-art and current best practices and identify solutions to the current fragmentation and lack of sustainability of ongoing data collection programmes and activities.

STAGE 1 Set the scene	STAGE 2 State-of-the-art & connecting communities	STAGE 3 Conclusions & forward look
<ul style="list-style-type: none"> • Look at current European ocean observing capability • Perspectives and reflections from community • Progress to date 	<ul style="list-style-type: none"> • State-of-the-art in European ocean observing • Lessons from past and ongoing coordination efforts • Exchange information and ideas for solutions • Connect communities via open dialogue 	<ul style="list-style-type: none"> • Key messages from Conference discussion • Perspectives and forward look on sustainability, integration and implementation • Best practices and required actions to strengthen Europe’s Ocean Observing capacity

The Conference showed that Europe’s ocean observing capability is strong. Both European countries and the EU have already invested significantly in ocean observing infrastructure, technology development and data management initiatives. And, thanks to a collective European effort to share marine data, good progress has been made in European initiatives such as the European Marine Observation and Data Network (EMODnet) and Copernicus, good progress has been made over the last decade to ensure that more data from ocean observations and marine monitoring are openly available for multiple use, including to increase our ocean knowledge, inform policy, create new opportunities for innovation and business development, improve productivity and reduce risks. However, the various ocean observing communities remain disconnected and there is no overall process for determining which observations are essential for achieving blue economy and societal objectives. The difficulty in setting up a more fit-for-purpose European observation system is not only money, but it is organisation. The European Ocean Observing Conference 2018 also highlighted the value of dialogue and connecting existing and emerging communities to improve collaboration and coordination, share and add value to existing efforts and to value ocean observations as a “public utility”, as for meteorological data, that benefit all of society. In order to be make this happen, it is now time to collaborate and move from concepts to concrete actions.

Driven by a broad range of observing communities and stakeholders that rely on ocean data and information, the Conference delivered a **Call to Action**. This communicates the inherent value of ocean observing and monitoring for society and calls on European countries and the EU to examine what is currently being done under their responsibility and to prioritize strategic planning and coordination efforts, working together towards a more concerted, fit for purpose and cost-effective European ocean observing capability. The Call to Action is being communicated to national, regional and European ocean observation, monitoring and data management actors, coordinators and funders. The uptake and impact of the Call to Action will be tracked 1 year after the Conference by Conference co-organisers, reporting to the wider ocean observation, monitoring and data management communities by Spring 2020.

Call to Action



Evolving European Ocean Observing Connecting communities for end-to-end solutions 21-23 November 2018, Brussels

What happens in our seas and oceans profoundly affects climate, weather and the livelihoods of billions who depend upon their resources. Technological progress is making marine resources more accessible, offering real solutions for clean energy and better health through resource-efficient food and breakthrough medicines. All these are essential to meet the needs of an increasing global human population if we are to avoid a climate catastrophe (IPCC; 2018¹).

Systematic observing and monitoring of our seas and oceans delivers crucial data and information to underpin the knowledge we need to revolutionise the blue economy² and improve our understanding of ocean health, geohazards, and the oceans' role in climate regulation. We therefore need to ensure that enough of the right observations are being made now and into the future.

European countries and the EU have already invested significantly in ocean observing infrastructure and technology. Numerous observing platforms and coordination networks exist; some activities are already well coordinated at national, sea-basin, European and global levels. More connections are now needed across all communities to ensure coherent priority setting, to foster collaborations, to increase efficiency and to provide long-term sustainability. We have to move beyond current short-term solutions to substantially enhance the applicability and value of ocean observations as a "public utility" for the benefit of all society.

We welcome the efforts undertaken to date to strengthen the coordination framework of ocean observing in Europe. An open and inclusive process is now imperative to move forward.

We therefore call on European countries and the EU to examine what is currently being done under their responsibility and establish roadmaps with specific actions and indicators to move towards a more integrated, transparent and coordinated approach. The following key actions should be undertaken:

- 1. Countries should coordinate all national marine and coastal data collection efforts to improve efficiency, and identify priorities and gaps to meet policy and societal needs. Observations should be standardised and operationalised within and across regional seas, building on the work done via existing regional coordination frameworks;**
- 2. EU agencies and authorities should consider how the EU can best rationalize its investment and activities related to ocean observing activities. This requires a concerted effort to ensure that different EU investments in marine and coastal data collection infrastructures are better connected and are linked to existing data management and sharing initiatives; and**
- 3. Both national and European authorities should support integration and drive innovation in infrastructure and technology development to reduce the cost and expand the coverage of ocean data collection, while optimising data analyses, synthesis and use.**

Possible further actions are suggested in an implementation plan prepared by some of the observing community³ which is a living document intended to encourage continued community contributions.

This Call to Action was launched at the EOOS Conference, 21-23 November 2018 in Brussels as the wider ocean observing and marine monitoring communities across Europe gathered to discuss "Evolving European Ocean Observing: connecting communities for end-to-end solutions".⁴ Progress of this Call to Action will be evaluated in one year's time by the members of the conference advisory committee, with support from the co-organising secretariats.

1 http://report.ipcc.ch/sr15/pdf/sr15_spm_final.pdf
2 All economic activities related to oceans, seas and coastal areas
3 <http://www.eoos-ocean.eu/strategy-and-implementation>
4 <http://www.eoosconference2018.eu/>

Conference Programme

CONFERENCE SESSIONS DAY 1 21 November 2018

Opening Session – Welcome and opening keynotes

The EOOS Conference 2018 was all about connecting communities, including those within the marine community and beyond. On Day 1 the stage was set for a 360° view of European ocean observing, and marine monitoring efforts, hearing perspectives from various communities and the background on existing efforts to coordinated within and across initiatives and stakeholder groups.

David Rose (LACS Training) opened the EOOS Conference by welcoming all participants to the event. As the Conference Master of Ceremonies, he gave an overview of the event, noting that with over 350 people registered, the EOOS Conference was a very well attended event with significantly more people than initially expected. He recognised the financial support of the European Commission and the collective effort to organise such a large event. He then outlined the purpose of the Conference which existed of three parts: (i) setting the scene; (ii) state-of-the-art, showcasing current capability and best practice and connecting communities over a range of key themes, and finally; (iii) Conference conclusions and key messages with a forward look on sustainability, integration and implementation of Europe’s ocean observing capability.



He noted the organising committee designed the Conference to stimulate interaction and dialogue through a variety of formats including Question and Answer sessions following presentations in Plenary, smaller group breakout discussions, poster pitch presentations, exhibits and evening networking sessions. He encouraged the audience to be active discussing the Conference on Twitter (#EOOS Conference18). He also explained that an idea box would be available at the Conference for participants to post specific ideas on EOOS and its future implementation that could be considered in the coming weeks by the EOOS Steering Group and wider community.



Jan-Bart Calewaert (European Marine Observation and Data Network, EMODnet) welcomed participants as Head of the EMODnet Secretariat, lead organisers of the event. He outlined the importance of the EOOS Conference, bringing together the strong and diverse, yet fragmented ocean observing and monitoring communities in Europe at a time when there was recognition of the need to work more together. He also welcomed inter-

national experts from beyond Europe, noting their perspectives and best practices were also vital to help focus on the key objective of EOOS, namely making existing efforts better aligned and fit for purpose so that high quality, standardized ocean data can be made available for society. He encouraged participants to take the opportunity at the Conference to actively engage and to share and develop ideas so that a clear agenda with next steps could be identified.

“There is a general understanding that we must work more closely together to coordinate existing capability and find an agreed process to ensure future ocean observing and monitoring systems achieve blue objectives and are fit for purpose and use by society. Now it’s time for action.”

Jan-Bart Calewaert

Ricardo Serrão Santos

(Member of European Parliament) began his opening speech noting that, despite a growing awareness, the majority of people still do not realise the importance of our seas and oceans as stabilising forces in the earth system, or the dependency we have on the ocean. He noted that especially in times of fast and big change, we depend on advancing technologies and constant and continuous data to understand the ocean. These data are vital to help solve pressing issues such as managing marine resources including fish stocks, predicting the future effects of climate change and meeting energy demands, whilst underpinning the blue economy. He recognised that this is a global issue and that regional efforts need to be tackled through international cooperation e.g. through the Sustainable Development



“Ocean observation depends on coherent and consistent systems, platforms and sensors that collect data, on data collection centres, and people: scientists, engineers and data analysts.... We need to speak the same language amongst different data collectors and monitoring services to share data and techniques and have a clear agenda of what to do next and how to achieve it together.”

Ricardo Serrão Santos

Goal 14 and other goals of the UN 2030 Agenda. He remarked that much progress had already been made to connect communities, with EOOS being featured in many policy publications. He called on the European Union to continue supporting activities through Horizon Europe and on the international community to support further coordination of the disparate European ocean observing efforts, including Europe’s outermost regions and overseas territories, and to bring EOOS to the global agenda.



Gilles Lericolais

(Ifremer, France) gave perspectives on behalf of the European Marine Board (EMB) on requirements for ocean observation and monitoring. He recognised the growing societal recognition of the value of ocean data and time series as inputs for modelling and delivering knowledge and products for society. He added that the Global Ocean Science Report shows that Europe has a good capacity and is well placed to deliver innovative ocean observations, products and technologies that are generally well supported by European funding, Joint Programming and national funding. But, he noted, more coordination is

still needed across stakeholders, geographical borders and scales. He explained that the Integrated Marine Policy and the creation of EMODnet make for marine an data and data products more accessible and had been essential in strengthening the value chain for ocean observing. He added that cooperation by EMB and EuroGOOS had catalyzed stakeholder dialogue on the development of EOOS, with EMB notably contributing scientific foresight from its extensive European expert network. He closed stating the community is ready and needs further financial support to link the dots from national to European and international levels, including the alignment of strategy and coordination effort to deliver open access to infrastructures and data.

“We are at an important turning point for ocean observation in Europe: The policy drivers and societal needs are there. Can we step up to the challenge and coordinate our existing capability?”

Gilles Lericolais

Elena Visnar Malinovska

(European Commission, DG Climate Action) spoke about climate change risks for coastal areas and related adaptation needs in Europe. Focusing on coastal areas, she noted that 50% of human society live a maximum of 50 km from a coast and this attracts a lot of infrastructure. However the coastal areas and, in particular Europe's outermost regions, are vulnerable to climate risks including hurricanes, salt water intrusion and sea level rise, with devastating economic consequences forseen, amounting to billions of Euros. She referred to the EU adaptation strategy to deal with climate change, explaining that the impacts are largely known and non-negotiable. She stressed the need to improve monitoring systems to deliver high resolution observation data so we can have more precise knowledge on our seas and oceans. This information is essential for adaptation initiatives, so we can predict exactly where sea levels will rise and plan how to



“For adaptation measures to be effective, we need to have up-to-date and high-resolution coastal data from ocean observations and monitoring.”

Elena Visnar Malinovska


adapt our coasts and what impacts we should foresee. Data are also crucial to provide early warning systems for natural hazards and to further develop the European seabed map. She added that coordination of ocean observation at European level will help to further harvest the necessary data to reduce uncertainty. She concluded that good adaptation should focus on synergies, solutions should not only protect coasts, but also take care of carbon sequestration.



Quillon Harpham

(HR Wallingford, UK) explained the importance of marine data and observations for the private sector. He highlighted that marine data and data products are a blue growth enabler, e.g. feeding modelling simulations of current and future ocean state, and underpinning many useful products for users. He stressed the importance of knowing the quality of data and their products, including any assumptions and limitations, and the need for easy and open access to data that are accessible with clear information, free from jargon enabling easy data processing. He gave an example of a specific use case of

a hydrodynamic model of the English Channel based on data from the EMODnet bathymetry portal, which was a reasonable size to download and good enough quality to use for analyses including in large-scale models. He also noted that as part of the EMODnet Sea-basin Checkpoints, there had been a use-case driven evaluation of the effectiveness of marine data for certain tasks. A set of indicators were developed that show the value of marine data, like a star rating for datasets. He urged the community to consider adopting these indicators as it could encourage help industry to share and use more ocean data. Finally, Quillon identified and explained three key questions industry and private sectors ask themselves to be able to identify the usefulness of a dataset or data product: (i) which parameters or variables are available?; (ii) what is the spatial and temporal coverage?; and (iii) is the industry licensed to commercially use the data?



Checkpoint 'Rome Indicators'

- **Visibility:** How easy was it to find out that the data existed and understand what was on offer? ★★ ★
- **Terms and Conditions:** Did you have a licence to use the data and at a reasonable price? ★★ ★★ ★
- **Availability:** How easy was it to obtain the data? ★★ ★
- **Accessibility:** How easy was it to open and process the data? ★★ ★★ ★★ ★
- **Clarity:** Did you understand the data? ★
- **Utility:** Spatial coverage and resolution; temporal coverage and resolution; was the data of a sufficient quality to meet your needs? ★★ ★★

identified and explained three key questions industry and private sectors ask themselves to be able to identify the usefulness of a dataset or data product: (i) which parameters or variables are available?; (ii) what is the spatial and temporal coverage?; and (iii) is the industry licensed to commercially use the data?

“Ocean datasets are a blue growth enabler. We need realistic and relevant data products with clear provenance that are simple to process. The better the data, the more reliable the conclusions and products can be, enabling blue growth.”

Quillon Harpham

Pierre-Yves Le Traon (Mercator Ocean, Copernicus Marine Environment Monitoring Service, and Ifremer, France) presented the main messages from the 4th GEO Blue Planet Symposium⁵, an initiative of the Group on Earth Observation (GEO) to ensure the sustainable ocean and coastal observations for the benefit of society. The 4th Symposium in Toulouse, France, in July 2018, brought together the international ocean observation community to discuss how to move from ocean observation to information and users and deliver data and products that are fit for use by a diverse range of stakeholders.



He remarked that the Copernicus Marine Service (CMEMS) had established a successful value chain, going from observations (satellite and *in-situ*) to products for user applications. Some key messages from the Symposium included the acknowledgement that observations underpin the marine knowledge value chain and that critical gaps in data collection e.g. for biogeochemical ocean variables remained. He welcomed EOOS to strengthen European coordination of *in-situ* observations, adding that international coordination was still essential.

Towards a European Ocean Observing System (EOOS)

Sheila Heymans (European Marine Board, EMB) presented the progress made to date towards EOOS⁶ as a community initiative to connect and coordinate the existing capability in ocean observation and monitoring across Europe. She noted that EMB and EuroGOOS had co-led the process since 2015, but that EOOS was open to all. Activities had included a number of events, workshops and consultations to seek feedback from the European ocean observing and monitoring community on priorities for coordination efforts and key communities to engage. She noted a key output of the 2016-2018 stakeholder consultations on EOOS was that we should make ocean observations a public utility, promoting leadership and innovation in and beyond Europe to turn data into information and useable products. A EOOS Strategy had been produced, in consultation with wider stakeholders, to explain the vision, guiding principles and added benefits of EOOS.



“EOOS is a community initiative to strengthen and connect European ocean observing capability. It is inclusive and open to input from all stakeholder communities.”

Sheila Heymans

Glenn Nolan (European Global Ocean Observing System, EuroGOOS) highlighted that EOOS is about being responsive to users’ needs, and that communication, consultation and adaptation were all key to successful implementation. He added that European initiatives e.g. EuroGOOS and



“EOOS should be requirement-driven to make sure observing systems are fit for purpose and so users can see the need to sustain it.”

Glenn Nolan

Copernicus together with projects e.g. AtlantOS have developed methods for collecting data requirements from users. Other initiatives e.g. EMODnet Sea-Basin Checkpoints have tested the existing observing and monitoring system from a user perspective. He noted that EOOS could be an overarching framework for further dialogue and implementation. He then explained key components of the EOOS draft Implementation plan, encouraging participants and the wider community to get involved in activities from mapping infrastructure to requirement setting. He explained another key component was effective cost-benefit analysis of data collection and that this should bring in wider experts beyond marine science, to include socio-economists. He concluded that this Conference built on the first EOOS Forum in March 2018 and a second Forum would follow by 2020.

Conference participants recognised EOOS and efforts made so far to connect across communities (see Annex I for more background on EOOS).

⁵ <https://symposium.geoblueplanet.org/>

⁶ www.eoos-ocean.eu

Session 1 – Economic and societal value of marine observing and monitoring

Ralph Rayner (London School of Economics, LSE, and National Oceanic and Atmospheric Administration, NOAA) introduced the session on behalf of Claire Jolly (OECD). He acknowledged the ocean economy had grown substantially in the past ten years and was now larger than the space sector and about the same size of the defence sector. He noted that science driven ocean observations are likely to play an increasingly important role for the future ocean economy but that a robust business case for ocean observing was now essential to demonstrate the importance of the oceans. He referred participants to ongoing work by the OECD on ocean observations, building on their Ocean Economy 2030 report, published in 2016.

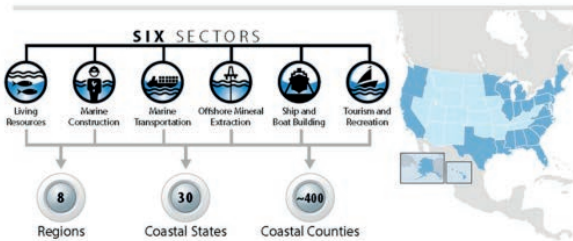


Ayeisha Brinson (National Oceanic and Atmospheric Administration, NOAA) spoke about assessing the economic value of ocean observation activities. She gave an example of a cost-benefit case study that NOAA conducted on the value of NOAA ocean data products and tools for fisheries assessments and for other maritime requirements including weather forecasts, maritime transport and seaports. Using a value chain analysis had been crucial to assess firstly the final products and users and then the inherent value of the marine infrastructure

“Valuing ocean observing infrastructure and marine data starts with the users. All stakeholders need to appreciate the full value chain.”

Ayeisha Brinson

Economics: National Ocean Watch (ENOW)



e.g. research vessels and autonomous platforms used to obtain the ocean observation data on salinity. However, she noted the limitations including the difficulty in reaching consensus on what should be included in the ocean economy, and on what scale. She outlined the economics national ocean watch (ENOW) initiative that uses six different indicators for regions, states and coastal counties of the United States, with data available online.

Arjen Uytendaal (European Network of Maritime Clusters, ENMC, Maritime by Holland) gave a business perspective on the marine knowledge value network. He identified several challenges for the blue sector, including: how to get young people interested in the blue sector; Research, Development and Innovation; the need for business to be competitive including the importance of creating a level playing field and; creating a strong and unified lobby for the ocean economy, to support business, policy makers and wider society. He remarked that data from



“Monitoring our ocean should not be a goal, but a beginning to support the blue economy and society.”

Arjen Uytendaal

different countries are still not always easily aggregated because of different definitions, interpretations and there remain many differences to be resolved e.g. through standards and methods.

Panel:

Economic and societal value of marine observing and monitoring

MODERATOR:

Ralph Rayner (London School of Economics, LSE and National Oceanic and Atmospheric Administration, NOAA)

PANELISTS:

Mario Dogliani (CS MARE Foundation, Italy)

Rémi Gruet (Ocean Energy Europe, OEE)

Richard Heard (Influence of Man-Made Structures on the Ecosystem, INSITE, North Sea project)

Alexandra Neyts (European Aquaculture Technology and Innovation Platform, EATiP and Norwegian University of Science and Technology NTN)

Ayeisha Brinson (National Oceanic and Atmospheric Administration, NOAA, US)

Arjen Uytendaal (European Network of Maritime Clusters, ENMC, Maritime by Holland)

TAKE-HOME MESSAGE:

Ocean data and information should be seen by industry as an additional source of wealth from the ocean, as well as other ocean resources (minerals, fish etc). For this to happen we need to find win-win benefits for industry and all stakeholders. We also need a comprehensive and iterative way to gather blue economy needs and map existing capability in terms of infrastructure and data collection to know how best to finance it and optimize data products and services for society. We need to connect the triple helix model bringing government, academia and industry closer together. And we need to be aware of how wider technological advancements e.g. digitization is transforming maritime industry and how the data and product requirements will change, together with the infrastructure for how we store, access and analyse data.

Summary of discussions

- To secure funding in ocean observing we need to understand blue economy needs and promote blue investors, drive societal interest and, ultimately, valuation;
- Industries e.g. aquaculture are already looking at a systems, holistic approach across the whole value chain to inform their monitoring data requirements;
- We also need a better mechanism to ask and gather industry needs and requirements. This will also drive innovation by developing new, more relevant products that industry need e.g. ballast water;
- Industry value initiatives like EMODnet to make ocean data open access and offer data and data products from multiple sources in one place to promote the transformation of data to information;
- Ocean business sectors e.g. maritime transport need more precise information on ocean state. Digitalisation is enabling this transformation of information to develop useful products for the blue economy. And it all starts with high quality, open access data;
- If you want industry to share more data you need to provide benefits e.g. new products so they have better tools e.g. to monitor environmental conditions;
- We need a better way to find out who and how ocean observing data are being used and for what purpose(s). This will help optimize the data streams for user needs and link it to core business requirements;
- Governments and public funding should not be the only financial support for the development of ocean observation and monitoring data collection and products. Maritime industries, including large and small-medium enterprises (SMEs) could invest more in marine data collection and the growing market for developing intermediary services and products.



Session 2 – European ocean observation gaps and requirements

Ana Tejedor Arceredillo (European Environment Agency, EEA), Chair of Session 2, recognised that the need for marine data and information is rising, both for the blue economy but also, increasingly, for policy frameworks. She noted that sound data and science are the foundation for meeting the policy needs



“Sound marine data and science are the foundations for marine assessments. For an end-user the data needs to be consistent over time and space and fit policies and policy implementation cycles.”

Ana Tejedor Arceredillo

for ocean information, but data does not always fit policy needs or policy implementation cycles. She further explained the Marine Strategy Framework Directive (MSFD) as a key policy driver in Europe, explaining that for an end-user, the data needs to be more coherent and consistent in time and space to enable high quality marine assessments. She also noted that data requirements were growing close to the coast but it was important to remember data are also required from the open ocean.



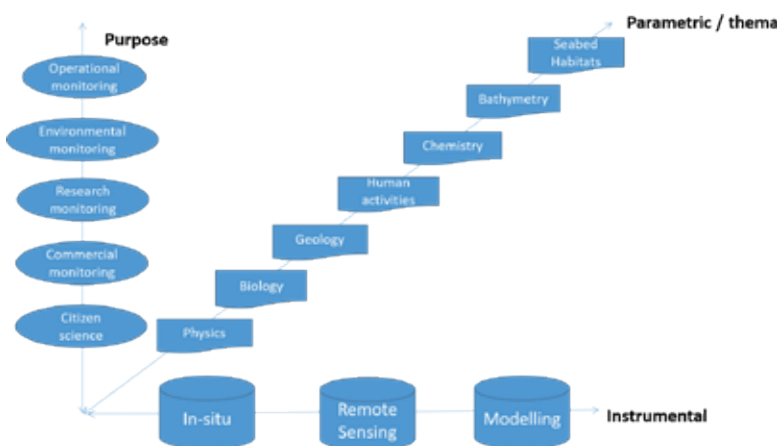
Jun She (Danish Meteorological Institute, DMI) gave a presentation on the European Marine Observation and Data Network (EMODnet) as a long-term community effort, supported by the European Union, to assemble and make available marine data and products to internationally recognised standards for open and free access and use by all communities requiring ocean data. He explained

“Open access and integration of ocean data enhances the value of the observations for all users. This is evident from the EMODnet Sea-basin Checkpoint challenges which tested data availability for real-life applications.”

Jun She

that users are central to EMODnet services. He outlined the EMODnet Sea-Basin Checkpoint initiative which was the first of its kind to assess the quality and provision of ocean observation and monitoring data through a user perspective, testing the data adequacy for specific real-life end-user challenges (see page 14 for more information). He noted that to identify future requirements it was vital to assess existing gaps in data provision. He explained that the EMODnet Checkpoint analysis

identified three main types of data gaps that required tailored solutions. He concluded that demonstrating the value of marine data was vital to achieve sustainability of ocean observing and data services. And for successful coordination, there were a number of institutional and community barriers to overcome to integrate across purpose, parameter and instrument/platform.



Integrated observing: breaking institutional and community barriers to unlock value of observations

Erik Buch (European Global Ocean Observing System, EuroGOOS) presented his perspective on ocean observation gaps and requirements from a range of European projects and initiatives. He noted that users have specific requirements for marine data depending on its use, including disaster resilience and climate change. He stressed that users often had specific requirements in terms of data resolution in space and time, integration of multiple parameters, or for data to be in a format ready for use in modelling approaches for scenario building, predictions or forecasting. He explained that data gaps could be addressed by future technology innovations as new sensor and technology developments would revolutionize the parameters and sampling rate and quality that was possible. Speaking about sustainability, he compared Europe's ocean observation capability to that of the meteorological community, remarking that ocean observing programmes are currently far less sustainable. In a survey conducted by the European AtlantOS project, over 50% of ocean observing community respondents identified upcoming funding issues within two to three years for their ocean observing and monitoring programmes. He explained that society places a higher value on atmospheric data as there is an inherent value associated with weather forecasting. He noted that in addition, some countries had legal obligations requiring systematic and long-term atmospheric data collection and delivery to support services e.g. for air traffic control. He proposed that the ocean community should develop a clearer strategy on how to communicate the value of ocean data, making more direct links to users and highlighting ocean data use cases e.g. to underpin climate and meteorological models and services for the blue economy. He concluded that regular mapping of user requirements, cost-benefit analysis and developing national and international commitments for ocean observing were essential and EOOS could play a key role in this strategic work in Europe.



"We need to define what we mean by requirements for ocean observations and to increase the value for users by understanding their specific needs in terms of data resolution in time and space."

Erik Buch



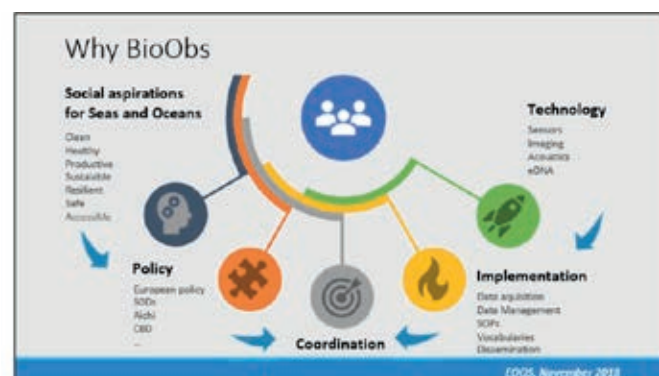
"We need to elevate biological ocean observing to the status of physical and biogeochemical variables. This is complex as understanding ecosystems requires measuring multiple variables in parallel and having a holistic approach."

Lisandro Benedetti-Cecchi

Lisandro Benedetti-Cecchi (University of Pisa, Italy) highlighted the importance of biological ocean observations. He noted that standard methods and technologies were already in place for many physical and some biogeochemical ocean observations. In contrast, he explained that despite the societal relevance, sampling biological parameters were not yet standardised. Sampling ocean biology is much more complex because many approaches exist, automation is still limited, sampling scale is very important and standardization is much more difficult. He referred to three main categories of existing technologies for collecting biological ocean observations by remote sensing techniques (satellite, acoustics), visual sensing, citizen science and genetics (e.g. eDNA).

He noted the Biology and Ecosystems Panel of the Global Ocean Observing System (GOOS BioEco Panel) had established essential biological ocean variables using Drivers-Pressures-State-Impact-Response methodology. For each variable, an implementation plan was now under development. He noted that a foresight review had been produced by the European Marine Board in 2018 which assessed the current status and the future vision of biological ocean observation towards more high technology approaches that would allow monitoring to be more autonomous, continuous and covering a larger scale. He added more coordination, capacity development was need-

ed and Europe could play a leadership role. At the global level there was a need to design observing systems that answered relevant questions for society, with flexibility to adapt to new needs. He referred to citizen science as a way to actively engage society, particularly at the coast which requires high resolution monitoring.



Antonio Reppucci (Copernicus Marine Environment Monitoring Service, CMEMS) introduced CMEMS explaining it is an operational service supported by the European Union that assimilates space-derived and *in-situ* marine data from key observation and monitoring networks. He noted the emphasis was on near real-time data and operational products and services e.g. modelling outputs and forecasts. He underlined that CMEMS is user-driven and consults and defines requirements from different communities which inform future evolution of products and users. He explained that continuity and consolidation of data collection efforts were important to assess gaps, including for biogeochemical ocean observations and in the Arctic Ocean, and to achieve sustainability of ocean observing and monitoring programmes. He noted that closing the gaps requires improved coordination and co-funding may be a way to complement national funding for ocean observation data collection.



“Copernicus Marine Service is an operational service assimilating space-derived and in-situ marine data for operational products and services for users.”

Antonio Reppucci

In a plenary discussion that followed, it was recognised that:

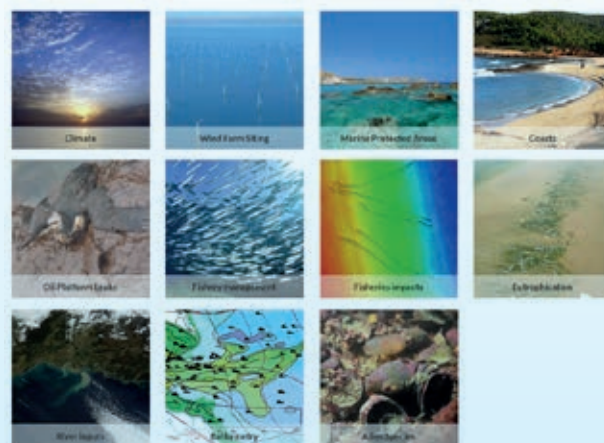
- There has been remarkable progress in the development of European and global ocean observing system capability in the past twenty years. A large number of ocean observing infrastructures, networks and systems are mature, with well-developed coordination for some communities e.g. the Global Ocean Observing System (GOOS) and EuroGOOS as the GOOS Regional Alliance for Europe;
- Major European data sharing initiatives such as the Copernicus Marine Service and European Marine Observation and Data Network (EMODnet) had both matured to their operational phase, assembling data, metadata and making data and products available for user applications;
- Not all ocean observing communities are at the same levels of maturity in terms of infrastructure, coordination, sustainability or accessibility to datasets;
- There is now a social responsibility to all stakeholders to communicate the value of ocean observing and on all data collectors to share every individual ocean measurement collected through observing and monitoring programmes for the benefit of society;
- A clear distinction can be made between data and information. Users are interested in ocean data information and more could be done to match user needs to the actual data collection to ensure more valuable products e.g. resolution of data collection in time and space, timeliness of delivery and integration of datasets from a variety of parameters;
- The role of EOOS as a coordinating framework was also raised, including the need to define what EOOS should and should not do, ensuring that governments and European institutions still play a major role with coordination required first at a national level for European coordination to be successful.



Are marine data fit for purpose?

A user perspective

Initiated in 2013, the EMODnet Sea-basin Checkpoint data stress test⁷ was the first of its kind to adopt a user perspective to assess if the current ocean observation monitoring data were fit for purpose. In each case, the availability and suitability of open access marine data were tested against 11 specific end-user challenges at the level of 6 European sea-basins (see image below). Each challenge was designed to simulate a real-life application e.g. tracking an oil spill, siting of a wind farm, or assessing environmental impact of fisheries on the sea floor. The requirements for each challenge, including the diversity of datasets required, depended on the application. Each Checkpoint had to demonstrate how well the current monitoring systems and data collection frameworks provide data to meet the needs of users. In doing so, data gaps and duplications as well as significant bottlenecks could be highlighted.



Overview of the 6 EMODnet Sea-basin Checkpoints and the 11 end-user challenges (stress tests)

When conducting each challenge, teams evaluated the availability and fitness-for-use of the data. If all required data and products were available to meet the user requirements for that application then the Challenge was a success. However, in many cases, data gaps were identified that can help future ocean observing and monitoring system design and data provision services.

Despite developing different methods to do the assessment, the Checkpoints provided converging and useful insights on the current deficiencies of the observing system and proposed some solutions. In particular, the Checkpoints identified three main types of data gaps:

(1) Data do not exist (low coverage or resolution, either spatial or temporal or both). Expanding *in-situ* monitoring efforts and better integration of data from satellites and models could help to fill the gaps;

(2) Data exist but they are not available: this can happen when the data are not visible, or even when they are findable, restrictions of access apply. This can hinder fulfilling the challenges in a reasonable time or under a certain cost. In this case, the lack

of data is not the problem. Instead, the promotion of Open Data Policy and supporting data assembling initiatives are suggested;

(3) Data exist but they are not fit for use, which can be related to characteristics e.g. timeliness, accuracy, precision, update-rate of the series or the type of format (more or less standard). In this case, complete metadata can inform users about those characteristics and allow them to assess whether it is worth downloading and processing the data or not.

2018 marked the end of the first set of Checkpoint challenges. All the outputs of each challenge, together with information on the datasets and products used and the results of the assessments are available on the EMODnet Central Portal. This assessment framework could be repeated periodically (e.g. a 3-5 year cycle) and turn into a “Checkpoint service” to regularly assess Europe’s capability and delivery of marine data for societal benefit, with the inclusion of new challenges and the development of new products depending on needs (blue growth, climate, environmental policies).

⁷ <http://www.emodnet.eu/checkpoints>

Session 3 – Shared observing and monitoring efforts across Stakeholders

David Mills (iMarDIS-SEACMS at Marine Centre Wales, Bangor University) chaired the third session on sharing observing and monitoring efforts across stakeholders. He pointed out that currently European ocean observation is a complex and fragmented landscape, with different sectors handling different approaches and methods on data collection and data handling. The challenge is how these approaches and methods can be better integrated, and what are the barriers or challenges associated with integration. David stated that integration is about reducing uncertainty and this can take place on several levels e.g. across parameters, infrastructure and communities from academia to industry. He noted the main aim of the session was to improve the understanding between different observing and monitoring communities on the diverse approaches, perspectives and challenges they face and identify concrete areas where collaboration would be beneficial.



“Integration is about reducing uncertainty to increase the use and value of ocean observation data and products.”

David Mills



Svend Otto Remøe (Research Council of Norway, RCN) presented lessons learnt from a Joint Programming Initiative Healthy and Productive Seas and Oceans (JPI Oceans) pilot action on international cooperation in marine and maritime research. He explained that the key idea of the action was to expand an existing monitoring programme to cover additional indicators in a flexible and cost-efficient way. In other words, the aim was to bring different communities together to share an infrastructure through multiuse. He noted several challenges and complexities surrounding offering shared access to

infrastructures and multi-purpose monitoring programmes. He identified some specific gaps, namely in management, lack of additional funding and underdeveloped coordination among national ministries and with wider agencies and stakeholders. He noted that a transformation is needed on the use and management of marine infrastructures for ocean observing and there is a large potential for cooperation with the private industry which is currently not well developed. He added that whilst some large companies are already engaging there is an opportunity for smaller private enterprises, particularly in the area of service provision to the user community.

“A transformation is needed on the use of marine infrastructures for ocean observing and monitoring, which also requires changing the way we manage and coordinate them.”

Svend Otto Remøe

Anders Hermansen (Equinor, Norway) presented the LoVe ocean observatory in the Lofoten-Vesterålen area of the Barents sea as a public-private collaboration producing a range of ocean observation time-series data. He explained the LoVe observatory delivers data for users, engages the public and serves as a test site for innovative new technologies. In this way, the LoVe project is co-financed and co-ordinated by industry, contributing vital knowledge on the marine ecosystem with open online access to raw data



“Fixed-point ocean observatories improve access to marine knowledge in remote areas which reduces the need for vessels and, ultimately, saves costs.”

Anders Hermansen

from many different parameters. Speaking of the platforms and infrastructure, he noted the autonomous sensors actually save costs for industry as they are continuously monitoring the ocean parameters and this reduces the need for vessels. He noted that currently, the data are predominantly used by the scientific community in Norway and Europe-wide, but with increasing interest from other communities including fishermen.



Steve Gibson (Joint Nature Conservation Committee, JNCC, UK)

gave a presentation on the EMODnet Seabed Habitats portal and key products, showing the added value of integrating diverse datasets to produce products for policy makers and wider stakeholders. He explained that habitat maps are not easy to produce, requiring multiple data inputs and layers across the full spectrum of ocean and environmental parameters from geology to biology. However, these products are highly valuable for policy makers who also require information

on the data behind the maps and the confidence levels to ensure these can be used for evidence-based decision making. As an example, he highlighted the EUSeaMap, produced by EMODnet Seabed habitats. He recognised that EMODnet, and the multiple thematic portals, is a great facility for data integration and that the EUSeaMap was a product of the integrating data from at least five different EMODnet portals, used in a model to produce the final integrated map. He recognised the large effort that had been involved which showed what can be achieved through partnerships and collaborations within and across disciplines. He concluded saying that EOOS could offer a framework for facilitating such collaborations to help drive innovation and to fill data gaps and user requirements.

“Policy makers need seabed habitat maps for evidence-based decisions. This requires community coordination and the integration of many diverse marine datasets, together with sound metadata and clear information on map confidence levels.”

Steve Gibson

The following key points were raised during this session’s plenary discussions:

- To collaborate and share across communities we need to overcome complex institutional and management gaps;
- There are challenges of institutions adapting to change: there is a dynamic of power linked with resources as many observing and monitoring programmes create and support jobs;
- We need a fundamentally transitional management approach to ocean observing and to achieve cross-infrastructure coordination and use;
- A move towards cloud computing may help promote data sharing as well as sharing of costs of highly expensive high performance computing power and data storage etc;
- EMODnet was confirmed to be a very useful, open access resource that, as a large partnership, unlocks and makes available data and products. The added value is collaboration across many organisations and working across disciplines to produce what users need;
- There is a growing need for intermediate users that can innovate new products and services from ocean data for the diversifying user community.

Session 4 – Regional ecosystem monitoring and observation efforts: from variables to indicators

David Connor (European Commission, DG Environment) introduced the session explaining that in Europe there are a wide range of environmental policy requirements, at national, regional and European levels to help safeguard marine ecosystems and human health. Some of these policies act as drivers for marine data requirements and the establishment of observation and monitoring programmes, with a specific purpose to provide evidence to inform policy. He noted that to understand and track the state of the environment, European policy makers and wider society need easy access to data, and relevant data products, across a wide range of indicators to assess human pressures on the environment and to find out the impact they actually have. He



“Marine monitoring has a real purpose, to inform policy on ocean state through data, information and evidence. Regional monitoring is well coordinated and now we need to extend this across regions and communities.”

David Connor

recognised that Europe has good mechanisms in place to define environmental indicators, marine monitoring methods and marine data management. In addition, co-ordination of regional monitoring is adequate thanks to close collaboration between nations in the context of the Regional Sea Conventions. However, he noted that the most challenging aspects concern the integration and coordination of data collection across all programmes, communities and regions, and reaching agreement on future strategy and sustainability.



“Drivers for marine monitoring include policy, money, technology push and science. We need to listen and learn from communities to design marine monitoring together, at every step.”

Lisette Enserink

Lisette Enserink (Ministry of Infrastructure and Water Management, Rijkswaterstaat, The Netherlands) presented perspectives and feedback from joint monitoring initiatives. She explained that most marine monitoring programmes were funded on the basis of providing data for specific policy requirements. Funding, scientific and technology drivers also play a role in monitoring design and implementation. Joint monitoring offers a way to further align efforts through collaboration and multi-use of infrastructure, and coordination in planning, organisation and funding. She gave two examples of European projects on joint monitoring to align regions (e.g. the North Sea and Celtic Sea) and to align efforts for specific parameters of indicators (e.g. eutrophication of the North Sea with satellite data). She noted that European policies, such as the Marine Strategy Framework Directive, require coherence across all countries and regions and this remains a challenge, for example in determining baselines for indicators and comparable datasets and information. She also presented an information cycle, highlighting the importance of an assessment framework to ensure joint monitoring delivers coherent assessments and the ongoing need to exchange information between data collectors and policy makers.

Jelena Knezevic (UN Environment/Mediterranean Action Plan) shared experiences of regional monitoring in the Mediterranean Sea-basin. She explained the importance of the long-standing Mediterranean Action Plan, agreed in 1975, as a basis for a coordinated programme for research, monitoring and exchange of information on the state of pollution and conservation of the Mediterranean Sea. She noted that in recent years there is increased application of the ecosystem approach in the monitoring and the assessment of human impacts on the marine and coastal environment and the continual updating of assessment criteria to fit policy needs, as seen in the Quality Status Report of 2017. She emphasised the importance of regular and consistent data collection of key parameters e.g. contaminants and long-term time-series of datasets and of quality-assured data that could be made openly available and used for the Integrated Monitoring and Assessment Programme of the Mediterranean Sea and Coast (IMAP). She noted that a regional IMAP data and information system was in development and would be fully available within two years. She also highlighted the importance of developing good practice and standards, including internationally recognised reference materials e.g. for organic contaminants. She concluded that a common framework, such as EOOS, could help avoid fragmentation, promote better use of data and increase the quality of ocean assessments.



“Marine monitoring in the Mediterranean Sea is now more coherent and moving towards an integrated ecosystem approach.”

Jelena Knezevic



“Turning data and knowledge into evidence is essential for society to determine good environmental status and set meaningful thresholds.”

Mark Dickey-Collas

Mark Dickey-Collas (International Council for the Exploration of the Sea, ICES) presented ICES, an intergovernmental organisation with a network of 1500 international scientists that provide the best available scientific advice to decision makers to inform evidence-based policy making. He highlighted the extent of the advice provided by ICES which covers over 240 fish stocks and by catch, multiple geographical regions from the coast to the deep sea, and includes social science. He noted that ICES has an extensive fisheries monitoring programme to produce the baseline knowledge. This is a large coordinated community effort involving thousands of trawl samples collected from many different ships and gear combinations. He noted that to achieve an ecosystem approach, diverse data from the marine environment, ecosystem and human activities were required with data analysis techniques ranging from the ageing of fish and population modelling to future scenario projections. He underlined that integration and interoperability of datasets, often with different metadata, was essential to produce the required scientific advice e.g. creating a fishing footprint. He stressed the importance of transparency and involving stakeholders and communities that

understand the methodologies behind each step and process. To get more legitimacy for the data it is also vital to connect to decision makers and explore scenarios with them. Engaging wider society remains crucial to assess the evidence and the risks to the ecosystem before setting thresholds. He also stressed the need for more coordination and reform across monitoring programmes to make them more efficient. He noted this was difficult to achieve as people’s jobs and livelihoods depend on monitoring programmes and there was often little community support for change. For this reason, he recommended to keep EOOS as a framework, and not to institutionalise it, as this could limit innovation and the ability to adapt to evolving societal needs.

Panel:
**Regional ecosystem
monitoring and observation
efforts: from variables to
indicators**

MODERATOR:

David Connor (European Commission,
Directorate-General for Environment, DG ENV)

PANELISTS:

Mark Dickey-Collas (International Council for
the Exploration of the Sea, ICES)

Lisette Enserink (Ministry of Infrastructure
and Water Management, Rijkswaterstaat, The
Netherlands)

Jelena Knezevic (UN Environment/
Mediterranean Action Plan)

Jacques Populus (Ifremer, France)

TAKE-HOME MESSAGE:

Data are the foundation of the marine knowledge pyramid and focused efforts are needed to coordinate and integrate existing data collection efforts, particularly at, and between national and regional scales and achieve coherence among individual national assessments across all of Europe. To make full use of the data, policy makers need to be assured of the quality, provenance and coherence of data to turn it into relevant and legitimate scientific advice. Transparency and multi-actor dialogue is crucial across every step of the process to help track and unlock the potential of existing data and co-design monitoring programmes for multiple users and benefits to reduce duplication, increase efficiency and fully implement the ecosystem approach.

Summary of discussions

- There remains a lack of raw marine data for common indicators required for regional policy assessments such as the Marine Strategy Framework Directive (MSFD). We need to find innovative ways to share and, where necessary, extend monitoring programmes to increase our knowledge base;
- In some cases, data are collected but not openly or easily available via open access initiatives such as EMODnet. Often, contracting parties to Regional Sea Conventions need to be willing to share their data, which is a slow process but one that should, and can be solved. In other cases moratoria are set on data for research or commercial purposes and new solutions need to be found;
- Some marine data are not used for providing scientific advice for policy because the quality is not sufficient, or not known. A better dialogue between those who collect data and those who use the data needs to take place;
- Policy makers do not necessarily need, or have time to wait for, the most scientifically robust data. But they do need to know, and be assured of the quality, provenance and – the holy grail – coherence across nations for regional assessments;
- Dialogue is essential at every stage and across countries and stakeholders to determine what data are needed and how they will be used, and to co-design relevant, legitimate and transparent scientific advice;
- National monitoring programmes are not fully mature across Europe, but most programmes for biodiversity and hydrography are in place and those for pollution are advancing, with national monitoring programmes expected to be in place across Europe by the end of 2019;
- Future planning, including Roadmap design, should include more co-design so that surveys can include monitoring requirements for multiple communities, thereby reducing duplication and increasing efficiency.





The session Chair, **Toste Tanhua** (GEOMAR Helmholtz Centre for Ocean Research, Kiel, Germany) underlined that society and societal benefit should be the main driver and that the goal for ocean observing should be to provide information for society, including understanding our oceans, climate change and natural hazards, powering the blue economy and benefits for wider society. He noted three strategic goals and objectives: Strengthening partnership across the ocean observing systems; Championing effective governance; Engaging industrial partners in the governance of ocean observing, a key focus of the upcoming

OceanObs'19 Conference in September 2019. He provided a summary of the GOOS Strategy to 2030, which outlined the key components of a successful, evolving ocean observing system including Advocacy, Capacity Development and effective Governance. He emphasised the need to regularly assess society needs and to involve the general public, assessing why and how we may need to update the existing ocean observing system.

Andrew Stewart (Department of Fisheries and Oceans, Canada) underlined that the ocean was of great cultural and economic importance in Canada and that the increase in citizen involvement reflected the high value placed by society on seas and oceans. He presented the emerging Canadian Integrated Ocean Observing System (CIOOS) as a comprehensive system with the aim to provide a connected system that delivered more information and value than individual stand-alone basin systems through effective collaboration and coordination mechanisms. He also noted that data should be discoverable, accessible and interoperable and that stakeholder engagement was crucial to identify users and deliver relevant data streams and products. He explained that the next stages of CIOOS development were to improve the business plan for future implementation and an initial pilot phase to be focused on 11 baseline variables to check the maturity of the variables per sea region around Canada, with regional associations responsible for gathering data, and a national portal that would be a single portal for cataloguing and providing access to the data and provide visualisation tools. Lastly, he shared advice on setting up an effective regional ocean observing system CIOOS. Together with business and engagement plans, the 3 C's are key: Consultation, Connection and Collaboration!



“Effective collaboration and coordination will be a core focus for the Canadian Integrated Ocean Observing System (CIOOS), to deliver more information and value than individual stand-alone observing systems.”

Andrew Stewart



“China has the largest national ocean observing capability worldwide and an ongoing cooperation in international data exchange.”

Xu Shanshan

Xu Shanshan (Marine Forecast and Disaster Mitigation Division, National Marine Data and Information Service, NMDIS, China) then presented overviews of Chinese observation activities. She explained the history of the National Marine Data and Information Service and highlighted the Chinese observation activities and how the data are collected and operated. She noted that China has invested significantly in the ocean and has the largest national ocean observing system (NOOS) worldwide. Furthermore, Xu highlighted the diversity of data in terms of platforms from operational buoys to voluntary observing ships along the full Chinese coastline, and the well-structured processes in place to collect and validate the data. She recognised the ongoing cooperation in international data exchange programmes and that more data were being shared than ever before, whilst noting that further integration is across institutes, from research to data centers.

Karen Wiltshire (Alfred Wegener Institute for Polar and Marine Research and Biological Station Helgoland and Wadden Sea Station Sylt, Germany) urged people to remember that in the next 50-100 years, 90% of the global population will live near the coast. She explained that ocean observing is increasingly a service to human kind, but that this is only a service if the data and results are published and openly available to all. She also reminded participants that the Sustainable Development Goals (SDGs) were a democratic decision, and common goals would require cooperation from everyone and that ocean observing would have an important contribution. She also recognised that successful ocean observing required moving away from individual gain and visibility towards networking, with the acceptance and responsibility of working together, archiving and linking data. She also recognised the importance of marine capacity building to maintain and develop the existing workforce, and also to raise awareness and stimulate interest in future generations. She ended summarising that we should network what we have, promote open access to data, have smart equipment and transfer knowledge.



“Investment in marine capacity building is vital to innovate the existing ocean observing workforce and stimulate interest in future generations.”

Karen Wiltshire



João Borges de Sousa (Underwater Systems and Technology Laboratory, University of Porto, Portugal) demonstrated the potential of autonomous technology and the possibilities of artificial intelligence and machine learning when applied to ocean data collection and analysis. He gave an overview of some of technology hardware and software developments that should lead towards truly smart sensors and samplers, giving the example of a novel, multi-vehicle system, finding, tracking and sampling features in the ocean with adaptive spatial-temporal resolution. He noted the issue of scalability and the need to connect observations across local to larger geographical scales, including mesoscale high resolution mapping of the seafloor

by autonomous underwater vehicles (AUVs) and the scalability to achieve larger, coordinated surveys through autonomous technologies that communicate and are interoperable with each other and other platforms such as drones for example.

The following key points were raised during this session's plenary discussions:

- There is a global shift from supply to demand for ocean observing and a need to fully define user communities and design more user-focused ocean data collection;
- A regular dialogue is needed with frontier research and technology to drive, adapt and evolve the future observing system design;
- Many regions worldwide have excellent capability. There is a large opportunity and value in sharing best practice to promote excellence and harmonisation in ocean observing;
- For Europe, the challenge remains to achieve a coordinated system and having a common, inclusive framework for European contributions to global ocean observing and monitoring.

Wake up talk – Strengthening science-based, multidisciplinary and integrated approaches to ocean observation and open data in Europe



Joaquín Tintoré (Balearic Islands Coastal Observing and Forecasting System, ICTS, SOCIB, Spain) noted that major changes in science are happening, and we need to harness this scientific excellence and integrate new innovations to have a more direct and clearer impact on society. He asked the audience to consider if we are ready for these changes. Do we have the capacities, the framework and right structures to reap all the benefits from these changes? He recommended we need to open our minds, adapt scientific and educational structures and management procedures to enable this. New technologies, he said, allow for a paradigm shift from early ocean observation

where data production was scarce and from a single, isolated platform, to multi-platform observations where data are much higher volume and more readily available. Amongst this backdrop, he underlined we must still strive for quality over quantity and that process-oriented ocean observation should remain and go hand in hand with large networked ocean observation. Using the latest technology and scientific know-how, he said that ocean observation should continue integrating across platforms and parameters but also scaling up to whole oceans, whilst not losing the important oceanic phenomena at small scales such as eddies and instabilities that are part of the ‘oceanic weather’. He also noted we need a paradigm shift in how we manage and deliver ocean observation. We should move from a focus on an individual ocean observing system that competes with others towards the bigger picture of how each ocean observing platform and asset fits into the full ecosystem. Giving the example of an orchestra, he noted that a conductor was essential to provide coordination, coherence and leadership and, ultimately ensuring the harmony amongst the various components. We should learn from this in ocean observation, which requires not only cooperation but, where relevant, integration to achieve the full societal impact. He noted that coordination of data collection efforts, including infrastructure was necessary and that European data centers are also essential in this story, which all need more European support and funding.

“It’s time to go from egosystems to ecosystems. This requires a paradigm shift in how we manage, build and deliver ocean observations.”

Joaquín Tintoré



Summary of breakout discussions

David Rose (LACS Training) asked participants to recall the past two days of intense discussion, sharing of ideas and innovative thinking. He then presented some key highlights from the six breakout discussion session topics. The main topics are reflected in the following summary word clouds.⁸ Further information on the breakout session discussions are provided on page 30-37 of this report.



Session 1: Economic and societal value of marine observing and monitoring



Session 2: European ocean observation gaps and requirements



Session 3: Sharing observing and monitoring efforts across Stakeholders



Session 4: Regional ecosystem monitoring and observation efforts



Session 5: Future trends in a global context



Session 6: Integrated ocean observing



⁸ WordClouds are based on key words from each breakout session report and were produced in open access WordItOut (www.worditout.com)

Session 6 – Sustainability, planning of activities, future priorities and next steps

MODERATOR:

George Petihakis (EuroGOOS and HCMR, Greece)

PANELISTS:

Mathieu Belbeoch (JCOMM Observing Program Support Centre, JCOMMOPS)

Catherine Boyen (Biological Station Roscoff, France)

Tammo Bult (The European Fisheries and Aquaculture Research Organisation, EFARO)

Laurent Louvart (French Hydrographic and Oceanographic Service, SHOM, France)

Pier-Francesco Moretti (Italian Research Council CNR, Italy)

Koen Verbruggen (Geological Survey, Ireland)

Werner L Kutsch (ICOS ERIC; Coordinator of the ENVRIplus Environmental ESFRIs cluster)

TAKE-HOME MESSAGE:

Long-term funding is the biggest threat to sustainable ocean observation. Shared responsibility, open data, integration of efforts and increased relevance to society are key to achieving investment from both public and private sectors. Ocean observations need to further connect with, and communicate the relevance of ocean observations on society, so that ocean observations are valued as a direct service and a public utility, like the meteorological observations today. Europe can also show more ambition and leadership to help transfer knowledge, build capacity and contribute as Europe to global challenges. Central to achieving more impact both within, and beyond, Europe is the development of an inclusive coordination framework for Europe's ocean observing and marine monitoring efforts. This should develop common goals e.g. to policy drivers, simplify the complex landscape and be flexible and able to adapt to new requirements and innovations to remain relevant into the future.

Summary of discussions

The moderator, **George Petihakis** (EuroGOOS and HCMR, Greece), introduced the Panel and invited a vivid discussion on sustainability of ocean observation and next steps to achieve it, specifically asking what the current threats to sustainable ocean observation are and what can be done to better plan and implement monitoring programmes.

Key discussion points included:

- Open sharing of data, protocols and best practice are crucial and now should extend to shared responsibility in delivering ocean observations for society;
- Diversity of the data acquisition is increasing. Ocean observing design must adapt to emerging capabilities, such as in biological observations e.g. genetic observations and citizen science;
- Trans-disciplinary connections e.g. with health science can provide solutions to technology bottlenecks e.g. sensors;
- Introducing more regulation and rules for ocean data collection could be considered, beyond fisheries monitoring, but would need to be appropriate and, where possible, a win-win for all stakeholders;
- Adaptability of an ocean observing system to future change, innovations and requirements is vital to promote investment and long-term funding;
- Policy drivers, such as the UN 2030 agenda and the Paris climate agreement, are an opportunity to develop common goals, simplify the existing complexity in ocean observing, promote an inter-connected earth observing system, and achieve longer-term sustainability to tackle grand challenges that require integrated, multi-scale data;
- Europe has a good capability and skills in ocean observing and can provide more leadership in ocean observing from sensors, samplers and platforms to data management and product development;
- An overarching framework for European ocean observing is needed to connect and make appropriate links between actors and advance coordination of Europe's existing efforts, potentially as part of an Ocean Agency.



Closing Session – International, European and National contributions to the future coordination of Europe’s ocean observing system

Vladimir Ryabinin (Intergovernmental Oceanographic Commission IOC of UNESCO and Assistant Director-General, UNESCO) gave a presentation on the global context of Europe’s ocean observing capability and coordination efforts. He recognised that globally, the ocean is becoming much more of a focus from many different sectors, including politics. He noted that whilst political action on the ocean is still voluntary, we are now going towards legally binding agreements. In addition, we know more about the ocean than ever before and we are sharing it more than ever, approaching an Intergovernmental Panel on Climate Change (IPCC) report publication on ocean. Referring to the UN 2030 agenda and the 17 Sustainable Development Goals (SDGs) he explained there is growing awareness and goodwill of the need to move towards better ocean governance. And, with the ocean economy being the seventh biggest in the world, the current investment in observing and understanding it is significantly smaller. He also explained that current investment is unsustainable and the ocean is under-observed and under-represented.



He emphasized the need for a united and engaged voice, noting that currently 22 organisations in the UN alone have oceans within their mandate. The UN Decade of Ocean Science for Sustainable Development, starting in 2021 offers a mechanism to achieve more coordination and coherence. He noted it will be a huge social responsibility and communication effort will change the face of oceanography from curiosity-driven to societal service. He explained the planning had begun, involving vision and partnership development, followed by a roadmap. He

emphasised the decade will be all inclusive and will be solution-oriented and innovative. Some priority areas included technology development, mapping of the ocean, a comprehensive ocean observing system, ecosystem functioning, coastal protection and bridging to earth system science. He gave the Marine Spatial Planning (MSP) roadmap as an example of a grand challenge, where the goal is that 33% of the world Exclusive Economic Zone’s (EEZs) should be covered by scientifically and environmentally approved zones by 2030. He explained the potential for the UN Decade to enable massive-scale projects that would be very ambitious and wide ranging with revolutionary science to solve critical knowledge gaps. He concluded by saying that ocean science is a shortcut to many aspects of sustainability and that Europe could play its part in this once-in-a-lifetime opportunity to take oceanography to the world. He warned, however, against being too European-centric and to consider how Europe could best transfer research and development, knowledge, skills and standards to enhance global ocean science capability.

“Ocean science is a shortcut to many aspects of sustainability and the UN Decade of Ocean Science for Sustainable Development is a life-time opportunity to take oceanography – and ocean observations – to the world.”

Vladimir Ryabinin

Closing round table – How can national and European authorities contribute to the coordination of European Ocean Observation and Monitoring efforts

MODERATOR:

Bernhard Friess (European Commission, EC, Directorate-General for Maritime Affairs and Fisheries, DG MARE)

PANELISTS:

Jacky Wood (Joint Programming Initiative for Healthy and Productive Seas and Oceans)

Jan Busstra (Ministry of Infrastructure, Public Works and Water Management, The Netherlands)

Marco Weydert (European Commission, Directorate-General for Research and Innovation, DG RTD)

Slawomir Sagan (Institute of Oceanology, IOPAN, Poland)

Giovanni De Santi (European Commission, EC, Joint Research Centre, JRC Sustainable Resources)

TAKE-HOME MESSAGE:

European ocean observations provide important data, information and services to support the blue economy, policy, scientific advancement and multiple other uses for wider society. We must strive to deliver reliable, transparent and open data sources to make information credible and usable for multiple applications. Funding for ocean observing is very diverse, but un-sustained. Joint Programming and other national and European funding offer ways for nations and stakeholder communities to join forces and tackle large-scale joint challenges of high societal relevance e.g. through co-financing. A European framework for ocean observations can have added value to catalyse strategy and coordination within, and between, nations and incentivize standardisation, harmonisation and integration.

Summary of discussions

The moderator, **Bernhard Friess** (EC, DG MARE), introduced the closing round table participants, noting the discussion would focus on the governance perspective of ocean observing, and how we can achieve better coordination of efforts that is useful for policy, environment, industry and society as a whole. He explained that a European framework for ocean observing could help to address big challenges, such as continued implementation of the Integrated Maritime Policy (IMP), Marine Spatial Planning (MSP) and connection of ocean observation and monitoring data for blue economy needs. He emphasised this is crucial to drive application solutions for maritime industries such as renewable energy and the seafood industry, and help promote new technology developments and innovations. Points raised included:

- Ocean observation and monitoring data must be collected in a reliable and transparent way and openly shared. This enables more integrated datasets and more credible evidence to support policy and deliver solutions to the blue economy and global challenges, further connecting the oceans to the public;
- Funding for ocean observing is currently very diverse and lacks sustainability at national and European scales. The European Union's next Research Programme, Horizon Europe, and Joint Programming are examples where national funding is brought together towards a common goal. This reduces silos and promotes coordination to address grand challenges;
- The ocean has global importance, and Europe can provide leading contributions to international initiatives e.g. with GEO and GEOSS and with ICES and the UN, IOC and GOOS;
- A European strategy for ocean observing can be a catalyst for improved national coordination, including the sharing of assets and infrastructures, e.g. vessels and the integration of data bases;
- The vision for EOOS is not as a traditional network, but more of an incentivising body. EOOS could provide clarity on who will provide funding, platforms, data for example, and could help set, and apply, EU standards to harmonise, integrate, compare and use data with open access, building on existing regional efforts such as done via the regional sea conventions, and European efforts such as EMODnet for example.



Conference conclusions

Conference Master of Ceremonies **David Rose** (LACS Training) kicked-off the final stage of the Conference reminding participants that the Conference consisted of three main stages:

1. **The first stage set the scene** by looking at the current situation and development of European ocean observing capability, with perspectives and reflections from the community by looking back at the past few years of developments until today.
2. **The second stage zoomed in on the latest state-of-the-art** in European ocean observing, best practice and ongoing coordination efforts at national, regional, pan-European and international levels and connecting communities through presentations, panel discussions and smaller breakout group interactions.
3. **The third and final stage of the conference** reflected on the many inputs and ideas to provide a forward-looking perspectives on sustainability, integration and implementation by considering what is working well and what could be done better in terms of the impact, governance and long-term funding for ocean observing at national, European and other geographical scales.



He then presented some key take-home messages of the conference:

- Data collection is at the foundation of the whole marine knowledge value chain and this should be collected, and made available, in a transparent and open way;
- Ocean data is a blue growth enabler and prerequisite for protecting the ocean health;
- Ocean science & observation is a service to mankind, but it is only a service if the data are made publicly available and published;
- There is a sense of urgency considering the global changes and grand societal challenges we are facing which will push us to rely even more on our ocean resources than before;
- Policy drivers and societal needs are there - can we step up to the challenge and coordinate our existing capability to deliver a more coherent approach?;
- There is already a broadly supported strategy and set of proposed implementation actions prepared by some of the leading science and observing communities;
- There are still challenges (e.g. difficulty of institutional and culture change) and open questions remain (e.g. organisation and sustainability of the coordination framework as well as the observing activities themselves);
- We have the infrastructures, know-how, networks, mechanisms and instruments to build on what exists already - we now need to enhance dialogue and bring what we have closer together;
- In doing so, we have to consider lessons learned from integrating activities beyond Europe: put in practice the 3 C's: Consultation, Connection and Collaboration!;
- “NOST”: Network what we have; Open Access; Smart equipment; Transfer Knowledge.

On the issue of sustainability, he noted that long-term funding is the biggest threat to sustainable ocean observation. Shared responsibility, open data, integration of efforts and increased relevance to society are all key to achieving longer-term and co-financed investment from both public and private sectors.

It was recognised that a wide range of capability exists in European, and international ocean observing and marine monitoring. Strong coordination efforts exist at network level, including EuroGOOS and platform-specific infrastructure networks, marine monitoring for policy assessments and emerging capabilities including biological observations and citizen science. Data initiatives such as EMODnet and Copernicus are already more user-oriented, and this trend is likely to continue as societal relevance, and value of ocean data continue to increase. Europe can learn from other regions worldwide in terms of connection to users, impact for society and coordination from data collection to data management. Europe can also play a stronger leadership role providing the knowledge and technology to support capacity development for global ocean observing worldwide. This was ever more relevant in a time of grand challenges and global societal needs, including the international UN 2030 agenda, Paris agreement on climate and the upcoming UN Decade of Ocean Science for Sustainable Development.



The Conference had recognised that a European framework for coordinating European ocean observing efforts could also add value to catalyse strategy and coordination within, and between, nations and incentivise standardisation, harmonisation and integration. This should be inclusive, spanning Europe's diverse ocean observing and marine monitoring efforts and could develop common goals e.g. to policy drivers, simplify the complex landscape and be flexible and able to adapt to new requirements and innovations to remain relevant into the future.

Moving to the final stage of the Conference, David Rose reminded participants that a **Call to Action** had been developed by the EOOS Steering Group and EOOS events Advisory Committee (see Annex II for names of representatives and their organizations). He concluded as spokesperson for the Conference, the organisers and the events Advisory Committee by presenting the Call to Action (see page 4 of this report for full text).



Jan-Bart Calewaert (EMODnet) thanked all Conference participants, on behalf of all organisers, for an intense yet productive few days. He noted it had been very rewarding to see the Conference had brought so many people and communities together with a common objective and constructive attitude. He acknowledged the financial support from the European Commission and the active inputs from David Rose as the Conference master of ceremonies and all the speakers, panelists, presenters and audience who had participated so dynamically in discussions. Jan-Bart also recognised inputs and contributions of the EOOS Conference organisers and the EOOS events Advisory

Committee, and particularly thanked Charlotte Herman, Andrée-Anne Marsan and Kate Larkin for their extra efforts. He recognised the positive momentum to move from words to actions and noted that the next year would be critical. Finally, he encouraged participants to disseminate the Call to Action, explaining that progress on the uptake and impact of the Call to Action would be evaluated by Spring 2020.

Closing address by Commissioner Vella

Karmenu Vella (EC, Commissioner for DG MARE)

thanked Conference participants and organisers for a very clear set of conclusions and actions, noting that the European Commission were at the Conference to listen to the ocean observing and monitoring community. He noted that ocean observations are now firmly on the international agenda and they are recognised as a key priority by G7 and commitments were made at the Our Ocean conference on this. He recognised that sound ocean data is indispensable to tackle major issues globally, and a necessity to develop the blue economy ensuring sustainable economic growth. He was glad to see that this is developing quickly across the world. He recognised that data collection efforts were ongoing worldwide and that all new data lead to insights that we could only dream of 10 years ago, although it raised some troubling realities about the status of ocean health. He noted such data are vital and we need these figures so we can address the challenges.



He recognised coordination efforts to date, but highlighted the overall setting of priorities and milestones and no real sharing of responsibility. He noted it was a costly business and that cross-sector collaboration is crucial. This was particularly true in Areas Beyond National Jurisdiction (ABNJ). We now need to make certain that observations are easy to access by other communities and here Europe can claim some success. He noted the Copernicus programme gives free access to satellite data, and EMODnet offers diverse datasets and products such as digital bathymetry maps which have significantly improved storm surge forecasting, and integrated seabed habitat maps. Data are now available from many different organisations and increasingly used for multiple purposes. Two years ago, Karmenu stated, the European Commission announced their International Ocean Governance Strategy to ensure that data sharing initiatives are interoperable with other continents, noting the ongoing trans-Atlantic cooperations to build a common picture. Mutual understanding with other regions such as China would further connect ocean data.

He urged participants to remember that although we have achievements to show, universal access to data is not yet a reality and we have to keep working hard to achieve this. If we want to have solid fact-based policy and harness society for challenges, then we need to make sure the observations continue. Equally, we should not share data as an afterthought but work strategically. He recognised the efforts of the Conference as an excellent step forward in this regard, noting also that the user communities and needs are there. He noted that communities need facts and figures, and as such ocean data and information is our shared responsibility to society. If we want to forecast what will happen in the future, we need to know what happened in the past and integrate datasets across parameters and disciplines.

Concluding, he recognised the Call to Action and the specific call for European organisations, including the European Commission to take further action to coordinate and streamline efforts in ocean observation, in combination with funds from national sources. He noted that international policy and agendas will also help to move this forward. The Conference was a great starting point, but let us not stop here. Now is the time for action.

“If we want to build solid, fact-based policy and harness our society for today’s and tomorrow’s challenges, we need to make sure that ocean observations continue [...] cross-sector international collaboration is a must and coordination and sharing is a Commission priority.”

Karmenu Vella

Breakout Session Reports

A series of breakout discussion sessions were organized during the EOOS Conference, spanning six key themes:

Session 1 – Economic and societal value of marine observing and monitoring

Session 2 – European ocean observation gaps and requirements

Session 3 – Sharing observing and monitoring efforts across stakeholders

Aims: The central aims of organizing smaller group discussions was to engage all participants, promote cross-sector dialogue, identify common areas of interest, share best practice and identify solutions. Due to the number of participants, three small groups were organized for each of the six topics.

Community-driven discussion: With multiple groups discussing in parallel (18 breakout groups over the course of the Conference) it was important to provide a structure to guide discussions. The Conference Organizers developed a set of key discussion questions for each session topic. These were in-line with the scope of the related plenary session presentations and panel discussions. It was also felt very important that the leaders (Moderators and Rapporteurs) of each breakout session should come from the wider stakeholders participating in the Conference, not from the organisers themselves. For this reason, 36 moderators and rapporteurs were actively engaged in the preparation and delivery of the breakout groups, assisted by 11 staff from the organizers (see breakout session summaries and Annex II for full list of names).

Methodology: The breakout sessions were designed to be very participatory and community-led with A0 flipchart templates per breakout session, with group discussion and written inputs using post-it notes. Participants were randomly placed into groups before the Conference to ensure a more even spread of participants across discussion groups.

Output: Each breakout session delivered a set of key messages, focusing on concrete solutions to overcome barriers and actions to strengthen coordination and for further implementation of EOOS. At the end of the breakout session, the key messages from all three groups on the same topic were summarized to provide overarching key messages for that topic.

An ideas box was also available at the Conference where ideas on concrete next steps could be submitted by any participant, for further consideration by the EOOS Steering Group.

The following 6 pages provide summary reports and key messages from the 6 breakout session themes.



Session 4 – Regional ecosystem monitoring and observation efforts

Session 5 – Future trends in a global context

Session 6 – Integrated ocean observing platforms



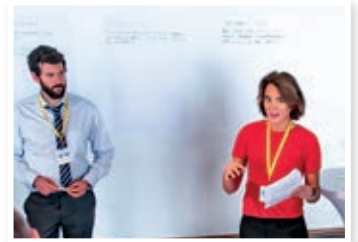
Moderators and Rapporteurs

Quillon Harpham (HR Wallingford, UK)
Fiona Buckley (ENGIE, Laborelec, Belgium)
Gerben De Boer (Van Oord, Netherlands)
Rémi Collombet (OEE)
Alexandra Neyts (EATIP)
Eoin MacCraith (Geological survey, Ireland)

Discussion points:

- How can more coordination of marine observations help save costs, generate added value, and improve quality of products/ services for users?
- What are the main barriers, drivers and solutions?

This session built on earlier discussions in plenary session 1 and related panel 1, discussing the economic benefits and societal importance of observing and monitoring our coastal and marine environment. Discussions, led by both public and private sector representatives, included how businesses can contribute to improve ocean information products and services, e.g. by sharing data, co-design and collaborations with the public sector. Discussion groups recognized that the communities that collect and use marine data and products are expanding and diversifying from science to government and public authorities and, increasingly, to the private sector. Industry is sharing more ocean data than ever before and many stakeholders are embracing the need for open data and open science. However, more could be done to communicate the value of collectively sharing data to overcome any barriers e.g. legislation, regulation, human skills and commercial sensitivity. Another barrier identified was the lack of information on how to access ocean data. It was



felt that the drive to connect to users through existing European portals e.g. EMODnet and Copernicus Marine Service (CMEMS) should continue. Increasing the coordination, sharing and co-financing of ocean observing and monitoring infrastructures were also identified as potential solutions to achieve sustainability of marine data collection. Securing the delivery of long-term continuous datasets and regularly asking users for their realistic needs and requirements of data quality and delivery time were also seen as vital for increasing the economic and societal value and, ultimately, the use of marine data for societal products and services.



KEY MESSAGES ON ECONOMIC AND SOCIETAL VALUE

For observations and data to have economic and societal value, we need:

- **Clarity & usability** – streamline data access and make it more user friendly
- **Quality Assurance & standardisation**
- **Transdisciplinary skills & approaches for the whole value chain**

To involve industry (and promote data sharing) requires:

- **Transparency, trust, common language**, understand sensitivities & motivations
- **Win-win incentives** (voluntary)
- **Regulation (mandatory):** e.g. data sharing as prerequisite to obtain offshore licences.

Moderators and Rapporteurs

Pierre-Yves Le Traon (Mercator Ocean CMEMS and Ifremer, France)

Vanessa Cardin (OGS, Italy)

Simon Claus (VLIZ, Belgium)

Lisandro Benedetti-Cecchi (University of Pisa, Italy)

Mathieu Belbeoch (JCOMM OPS)

Nadia Pinardi (University of Bologna, Italy)

Discussion points:

- What are the requirements for ocean observing?; How are these priorities changing?
- Are the data we collect fit for use?; Where are the gaps and how can they be filled?;
- What could we do better/more if we were to fill some of the gaps?

This session further discussed points raised in plenary session 2, focussing on how to identify the requirements for ocean observation data, how these might evolve and how to assess the gaps in existing ocean monitoring and observation efforts, with a focus on developing a solution-based approach to meeting user needs. Discussion groups recognised that there remain specific gaps in the existing observing and monitoring programmes, including biogeochemical and biological parameters. Further strengthening of coordination efforts was considered to be required across multiple geographical scales and across existing programmes and initiatives to fully assess existing capability and remaining gaps. In addition, further collaborations across fields (physical, biological, etc), disciplines and domains (terrestrial, atmospheric etc) were needed to ensure all relevant ocean data were made available, including from citizen science efforts and crowd-sourcing data collection approaches. Investing in people to maintain a skilled workforce for ocean observing and monitoring was for many participants a growing issue that was central to securing sustainability of European efforts and data delivery and processing. Participants found that a user-driven approach remained essential. More connection and regular consultation with the



many diverse user groups (e.g. public authorities, science, industry, policy and wider society) would allow requirements to evolve according to changing needs into the future. There was also a need for users to both understand and communicate the value of data collection and see this as the indispensable first step in an end-to-end marine knowledge chain leading to data management/sharing efforts and underpinning data product and service provision to the many user communities.



KEY MESSAGES ON GAPS AND REQUIREMENTS

- **Skilled human capital** to ensure sustainability of efforts;
- **Strengthened coordination and integration across observing efforts** at national, regional & European level, fields, disciplines and domains;
- **Inclusive, open access to all data:** Ensure data from citizen science, crowd-sourcing data and all potential sources are made available;
- **A user-driven approach**, with early and regular feedback from users to drive system evolution based on multiple requirements;
- **A more coherent and connected approach** to ocean observing across the full marine knowledge chain, linking ocean observations to the provision of information to users;
- **Need for best practices from sampling protocols to data delivery** e.g. on sampling guidelines, data harmonisation, data quality assurance, appropriate metadata and standards.

Moderators and Rapporteurs

- Slawomir Sagan** (IOPAN, Poland)
- Cooper Van Vranken** (Berring Data Collective)
- Corine Lochet** (SHOM, France)
- Guenter Hoermandinger** (European Commission, DG Environment)
- Norman Graham** (European Commission, DG Maritime Affairs and Fisheries)
- Tom Redd** (JPI Oceans)

Discussion points:

- What are the main efforts and how these could be better integrated?
- How can we reduce the cost by better sharing of resources between communities?
- What could be done better through collaboration, and how can we overcome barriers?

This session assessed the complex and fragmented landscape of marine observation and monitoring efforts in Europe, drawing on plenary session 3 with a focus on collaboration initiatives in and across different sectors. The aim was to generate a better common understanding between different observing and monitoring communities on the diverse approaches, perspectives and challenges they face and identify concrete areas where collaboration would be beneficial. The discussions were led by a wide variety of stakeholder communities including marine science, hydrographic organisations, policy makers and funders. Participants shared experiences on the capabilities across many diverse communities, agreeing that many infrastructures and capability exist that are equally valuable and need to be connected to create added value. It was proposed that EOOS could create a living inventory of ocean observation and monitoring capability. Collaboration was viewed as a way to increase efficiency and



maximize the value from the combined effort across public and private-sector funded ocean observing infrastructures and monitoring programmes. Policy and societal drivers could be a framework for data collection and act as common focal points for coordination and communication across stakeholder groups. But, ultimately, building effective human relationships and an open, cooperative mindset were seen as key to achieving efficient sharing and collaboration.



KEY MESSAGES ON OPTIMIZING SHARING EFFORTS IN OBSERVING AND MONITORING

- **Recognize the diversity, map and connect communities;**
- Transparency is vital to promote sharing and political will;
- **Combine efforts and add value:** Cost-effectiveness is not always about cost reduction;
- **Coordination and integration at multiple levels** e.g. national and European and communities is essential;
- **Develop solutions based on clearly identified bottlenecks** (e.g. data credibility; human resources & technology development);
- **Increase communication** between all the actors in the ocean observation and marine knowledge value chain;
- **Link to clear policy and societal drivers** as a framework and focal point for data collection across communities;
- **Simplify and streamline access to data:** Expand the concept of central access to ocean observation data to make it more accessible to find, trace back to the data collector and with clear links to relevant products;
- **Breakdown national barriers** e.g. ‘Schengen’ area for the ocean observing data collection;
- **Don’t forget the human factor!** Dialogue, team spirit and honesty are all essential to build and inspire collaborations and overcome cultural barriers and resistance to change.

Moderators and Rapporteurs

- Veronique Creach** (CEFAS, UK)
- Lisette Enserink** (RWS, Netherlands)
- Atanas Palazov** (Institute of Oceanology; Bulgarian Academy of Sciences)
- David Mills** (Bangor University, UK)
- Neil Holdsworth** (ICES)
- Kees Borst** (RWS, Netherlands)

Discussion points:

- How do national monitoring efforts/plans feed into regional sea-basin level programmes and assessments? Are these efforts currently fit for purpose?
- What are the current barriers to improving regional monitoring/observing?
- Where could EOOS help overcome these barriers?

This session built upon plenary session 4, and the related panel, to discuss how to better align existing sea-basin scale monitoring and integration efforts and consider how to better align the various efforts, increase collaboration across actors and ensure connection to a wider European and global framework. There was agreement that whilst good capability exists for ocean observing and monitoring, regional monitoring is generally not yet fit for purpose. More regular and targeted dialogue with users of monitoring data and products would help to guide the monitoring design, including the correct scale (both spatial and temporal) as well as the essential parameters to measure. More harmonisation and coordination is required between national level and regional sea-basin programmes, e.g. through existing channels such as the Marine Directors meeting of the Marine Strategy Framework Directive, and through public – private collaboration. Institutions, organisations and countries should be more open to adapt to new needs and innovative technologies that could make certain monitoring more efficient, offer new ways to measure ocean parameters, or simplify the data flow and accessibility to marine data and products. Working across disciplines e.g. with computer scientists could create innovative solutions to the need to assemble and analyse ever increasing big data sets for regional monitoring assessments.



KEY MESSAGES ON REGIONAL MONITORING AND OBSERVATION EFFORTS

Regional monitoring should deliver more than the sum of national programmes. This requires:

- **Harmonisation and coordination** to ensure national data can be both shared and used also at regional, European and wider levels;
- **Information & knowledge exchange** to share and adopt best practices within Europe and worldwide;
- **Stakeholder engagement and co-design:** Build trust early and maintain dialogue at each level (local, national, regional) to better define the purposes of monitoring and to help create decision support tools for evaluating observing system design;
- **Transdisciplinary dialogue** beyond the marine sector is needed to optimize marine monitoring, data access and processing;
- **Institutions, organisations, countries and European policies** could be more open to adapt monitoring programmes to include the latest innovation e.g. sensors, infrastructures or data delivery to make regional monitoring more efficient, and societally relevant.

How can EOOS add value to regional monitoring?

- **A business case is needed to show how EOOS can add value for regional monitoring;**
- **Communicate the need for coordination and Call to Action to key regional actors from data collectors to funders and policy makers.**

Moderators and Rapporteurs

Dick Schaap (MARIS, The Netherlands)
Giovanni Coppini (CMCC, Italy)
Joaquín Tintoré (SOCIB, Spain)
Rogerio Chumbinho (Smartbay, Ireland)
Geraint West (Sonardyne, UK)
Francisco Campuzano (Instituto Superior Técnico, Portugal)

Discussion points:

- What is the added value of an integrated European ocean observing system in a global context?
- What can Europe learn from other regional ocean observing worldwide to strengthen integration?
- What are the future trends in ocean observing systems e.g. technology, infrastructure, data and digitalisation? How will these influence and facilitate European integration?

Discussions added further insights on European ocean observing in a truly global context, building on presentations in plenary session 5 to see how a coordinated European could both add value to global efforts and learn from other regional initiatives worldwide. Participants recognised there are significant advancements and capabilities in ocean observations worldwide with a number of established and developing coordination networks at regional level e.g. GOOS Global Regional Alliances but also national efforts in the U.S., China, Australia, Canada etc. In addition, with the growing demand for marine data for the blue economy and wider society, it was in the interest of all regions to ensure their regional observing and monitoring systems were fit for purpose both within their region and for global goals and objectives. It was felt that EOOS could add value as a European focal point for connecting within and beyond Europe, sharing best practices and harmonisation of data collection, standardisation of data, accessing funding, etc. A global context for EOOS would also allow Europe to assess global technology developments within marine science and engineering, e.g. sensors and platforms, and other disciplines, e.g. in Artificial Intelligence and machine learning and cloud computing. This would ensure the latest international developments would be considered for European ocean observing design planning, and the latest innovations from Europe shared and used worldwide. It could also be a hub for new digitalisation skills (data scientists) and innovative sources of data and funding (crowdsourcing and citizen science). Communication and ocean literacy were also considered important for EOOS in a global context for making society and policy aware of the importance of the ocean observations and the value in Europe, set in a global context.



KEY MESSAGES ON FUTURE TRENDS IN A GLOBAL CONTEXT

Future trends

- Digitalisation and technology developments are creating new opportunities and jobs, requiring new skills for a global workforce;
- The growing and evolving user demand and societal need for ocean observation and marine monitoring data requires communities to cooperate on some common global goals (e.g. pressure of coastal environment, UN 2030 agenda);
- Innovative sources of data and funding can be explored from public-private partnerships to citizen science and crowdsourcing to secure long-term sustainability.

European added value in a global context

More coordination across European ocean observing is vital to:

- Share best practices, harmonisation of data collection, standardisation of data delivery with global stakeholders;
- Promote European innovation in ocean observing and facilitate international dialogue on the latest international developments in marine science, engineering and wider domains e.g. Artificial Intelligence (A.I.);
- Strengthen existing communication and ocean literacy efforts.

Moderators and Rapporteurs

Andre Cattrijsje (VLIZ, Belgium)
Sylvie Pouliquen (Ifremer, France)
Juanjo Dañobeitia (EMSO ERIC)
Benjamin Pfeil (University of Bergen, Norway)
Catherine Boyen (Biological Station Roscoff, France)
Jane Delany (Dove Marine Labs, Newcastle, UK)

Discussion points:

- What are the current barriers preventing integration of ocean observing and monitoring efforts in Europe?
- How can we achieve better dialogue across key communities operating ocean observing and monitoring infrastructures? How can we better align national and European efforts?
- How can we engage emerging communities and networks into the existing system?

This session took an overarching look at how the various existing components of European ocean observing and monitoring infrastructures and networks could be aligned further to help promote long-term sustainability and commitments. Participants recognised the diversity in the existing capability from research infrastructures e.g. research vessels and fixed-point environmental monitoring platforms to monitoring programmes for assessments, operational oceanographic platforms and emerging data collection networks including citizen science initiatives. Current barriers included the need to further identify and map all the key actors, infrastructures and networks in the existing landscape, not just from the research community but beyond to include the wider public and private sector capabilities. Improved coordination, starting at the national level would further strengthen regional and European coordination efforts, but these efforts lacked financial resources. A common strategy could promote cooperation activities across infrastructures, platforms and communities to allow finite resources (hardware and people) to be optimised. Sharing best practices was also highlighted



as essential, together with enhanced communication to break down barriers and promote collaboration rather than competition. Setting societal priorities for ocean observing and monitoring needs at various geographical scales would help foster common goals to be established and more resources to be communally shared.



KEY MESSAGES ON INTEGRATED OCEAN OBSERVING SYSTEMS

- **Guiding principle of open and inclusive dialogue and working;**
- **Improve coordination, starting at national level and cooperate at European and international level** e.g. regular national status reporting; then through coordination frameworks like EOOS;
- **Stimulate cross - disciplinary integrating activities** that connect research infrastructure platforms, projects and network;
- **Promote collaborations across communities for shared monitoring programmes** e.g. involve industry with environmental monitoring for national and European assessments e.g. the Marine Strategy Framework Directive (MSFD)
- **Seed money will help to kick-off a coordination framework to establish dialogue and to facilitate integration;**
- **Map existing capability** to clarify who is operating what on a national and supra- national scale;
- **Identify “win-win” collaborative partnerships amongst different communities;**
- **Include citizen science in planning** and come up with best practices and sensors for that, especially for coastal areas.

POSTER PRESENTATIONS AND EXHIBITION:

Connecting the dots for EOOs

The EOOs Conference crucially brought a large and diverse group of stakeholders together, many of whom had not previously met.

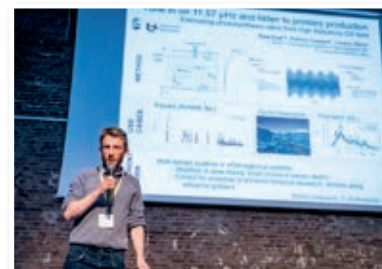
EOOs community Posters

In total 54 posters were exhibited at the EOOs Conference from organisations, projects and wider networks from 11 countries. The posters were divided in 9 themes :

- Ocean Observation gaps and requirements, and solutions to tackle the challenges
- Sharing efforts and collaboration across sectors and communities
- From stand-alone to integrated ocean and coastal observing platforms
- Linking ocean observations to modelling
- Regional ocean monitoring efforts
- Future look at the next generation of observing and monitoring tools and approaches
- EOOs: Sustainability, future priorities and next steps
- Citizen science for observation and monitoring
- Ocean observation and human health: Monitoring needs and benefits

You can download the list of posters at:

<https://www.eoosconference2018.eu/posters-exhibition>



Poster pitch presentations: Posters were presented on Day 1 and Day 2 of the Conference by a wide variety of stakeholders from researchers and data collectors to policy makers, managers and industry and from senior researchers to young scientists of the next generation. Each poster presenter was entitled to a 1-minute pitch opportunity to present their poster to the audience. All posters were exhibited in the Conference venue for participants to view and speak with poster presenters over the 2.5 days.

Poster competition: All participants were invited to vote at the Conference itself (with Slido) for the “Best poster” and “Best pitch presentation”.

Winner of the “Best poster”: Paola Fisticaro (LNE, France) - European Metrology Network on Climate and Ocean Observation: the creation of a ‘one-stop shop’ for reliable measurements of ECVs

Winner of the “Best pitch presentation”: Tom Cox (University of Antwerp, Belgium) - Tune in on 11.57 μHz and listen to primary production – estimating photosynthesis rates from high frequency O₂ data

Evening keynote presentation:

An engaging and inspiring evening talk was given by **Toste Tanhua** (Helmholtz Centre for Ocean Research, GEOMAR, Kiel, Germany) on *“Sailing yachts as ocean observing platforms – experience from the Volvo Ocean Race”*.

Ocean Race Yachts (CP1756) were fitted with ocean observing sensors and wider technology to take oceanographic measurements on the transects covered by the Volvo Ocean Race. In this way, sailing yachts can be used as platforms for ocean observing to add further data points and information to support scientific/technical knowledge on our seas and oceans which can be available for societal benefit e.g. climate studies.



“Our global ocean observing system is vital to support our understanding of oceans and blue economy, climate change, food, risks. Our collective main goal for ocean data collection should be for societal benefit.”

Toste Tanhua

Participants were also treated to a very special jazz music performance from Belén Martín Míguez (singer) and Bas Bulteel (pianist) playing songs from their new album ‘Engranaje’.



Exhibition showcase

The Conference also offered a venue for participants to exhibit their ocean observing and monitoring projects, infrastructures, wider initiatives and demonstrations. The exhibitions were also popular and gained international interest, with 18 booths from organisations and companies based in seven countries worldwide. You can find the full list at: <https://www.eoosconference2018.eu/posters-exhibition>

Continuing the conversation on Twitter



The official Twitter # of the Conference was #EOOSConference18. Many participants actively engaged on twitter to continue the conversation, communicate their views and connect with people to extend their professional networks. This resulted in a lot of uptake and interest from a wide variety of ocean observing organisations and key policy bodies and decision makers including the European Commission and the European Parliament.



Annex I:



Between 2015 – 2018, EuroGOOS and the European Marine Board (EMB) jointly initiated and promoted activities to strengthen the coordination of Europe’s capability in ocean observation and monitoring. With guidance from a Steering Group, several stakeholder meetings and consultations were organised as part of this initiative to consider how to improve the coordination and dialogue between various local, national, regional and pan-European marine data collection systems and networks.

In October 2017, the EMODnet, EuroGOOS and EMB Secretariats agreed to join forces to organise two linked events in 2018 to further progress the EOOS agenda: an EOOS Forum and an EOOS Conference. These events were co-designed with an EOOS events Advisory Committee, including representatives from a wider range of ocean observing and monitoring communities in Europe. The EOOS Forum (8 March, Brussels) focussed on sustainability of the current observing systems and how we can ensure their fitness for purpose.

This first EOOS Conference (21-23 November, Brussels) builds on the Forum and three years of community action with the aim to bring together diverse stakeholders delivering to, and dependent on, Europe’s ocean observation capacity; to showcase current and future capability; present insights from major ongoing activities; and connect diverse observing and monitoring communities and those that rely upon their outputs and services. The Conference considered gaps and requirements as well as cost-effective solutions that will contribute to evolving an efficient, inclusive and effective end-to-end European ocean observing capacity. Conference participants were invited to assess the future implementation of a

proposed coordination framework, EOOS governance options and identify further concrete joint actions to advance the EOOS agenda. Up to now discussions on EOOS have focused primarily on the research community but this event brought in a much wider set of stakeholders involved in ocean observation. The scope was European but the global context and future trends for ocean observing are also taken into consideration.

The first EOOS Forum in March 2018 followed by the EOOS Conference in November 2018 both stimulated further dialogue and brought people together to share ideas, best practice and promote the implementation of joint actions that would strengthen coordination and deliver more clarity, strategy and societal relevance for Europe’s ocean observing capability.

The Call to Action released at the EOOS Conference is aimed at national, regional and European ocean observation, monitoring and data management programme managers, coordinators and funders to assess the current capability currently under their responsibility and to prioritize the development of Roadmaps with concrete actions to deliver a more coordinated, integrated and transparent ocean observing and monitoring effort.

The Call to Action is being communicated to national, regional and European ocean observation, monitoring and data management actors, coordinators and funders. The uptake and impact of the Call to Action will be tracked 1 year after the Conference, reporting to the wider ocean observation, monitoring and data management communities by Spring 2020.

www.eoos-ocean.eu

Annex II: Acknowledgements

The EOOS Conference organisers would like to thank the many diverse stakeholder communities and >300 participants that engaged in the EOOS Conference 2018, and many also in the stakeholder events and consultations leading up to the Conference.

Organising Committee: European Marine Observation and Data Network (EMODnet), European Marine Board (EMB) and European Global Ocean Observing System (EuroGOOS) Secretariats, with the support of the European Commission DG MARE.

EOOS events Advisory Committee: Neil Holdsworth & Mark Dickey-Collas, ICES; Pierre-Yves Le Traon Mercator Ocean / Ifremer, France; Corine Lochet, SHOM, France; Jan Mees, EMB; George Petihakis, EuroGOOS; Nadia Pinardi, Bologna University / JCOMM / Copernicus; Susana Salvador, OSPAR Commission; Isabel Sousa-Pinto, CIMAR, Portugal; Joaquín Tintoré, SOCIB, Spain; Koen Verbruggen, Geological Survey of Ireland; Jacky Wood, JPI Oceans; Phil Weaver, EMODnet Steering Committee Chair; Catherine Boyen, Biological Station Roscoff, France / Euromarine Network; Ricardo Serrão Santos, Member of the European Parliament; Richard Gilmore & Fabienne Jacq, European Commission DG GROW; Sigi Gruber, European Commission DG RTD (Marine Resources Unit); Agnes Robin, European Commission DG RTD (Research Infrastructures); Iain Shepherd, European Commission DG MARE; Glenn Nolan (EOOS Steering Group co-chair), EuroGOOS; Sheila Heymans (EOOS Steering Group co-chair), EMB; Jan-Bart Calewaert, EMODnet Secretariat. Supported by the Secretariats of EMODnet, EMB, EuroGOOS.

Call to Action: The EOOS Call to Action was drafted by the organising committee with input from the EOOS Steering Group and EOOS events Advisory Committee.
<http://www.eoosconference2018.eu/call-action>

Conference Report: The Conference Report was prepared by the European Marine and

Observation Data Network (EMODnet), with input from the European Marine Board (EMB) Secretariat and European Commission (Directorate-General for Environment, Maritime Affairs and Fisheries, DG MARE, European Commission)

Editorial team: Kate Larkin, Andrée-Anne Marsan, Nathalie Tonné, Jan-Bart Calewaert (EMODnet).

Conference Master of Ceremonies: David Rose (LACS Training, Belgium).

Conference support team: Jan-Bart Calewaert, Andrée-Anne Marsan, Nathalie Tonné, Pascal Derycke, Kate Larkin* (EMODnet), Sheila Heymans, Joke Coopman, Paula Kellett, Ángel E. Muñoz Piniella (EMB), Dina Eparkhina, Vicente Fernandez, Glenn Nolan (EuroGOOS), Marieke Willems (Trust-IT), Charlotte Herman (European Commission, DG MARE) and Marisa Cabello (GOPA Com).

*EMB until December 2018.

Conference Break-Out session Moderators and Rapporteurs: The 18 Moderators and Rapporteurs for the Conference breakout sessions are named on the Breakout session pages in this report (pages 30 to 37).

Conference photography: Dirk Leemans (FotostudioLeemans).

Conference video: Full Tunes Production. To download, visit <https://www.eoosconference2018.eu/video-eoos-conference-2018>

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